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THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

JANUARY 30, 1915.

I hereby certify that printed copies of the PROCEEDINGS for 1914 were mailed as follows:—

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EDWARD J. NOLAN,
Recording Secretary.

PUBLICATION COMMITTEE:

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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1914.

JANUARY 20.

MR. CHARLES MORRIS in the Chair.

Nineteen persons present.

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

"Notes on some igneous rocks at Ogunquit, Maine, and Pigeon Cove, Mass.," by Frank J. Keeley (December 30, 1913).

"Conspicuous flowers rarely visited by insects," by John H. Lowell (January 2).

"Mimicry in North American butterflies: A reply," by Edward B. Moulton (January 9).

The death of Silas Weir Mitchell, M.D., a member, January 4, was announced.

The Council reported the following appointments:

COMMITTEE ON FINANCE.—John Cadwalader, A.M., Edwin S. Dixon, Effingham B. Morris, James D. Winsor, and the Treasurer.

ON LIBRARY.—Thomas Biddle, M.D., George Vaux, Jr., Henry Tucker, M.D., Frank J. Keeley, and Witmer Stone, A.M., Sc.D.

ON PUBLICATIONS.—Henry Skinner, M.D., Witmer Stone, A.M., Sc.D., Henry A. Pilsbry, Sc.D., William J. Fox, and Edward J. Nolan, M.D.

ON INSTRUCTION AND LECTURES.—Henry A. Pilsbry, Sc.D., Charles Morris, Henry Tucker, M.D., George S. Morris, and Stewardson Brown.

SOLICITOR OF THE ACADEMY.—George Vaux, Jr.

CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.—Frank J. Keeley.

CUSTODIAN OF THE ISAAC LEA COLLECTIONS.—Joseph Willcox.

The President of the Academy is *ex officio* a member of all Committees.

PHILIP P. CALVERT, PH.D., made an illustrated communication on epiphytic Bromeliads of Costa Rica and their animal inhabitants. (No abstract.)

Mr. Arthur Howell Napier was elected a member.

The following were ordered to be printed:

NOTES ON SOME IGNEOUS ROCKS AT OGUNQUIT, MAINE, AND PIGEON COVE, MASS.

BY FRANK J. KEELEY.

It would probably be difficult to find a more remarkable display of igneous rocks than that along the coast of Maine south of Ogunquit. Here for a couple of miles the shale, dipping nearly vertically, is penetrated by almost innumerable dikes, varying from a few inches to over fifty feet in thickness and showing great variety in color and texture.

The shale itself, as the result of these numerous intrusions, has been metamorphosed and indurated until it is frequently as hard as the igneous dikes. Fresh fractures are usually gray with faint indications of differently constituted lamina, but on the weathered surfaces the various layers assume different colors, often producing a decidedly striped appearance resembling banded jasper, becoming particularly noticeable in the rounded pebbles occasionally lining the shore. Numerous ramifying veins of white and yellow quartz further characterize the shales, and the extremely rugged character of the coast line, with several coves and an overhanging cliff exceeding fifty feet in height, together with the almost unlimited variation in color due to weathering of the shale and its igneous intrusives, has resulted in this section becoming a favorite haunt of artists. From early times it has likewise attracted the attention of geologists, and in the first geological survey of Maine, published in 1838, Charles T. Jackson gives considerable space to the description of the features of this district and calls attention to the manner in which some of the dikes intersect each other, as indicating that the igneous intrusions can be referred to at least three periods.

During the past summer, with the view of becoming better acquainted with the petrographical character of these rocks, I collected a number of specimens, from which I have since prepared sections and studied them microscopically. The locality receiving particular attention was a small cove on Israel's Head, between the mouth of the Ogunquit River and Lobster Point. Here a patch of sand beach, used by the guests of the Ontio and Lookout Hotels as a bathing place, is surrounded by the usual shales of the region, penetrated by several dikes and intrusions of igneous rocks. A series of these rocks was collected and this particular place selected for the purpose, not only because the intrusions seemed to include the principal types of igneous rocks, but also for the reason that they are located where they can be readily identified from the description by anyone interested.

Commencing with the rocky point which extends out to low-water mark on the north of the bathing beach, this is penetrated by a dike about twelve feet thick of diabase porphyrite with phenocrysts of plagioclase too much zoizitised for specific identification, in a matrix of diabasic texture, composed of augite, biotite, plagioclase, and chlorite, the latter apparently altered pyroxene; also as accessory constituents, titanite, apatite, and secondary calcite. Dr. F. Bascom, who kindly looked over these sections with me, suggests that the reason much of the pyroxene is entirely fresh or in part altered to hornblende, while in other cases it is completely replaced by chlorite, is probably that there may have been two distinct varieties of pyroxene originally present, one more readily altered than the other. Near contact with the shale, this dike becomes basaltic in texture, a fine-grained mixture of feldspar, biotite, magnetite, and brown hornblende, the latter no doubt replacing primary pyroxene, with phenocrysts having the outlines of pyroxene, almost invariably completely altered to chlorite.

A short distance toward the south, in the rocky wall back of the beach, is a twelve-inch dike of diabase with a small branch dike forking from it. Except that it contains a few small vesicles filled with secondary calcite, this is a typical diabase, fine and uniformly grained. Beyond it is a dike of basalt, four to eight inches thick. At the contact it is glassy, with lath-shaped feldspars oriented parallel to the wall. The interior is more completely crystalline, with phenocrysts of pyroxene altered to chlorite and many small, rounded patches of calcite, apparently filling vesicles.

Further south is an irregular angular intrusion of trachyte. It consists almost exclusively of intermeshed rods of feldspar, apparently orthoclase somewhat kaolinized, with scattered patches of ferruginous material slightly translucent and dark red in color when sufficiently thin, also generally red by reflected light. This rock corresponds in texture to the dyke rocks which have received the name of bostonite, but in the absence of any microscopical evidence of the presence of anorthoclase, a chemical analysis would probably be necessary to determine whether it should be so classed.

Next comes another dike of diabase, characterized by the presence of considerable pyrite, which occurs in rounded aggregates, filling the interstices between crystals of augite and plagioclase. It also contains vesicular cavities averaging about a millimeter in diameter, filled with calcite and a little quartz, margined by acicular secondary hornblende.

Somewhat south of the beach is a large intrusion having an irregularly rhomboidal outline, consisting of trachyte porphyry with large orthoclase phenocrysts in a felsitic matrix containing some hornblende and a little quartz.

Four sections were made from specimens of the shale associated with dikes mentioned, one broadly striped, another showing finer laminations, and the remaining two of rather uniform texture. All are highly silicious, including quartz grains up to a half millimeter in diameter scattered among finer grains of quartz and some secondary minerals, chiefly micas, sometimes biotite, and in one sample, a bright green mica. The extent of metamorphosis is indicated by apparent metosomatic penetration of the secondary minerals into some of the primary quartz grains. Striping, when present, is due to the concentration of such secondary minerals in layers, which in the original sediment were probably less purely silicious than the rest.

Beyond a gully south of Lobster Point is a very noticeable dike about five feet in diameter, transected at an acute angle by another of same size. The first may be classed as a diabase porphyrite and contains vesicles about a millimeter in diameter such as characterize so many of the dikes here, but in this case there is about as much quartz as calcite in the cavities, while generally the filling is entirely of calcite. This rock also contains much pyrite in the form of isolated grains in the interior of the dike, but in clouds of minute particles several millimeters across, in the basaltic textured rock near the contact. The other dike is an olivine diabase, notable for numerous large idiomorphic phenocrysts of olivine now completely altered to serpentine of unusually high double refraction, apparently consisting, in part at least, of chrysotile, showing development along irregular cracks, so characteristic of the alteration process in olivine.

Possibly a mile further south, beyond Perkin's Cove, there is exposed on the shore an extensive intrusion of diabase, under which there is a water-worn cave between tide levels, locally known as the Devil's Kitchen. This rock is a rather coarse-grained diabase with some primary biotite, in which the augite is perfectly fresh, but another ferro-magnesian constituent originally present has been completely altered to a brown serpentine-like material sometimes apparently mixed with felted masses of biotite and chlorite. This may have been an orthorhombic pyroxene, as slight traces of it remaining in the heart of a couple of the brown areas showed parallel extinction, and it has none of the characteristics of olivine. In addition to the usual magnetite, apatite is present as an accessory mineral, but not at all plentifully.

While the indurated shale is continuous along the sea coast for a couple of miles south of Ogunquit, granite outcrops at a number of places not far back from the shore, as at Pine Hill and further to the west at Mt. Agamenticus. It is hornblendic at the outcrops noticed, but I did not collect or further study any specimens. Some additional collections of dyke rocks were, however, made just north of Ogunquit on the road to Portland. Here, in widening the road, several outcrops have been cut away, leaving fresh exposures. One such is located on east side of road about one-eighth mile north of the car barn and shows three different igneous rocks penetrating or in contact with each other. Toward the south, there is first a gray, medium fine-grained diabase, then a compact black basalt. A section of the contact demonstrates that the basalt was a later flow than the diabase. Next to it comes a coarse diabase porphyrite with feldspar phenocrysts, sometimes exceeding an inch in length, and beyond this another fine-grained diabase, and then indurated shale similar to that described from the shore.

On the west side of the road, one-eighth mile further toward the north, is another good exposure of diabase porphyrite, in which the phenocrysts are developed to an extent that they appear to make up more than half the rock, in contact with basalt of later origin.

For comparison, I give the following brief description of igneous rocks at Pigeon Cove, Mass., where years ago I collected and studied specimens from the dikes along a similar short section of the shore. The end of Cape Ann consists of light gray hornblende granite, quarried extensively for commercial purposes. Its feldspar is almost exclusively microcline and the hornblende is generally accompanied by biotite. This granite is penetrated by many igneous dikes, although these are not so numerous or varied in character as those at Ogunquit.

Near the extreme point of the cape, known as Andrew's Point, below an unfinished square stone tower, is a dike of solvsbergite, a uniformly crystalline mixture of plagioclase with hornblende showing pleochroism from olive to indigo-blue, much finer grained in an offshoot which extends into a parallel crack in the granite. A block of granite which has been picked up by the molten dike rock is exposed in the interior of the latter.

East of this is an extensive intrusion of quartz porphyry, so classed from the general characteristics of the whole mass, rather than from the microscopical examination of individual sections, some of which would otherwise rank as fine-grained granites, while others show a few phenocrysts and patches of micro-pegmatite. Within this intrusion are segregations containing crystals of hornblende several inches long and large masses of blue quartz. It has been injected with diorite, but as it does not split in straight lines like the granite, no regular dike is exposed. The diorite has forced its way irregularly among the fragments of the older rock, some of which are included in it. The diorite consists of a fine-grained mixture of hornblende, biotite, and triclinic feldspar, with a few phenocrysts of zoizitised plagioclase and occasionally a small one of light colored pyroxene. It is intersected by numerous small white veins, no doubt of secondary origin, and consisting in one section examined of feldspar, both orthoclase and plagioclase, and light colored pyroxene.

To the south, the dike of solvsbergite, which crosses the point, again appears, and further on a sharply defined dike of quartz porphyry several feet thick. Still further south are three small dikes of diorite, differing from that at the point in several minor respects. There is but little biotite, and the hornblende is of a bluish-green color. No veins were noted, and the smallest dike, which is but a few inches thick, is very fine-grained and free from phenocrysts. They are probably all derived from the same source.

Beyond them comes another series of dikes, all no doubt of similar origin. They are, respectively, two to three inches, twenty-eight inches, sixteen inches, and eighteen feet in thickness, the latter just below the Ocean View Hotel, while further on is still another nearly as large. The larger dikes are typical fully crystallized diabases, coarser or finer grained according to size of dike, with unaltered constituents and basaltic texture near the contacts. The two- to three-inch dike is basaltic throughout. It passes close to a swimming pool blasted out of the rocks, and is visible over the sloping shore for a couple of hundred feet, occupying a crack in the granite as straight and sharply defined as if cut with a knife.

The sixteen-inch dike is admirably adapted for illustrating the effect of quick or slow cooling on an igneous rock, as it has an offshoot or branch, three-eighths to two inches thick, extending into the granite. Where three-eighths to one-half inch thick, chips of the rock are procurable which permit of sections being made showing the granite penetrated by the small dike. Here the matrix is an almost opaque glass with plagioclase rods and phenocrysts of augite. When it becomes three-fourths inch thick, a slight tendency toward crystallization of the matrix is noticeable in the centre, and so on until the middle of the main dike is reached, where but little trace of the basaltic texture remains and the rock is a characteristic diabase. A similar series of sections can of course be made by starting from the contact in one of the larger dikes, but the transition from basalt to diabase is much more sudden.

Two other rocks occurring nearby, but not appearing on the shore line just considered, are worthy of mention. One is a highly porphyritic andesite with phenocrysts sometimes two inches long, indicated by their extinction angles to be oligoclase, in a matrix consisting of uralite, biotite, and plagioclase. This rock is not well exposed at Pigeon Cove. I have noted an outcrop in a door yard near centre of village and another in a hollow west of what is known as Sunset Rock, but across Sandy Bay it appears as a sharply defined dike in the granite, on the shore between Rockport and Straitsmouth. As the granite here seems capable of cleaving in a straight line for an indefinite distance and the three exposures are approximately in line, although widely separated, they may all pertain to the same dike. The other rock referred to occurs in a cut leading from the shore to the Rockport Quarry, near the archway under main road. It is a light brown crystalline rock which proved to consist entirely of micro-pegmatite, the best example I have seen of this intergrowth of quartz and microcline.

ON A COLLECTION OF MAMMALS FROM ECUADOR.

BY WITMER STONE.

Mr. Samuel N. Rhoads made a collecting trip to Ecuador, February-July, 1911, and secured a valuable series of vertebrates. His entire collection was purchased by the Academy of Natural Sciences of Philadelphia, and reports on the fishes and reptiles have already appeared in the PROCEEDINGS.[1] The mammals, comprising sixty-eight specimens, referable to nineteen species, were obtained for the most part on the paramo and the region immediately below, on Mt. Pichincha, 10,000–13,000 feet, while a few additional specimens were obtained from the mountains above Chambo, from the Pagma forest near Chunchi, 7,000 feet, and from Bucay, province of Guayas, 975 feet.

As the Academy previously possessed no mammals whatever from the Andes, the satisfactory identification of much of Mr. Rhoads' material was rendered impossible until such specimens could be secured for comparison. Upon his return from Peru, Mr. Wilfred H. Osgood, being anxious to make comparisons with certain Ecuador species, generously offered to compare Mr. Rhoads' specimens with the series in the Field Museum in return for their use in the identification of his Peruvian mammals. This he has done and has given me his opinion as to their relationships.

The American Museum has, through Dr. J. A. Allen, curator of mammals, loaned me specimens of *Blarina thomasi* and *B. squamipes* for purposes of comparison and the U. S. National Museum a series of *Sciurus hoffmanni*.

For this aid I would extend my sincere thanks especially to Mr. Osgood, without whose co-operation this paper could not have been prepared.

Mr. Rhoads has kindly furnished me with some field notes on *Cænolestes* and other interesting species which are duly credited.

1. **Ichthyomys söderströmi** de Winton.

Ichthyomys söderströmi de Winton, Proc. Zool. Soc. London, 1896, p. 507.

Two specimens of this interesting fish-eating rodent were obtained from Mr. Söderström, of Quito, who collected the type specimen on

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[1] 1911, p. 493; 1913, p. 153.

the Rio Machangara, Ecuador, February, 1895. One of the specimens before me was obtained March 16, 1904, but neither has an exact locality.

2. Epimys rattus (Linn).

Mus rattus Linnæus, Syst. Nat., ed. 10, vol. 1, p. 61, 1758. (Sweden.)

One skin and three skulls in the collection, obtained at Hacienda Jalancay, Chunchi, Chimbo, and at Bucay, Guayas.

3. Epimys norvegicus (Erxleben).

Mus norvegicus Erxleben, Syst. Regni Anim., vol. 1, p. 381, 1777. (Norway.)

One skull, from specimen caught in a house at Bucay, June 15, 1911.

4. Mus musculus (Linn).

Mus musculus Linnæus, Syst. Nat., ed. 10, vol. 1, p. 62, 1758. (Sweden.)

Five specimens obtained at Riobamba and Hacienda Garzon at the southern foot of Mt. Pichincha, 11,000 feet.

5. Oryzomys minutus (Tomes).

Hesperomys minutus Tomes, Proc. Zool. Soc. London, 1860, p. 215. (Ecuador.)

The *Hesperomys minutus* of Tomes was based upon an immature specimen obtained by Fraser, but without definite locality, although it was supposed to be from Pallatanga. Oldfield Thomas, in describing a new species of this genus from Peru (*Ann. and Mag. Nat. Hist.*, 1894 (XIV), p. 357), identified with Tomes' type an adult specimen in the British Museum which was also collected by Fraser at Pallatanga, December, 1858. Later (*op. cit.*, 1898 (II), p. 267) he described this specimen as new under the name *Oryzomys dryas*. His explanation of this action is that specimens received from Mr. Söderström (locality not given) were obviously identical with Tomes' type and different from the Pallatanga skin.

Mr. Rhoads' five specimens were all obtained in the vicinity of Hacienda Garzon (or Rosario) at the southern foot of Mt. Pichincha, some of them "in meadows and swamps below the house, 10,150 feet," others higher up near the paramo, 12,000 feet.

	Length.	Tail.	Hind foot.	Ear.
♂, May 12, 1911	180	100	23	11.5
♂, May 12, 1911	183	103	23	12
♂, May 13, 1911	178	98	23	13
♂, May 15, 1911	180	100	23	13
♀, May 12, 1911	190	103	22	12

The Söderström specimens mentioned by Thomas doubtless came from Pichincha, which is of easy access from Quito, and probably

Tomes' type was also obtained there. While the latter is probably not absolutely identifiable after this lapse of time, it seems best to retain his name *minutus* for this form. The animal is a little smaller than *Mus musculus* and almost exactly the same color below, while above it is very much more rusty with a clearer line of demarcation on the side. The ground color above, at the base of the tail where it is purest and brightest, is "tawny ochraceous" of Ridgway's Color Standards 1912, but is duller and browner on the back and head and thickly mixed everywhere with black hairs.

6. **Reithrodontomys söderströmi** Thomas.

Reithrodontomys Söderströmi Thomas, Ann. and Mag. Nat. Hist., 1898 (I), p. 451. (Quito.)

Four specimens obtained from Mr. Söderström, who collected them at or near Quito, and one obtained in Quito by Mr. Rhoads, April 25, ad. ♀, length 185 mm., tail 105, hind foot 20, ear 14.5.

7. **Phyllotis haggardi** Thomas.

Phyllotis Haggardi Thomas, Ann. and Mag. Nat. Hist., 1898 (II), p. 270. (Mt. Pichincha.)

One immature female (12,697, Coll. A. N. S. Phila.) obtained at Hacienda Garzon at the southern foot of Pichincha, at 12,000 feet, nearly up to the paramo, May 12, 1911.

It agrees very well with Thomas' description, excepting that the tail is only 50 mm. in length, whereas that of the type measured 86 mm.

8. **Æpeomys vulcani** (Thomas).

Æpeomys vulcani Thomas, Ann. and Mag. Nat. Hist., 1898 (I), p. 452. (Mt. Pichincha, 12,000 feet.)

A partially mummified skin (12,698, Coll. A. N. S. Phila.) obtained from Mr. Söderström, collected on the west side of Mt. Pichincha. Thomas seems to have made a mistake in citing the tail as "barely as long as the head without the body," since a few lines below he gives length of "head and body 111 mm. and tail 84 mm." The measurements are probably correct as given, since our dried specimen is 100 mm. long exclusive of the tail which measures about 72 mm.

9. **Thomasomys paramorum** Thomas.

Thomasomys paramorum Thomas, Ann. and Mag. Nat. Hist., 1898 (I), p. 453. (Paramo, south of Chimborazo.)

Ten specimens obtained on the paramo of Mt. Pichincha are apparently referable to this species, obtained originally in a similar region near Mt. Chimborazo.

They are almost exactly like the much smaller *Oryzomys minutus* in color, both above and below.

Mr. Rhoads' measurements are as follows:

	Length.	Tail.	Hind foot.	Ear.
♀, Hacienda Garzon, 10,500 ft., May 4	201	108	23	14
♀, juv., Hacienda Garzon, 10,500 ft., May 13	174	95	23	14
♀, Hacienda Garzon, 10,500 ft., May 15	215	118	24	12
♂, Hacienda Garzon, 10,500 ft., May 15	216	118	24	16
♂, Paramo, 13,000 ft., May 7.	205	100	24	15.5
♀, Paramo, 13,000 ft., May 7.	205	125	25	16
♀, Paramo, 13,000 ft., May 7.	204	112	24	14
♀, Paramo, 13,000 ft., May 7.	195	102	24	14
♂, Paramo, 13,000 ft., May 7.	210	115	25	15

10. **Thomasomys rhoadsi** sp. nov.

Mr. Rhoads secured a series of seven specimens of another *Thomasomys* on the paramo of Mt. Pichincha apparently allied to *T. cinereus* Thomas, from Cutervo, Peru. As no such animal seems to have been described from Ecuador, I propose to name it *Thomasomys rhoadsi*, in honor of Mr. Samuel N. Rhoads whose expedition to Ecuador has brought to light so many interesting species of vertebrates.

Type No. 12,709, Collection Academy of Natural Sciences of Philadelphia, ♂. May 15, 1911, Hacienda Garzon, Mt. Pichincha, 10,500 feet. Coll. by Samuel N. Rhoads.

Skull similar to that of *T. cinereus* Thomas, but a little larger with much wider interpterygoid fossa. Fur long and soft. Brown tints of upper parts nearly bistre of Ridgway's "Color Standards," but so mingled with black hairs that the general appearance is very much darker, nearly black on the back. The fur of the under parts is gray with buffy tips, not whitish. The upper side of the hind feet is clothed with dusky hairs down to the base of the toes, while the latter have scattered white hairs, notably at their extremities. The fore feet are but scantily haired, while the hairs on the tail in no way conceal the scales. The ears are well haired.

Length 250 mm., tail 110, hind foot 31.5, ear 16. Skull measurements.[2] Total length 35 mm., greatest breadth 18, molar series 7, incisors to first molar 10, breadth of constriction between orbits 6 lower jaw (bone only) 20.

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[2] As used by Thomas in description of *T. cinereus*.

The series of skins measures as follows:

	Length.	Tail.	Hind foot.	Ear.
♂, Hacienda Garzon, 10,500 ft., April 28	250	115	32	17
♀, Hacienda Garzon, 10,500 ft., April 28	212	103	29	16
♀, juv., Hacienda Garzon, 10,500 ft., April 28	210	100	28.5	15.5
♂, Hacienda Garzon, 10,500 ft., April 28	253	115	30.5	15.5
♂, Hacienda Garzon, 10,500 ft., May 12			30	15
♀, Hacienda Garzon, 10,500 ft., May 15	250	110	31.5	16

Mr. Osgood informs me that so far as he is aware all of the described species approximating this in size have relatively shorter tails, while the blackish back distinguishes it from all those species available for comparison.

"Several specimens of this mouse were secured above the Casa Garzon, along the trail from that Hacienda to the summit of Mount Pichincha. The elevation was a few hundred feet above the valley, where the marsupial *Cænolestes* was secured, approximately 10,500 feet and probably this is their lowest range, as much trapping was done 200 to 300 feet farther down without securing any. Their habitat was on the rocky wooded slopes, where they had burrows similar to those of our North American Microtine rodents, from one to three inches below the surface of the soil and débris.

"I was interested to notice, when skinning these mice, that all of them, or possibly only the males, were supplied with a remarkable prolongation of the anus, that organ being extended, or rather, extensible, beyond the thighs for half an inch or more, as indicated in the memoranda on the labels of the specimens. This prolongation was not an internal extension, but external, being hairy throughout." (S. N. Rhoads.)

11. **Akodon mollis altorum** Thomas.

Akodon mollis altorum Thomas Ann. and Mag. Nat. Hist., 1913 (II), p. 404. (Cañar.)

Nine specimens of this mouse were obtained on the paramo of Pichincha or near Hacienda Garzon, a little lower down.

Externally they are almost exactly like *Thomasomys paramorum*, averaging perhaps a little darker or duller, but are easily recognized by the shorter tail.

The measurements of the series are as follows:

	Length.	Tail.	Hind foot.	Ear.
♂, Hacienda Garzon, 10,500 ft., April 28	185	73	24.5	14
♀, Paramo, 13,000 ft., May 7.	105	26	....	14
♂, Paramo, 13,000 ft., May 7.	169	69	23	14
♀, Paramo, 13,000 ft., May 7.	160	64	23	12
♀, juv., Paramo, 13,500 ft., May 8	155	60	23	10
♂, Paramo, 13,500 ft., May 8.	187	80	23.5	11
♀, Hacienda Garzon, 10,500 ft., May 12	172	72	23	13.5
♀, Hacienda Garzon, 10,500 ft., May 16	172	68	23	15
♀, Cumboya, N. S. of Quito, May 29	152	60	23	13.5

12. Sciurus irroratus (Gray). ?

Macroxus irroratus Gray, Ann. and Mag. Nat. Hist., 1867, XX, p. 431. (Upper Ucayali River, Brazil.)

One specimen (12,725, Coll. A. N. S. Phila.), male, procured in the Pagma forest, July 11, 1911, is perhaps referable to this species, though no suitable material is available for comparison.

Length 330, tail 152, hind foot 50, ear 20.

"Squirrels were reported by the natives to be in the forests about Huigra from 4,000 feet and upwards, but we saw none until we penetrated the Pagma forest above Hacienda Jalancay, 6,000 to 7,000 feet. They were exceedingly rare, however, even in this forest. I saw one, after the specimen secured was taken, in an orange grove near the Casa, 1,500 feet lower down. I can state nothing about their habits, not having personally observed them in life. No other species of squirrels were observed in our wanderings." (S. N. Rhoads.)

13. Sciurus hoffmanni söderströmi subsp. nov.

One specimen (No. 12,726, Collection Academy of Natural Sciences of Philadelphia), from Mt. Pichincha, November, 1903, collected by L. Söderström.

While a member of the *S. hoffmanni* group, this specimen is much more rusty-red especially across the shoulders and on the fore legs than any specimens I have seen from Costa Rica or any in a considerable series with which Mr. Osgood has compared it in the Field Museum. In other respects it does not seem to differ.

I find no name applicable to this form and would propose that it be called *Sciurus hoffmanni söderströmi*, in honor of its collector.

who has done so much in developing our knowledge of the birds and mammals of Ecuador.

14. Sylvilagus andinus (Thomas).

Lepus andinus Thomas, Ann. Nat. Hist., XX, 1897, p. 551. (Mt. Cayambi.)

Three specimens obtained on the mountains above Chambo, 10,000–10,400 ft.

	Length.	Tail.	Hind foot.	Ear.
♀, April 10	330	17	73	57
♂, April 10	340	17	72	59
♂, juv., April 17	280	15	60	55

These specimens no doubt represent *S. a. chimbanus* Cabrera (*Trans. Mus. Cien. Nat. Madrid; Zool. Series*, No. 9, 1913), but as I am unable to appreciate the difference between the two forms and have no typical material of either for comparison, I prefer to refer the specimens to Thomas's *S. andinus*.

"These cottontails were found, as we rose from the Chimbo River valley up the slopes, 500 to 1,000 feet above the town of Chambo. They frequented the brush-grown pastures in similar situations to those frequented by our cottontails of the United States, only they kept more closely to the bushes and were not found in the open pastures. They seemed to range from that point no lower, but to reach up the slopes into the paramo, at an elevation of 12,000 to 13,000 feet, but we secured none in the paramo region, abundant as they evidently were by their tracks and droppings in the thick tussock grass. We also saw several on the paramo of Mount Pichincha, above Hacienda Garzon, but were fated to secure no specimens. None were seen in this locality below the paramo, viz., 11,000 feet, approximately. It is quite possible that the paramo rabbit is distinct from the animal of the templada, at least subspecifically, or that there are two species, not distinguishable at a distance by a field observer." (S. N. Rhoads.)

15. Mazama americana (Erxl).

Moschus americanus Erxleben, Syst. Regni. Anine, vol. I, p. 1777.

One female specimen (12,730, Coll. A. N. S. Phila.) obtained at the junction of the Chanchan and Chaguancay Rivers on the lower western slope of the Andes, February 27, 1911.

Length 1,050 mm., height at shoulder 600, height at rump 715, tail 160, ear 115.

Mr. W. H. Osgood has revived Erxleben's name for *M. nemorivagus* (*Field Museum, Nat. Hist. Publ.*, No. 155, vol. X, p. 43, 1912) but Oldfield Thomas (*Ann. and Mag. Nat. Hist.*, XI, 1913, p. 585) considers that it applies rather to *M. rufus* of authors, and I so use it.

16. Mustela aureoventris Gray.

Mustela aureoventris Gray, Proc. Zool. Soc. London, 1864, p. 55. (Ecuador.)

One specimen (12,731, Coll. A. N. S. Phila.), male, procured in the Pagma forest, July 11.

Measurements: Length 420 mm., tail 165, hind foot 48, ear 12.

While there is an earlier *Mustela auriventer* Hodgs, 1841, which in my opinion would invalidate Gray's name, yet it does not seem desirable to propose a substitute until the relationship of the Ecuador species to those described from Colombia and Peru is definitely settled. At present I am unable to secure any of the material necessary for comparison.

"The only weasel seen on the expedition was shot by Mr. Lemmon, my assistant, in the Pagma forest from a tree at a low elevation, and, until picked up, was thought to be a squirrel." (S. N. Rhoads.)

17. Blarina osgoodi sp. nov.

Eight specimens of a *Blarina* were obtained at Hacienda Garzon on Mt. Pichincha at an altitude of 10,500 ft. and on the paramo 1,500 ft. higher. Four of these were prepared as skins and the others preserved in spirits.

So far as I am aware, no Blarina has previously been found south of Colombia (*B. thomasi* Merriam and *B. squamipes* Allen) and Merida, Venezuela (*M. meridensis* Thomas); and as the Ecuador specimens differ from all of these, I propose to name them *Blarina osgoodi* for Mr. W. H. Osgood, of the Field Museum of Natural History, whose expeditions to South America have done so much to enrich our knowledge of its mammals and birds.

Type from Hacienda Garzon, Mt. Pichincha, 10,500 ft. altitude, May 12, 1911, female, collected by Samuel N. Rhoads. No. 12,732, Collection A. N. S. Phila.

Similar in size and coloration to *B. thomasi* Merriam from Bogota, but not quite so brown.

Anterior unicuspid teeth less distinctly angulate on the inner side than in *B. thomasi* and the third and fourth unicuspids quite different. The third unicuspid in *B. thomasi* is apparently as long as broad, while in *B. osgoodi* it is very much broader than long, and both it and the fourth unicuspid are smaller in every way.

Total length 105 mm., tail 30 mm., hind foot 14 mm.

Skull measurements: total length 22 mm., greatest breadth 10 mm.

Measurements of the other skins:

	Length.	Tail.	Hind foot.
♀, Hacienda Garzon, 10,500 ft., May 5	113	30	14
♀, Paramo, 13,000 ft., May 7	105	26	14
♂, Paramo, 13,000 ft., May 7	106	26	14

I am not prepared to say how good a character the squamation of the feet may prove to be, but *B. osgoodi* exhibits scaly plates on the hind feet similar to, but smaller than, those of *B. squamipes.* They are not apparent on the fore feet nor on any of the feet of *B. thomasi* which has the feet much more thickly haired than either *B. osgoodi* or *B. squamipes.*

In general size, color, and length of tail *B. meridensis* and *B. squamipes* appear to be very similar, and it would be interesting to know whether the former exhibits the marked squamation.

"These shrews were first taken at the Hacienda Garzon on the southern slope of Mount Pichincha, about on the level with the Casa. They were trapped in runways along the banks of a deeply cut artificial ditch, the kind used in that country in lieu of a fence against cattle. The location was wooded clearing and brush land, at that point deeply shaded upland. The runways in location and character were precisely like those made and used by Blarinas in the United States." (S. N. Rhoads.)

18. Didelphis marsupialis Linn.

Didelphis marsupialis Linnæus, Syst. Nat., ed. X., 1758, p. 54.

One specimen obtained at Quito collected on the east side of Cayambe. Also a ramus of a lower jaw found at Bucay, June 20.

Mr. Osgood has compared the Cayambe specimen with true *marsupialis* of Guiana and Venezuela and finds but little difference except that it is somewhat larger. It may possibly be referable to *D. m. colombica* Allen, type locality Santa Marta.

19. Cænolestes fuliginosus (Tomes).

Hyracodon fuliginosus Tomes, Proc. Zool. Soc. London, 1863, p. 51. (Ecuador.)

Two female specimens of this little known marsupial were obtained by Mr. Rhoads at Hacienda Garzon, near the paramo of Mt. Pichincha, May 12, 1911, about three months after Mr. Osgood had rediscovered the very closely allied *C. obscurus* on the Paramo de Tama on the borderland of Colombia and Venezuela.

So far as I am aware, no specimen of this interesting animal has been obtained in Ecuador since the type was taken by Fraser about

1859 (see Tomes, *P. Z. S.*, 1860, p. 213). Fraser's specimen was supposed to have come from Pallatanga, but this was not certain as the collection had been mixed up, and it is quite as likely, in view of Mr. Rhoads' discovery, that he got it on Mt. Pichincha.

As given by Tomes in describing the animal in 1863, the measurements of the type (reduced to millimeters) are: head and body 97 mm., tail 97, head 31.

In his description of *C. obscurus* Thomas gives the measurements as head and body 151, tail 144, hind foot 23, ear 12 x 11.5, and bases the species as distinct from *C. fuliginosus* on the fact that it is "double the size."

Mr. Rhoads' measurements of his two specimens are:

	Length.	Tail.	Hind foot.	Ear.
♀, Hacienda Garzon, 10,500 ft., May 12	198	103	22	11
♀, Hacienda Garzon, 10,500 ft., May 12	217	110	22.5	11.5

Mr. Osgood's series of five females of *C. obscurus* averaged as follows: Total length 223 mm., head and body 107.6, tail vertebræ 115.4, hind foot 22.5.

It will be readily seen, therefore, that his specimens and those of Mr. Rhoads are practically identical in measurements, while a comparison of the skins made by Mr. Osgood shows "no appreciable difference." Unless it is maintained that there are two species in Ecuador, it looks very much as if *C. obscurus* Thomas might become a synonym of *C. fuliginosus* Tomes. Such a view, involving the assumption that Tomes' measurements were quite erroneous or that his specimen was a young one, seems to me much more rational than to suppose that two species of quite different size occur in Ecuador.

"The two specimens were secured in swampy ground, the edge of a large pasture on the Hacienda Garzon, within a few feet of a swiftly flowing stream of considerable size. They were caught in small cyclone mouse traps set in underground runways among the thick grass, these runways being about on the level with the waterline of the swamp. They were caught on the same day, soon after placing the traps in that locality, but although I continued to trap there for a week longer, having as many as 40 or 50 traps in that place, I secured no more specimens there, nor in any other similar localities where trapping was done. The stream alluded to runs over a bed strewn with volcanic rocks and boulders and is in an open cultivated valley-head, draining the south slopes of Mount Pichincha, about 8 miles south of Quito and at an elevation of about 10,500 feet, the valley at this point being about half a mile wide and extending to even greater widths as far as one can see, in a southerly direction." (S. N. Rhoads.)

THE DISTRIBUTION OF THE GENUS CYCLOPS IN THE VICINITY OF HAVERFORD, PENNSYLVANIA.

BY REYNOLD A. SPAETH.

The original purpose of this paper was, after the notes and observations of two years had been collected, to prove that by a careful and regular study of the water from a single locality, many of the forms of the *Cyclopidæ* which are now considered rare would be found to be quite abundant, at least at certain seasons of the year. Owing to unforeseen circumstances, this purpose had to be abandoned in part, and although all the forms recorded in this paper have been taken from a single small pond in the vicinity of Haverford College, the records of monthly abundance or rarity of the different species are not complete. Certain species, notably *C. varicans, C. fimbriatus* var. *poppei.* and *C. phaleratus,* appear far more abundantly in the spring from the middle of March to the end of May. *C. prasinus* I have found in the greatest numbers in September and early October collections. *C. albidus, C. viridis* var. *insectus,* and *C. serrulatus* do not vary so noticeably in the collections, while *C. fuscus* is the most unvarying species of the genus, a few being found in the water taken the year round.

In his paper of '97, E. B. Forbes has made a most excellent revisional study of the North American *Cyclopidæ.* His work has simplified investigation for all future workers in this field, and his very careful and excellent observations can hardly be overestimated. I have followed his system of subgenera to avoid confusion.

Cragin's paper of '83 has scarcely received due credit from the investigators who have followed him. His drawings show considerable accuracy of detail and very few of the important structural features have escaped his notice.

Marsh's work has been rather more of a plankton study than one of individual structure. Brewer's paper of '98 lays considerable emphasis on feet-armature, which is now generally considered a variable feature and not a reliable character for specific distinction.

Miss Byrnes' recent paper of '09 is somewhat confusing. Rather unfortunately she has reverted to Herrick's varietal names of *C. signatus,* has credited Forbes with both *C. bicuspidatus* Claus and *C. serrulatus* Fischer in her list of species studied, and has confused

C. bicolor Sars with *C. varicans* Sars. Many of her drawings, however, are excellent, and she has furthermore presented all figures on the same scale, which is of value in a comparative study of the species. Her chief source of information has apparently been Herrick, whose work, while remarkable, considering the number of species described, is, owing to its large field, often misleading and at times quite incorrect. She has neglected both Schmeil and Forbes—the most complete modern works on the subject. Her most careful study has been on the armatures of the four pairs of swimming feet, which, while interesting in showing the variations that occur, are not sufficiently constant characters to warrant a deduction of general conclusions.

E. B. Forbes was the first American investigator to lay much stress on the importance of the shape of the *receptaculum seminis.* He was convinced by Schmeil's work of '92 that it was the most important character for specific distinction. Its shape, while often somewhat obscure, varies very little, and the same general outline is preserved in all members of the same species. This outline is effected largely by the number of spermatozoa contained in the receptaculum. Other important distinguishing characters are the number of female antennal segments, the length of the first female antennæ, hyaline plates and sensory hairs and clubs, armature of the stylets (variable in some species), and the shape and armature of the fifth foot.

The number of female antennal segments is usually quite constant. Of the specimens from this locality, *C. phaleratus* and *C. varicans* were the only exceptions to the rule. The former may have either ten or eleven joints and the latter eleven or twelve. In the plate of *C. varicans* I have shown only the eleven-jointed form of the first antennæ, as this seems to be a winter transitional stage, though such individuals were all sexually mature. The twelve-jointed form did not appear until the April collections. The length of the female first antennæ varies remarkably in *C. serrulatus,* but in all species having antennæ of less than twelve segments, it is quite constant. Hyaline plates vary very slightly as to their edges. Minute serrations occasionally appear or are absent, notably in *C. prasinus.* Sense-clubs and hairs are constant features.

The armature of the stylets and their proportions are constant in some species, as *C. modestus, C. varicans,* and *C. phaleratus.* In others, as *C. bicuspidatus* and especially in *C. serrulatus,* the variation is very great.

Forbes considers the armature of the swimming feet "of considerable value in certain cases, and constant as a rule;" that "the general character with regard to strength, etc., may usually be relied upon; but I have often seen in a single specimen all the gradations between spines and setæ, and it would be impossible from this character to say which of the two names should be applied." The more I have worked out the armature of the swimming feet, the more I am convinced that a constant standard cannot be obtained for such an armature for all members of the same species. The following table is an illustration of the confusing results obtained in attempting to establish a standard swimming-feet armature for *C. phaleratus*.

Case Number 1.

First pair—outer ramus, three spines, five setæ; inner ramus, one spine, four setæ.
Second pair—outer ramus, four spines, four setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

Case Number 2.

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

Case Number 3.

First pair—outer ramus, four spines, five setæ; inner ramus, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—(right) three spines, five setæ; inner ramus, one seta, two spines, two setæ.
Fourth pair—(left) four spines, four setæ; inner ramus, one seta, two spines, two setæ.

The above cases show a variation in both outer and inner ramus of the first pair, in the outer ramus of the second pair, and the outer ramus of the fourth pair. The case of a spine becoming a seta as in the outer ramus of the fourth foot of Number 3 right and Number 3 left is not as unusual as the appearance of an extra spine, as on the outer ramus of the first pair of Number 3 compared with the corresponding ramus of 1 and 2. In some species the armature is considerably more constant. In *C. modestus,* for example, it rarely varies at all, specimens from widely separated localities showing an identical arrangement of both spines and setæ. After the examination of 'a great many specimens of a number of species, I have concluded that unless there are very distinct differences in some of the other important distinguishing characters, a slight variation in swimming-feet armature is not sufficient proof for establishing a new species or even a variety.

The fifth foot, both in armature and shape, is constant as a rule. There are slight variations occasionally in the shape of the segments and comparative lengths of spines and setæ. In a single case I have found a mature female of *C. viridis* var. *insectus* with an extra completely developed seta on the distal segments of both fifth feet. This very unusual form is now in the collection of C. D. Marsh.

The *receptaculum seminis* has already been mentioned. In preserving specimens it is advisable to use a 1 per cent. solution of formalin to avoid contraction and distortion of this organ.

All of the plates have been drawn from life. The movements of the living animals may be readily overcome by the use of a 1–1000 parts solution of chlorotone. This I have found to be very convenient and all danger of flattening and distorting the outline of specimens may be thus avoided. By this method the same individual may be repeatedly used, as the animal recovers a few moments after having been replaced in fresh water. Care must be taken that the solution of chlorotone does not become concentrated by evaporation, in which case the animals are killed by its too violent effects.

The work in this paper covers a period of three years. All of the species described herein have been taken from a single pond of less than one acre area. The *Copepoda* having been largely neglected in this part of the country, it is interesting to note the presence of some of the more unusual forms, as *C. varicans, C. fimbriatus* var. *poppei,* and several others. I am greatly indebted to Dr. C. D. Marsh for his identification of specimens and his general interest and assistance throughout the period of study. My thanks are also due Mr. E. B. Forbes and Dr. H. S. Pratt. The latter, through his unfailing personal interest and encouragement and by placing the very best of the laboratory equipment at my disposal, is largely responsible for the existence of this paper. I gladly take this opportunity to acknowledge also the assistance of Mr. J. Ashbrook in collecting material.

Genus **CYCLOPS** O. F. Müller.

Subgenus CYCLOPS Claus s. str.

Cyclops bicuspidatus Claus. Pl. II, figs. 1–5.

Cyclops bicuspidatus Claus, '57, p. 209.
Cyclops pulchellus Sars, '63, pp. 246, 247, pl. XI, figs. 6 and 7.
Cyclops navus Herrick, '82*a*, p. 229, pl. V, figs. 6–13, 15–17.
Cyclops thomasi Forbes, '82*a*, p. 649.
Cyclops bicuspidatus Schmeil, '92, pp. 75–87, pl. II, figs. 1–3.
Cyclops minnilus Forbes, '93, p. 247.
Cyclops serratus Forbes, '93, pp. 247, 248.
Cyclops forbesi Herrick and Turner, '95, p. 104.
Cyclops navus Brewer, '98, p. 133.
Cyclops pulchellus Brewer, '98, pp. 133, 134.
Cyclops bicuspidatus Lilljeborg, '01, pp. 11–14, pl. I, figs. 12–17, pl. II, fig. 1
Cyclops pulchellus Byrnes, pp. 24, 25, pl. X.
Cyclops bicuspidatus Byrnes, pp. 25, 26, pl. X.

Synonymy and Distribution.—In his discussion of the synonymy of this very variable and widely distributed species, Forbes has cleared up the question of *C. thomasi* Forbes, *C. navus* Herrick, *C. minnilus* Forbes, and *C. serratus* Forbes=*C. forbesi* Herrick. He finds, after a careful comparative study, that they should all be considered as slight variations of the type *C. bicuspidatus*, but the differences are not sufficient to warrant the varietal names. Schmeil has also discussed the question at great length. He does not consider *C. thomasi* Forbes nor *C. navus* Herrick of specific value, since the latter is only a variety of *C. thomasi* Forbes. Brewer has described, as *C. navus* Herrick and *C. pulchellus* Koch, two species of cyclops from the vicinity of Lincoln, Nebraska. His descriptions of the rudimentary and swimming feet show that he was dealing with slightly different specimens of *C. bicuspidatus* Claus. As *C. pulchellus* Herrick and *C. bicuspidatus* Forbes, Miss Byrnes has described examples of *C. bicuspidatus* Claus from Long Island. Her descriptions of the swimming feet and her drawings of the *receptaculum seminis* show very conclusively that the two forms both belong under this specific name. The variation of the single seta on the fifth foot is frequently encountered in the species. The form of the fifth foot in what she describes as *C. bicuspidatus* Forbes is very interesting, for Forbes has found it but once and on that occasion from Woods Hole, Mass. It corresponds exactly with the European forms and with the representatives of this species from this locality.

C. bicuspidatus Claus is very widely distributed over the United

States. Forbes states that "it has been found in Massachusetts and Wyoming and in all the intervening territory," and further that "it is the commonest Cyclops in the Great Lakes." Miss Byrnes has recently found it to be a common form in the Long Island waters. I have noted that it occurs very abundantly in one of the large streams in this vicinity, but in the small pond from which I have taken every other species described in this paper I have found but a single specimen.[1]

Specific Description.—In the specimens of *C. bicuspidatus* Claus from this vicinity, the lateral angles of the cephalothorax are very prominent, as in the "specimens from the far west" (Forbes). The first thoracic segment is a little more than half the length of the entire cephalothorax (Pl. II, fig. 1). The posterior borders of all the thoracic segments are smooth.

The first abdominal segment (Pl. II, figs. 1 and 5) is unusually expanded, laterally, on the anterior side of the suture. It is about as long as the remaining three abdominal segments. The posterior margins of the first three abdominal segments are finely serrated (Pl. II, fig. 5). The fourth segment has the usual row of spinules on its posterior margin (Pl. II, figs. 1 and 2).

The stylets (Pl. II, fig. 2) are more than twice as long as the last two abdominal segments. Their length is about six times their width and they are frequently slightly out-curved. The above proportions hold good only in the cases of the specimens examined. They vary considerably in different localities. The lateral spine is inserted at the beginning of the posterior third of the ramus, and at a distance of about one-quarter of the length of the stylet from its insertion point there is always present a minute lateral comb of spinules (Pl. II, fig. 2). Of the apical setæ, the outermost is heavy, finely plumose, and about as long as the delicate inner seta. The longer of the two prominently developed setæ is about equal in length to the abdomen and twice that of the shorter seta. They are both delicately plumose.

The first antennæ of the female (Pl. II, fig. 1) are seventeen-jointed and terminate at the end of the first thoracic segment. At the distal end of the twelfth segment there is borne an unusually long, spear-shaped sense-club (Pl. II, fig. 3). The setæ are all quite short and plumose for the most part. The terminal segments bear

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[1] In late March and April, 1910, collections in the vicinity of Cambridge, Mass., this was by far the most abundant form.

no hyaline plates and the last three gradually increase in length to the end.

The armature of the swimming feet is as follows:

First pair—outer ramus, two spines, four setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, three spines, four setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, four setæ; inner ramus, one seta, two spines, two setæ.

The fifth foot (Pl. II, fig. 4) is two-segmented, the basal segment being about as long as broad and bearing a plumose seta on its outer distal angle. The distal segment is cylindrical, about twice as long as wide, and bears a long plumose seta and a short, thick spine. For this spine is often substituted a longer seta-like form, though that is not the regular armature in the local specimens.

The *receptaculum seminis* (Pl. II, fig. 5) consists of two divisions. The anterior portion extends as a low arch across the segment. The posterior division is bag-shaped and reaches a point half-way to the posterior margin of the first abdominal segment. Its anterior border branches out abruptly on either side along the suture. The porus is situated on the median line, between the lateral angles on the suture.

The egg-sacs are unusually large and are carried at a considerable angle from the body. Forbes gives the size of this species as 1–1.4 mm. Schmeil gives 1.3–2 mm. for the European forms. The specimens from this locality average about 1.5 mm.

The color of *C. bicuspidatus* is generally a very pale shade of yellow. Often individuals appear to be quite colorless. The dorsal surface of the thorax, especially the anterior portion, usually has a peculiarly shiny appearance.

The last characters for the distinction of this species are its slim form, the shape of the fifth feet and the *receptaculum seminis,* and especially the small lateral combs of spinules on the outer sides of the stylets.

Subgenus MARCOCYCLOPS Claus.

Cyclops fuscus Jurine. Pl. I.

Monoculus quadricornus fuscus Jurine, '20, pp. 47, 48, Taf. II, fig. 2.
Cyclops signatus Koch, '38, Heft 21, Nr. 8.
Cyclops coronatus Claus, '63, pp. 97–99, Taf. II, fig. 16 and Taf. X, fig. 1.
Cyclops signatus var. *coronatus* Herrick and Turner, '95, p. 106, pl. XV, figs. 1–4.

Cyclops fuscus Schmeil, '92, pp. 123–127, 136–140, pl. I, figs. 1–76; pl. IV, fig. 16.
Cyclops fuscus Jurine, Marsh, '95, pp. 16, 17, pl. VI, figs. 5, 7, and 11.
Cyclops signatus var. *coronatus* Herrick, Brewer, '98, pp. 129, 130.
Cyclops fuscus Jurine, Lilljeborg, '01, pl. III, figs. 12–15.
Cyclops signatus var. *coronatus* Herrick, Byrnes, '06, pp. 193–200, pl. VII, figs. 1–6, pl. VIII, figs. 1–3.
Cyclops signatus var. *coronatus* Byrnes, '09, pp. 9, 10.

Synonymy and Distribution.—In his discussion of the differences between this species and the closely related *Cyclops albidus* Jurine, Dr. Schmeil has proven not only that we are dealing with two distinct species, but also that Jurine was the first investigator to distinguish these two. It is only right, then, that Jurine's names should stand and that Koch's *Cyclops signatus* give way to (1) *C. fuscus* and (2) *C. albidus* Jurine. In spite of Schmeil's careful proof, several of our American investigators have clung to Herrick's varieties *tenuicornis* and *coronatus* of *C. signatus* Koch. C. D. Marsh accepted Schmeil's proof in his paper of '95. Even after the publication of Forbes' paper of '97, in which he abandoned Herrick's terms for those of Jurine, Brewer in '98 and Miss Byrnes in '06 and again in '09, have reverted to Herrick's varietal names.

In speaking of the "two varieties," *coronatus* and *tenuicornis*, Brewer states that "the real differences between them are confined to the seventeenth joint of the antenna and the caudal setæ." He then continues: "The difference between their first cephalothoracic segments and their furcæ is hardly distinguishable." On p. 136 of Schmeil's monograph there is a table of "the most important distinguishing characters" of the two species in question. Of the *eleven* "important characters" mentioned, Brewer has noted four, and no mention is made of such important features as the *receptaculum seminis* and the sense-club (present or absent) on the twelfth antennal segment.

It is quite evident that Miss Byrnes has overlooked the more important distinguishing differences between the two species. In her recent paper, *The Fresh Water Cyclops of Long Island* ('09), in spite of the carefully tabulated proofs of Schmeil in Germany and the acceptance of his views by both Marsh ('95) and Forbes ('97), Miss Byrnes has clung to the obsolete name of *C. signatus* Koch and attempts to revive Herrick's varietal name *coronatus* and Richard's(?) *annulicornis*. In a foot-note (on p. 9) she states: "I have used the more recent name *C. signatus* var. *coronatus* instead of the older name *C. fuscus* Jurine, because it expresses more clearly the evidently close relationship that exists between *C. signatus* var.

coronatus and the allied form *C. signatus* var. *annulicornis*, called *C. albidus* by Jurine."

It is quite evident that Miss Byrnes has not had Dr. Schmeil's exhaustive work on the *Cyclopidæ* of Germany at hand. He has shown conclusively (129, 130 and 137–140) that by right of priority Jurine's names should stand. No matter how "close" the "relationship" between the two forms in question, Miss Byrnes is hardly justified in using "the more recent" name. In her description of *Cyclops signatus* var. *coronatus* (p. 9) she states that this form has "serrations in the hyaline plate on the two distal segments of the antennæ" and, furthermore, that "the notches in the hyaline plate of the antennæ form gradually and may or may not be present. In fig. 4 they are seen on the last segment only." The first statement I am unable to verify, nor do any of the investigators mention a serration of the "two distal segments of the antennæ." They are always present in the hyaline plate of the *distal* segment in adult forms. In the immature forms the plate on the distal segment of the antennæ is often exactly as in *C. albidus* Jurine. The serrations do *not* "form gradually." I have several times observed a young specimen of *C. fuscus* just before the last ecdysis. In such cases there was a finely serrated hyaline plate on the last segment, but the coarsely serrated plate of the adult form could be distinctly observed below the transparent chitin folded flat down along the segment. In every case the serrations of the coming plate were complete. In her conclusion Miss Byrnes states that "there are wide ranges of variability in the reduced seta on the inner ramus of the fourth foot of *annulicornis* and in the hyaline plate of the antennæ of both varieties—in short, in the most important differential characters of the two varieties." It is not at all surprising that Miss Byrnes considers the "two varieties" so closely related when we find that half of (to her) the "most important differential characters" are concerned with a *single seta* on the inner ramus of the fourth foot. In her description of this species, as well as all the others described by her, Miss Byrnes obviously neither considers the *receptaculum seminis* a most important feature, nor does she mention the presence of sense-club or hair in a single species.

Miss Byrnes has added very little to the evidence of the close relation that may exist between these two species. She gives but one-quarter of the observations in Herrick's "diagnosis," which is incomplete even in its full form, and then draws her conclusion mainly from her own notes on the difference in the single seta of the inner ramus of the fourth foot, already mentioned. I quote from her paper once more. "He (Herrick) states that the two varieties have similar armature of the swimming feet, but that *tenuicornis* differs from *coronatus* in the absence of serrations on the antennal lamellæ and in the divarication of the ovisacs." Here follows the original description of Herrick's "*Cyclops signatus* var. *tenuicornis.* First segment of thorax shorter, its length to that of the entire thorax as 1 : 1.9. Last segment of antennæ with unserrated lamella. Caudal stylets longer, length to width as 2.1 : 1, inner aspect not ciliated. Outer apical seta half as long as inner. Second segment of antennules longer. Color variable, but always banded or splotched. It is also generally true that the ovisacs in the present variety are more strongly divaricate than in the variety *coronatus.*" Miss Byrnes now concludes that since "the antennal lamella of *annulicornis* sometimes bears serrations and *coronatus* sometimes bears its egg masses in a divaricate position, as I have found in attempting to distinguish the two forms by this character, ... consequently Herrick's diagnosis is untenable." This gives Herrick absolutely no credit for *six* of his *eight* points of difference noted. Herrick's diagnosis should not be considered untenable, but merely incomplete.

This species, while not as common as *Cyclops albidus,* appears to be quite generally distributed over the United States. Forbes reports it from the "ponds and lakes of Wisconsin, Michigan, Illinois, and Massachusetts," where it "occurs sparingly." Brewer found it with *C. albidus* Jurine (= *C. signatus* var. *tenuicornis* Herrick) in the vicinity of Lincoln, Nebraska, but "always in small numbers." Miss Byrnes has studied the species at Cold Spring Harbor, Long Island. Kofoid does not mention it in his studies of the "Plankton of the Illinois River." I have found it in this locality; rather more abundantly in September, October, and April than during the winter months. I have never found it in very great numbers. During the summer and fall of 1909, it occurred sparingly in collections from Lake Winnepesaukee, N. H., and in a small pond adjoining "Fresh Pond" at Cambridge, Mass.

Specific Description.—The cephalothorax (Pl. I, fig. 1) in this species is a little more than twice as long as the abdomen. They are to each other as 21 : 10. The first segment is to the entire cephalothorax as 7 : 11. The length of the thorax to its width is as 11: 6. In the living animal none of the lateral angles of the thoracic segments are prominent. The posterior borders of the thoracic segments are all unserrated. The fifth segment has a row of minute chitinous teeth extending transversely across the ventral side between the fifth feet. This same segment has on its lateral sides a row of fine spinules as well as a minute fringe of hairs, as in *C. prasinus.*

The abdomen tapers but little towards its posterior end. The first segment is about as long as the three following ones. The posterior edges of the first three abdominal segments are smooth. Occasionally there are very slight and uneven serrations present (Pl. I, fig. 3). The ventral posterior border of the fourth segment has a prominent fringe of spines which do not extend to the edge of the anal opening, as is the case in *C. albidus.* I find no mention of this characteristic in any descriptions of *C. fuscus* that I have at hand.

The stylets (Pl. I, fig. 3) are short; the branches often slightly out-curved. The length is three times the width. Schmeil states that the inner border is "densely" set with hairs. In the specimens from this locality these hairs are often very irregular, rarely "dense," but always present. The apical setæ are well developed and densely plumose. The outer is to the inner as 4 : 7. The longest is to the next in length as 7 : 5.

The first antennæ of the female (Pl. I, figs. 1 and 9) reach to the anterior border of the first abdominal segment. They are seventeen-jointed and bear a minute sensory hair upon the twelfth segment in place of the sense-club found in *C. albidus* (Pl. I, fig. 9). On their anterior edges at the point of juncture with the following segments, the eighth, ninth, tenth, twelfth, thirteenth, and fourteenth segments are ornamented with a row of prominent, obliquely set spinules. These rows of spinules form almost a quarter circle on the eighth, ninth, and tenth segments. On the twelfth and thirteenth segments they are not so closely set and are fewer in number. It is interesting to note that where Schmeil found six spinules on these segments in European forms, I have found but four or five, and on the fourteenth segment where he records four, I have noted five in every case. I have never seen more than seven of these spinules on the eighth, ninth and tenth segments, and the eighth and tenth usually have but five. Besides these regular rows of spinules, there are smaller transverse and longitudinal rows and irregular groups of very minute spinules (Pl. I, fig. 9) on the ventral side of the first fourteen antennal segments. The longitudinal rows mark the boundary between the smooth portion of the segment and that on which the spinules occur.

The three terminal segments bear transparent hyaline plates.

These plates are smooth on the fifteenth and sixteenth segments, but on the seventeenth (Pl. I, fig. 7) the plate is coarsely serrate from the base of the segment to the insertion point of the middle seta; from thence to the end minutely serrated as in *C. albidus*. This plate projects somewhat beyond the end of the seventeenth segment.

The second antennæ (Pl. I, fig. 5) are unusually long. The third segment is the longest of the four—a distinguishing difference between this and the following form. The swimming feet are armed as follows:

First pair—outer ramus, four spines, four setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, three spines, two setæ.

Marsh has noted that "the larger of the two terminal spines of the endopodite of the fourth foot, instead of being serrated on its edges as is customary in all the spines of the swimming feet, is beset on its inner margin with long, rather irregular teeth." I find this character present in the local specimens, though the "irregular teeth" do not extend to the tip of the spine on its inner margin. There are but five or six of these long serrations at the middle of the inner margin, thence to the tip of the spine the serrations are normal. Schmeil notes that the lamella which connects the basal segments of the fourth pair of swimming feet is ornamented by a fringe of long hairs. This is found also in *C. albidus*, and is therefore hardly a distinctive character of *C. fuscus*. In all the specimens that I have examined, these "hairs" are very coarse, resembling rather long serrations. There is a very noticeable characteristic in the lamella between the basal joints of the *third* pair of swimming feet. There are two very minute rows of blunt spinules extending transversely across the lamella. The upper row is broken in the middle. In the following species this character is very different.

The fifth foot is practically identical with that of the following species. Miss Byrnes states that the basal segment of the rudimentary fifth foot in "*coronatus*" (= *C. fuscus*) is conspicuously short. Schmeil finds no such difference. Among all the representatives of *C. fuscus* that I have compared with *C. albidus*, I have found only very slight differences in the lengths of the basal segments of the fifth feet. The *apparent* difference in length may often be accounted for by the strongly arched cephalothorax of *C. albidus*, which enables the animal to place the fifth feet close upon the first abdominal segment. In *C. fuscus* the shorter basal segment is frequently only a foreshortening because of the angle at which the feet are held. The arrangement of the spinules, the spines and the setæ are exactly as in *C. albidus* (Pl. I, fig. 13).

The *receptaculum seminis* (Pl. I, fig. 11) consists of two main divisions. The anterior portion is wide, shaped very much like the corresponding portion of the receptaculum in *C. albidus*, but with a very distinct indentation on its anterior border. The posterior part appears as a pair of slightly elongated reniform divisions separated by a median line and fusing at the porus. The color of the receptaculum is always a deep reddish-brown which frequently makes it difficult to distinguish its outline.

The egg-sacs are carried very close to the abdomen. The eggs are dark; in the living animal they look quite black, but in reality they are a deep shade of brown. This applies only to freshly deposited eggs, as all *Cyclops* eggs from which the young are about to emerge show a characteristic salmon tinge due to the color of the bodies of the nauplius.

The length of the female varies but little. The following five measurements give an approximate average for *C. fuscus* from this locality. All measurements include the caudal setæ.

No. 1	3.75 mm.
No. 2	3.2 mm.
No. 3	3.4 mm.
No. 4	3.4 mm.
No. 5	3.58 mm.
Average	3.46 mm.

Schmeil gives 3.4 mm. Brewer's figures are much smaller—1.4 mm.–1.8 mm. The males are often only half as long as the females. An average length is 1.75 mm.

The color of the first four thoracic segments and the abdomen from the posterior half of the first segment to the furca is usually a dark green. The fifth thoracic segment, the stylets, and the fourth, fifth, twelfth, thirteenth, and fourteenth segments of the first antennæ are blue. The anterior half of the first abdominal segment is reddish-brown. Occasionally there are irregular blotches and streaks of blue on the posterior borders of the first four thoracic segments. The remaining segments are a dirty yellow color, deeper on the anterior border.

C. fuscus may be readily distinguished from all other members of the genus by its size, dark color, and closely lying dark egg-sacs. The absence of the sense-club of the twelfth antennal segment, the coarsely serrated hyaline plate of the seventeenth antennal segment, the form of the *receptaculum seminis*, and the ciliated inner border of the stylets are the most easily distinguishable characteristics of this species. In order to simplify the comparison of *C. fuscus* with *C. albidus*, I have arranged the following tabulated form for the characters of the two species:

	Cyclops fuscus.	*Cyclops albidus.*
(1) Inner borders of the stylets	ciliated.	smooth.
(2) Third segment of second antennæ	long.	short, pear-shaped.
(3) *Receptaculum seminis*	(Pl. I, fig. 3.)	(Pl. I, fig. 4.)
(4) Twelfth segment of first antennæ bears	sense-hair.	sense-club.
(5) Hyaline plate of seventeenth antennæ segment	coarsely serrate.	finely serrate.
(6) Egg-sacs carried	close to abdomen.	widely divergent.
(7) Length of outer furcal seta to that of inner	4 : 7.	1 : 3.
(8) Furcal setæ	densely plumose.	lightly plumose.
(9) Posterior border of fourth thoracic segment	smooth.	finely serrate laterally.
(10) Serration of posterior border of fourth abdominal segment	do not extend to anal opening.	extend to the anus.
(11) Lamella of third pair of swimming feet	minute spinules.	coarse spinules.
(12) Color	dark (green and blue).	light with occasional black portions.

Schmeil notes differences in the form of the spermatozoa and their position in the spermatophore. The twelve points of difference noted above should enable anyone to distinguish the two forms positively.

Subgenus MARCOCYCLOPS Claus.

Cyclops albidus Jurine. Pl. I.

Monoculus quadricornis var. *albidus* Jurine, '20, p. 44, pl. II, figs. 10 and 11.
Cyclops signatus var. *tenuicornis* Herrick and Turner, '95, pp. 106, 106, pl. XV, figs. 5–7; pl. XX, figs. 1–7; pl. XXXIII, figs. 1, 2.
Cyclops albidus Schmeil, '92, pp. 128–132, pl. I, figs. 8–14*b*; pl. IV, fig. 15.
Cyclops albidus Forbes, '97, pp. 47–49, pl. XIII.
Cyclops albidus Lilljeborg, '01, pp. 49–51, pl. III, figs. 21 and 22.
Cyclops albidus v. Daday, '06, p. 184.
Cyclops signatus annulicornis Byrnes, '09, pp. 10–13, pl. IV.

Specific Description.—The first segment of the strongly arched elliptical cephalothorax (Pl. I, fig. 2), is in the proportion of 3 : 4 compared with the entire length of the cephalothorax. The lateral angles of the segments are not prominent. The fifth segment is rarely visible from above, owing to the arched form of the cephalothorax. The first three segments are smooth along their posterior borders. I find in all of the specimens examined from this locality that the fourth segment has on its posterior border, laterally and not extending to the median line, a row of very minute chitinous serrations. These are only visible when the animal is turned on its side. I find no mention of these serrations in any of the descriptions of this species to which I have access. The fifth segment bears, dorsally situated, three transverse rows of spinules. The last of these is the only complete one and borders the segment posteriorly. The second row does not extend to the median line. The first row is quite short, lateral in position, and the spinules are considerably larger than in the other two. Schmeil states in his note number three, p. 130, that, with two exceptions, these rows of spinules have "never been observed." In Cragin's paper of '83 in his description of *Cyclops tenuicornis* Claus (= *Cyclops albidus* Jurine), he says: "Either side of the fifth thoracic segment is furnished with three transverse rows of serrulations, of which the posterior one is marginal." Furthermore, he illustrates the point in his Pl. II, fig. 13. His drawing is inconsistent, however, with his description, as it does not show the marginal row extending the entire width of the segment. Forbes, very properly, does not mention the row of blunt spinules between the insertion points of the fifth feet. This is not a "characteristic," as it is found in *Cyclops fuscus* Jurine.

The width of the cephalothorax is to its length as 1 : 2. Its length to that of the abdomen is as 7 : 4. (Schmeil reverses these figures and gives abd. : ceph. : : 9 : 5, obviously an oversight).

The abdomen is heavy; the first segment tapers only slightly, but the enlargement at the anterior end extends beyond the width of the last thoracic segment. The second and third segments are cylindrical and their posterior margins are very slightly and unevenly serrated, largely on the under side. The fourth segment has the usual fringe of spines on its posterior edge, and tapers suddenly to the insertion point of the stylets. The stylets (Pl. I, fig. 4) are short, but slightly divergent and smooth on their inner sides. This is an important character which Forbes does not note in his description. The proportion of the length to the breadth of each ramus is 3 : 1. There are four well-developed apical bristles. The longest is to the second in length as 7 : 5; the outer to the inner as 1 : 3. They are all plumose, but not as densely so as in *Cyclops fuscus* Jurine.

The first antennæ vary very little in length. In the female they usually reach to the middle or posterior border of the last thoracic segment. They are seventeen-jointed, the terminal joints attenuated, the last three being each armed with an hyaline plate. The edges of these plates on the fifteenth and sixteenth segments are for the most part entire, but I have repeatedly seen them, especially at the base of the fifteenth segmental plate, minutely serrated. More rarely these serrations extend along the entire edges of all three plates. The plate of the last segment is always finely serrated on its distal half. The point where these serrations cease and the smooth edge begins is sharply defined by a much deeper notch or indentation (see Pl. I, fig. 8). The twelfth segment bears a well-developed sense-club (Pl. I, fig. 10). Its length is about equal to that of the thirteenth segment. All of the segments, except the three terminal ones, bear an irregularly broken, longitudinal row of minute spinules on their under side. The eighth, ninth, tenth, twelfth and thirteenth segments have each a short row of small cone-shaped serrations at the point of juncture with the following segments, as in *Cyclops fuscus.* The twelfth segment (Pl. I, fig. 10) has, in addition, several (usually two) rows of smaller spinules extending parallel to the marginal semicircular row.

Marsh ('95) failed to find these "crowns of spines" on the antennæ of "a large number of mature females" of *C. albidus* which he "examined with great care." He concludes that this peculiar character "seems to be rarely true in our forms." Forbes has found it in the specimens examined by him from many parts of the country. I have never failed to find it in the local specimens.

The third segment of the second antennæ (Pl. I, fig. 6) is short and somewhat pear-shaped. The armature of the swimming feet is as follows:

First pair—outer ramus, four spines, four setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines (inner smooth-edged), two setæ (distal one reduced) (see Pl. I, fig. 14).

The lower row of spinules on the lamella connecting the basal segments of the third pair of swimming feet is very large and well developed (about twelve coarse spinules).

The fifth foot (Pl. I, fig. 13) is essentially like that of *C. fuscus* Jurine. Lilljeborg, in his Pl. III, fig. 21, shows the fifth foot differing from that of *C. fuscus* (fig. 13) on the same plate by the absence of the rows of spinules on the two segments. The fifth foot consists of two segments. The basal segment is slightly convex on its outer margin, while the inner margin is correspondingly concave (see Pl. I, fig. 13). Toward the inner lateral surface of this same segment there are several, usually three, rows of well-developed spinules. At the outer distal corner it bears a long seta, plumose on its distal half. The distal segment is set well towards the inner side of the lower segment and at the point of juncture is ornamented with a $\frac{3}{4}$ circle of small spines. It bears on its tip two heavy spines and a slender seta. The inner spine is slightly longer than the outer. At its base there is a semicircle of quite prominent spinules. Both of these spines are more densely plumose on their inner edges. Between them and borne at the end of a truncated cone-shaped projection is the long middle seta. It is only slightly plumose at its distal end, and these hairs (8–10 on each side) are placed at regularly diminishing intervals.

The shape of the *receptaculum seminis* (Pl. I, fig. 12) can be readily noted. The anterior division is almost elliptical when fully distended. The posterior portion is two-lobed and has the form of a low, widely spread letter w. This organ is practically colorless, and for this reason its form can be unmistakably observed.

The egg-sacs (Pl. I, fig. 2), carried at a considerable angle from the abdomen, are nearly as long as the abdomen. In a ♀ in which the abdomen measured .6 mm. the egg-sacs were .57 mm. long.

In discussing the size of this species, Forbes states that "the usual length of the female in America is from 1.26–1.4 mm., but it seems to be much greater (2.5 mm.) in the European representatives of this species." It is interesting to note the measurement of the following five females taken at random:

No. 1	2.5 mm.
No. 2	2.51 mm.
No. 3	2.21 mm.
No. 4	2.50 mm.
No. 5	2.47 mm.

This gives an average measurement of 2.43 mm. for representatives of the species from this locality—less than .1 mm. difference in size from European forms. Taking Forbes' figures and the above together, we get an average measurement of 1.88 mm.

The color, a blue-gray, occasionally nearly black, is most prominent in the stylets and last abdominal segment, the second, third, first half of the fourth, ninth and tenth segments of the first antennæ (♀) and in irregular transverse bands, usually four, on the cephalothorax. The remaining portions of the animal are nearly colorless or a pale shade of yellow, though I have frequently noted individuals in which they were a bright blue-green.

The species seems to be one of the commonest not only in America, but all over the world. Forbes found it "in all localities examined." In nearly all the lists of crustaceans to which I have access it is recorded as a common but rarely abundant variety.

Kofoid records it as "numerically the least important of the dominant members of the genus in our plankton" (Illinois River). I have found it to be one of the commonest of the *Cyclopidæ*.

Miss Walker has studied the species in Todd's Pond, Oregon, where she found it to be, with *Cyclops serrulatus*, second in abundance after *Cyclops prasinus*.

In collections made during the summer of 1909, at Lake Winnepesaukee and in the vicinity of Cambridge, Mass., in March and April, 1910, *C. albidus* was a common but not an abundant form.

Subgenus ORTHOCYCLOPS Forbes.

Cyclops modestus Herrick. Pl. II, figs. 6–11.

Cyclops modestus Herrick, '83*a*, p. 500.
Cyclops modestus Herrick and Turner, '95, pp. 108, 109, pl. XXI, figs. 1–5.
Cyclops modestus Marsh, '93, pp. 213, 214, pl. V, figs. 10–13.
Cyclops capilliferus Forbes, '93, pp. 248, 249, pl. XL, figs. 14–17; pl. XLI, fig. 18.
Cyclops modestus Forbes, '97, pp. 51–53, pl. XV, fig. 4; pl. XVI, figs. 1–3.
Cyclops modestus Byrnes, '09, pp. 26, 27, pl. XI, figs. 4 and 5.

Specific Description.—The shape of the cephalothorax is very characteristic in this species (Pl. II, fig. 6). The first segment reaches its maximum width considerably in front of the posterior border, and the anterior border line is somewhat straighter than usual, resembling *C. prasinus* in this respect. This segment is to the entire thorax as 5 : 8. The fourth segment is regularly, semicircularly excavate on its posterior margin. Forbes finds the posterior edges of the first three segments irregularly notched, but the fourth smooth. I am unable to verify this observation; all the thoracic segments of specimens examined by me had smooth posterior edges. The thorax is about twice as long as wide and one-third as long again as the abdomen.

In the male the cephalothorax (Pl. II, fig. 7) tapers only a very little. The first segment is distinctly concave on its anterior border. It expands abruptly in its anterior third, but its middle does not attain the width of the preceding thoracic segment. The first three segments have smooth or faintly uneven posterior margins. The last segment Forbes notes to be "peculiar in lacking the usual fringe of spines on the posterior edge." I have noted on either side of the anal opening peculiar, out-curving, hook-like projections of the chitin (Pl. II, fig. 8) on the posterior border of the fourth abdominal segment. Otherwise its edge is smooth. It is interesting to note that half-way between the anterior border of the anal opening and the posterior margin of the third abdominal segment there are present in this, as in all the *Cyclopidæ*, two peculiar button-like projections whose function may be sensory (Pl. II, fig. 8).

The stylets (Pl. II, fig. 8) are rather slim and about twice as long as the fourth abdominal segment. Their length is four times their width. The lateral spine is inserted slightly beyond the middle of each ramus and from this point half-way to the posterior margin of the stylets, they are in the female peculiarly excavate. Along the curving line that marks this character there is a very minute row of spinules. The outer apical seta is rather short and finely plumose. The other three apical setæ are all well developed. The outer is to the inner as 4 : 3. The middle is the longest and is to the next in length as 3 : 2. Though Forbes has shown the inner borders of the stylets to be densely and coarsely plumose in his fig. 4 of Pl. XV, he fails to mention this character in his description. I have never seen a specimen of *C. modestus* with the stylets as densely plumose as he shows them to be. All of the specimens examined from this locality showed very fine and often unevenly distributed hairs on the inner surfaces of the stylets (Pl. II, fig. 8). They are only visible under a high power.

The female first antennæ consist of sixteen segments. Herrick notes a similar form with seventeen joints, but this again I am unable to verify. They extend a little beyond the posterior margin of the first thoracic segment. The second, third, tenth, and thirteenth segments bear unusually long, heavy, plumose setæ. In the males these spines, which correspond to those of the third segment in the female antennæ, are very conspicuous (Pl II, fig. 7). When the first antennæ are folded under the body they protrude as shown in the figure. This also occurs when the female antennæ are folded under the cephalothorax. The female antennæ show an unusual change of direction between the third and fourth segments, giving the animal a characteristic appearance and making the females resemble the males to the naked eye. On the fourteenth and fifteenth segments of the first female antennæ occur several characters that may be sensory in function. The fourteenth segment bears a minute sensory hair and a very inconspicuous, transparent, hyaline plate that contains about twelve coarse serrations (Pl. II, fig. 11). The fifteenth segment bears a smooth-edged hyaline plate of which the distal end is club-shaped and protrudes considerably beyond the anterior end of the segment. Forbes ('97) indicated the position of this plate in his fig. 1, Pl. XVI, of the first female antennæ, but he seems to have overlooked the character of the organ. In the figure, the positions of the large setæ of the fourteenth and fifteenth segments are indicated.

The armature of the three segmented swimming feet is very constant. The setæ and the apical spines are long and slender. Forbes notes that "the distal segments of the third and fourth pairs of legs turn inward in a way peculiar to this species." The inner border of the distal segment of the inner ramus of all four pairs is finely plumose. The feet armature is as follows:

First pair—outer ramus, four spines, four setæ; inner ramus, six setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, six setæ.
Third pair—outer ramus, three spines, five setæ; inner ramus, six setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

The lamellæ connecting the swimming feet have a peculiar form. Pl. II, fig. 10, shows this feature in the third pair. In the fourth pair the place of the seta on the basal joint is taken by a short chitinous point. The lamella of the second pair is similar to that of the third, while in the first pair the chitin points have become quite rounded and smooth.

The fifth foot (Pl. II, fig. 9) is generally considered as having three joints. Forbes states that it "has three freely movable segments, though the basal one is small." Miss Byrnes simply states that "the fifth foot is *very distinctly* three-jointed, and not 'obscurely' as Herrick observed." The basal segment is certainly very short, though its presence is no longer a matter of conjecture. Whether it is "freely movable" I am unable to say. The second segment is almost square and bears a short seta on its outer side. They are both plumose and the larger is borne at the end of a slight projection of the segment. The shorter of these setæ is usually folded under the longer, as shown in the figure. The rudimentary feet in this species are unusually large.

The *receptaculum seminis* is very much like that of *C. bicuspidatus* Claus. The anterior division is very low, extending but a little beyond the porus. The posterior, bag-shaped portion reaches halfway to the posterior margin of the abdominal segment.

The egg-sacs are narrow and extend a little beyond the ends of the stylets. They usually contain from 10-12 dark ovæ.

Forbes gives 1.2 mm. for the length of *C. modestus*. I find it slightly larger, 1.3 mm. being an average length for females.

The color of this species is most beautiful, violet and lavender shades predominating. It is evenly distributed in the chitin and persists in preserved material. There are usually a number of large, orange-colored globules below the chitin. These are specially numerous in the cephalothorax and the swimming feet.

C. modestus can be readily distinguished from all other species by the sixteen-jointed first antennæ, the three-jointed fifth foot, the very characteristic stylets, and the *receptaculum seminis*.

While nowhere an abundant species, *C. modestus* appears to be very generally distributed over the United States. Forbes reports it from several localities in Illinois and from Grebe Lake in the Yellowstone Park. Marsh found it in Rush Lake, Wisconsin, and Herrick in Cullman County, Alabama. Miss Byrnes has recently studied the species from the Long Island waters. I have found it, always in small numbers, one of the rarer species of the genus from this locality.

In a collection from "Fresh Pond," Cambridge, Mass., made in the fall of 1909, this form outnumbered all other species. It occurs also in collections from Lake Winnepesaukee made during July and August, 1909.

Subgenus MICROCYCLOPS Claus.

Cyclops varicans Sars. Pl. III, figs. 6 10.

Cyclops varicans Sars, '62, pp. 252, 253.
Cyclops varicans Schmeil, '91, pp. 33, 34; '92, pp. 116–118, pl. VI, figs. 1–5
Cyclops varicans Forbes, '97, pp. 63 and 64.
Cyclops varicans Lilljeborg, '01, pl. IV, figs. 23, 24, pp. 72–74.
Cyclops rubellus Lilljeborg, '01, pl. IV, figs. 25 and 26, pp. 75 77.
Cyclops bicolor Byrnes, '09, pl. XIII, pp. 29–31.

Synonymy and Distribution.—Though I am unable to translate Lilljeborg's Swedish description of his new species *C. rubellus,* I am convinced from the Latin synopsis as well as his drawings of the *receptaculum seminis* and abdomen that this species is synonymous with *C. varicans* Sars. His drawing of the *receptaculum seminis* shows this organ to have the form of that pictured by Schmeil (Taf. VI, fig. 3) with a slightly greater expansion of the "wings" of the anterior division. By a careful study of this organ in a number of specimens, I have concluded that what Lilljeborg pictures as the *receptaculum seminis* of the type *C. varicans* (see Taf. IV, fig. 24, of his paper of '01) is the extreme form of narrow anterior portion, Schmeil's drawing showing a slightly greater expansion of this same division. Lilljeborg's drawing of the *receptaculum* of *C. rubellus* and my own (Pl. III, fig. 10) of this organ in *C. varicans* are examples of the extremely wide and wing-like form. The proportional lengths of the caudal setæ, as shown by Lilljeborg, are identical with those of the typical *varicans* (Pl. III, figs. 6 and 7).

Miss Byrnes in her recent paper (March, '09) has described a species of *Cyclops* under the name of *C. bicolor.* Her description of the antennæ, which she states "contain each twelve segments," at once suggests *C. varicans,* for nowhere do I find a record of *C. bicolor* with more than eleven joints in the first female antennæ. Schmeil gives eleven, Lilljeborg 10–11, and Marsh has noted a form with ten segmented antennæ, though he finds the usual number is eleven. Herrick, with whose description she seems to have compared her own, also gives eleven as the number of female antennal segments. Miss Byrnes' formula for the swimming feet agrees exactly with that of specimens examined from this locality. In speaking of the variation of this species, she says: "The species *C. bicolor* is usually placed (*e.g.,* by Marsh) among Cyclops having ten or eleven segments. The occurrence, therefore, of a twelve-jointed antenna shows that considerable variation may occur in this organ. Except in this respect, the form from Cold Spring Harbor agrees with Professor Marsh's description." The above extract needs no comment. Herrick assigns *C. varicans* a place among the twelve-jointed-antennæ forms having a *two*-segmented fifth foot. This may account for Miss Byrnes' error, for Herrick's drawing of the fifth foot of *C. varicans* is quite incorrect.

C. varicans is one of the rarer species of the genus. Schmeil found it sparingly in the vicinity of Halle. Lilljeborg reports it and describes it from Sweden. Herrick found it but once, and Miss Byrnes also collected it in a single instance from a pond on Long Island, describing it as a twelve-jointed variation of *C. bicolor*. In his summary of species Forbes records it as "a fairly common species throughout the range of *Cyclops* in North America." I have found it in small numbers in the March and April, 1909, collections in this locality and sparingly in the vicinity of Cambridge, Mass., and from Lake Winnepesaukee collections taken in July and August, 1909.

Specific Description.—The first segment of the almost elliptical cephalothorax (Pl. III, fig. 6) is about as long as wide and a little over half as long as the entire thorax (3 : 5). The lateral angles of the third, fourth, and especially the fifth thoracic segments are prominent. The proportion of cephalothorax and abdomen is as 10 : 7. The posterior borders of all the thoracic segments are smooth. The fifth segment is somewhat flattened and extended laterally. Its lateral edges protrude considerably beyond the first abdominal segment. At the ends of these wing-like projections of the fifth thoracic segment are inserted long, curving, plumose setæ, which are usually considered homologous to the outer setæ of the basal segments of the two-jointed rudimentary fifth feet. The fifth feet are inserted at the inner corners of the lateral projections of the fifth thoracic segment on its posterior edge (Pl. III, fig. 9).

The first abdominal segment is considerably expanded in its anterior half (Pl. III, figs. 6 and 10). The entire abdomen, which is rather slim, tapers gradually to the furca. The posterior borders of the first three segments are smooth. On the posterior edge of the fourth abdominal segment, ventrally placed and rarely extending half way around the circumference of the segment, there is present a short row of long serrations.

The stylets (Pl. III, fig. 7) taper slightly and are carried very close together. They are slightly shorter than the last two abdominal segments taken together. The outer apical bristle is rather heavy, sparsely plumose, and nearly as long as the delicate inner one. Of the two developed apical setæ, the inner longer one is to the outer as 10 : 7. Schmeil shows both of these setæ to be evenly plumose on their distal seven-eighths. This character is rarely present in the specimens from this vicinity. The anterior plumose portion is replaced by a short row of delicate spines on either side of the setæ (Pl. III, fig. 7). These do not merge into the hair-like forms gradually, but end abruptly at the beginning of the plumes as in the long median caudal seta of *C. phaleratus.* The lateral spine is inserted two-thirds of the length of the stylets from their anterior border. It is usually delicately plumose, although the bare form is not rare.

The female first antennæ may have either eleven or twelve segments. The number given by Schmeil is twelve, but I have frequently found eleven-jointed sexually mature forms, bearing eggs. Such forms occur more frequently in late winter and the twelve-jointed-antennæ forms in April and May (Pl. III, figs. 6 and 8). The antennæ are a little over two-thirds as long as the first thoracic segment. The division from eleven to twelve joints takes place in the third joint. The fourth, fifth and sixth joints are often narrower than the seventh and eighth. Most of the antennal bristles are not plumose. Schmeil notes the presence of a well-developed, closely lying sense-club on the ninth segment. This I cannot discover on the specimens that have come under my observation. In its place there is a minute sensory (?) hair.

The first antennæ of the male are peculiar in the unusual development of the sensory structures of the first division. These are larger than in any other species of the genus and may be readily noted even under a slight magnification as long blue, semi-transparent, narrow bag-shaped structures on the posterior side of the antennæ.

The swimming feet are all two-jointed. The outer ramus of the fourth pair is generally visible from above in life. This is due to the unusually large lamella connecting these feet which makes them protrude at a greater lateral angle. Schmeil notes that the fourth pair of swimming feet is less fully developed than the other three pairs. In fig. 11 of Pl. III I have shown a foot of the third pair. It is interesting to note an indication of the third segment; a row of short hairs at the middle of the distal segment of the outer ramus and a group of longer hairs on the corresponding segment of the inner ramus. This character is always present in the first three pairs of swimming feet.

The armature of the swimming feet is as follows:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.

Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, five setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, five setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, three setæ.

The above armature is quite constant. Herrick states the fifth foot is two-jointed. Since he has only collected the species in a single instance, this must be considered an error. There is often a very inconspicuous indication of a former large basal segment (Pl. III, fig. 9), but the movable fifth foot consists of a single cylindrical joint. At the middle of its distal end there is borne a long, delicately plumose seta (Pl. III, fig. 9).

The shape of the *receptaculum seminis* has already been discussed. Fig. 5 of Pl. III shows what is probably the extreme "wing-like" formation of the anterior division. The posterior portion is about as long as the anterior and has the form of a short bag. The porus is situated immediately between the two portions on the narrow transverse division that extends entirely across the first abdominal segment.

The egg-sacs contain from ten to twelve ovæ and are carried at a slight angle from the abdomen.

The following measurements of six females taken at different times give an average length of .867 mm.

No. 1	Total length	= .895 mm.
No. 2	" "	= .841 mm.
No. 3	" "	= .966 mm.
No. 4	" "	= .96 mm.
No. 5	" "	= .89 mm.
No. 6	" "	= .89 mm.

The females average .21 mm. in width. The males are somewhat smaller than the females .69 mm. being an average length. Schmeil gives .8-.92 mm. for the size of the females and "about" .7 mm. for the males. Sars' figures are somewhat greater 1 mm. Herrick gives .8 mm.

The color of *C. varicans* is ordinarily very pale. A faint shade of yellow is noticeable throughout the body, making the animal unusually inconspicuous. It may be readily distinguished from all other species of the genus by its short, twelve-jointed antennæ, the very characteristic *receptaculum seminis*, and the two-jointed swimming feet.

Subgenus EUCYCLOPS Claus.

Cyclops prasinus Fischer. Pl. III, figs. 1-5.

Cyclops prasinus Fischer, '60, pp. 652–654, pl. XX, figs. 19–26*a*.
Cyclops fluviatilis Herrick, '82, p. 231, pl. VII, figs. 1–9.
Cyclops magnoctavus Cragin, '83, pp. 70, 71, pl. III, figs. 14–23.
Cyclops prasinus Schmeil, '92, pp. 150–156, pl. V, figs. 1–5.
Cyclops fluviatilis Herrick and Turner, '95, pp. 114, 115, pl. XXVI, figs. 1–8; pl. XXX, fig. 1.
Cyclops prasinus Forbes, '97, pp. 57–59, pl. XIX, figs. 1 and 2; pl. XX, figs. 1 and 2.
Cyclops fluviatilis Brewer, '98, pp. 135, 136.
Cyclops prasinus v. Daday, '06, p. 180.
Cyclops fluviatilis Byrnes, '09, pp. 28, 29, pl. XV, figs. 1 and 2.

Specific Description.—The form of the cephalothorax in this, the smallest species found in this locality, is that of an ellipse slightly flattened at the ends. The first segment is to the total length of the cephalothorax as 5 : 7. Its length is to its width as 5 : 4. The lateral angles of all the thoracic segments are obscure. Their posterior borders are unserrated. The lateral edges of the last segment bear each a fringe of very minute hairs (Pl. III, fig. 5).

The abdomen, which is to the cephalothorax as 5 : 9, is rather slender and tapers only slightly towards its posterior end. The first segment is enlarged at its anterior end and about as wide as the last cephalothoracic segment. The posterior borders of all the abdominal segments are unevenly and minutely serrated.

The short stylets (Pl. III, figs. 1 and 2) stand well apart in the living animal. The lateral spines are situated $\frac{3}{5}$ of the length of the stylets from their anterior end. Of the apical setæ only two are well developed. The inner and outer bristles are small. Of these the outer is much heavier and is slightly shorter than the inner. Neither attains the length of the stylets. Of the large middle pair the inner is to the outer as 5 : 3. Brewer gives 4 : 5 "or equal." The larger of the two is four times, the shorter about three times, as long as the stylets. Both are delicately plumose.

The first pair of (twelve-jointed) antennæ (Pl. III, fig. 1) reach in the female to the posterior border of the third thoracic segment. Forbes finds them often reaching "quite to the first abdominal segment." The eighth joint is the longest, exceeding that of the two preceding segments. Dr. Schmeil finds on the ninth segment a "well-developed sense-club," and, in his foot-note, states that Richard "even denied the presence of a sense-club." All of my specimens agree with Forbes' description in the absence of the sense-club, but "minute sensory bristle" on the tenth segment. This seems, then, to be undoubtedly a characteristic point of difference from the European forms. The three terminal joints are slightly curved and each bears a well-developed hyaline plate. The edges of these plates, which Forbes found to be entire, seem to vary. I have frequently found them finely serrated on the distal *third* of the terminal segmental plate. Again I have noted a very distinct notch or indentation at the posterior end of the serrations. This resembles somewhat the characteristic "notch" in the corresponding plate of *Cyclops leuckarti* Claus, though it is not so deep nor conspicuous. Occasionally I have observed a specimen in which all *three* hyaline plates were finely serrated. The commonest form has two of the plates with smooth edges, though the plate of the last segment invariably has the slight notch mentioned above (Pl. III, fig. 3).

The very long and strong setæ on the first and fourth antennal segments and the change of direction of the remaining segments beyond the fourth, as well as the short caudal stylets, suggest a superficial resemblance to *Cyclops modestus* Herrick.

The four pairs of swimming feet are armed as follows:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, six setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, three setæ.

Both the spines and setæ of these feet are peculiarly long and slender.

The rudimentary fifth foot (Pl. III, fig. 4) consists of a single segment, armed with a spine and two setæ. The spine is inserted immediately above the characteristic bulge of the minutely plumose inner side. The longer of the two setæ is borne at the end of a cone-shaped projection of the distal end of the segment. The remaining seta is inserted on the outer side of the segment at the base of the cone-like process. Its length is two-thirds that of the apical seta and slightly greater than that of the spine. Both the setæ are delicately plumose; the spine is more coarsely so. Brewer notes that the "three setæ" are bare in his specimens.

The form of the *receptaculum seminis* (Pl. III, fig. 5) is the most characteristic feature of this species, though it is frequently quite difficult to distinguish owing to the density of the pigment matter in the first abdominal segment. It consists of two very distinct divisions. The anterior portion has a central arm extending halfway to the upper edge of the first abdominal segment, which branches into two wing-like projections at right angles to the central arm and extending transversely across the abdomen on either side of the median line. The outer ends of these projections are often slightly enlarged. Forbes and Schmeil both find that these side arms are "S-shaped." Among all the specimens that I have examined from this locality, I have noted the "S shape" in only one instance. In many cases the outer ends of the wing-forms tend to turn up slightly but the "S-shaped" canals are certainly the exception and not the rule among the local representatives of this species. Consequently, in my drawing (Pl. III, fig. 5) I have shown what I consider a rather more characteristic form of the *receptaculum seminis* for *C. prasinus*. This somewhat insignificant detail shows that the *receptaculum seminis* may be a variable character.

The portion of the receptaculum behind the suture consists of two lateral sacs connected by a narrow transverse canal lying close under the suture. In the middle of the anterior edge of this lower connecting arm is the porus. The anterior division of the receptaculum fuses with the posterior at this same point.

The contents of the upper and lower portions differ in appearance only. Dr. Schmeil has proved that the spermatozoa in the upper portion are simply more densely packed together than in the lower.

The egg-sacs contain only a few ova. I have never noted more than ten; seven is an average number. They adhere closely to the abdomen, often covering two-thirds of its dorsal area.

An average length for the female from this locality is .82 mm. Forbes gives .48-.7 mm. Some of the European measurements are as follows:

Vosseler	1.0 mm.
Richard	.9 mm. (after Schmeil).
Vernet	.88 mm.
Schmeil	.8-.9 mm.

The males average .62 mm. long and .14 wide. They have a very long setæ at the distal end of the first division of the first antennæ.

The color seems to be quite constant. The first thoracic segment is a pale yellowish-brown with irregular patches of blue-green along its posterior border. The remaining thoracic segments are a deep shade of blue-green. The first abdominal segment is brown, more dense in the anterior half. The remaining segments are irregularly blotched with the thoracic shade of green which becomes solid in the stylets. The first pair of antennæ are a brownish-yellow; their anterior border is often tinged with green. Forbes has "seen both blue and pink individuals." Herrick found that the color varies "from deep indigo to greenish-brown." Cragin states: "Animal dirty blue-green, antennæ lighter. Dark green pigment masses are scattered beneath the integument in various places, particularly along the anterior side of the first antennæ."

This species is quite generally distributed over the eastern and central United States. Herrick found it in Lake Minnetonka, Minn. Marsh reports the species from Lake Erie, Lake Michigan, and some of the smaller lakes of Michigan and Wisconsin. Forbes has found it in collections from Sister Lake, Fla., and many localities in the State of Illinois. As *C. fluviatilis* Herrick, Brewer reports it from the vicinity of Lincoln, Nebraska, and Miss Byrnes from Long Island. Miss E. R. Walker reports it as the most abundant form from Todd's Pond, Oregon. It is one of the most abundant forms in September and October dredgings, but I have noted only a few individuals during the winter months.

It is easily distinguished by its small size, its habit of swimming near the surface, its dark color (it frequently appears to be black to the naked eye), and, under the microscope, by the very characteristic form of the *receptaculum seminis* and short caudal setæ.

Subgenus PARACYCLOPS Claus.

Cyclops phaleratus Koch. Pl. IV, figs. 1–4.

Cyclops phaleratus Koch, '35–'41, Heft 21, pp. 8, 9, pl. IX.
Cyclops perarmatus Cragin, '83, pp. 72, 73, pl. I, figs. 9–18.
Cyclops phaleratus Schmeil, '92, pp. 170–178, pl. VIII, figs. 1–11.
Cyclops phaleratus Herrick and Turner, '95, pp. 120, 121, pl. XVII, figs. 1–7; pl. XVIII, figs. 2–2*d*; pl. XIX, fig. 1; pl. XXI, figs. 6–10.
Cyclops phaleratus Marsh, '95, pp. 19, 20.
Cyclops phaleratus Forbes, '97, pp. 59–62, pl. XX, fig. 3.
Cyclops phaleratus Lilljeborg, '01, pp. 105–109, pl. VI, figs. 20, 21.
Cyclops phaleratus Byrnes, '09, pp. 31–33, pl. XIV, figs. 1–9.

Specific Description.—The first segment of the unusually broad cephalothorax is a little longer than the other four thoracic segments. Its width is slightly greater than its length. The posterior borders of the first three thoracic segments are smooth. The fourth segment is ornamented with a minute fringe of short serrations. The chitinous covering of the fifth thoracic segment is composed of a continuous cylinder like the abdominal segments, and not of a dorsal and ventral plate, as is the case in the corresponding segment of other species of this genus. This segment is armed ventrally along its posterior margin by a row of heavy, cone-shaped teeth (Pl. IV, fig. 4) which extend at a slight angle and not parallel to the body. This row is, furthermore, not continuous, but generally interrupted in the middle for a short distance on either side of the median line. Occasionally, however, I have noted specimens in which this row of spinules is practically continuous, though there is always a slight break. The length of the entire cephalothorax to that of the abdomen is as 7 : 5.

The first abdominal segment is very slightly smaller than the fifth thoracic segment, and the whole abdomen tapers but little. How small this taper is may be readily seen from the following proportional width of each segment at its posterior border.

First segment	27
Second segment	26
Third segment	24
Fourth segment	21

The proportional lengths of the four abdominal segments beginning with first are 11 : 7 : 6 : 2. All the segments are cylindrical. The posterior borders of the first, second, and third segments are minutely serrated (Pl. IV, fig. 2). The last abdominal segment is less than one-fifth as long as the first segment and bears on its posterior border a fringe of unusually long and heavy spines (Pl. IV, fig. 2).

The stylets are short (Pl. IV, fig. 2). Their length and width are to each other as 4 : 3—a proportion that shows them to be very wide. Below the point of insertion of the short lateral spine, which may or may not be plumose, the stylets taper rapidly. In addition to this lateral spine, there is a row of slightly shorter spinules (usually from four to six) extending from the lateral spine, ventrally, slightly below the middle of the side of each stylet. Forbes mentions "a row of long spinules on the ventral side of each ramus, extending from the middle line of the anterior border to the point of insertion of the lateral spine." I have never noted such a row of spinules in any of my specimens, though this entire minutely spinose armament of the stylets must be considered a variable feature. There are two or three rows of minute hairs extending obliquely from the middle of the anterior border of each stylet towards the posterior border. The interior border of the stylets is often plumose (Schmeil found an "unbehaarten Innenrande") and the inner and posterior dorsal surfaces are armed with irregular groups and rows of short, blunt spines (Pl. IV, fig. 2). Forbes and Schmeil both note that the outermost apical bristle "is placed high up on the side of the stylet." In his fig. 1 on pl. VIII, Schmeil has shown this to be the case, but in fig. 2 of the same plate he shows this spine inserted directly beside the shorter of the two developed caudal setæ. I have found it only as he shows in fig. 2 (Pl. IV, fig. 2). This spine is often quite blunt and always densely plumose on both sides. At the point of insertion there are several long, dorsally placed serrations extending a third of the distance about the base of the spine. The innermost bristle is very delicate, about as long as the outer, and plumose on its outer side only. Of the two well-developed median bristles, the inner is from two and one-half to three times as long as the outer. Its first third is bare, the middle portion fringed with small spines, and the last third finely plumose. It is longer than the abdomen and unusually wide at its insertion point. The smaller of the two developed caudal setæ is bare for one-quarter of its length, thence to its tip it is fringed with a row of small spines on the outside and delicately plumose on the inner. Between the insertion point and the beginning of the outside row of spines there is often a minute fringe of hairs. The dorsal median seta is quite slender, a little longer than the outer apical spine, and not plumose.

The first antennæ of the female (Pl. IV, fig. 3) are eleven-jointed in most cases, though the ten-jointed form appears occasionally. Schmeil records only the ten-jointed form from Germany, and Lilljeborg the same from Sweden in his paper of 1901. Forbes states that they "may be either ten- or eleven-segmented," and Miss Byrnes has noted a single individual in which the left antenna had eleven, the right but ten segments. I have noted a similar individual in a single case. Herrick found that "the antenna is usually ten-jointed, but frequently is eleven-jointed (?), and is much shorter than the first thoracic segment." The question-mark seems to indicate some doubt as to the existence of the eleven-jointed form, though subsequent workers have verified his observation in the case of the American representatives of this species. It is interesting to note here that the eleven-jointed form has, as far as I am able to ascertain, been recorded only by the American investigators. In the eleven-jointed form there is borne at the distal end of the eighth segment, in place of a sense-club, a minute sensory bristle. The antennæ taper but little in the first nine joints, the last two being considerably narrower than the others. The last joint bears an unusually strongly developed seta. The armature of the other antennal joints is quite uniform. The length of the female first antennæ is a little more than half that of the first cephalothoracic segment.

Schmeil states the first antennæ of the male are normal. I have noted that there is on the last division an unusually large spine, set well towards the distal end. There is also a small blunt spine with a large comb-like fringe on its outer margin, placed about in the middle of the second large division of the male antennæ. The remaining spines are rather smaller than in other species. On the joints of the first division there are present, on the under side, the usual long, blunt, finely plumose sensory structures.

The second antennæ are very short and broad. The long curving seta of the basal segment I have never found to be evenly plumose as Schmeil shows it. It is usually armed with a row of short spinules on each side of its distal three quarters, while the first quarter bears, only on its upper side, an uneven row of longer spinules. The second segment bears on its outer side a double row of delicate spines, and on its upper side a fringe of spinules and near its distal end a peculiar spine. The distal half of this spine is curved and bears on its upper side a comb-like fringe of fine spinules. The smaller spine on the distal end of the third segment has this same peculiar curve and fringe. The curved setæ at the top of the fourth segment are short and very broad.

The four pairs of swimming feet are all three-segmented, both spines and setæ are well developed, and the outer edges of the first and second segments of each ramus bear rows of heavy spinules. The armature is most variable. For example, I have found on the outer ramus of the first pair either three or four spines and five setæ. Again in the second pair on the corresponding ramus I have found four spines with either four or five *setæ*. In another case I have found on the outer ramus of the fourth foot of the right side, three spines and five setæ and on the same ramus of the opposite side four spines and four setæ. Furthermore, the armature of the inner ramus of the second and third pairs of swimming feet differs consistently from that given by Forbes, in the presence of an extra seta on the inner side. This seta is very obscure and may be overlooked on account of the long spinules on the same side of the ramus, but its existence can be positively identified by its position and by the fact that, though it is often not much larger than the accompanying spinules, it is the only one that is plumose. I give this rather lengthy discussion of the swimming feet merely as an example of the armature *not* being constant nor reliable as a point of differentiation of species. (See Introduction.) The following is an average armature for the local specimens:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.

Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

The fifth feet (Pl. IV, fig. 4) are merely flange-like projections of the fifth thoracic segment. They are more lateral than ventral, and there is ordinarily no line marking the position of a former segment. Occasionally, however, I have noted a faint indication of a possible segment, extending from the base of the outer spine obliquely to a point below the inner spine where the large row of serrations connecting the two fifth feet ceases (see description of cephalothorax and fig. 4, Pl. IV). The fifth foot is armed with three nearly equal spines, of which the inner is coarsely plumose, the middle one more finely plumose, and the outer bare or finely and sparingly plumose on its outer side. Schmeil's criticism of Brady's "otherwise excellent drawing," in which he shows all three spines to be plumose, is hardly justifiable (see note 2, p. 176, of Schmeil's monograph). In addition to the three large spines there are several small serrations about the base of the inner spine and an uneven mass of similar small serrations laterally below the outer spine.

The *receptaculum seminis* consists of two nearly equal divisions extending as narrow bands transversely across the entire first abdominal segment. The porus is situated in the middle of the short, median, common portion. Owing to the dark color of this species, the structure of the receptaculum is extremely difficult to observe.

The egg-sacs are borne close to the abdomen and frequently extend quite beyond the end of the stylets. They usually contain from ten to twenty large dark eggs. The oviducts are of unusual interest in this species. While in all other species they terminate within the cephalothorax, in *C. phaleratus* they extend as a blind duct to the anterior border of the fourth abdominal segment (Pl. IV, fig. 1).

The following measurements of six females covering collections from the same spot during two years, give an average length of 1.73 mm.

No. 1 . . . . . . Total length = 1.6
No. 2 . . . . . . " " = 1.95
No. 3 . . . . . . " " = 1.88
No. 4 . . . . . . " " = 1.78
No. 5 . . . . . . " " = 1.61
No. 6 . . . . . . " " = 1.6

The males are only a little smaller—1.6 mm. being an average length for local specimens. The coloring of *C. phaleratus* is most brilliant. The ground-color, which in this species is directly in the chitin, is a brick-red. The second thoracic segment, the last abdominal segment, the stylets and the caudal setæ and spines, the swimming feet, the mouth parts, second antennæ, and the last segment of the first antennæ are sky-blue, which varies in intensity. Often these parts appear quite colorless. The egg-sacs are dark blue or lavender in the first stages of development.

C. phaleratus is a pelagic species. In aquaria it may often be found a little above the water line, where it sometimes crawls even beyond the upper margin of the meniscus line. Its swimming motion is a rapidly darting one. The easiest way of distinguishing it from all other members of the genus is by its superficial resemblance to the genus *Canthocamptus.* The short, eleven-jointed antennæ, and form of the rudimentary fifth feet, are certain microscopic points of identification.

This species seems to be very widely distributed in America, though nowhere is it particularly abundant. Forbes reports it from several localities in Illinois and Wisconsin and from Portage La Prairie, Manitoba. Marsh has found it in several of the Michigan lakes and Cragin reports it from Cambridge, Mass., as *Cyclops perarmatus.* Miss Byrnes has studied the species on Long Island, where she found it in "shallow, fresh-water ponds." I have noted it rather more abundantly in the spring collections, but *never* in great numbers from the vicinity of Haverford, Pa., and from a small spring-water pond near Gillette, Wyoming, as well as in collections from Lake Winnepesaukee and the vicinity of Cambridge, Mass.

Subgenus PARACYCLOPS Claus.

Cyclops fimbriatus var. **poppei** Rehberg. Pl. IV, figs. 5-11.

Cyclops poppei Rehberg, '80, p. 550, Taf. VI, figs. 9–11.
Cyclops fimbriatus Schmeil, '91, pp. 35, 36.
Cyclops fimbriatus var. *poppei* Schmeil, '92, pp. 168–170, Taf. VII, figs. 14–16.
Cyclops fimbriatus Herrick, '95, pp. 121, 122, pl. XVII, figs. 8, 9; pl. XXI, fig. 11; pl. XXV, figs. 9–14.
Cyclops fimbriatus var. *poppei* Forbes, '97, pp. 63 and 65.
Cyclops fimbriatus Byrnes, '09, p. 33, pl. XV.

Synonymy and Distribution.—In his *Beiträge zur Kenntniss,* etc., of '91, Schmeil considered *Cyclops poppei* Rehberg, synonymous with the typical *C. fimbriatus.* The following year, however, after a more careful study of the species, though he still claimed the differences to be too few to warrant a new species, he granted that there should be a variety of *C. fimbriatus,* which he named *C. fimbriatus* var. *poppei* Rehberg.

All of Herrick's drawings of the stylets of what he describes as *C. fimbriatus* Fischer show that his specimens belonged to the var. *poppei,* and not to the typical form. Forbes recognizes the variety *poppei,* but gives no description or figures in connection with his note of the occurrence of the species. Miss Byrnes, following Herrick's mistake, has described this variety as the typical *C. fimbriatus* from Long Island. Her fig. 5, pl. XV, of the stylets with their characteristic armature of a longitudinal row of spines proves that the animal examined by her was not *fimbriatus,* but the variety *poppei* of Rehberg. There has been not a little confusion of the above-mentioned two forms. I cannot find a single description of the typical *C. fimbriatus* Fischer by any American investigator. The species seems to be represented in this country by the variety only. This has been described at least twice under the name of the type form.

Cyclops fimbriatus var. *poppei* seems to be one of the rarer species of the genus. Several of the investigators have failed to find it. Kofoid states in his *Plankton of the Illinois River,* "E. B. Forbes ('97) records in May, September, 1896, *C. varicans* Sars as common, and *C. fimbriatus* var. *poppei* Rehberg and *C. bicolor* Sars as rare." Forbes states that this is "a rare species in Manitoba, Alabama, and the north central States." Brewer does not record it from the waters about Lincoln, Nebraska. Marsh, in '95, names "*fimbriatus*" in his *Key to Species of Cyclops,* but gives no description. Miss Byrnes has studied the species from Long Island waters, where she states that "*Cyclops fimbriatus* has been taken in great numbers—especially in the collections made in the early spring." This observation agrees very closely with my own regarding the variety *poppei* in this vicinity. In a collection made in the spring (March) of 1907 it was the most abundant form. I have never recorded it from September to January. In February, 1909, I found a few egg-bearing females. I consider it one of the rarest of the members of the genus found in this locality.

Specific Description.—The somewhat slim cephalothorax (Pl. IV, fig. 5) tapers only slightly posteriorly. The first segment is half as long as the entire thorax. The dorso-ventral diameter is short in proportion to the length of the animal. In a specimen measuring 1.13 mm. it was but .14 mm. The width of the three posterior thoracic segments diminishes but a little. The lateral angles of the thoracic segments are not prominent. Both Herrick and Miss Byrnes have obviously drawn their specimens under pressure, when, as I have repeatedly observed, the thoracic outline is entirely changed. Fig. 5, Pl. IV, shows the form of cephalothorax in life. The third segment is finely serrated along its entire posterior margin (fig. 10, Pl. IV). These serrations often are slightly larger at the end of the marginal row. The fourth thoracic segment bears, laterally, a short row of minute but rather coarse "hairs" (fig. 11, Pl. IV). On the corresponding portions of the fifth segment there are present similar short rows of coarse hairs, but on this segment they are much larger (fig. 8, Pl. IV). The entire cephalothorax is to the abdomen as 7 : 5. Its length to its width is as 2 : 1.

The abdomen is wide, the first segment being but a little narrower than the fifth segment of the thorax. In my drawing of the living animal (fig. 5, Pl. IV) the first abdominal segment is foreshortened owing to the curve of the entire dorsal surface. This fact, taken together with the short first antennæ and the method of locomotion, suggests a strong resemblance to members of the genus *Canthocamptus*. The first three abdominal segments are finely serrate on their posterior margins. These serrations in the fourth segment, instead of stopping at the sides of the anal opening, turn anteriorly and extend a short distance along either side of this opening. There are, furthermore, between the upturned portion of the posterior row of serrations and the side of the anal opening, two very minute rows of what Schmeil calls "button-like projections" (fig. 6, Pl. IV). Neither Herrick's nor Miss Byrnes' drawings give an accurate view of this armature, though the former evidently noticed this detail from his fig. 11, Pl. 21, of his report of '95. Miss Byrnes' drawing shows the marginal row of serrations of the fourth abdominal segment extending across the anal opening. All the abdominal segments bear transverse rows of minute indentations of the form of the marginal serrations, but not projections of the cuticula. This may easily be proved by turning the animal on its side, when the dorsal and ventral lines of the abdominal segments will appear as unbroken lines. I find this character quite constant in specimens of the variety *poppei*, though Schmeil notes that it is often missing in the type *fimbriatus*.

The stylets (fig. 6, Pl. IV) differ from those of the typical *fimbriatus*. They are only as long as the last two abdominal segments. Their length is three times their width and their inner margins almost meet at the point of insertion in the abdomen. One of the main differences between this form and the type lies in the characteristic armature of the dorsal surface of the stylets. The lateral spine is inserted well towards the median line. On the outer lateral surfaces and a little below the position usually occupied by the lateral spine there is a row of prominent serrations. The position and course of this row of serrations may be seen in fig. 6 of Pl. IV. There are two well-developed apical setæ which are carried prominently divaricate. Of these two, the outer is a little over half as long as the inner and is ornamented on its outer surface with minute spines, its inner surface bearing the usual hairs. Herrick's statement, "inner two-thirds as long as the outer," is undoubtedly another case of reversed proportions. The longer seta is plumose. The delicate innermost setæ are as long as the outer and generally curved as in fig. 6, Pl. IV. The outermost setæ are very heavy, rather blunt and delicately plumose on their inner surface only. About the base of each there is a $\frac{3}{4}$ circle of long serrations.

The first antennæ of the female (fig. 7, Pl. IV) are eight-jointed. They are only half as long as the first thoracic segment and are carried at right angles to the median line, as is the case with practically all of the *Cyclopidæ*. The segments taper rapidly, the distal one being but one-quarter as wide as the first at its line of juncture with the second. The fourth segment is the longest. The two distal segments are slightly bent forward in life (fig. 5, Pl. IV). Herrick states: "The basal joint with a small semicircular series of fine bristles." This is not a characteristic of this species, but of the entire genus. Miss Byrnes' description is this: "The antennæ contain but eight segments; they are short and are characterized by two well-developed setæ." The fifth segment bears a well-developed sense-club (fig. 7, Pl. IV). This is somewhat different from Schmeil's figure of this organ for the type form. In the specimens that I have examined I find it to be rather more slim and spear-shaped than "club-shaped" as in the type. It suggests the form of the corresponding organ in *C. bicuspidatus* Claus (Pl. II, fig. 5). Many of the setæ of the first seven segments are delicately plumose, but those of the terminal segment are, as far as I have been able to observe, quite bare. Along the line of the distal third of the third segment (fig. 7, Pl. IV) I have repeatedly noted what appears to be the beginning of the segmentation of another antennal joint. However, I have never observed a specimen of "var. *poppei*" with nine-jointed first antennæ. The semicircle of fine bristles at the base of the first joint is unusually prominent.

The antennules are characterized by the two very short terminal segments.

The armature of the three-jointed swimming feet is as follows:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like the second pair.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

The inner margins of all the branches of the swimming feet are ornamented with rows of bristles. This is especially the case in the second, third, and fourth pairs. In her description of the variations of this species, Miss Byrnes says: "The most striking variation in *C. fimbriatus* is a tendency toward a reduction in the armature of the inner ramus of the first swimming feet, where in the apical position, for example, a single large spine replaced two setæ or a spine and a seta, which is the typical armature of the organ." She does not give the "typical armature" in her table, and the small seta on the inner side of the inner ramus of the first pair of swimming feet she has probably overlooked.

The fifth foot (fig. 8, Pl. IV), which is one-jointed, I find bearing the following armature: On the inner side of the distal end of the single segment there is a heavy spine, serrate on its inner surface and finely but not densely plumose on its outer margin. The row of minute serrations which Schmeil shows to be present in the type form at the base of the corresponding spine (see his Taf. VII, fig. 12) I do not find at all after a careful examination of a number of specimens. There is a single spine-like projection at the base of the inner spine, but no indication of a row. On the outer distal corner of the fifth foot there is a very coarse spine-like seta that is densely plumose on its inner and outer side. These two "spines" (the outer is more nearly a spine than a seta) are of equal length. Between them and borne at the end of a button-like process is the middle seta, slightly longer than the two spines and plumose on its distal half. Rehberg noted that "das rudimentäre Füsschen ist mit zwei gleichlangen Dornen und einem kürzeren Haar besetzt, während sich bei *Cycl. fimbriatus* nur ein kurzer Dorn und zwei lange Haaren befinden." Schmeil admits that Rehberg's description and drawing is quite accurate, states, however, that the fifth feet in type and variety are identical. I am inclined to agree with Rehberg that the outer seta of the type form is replaced in his variety by a spine. There has been much confusion over this point. Herrick states that the fifth foot has "three spines." Miss Byrnes agrees in her description with Schmeil, for she finds "a coarse inner spine and two setæ." This is undoubtedly one of those details of structure which may vary considerably, and I merely give the observations of the investigators to show their opinions on this point.

The *receptaculum seminis* (fig. 4, Pl. IV) is of a very characteristic form. It consists of two portions. These are in the shape of long, closely lying narrow ellipses. The upper portion has a slight indentation in the middle of its anterior margin and the ends are slightly upturned. The porus is situated in the middle of the short common portion which connects the two divisions of this organ. The structure of the *receptaculum seminis* has never before been observed in the American representatives of this variety. The egg-sacs contain but a few dark ovæ, 7–10, and are carried close to the abdomen in life.

I have found that 1.17 mm. is an average length for females of the variety *poppei.* Schmeil gives .86 mm. and Herrick .8 mm. The former states that "die Varietät ist etwas kleiner als die typische Form." For the "typische Form" Schmeil gives for the female "0.92–1 mm." The smallest mature female that I have measured was 1.13 mm. long—longer than the typical European form. Schmeil's observations on the size of this species does not seem to hold good, then, for the American forms. In fact, the reverse is true of specimens from this vicinity. Further study of the species will undoubtedly show that type and variety are of a size.

The variety *poppei* is practically colorless. Irregular chains (fig. 5, Pl. IV) of rose-colored globules are scattered occasionally throughout both cephalothorax and abdomen, and the ovaries, when distended, appear a deep shade of lavender.

The most readily distinguished characters of this variety are the short eight-jointed antennæ (which show that it belongs either to the type or variety) and the very characteristic armature of the dorsal surfaces of the caudal stylets.

The following table illustrates the main points of difference between type and variety:

	C. fimbriatus Fischer.	*C. fimbriatus* var. *poppei* Rehberg.
(1) Fifth foot	with a spine and two setæ, the spine circled at its base by a row of minute spinules.	with two spines and a seta, one spine plumose, and no row of spinules at the base of either.
(2) Receptaculum seminis	"may reach the anterior border of first abdominal segment" (Schmeil).	narrow, low lying, ellipse (fig. 9, Pl. IV), with slight indentation in middle of anterior border.
(3) Fourth abdominal segment	serrations stop at side of anal opening.	serrations turn up (fig. 6, Pl. IV).
(4) Transverse row of serrations on stylets	form semicircle about stylets stopping above lateral spine.	extend longitudinally (fig. 6, Pl. IV).
(5) Stylets	narrow, set far apart, almost equal to last three abdominal segments.	shorter, inner margins almost meet, length equal to last two abdominal segments.

Schmeil notes further minute differences in the structure of the male first antennæ.

N. B.—Since the compilation of the above table I have had occasion to examine collections from Lake Winnepesaukee, N. H., in which a form occurs which bridges over the gap between type and variety as regards character No. 4. In these forms the transverse row of serrations on stylets is exactly as in the type form as figured by Schmeil, but the proportional length of stylets agrees with var. *poppei* and not with the type form.

List of Cyclopidæ Recorded from a Single Small Pond in the Vicinity of Haverford, Pa.

(The above small pond is on the estate of Mr. McFadden, directly on the south side of the Philadelphia and Western Railroad tracks and to the right of the bridge that crosses these tracks at Haverford station.)

Genus **CYCLOPS.**

I. Subgenus CYCLOPS Claus s. str.

1. **Cyclops viridis** var. **insectus** Forbes.

Not described in this paper, but an abundant form.

2. **Cyclops bicuspidatus** Claus.

II. Subgenus MACROCYCLOPS Claus.

3. **Cyclops fuscus** Jurine.

4. **Cyclops albidus** Jurine.

IV. Subgenus ORTHOCYCLOPS Forbes.

5. **Cyclops modestus** Herrick.

V. Subgenus MICROCYCLOPS Claus.

6. **Cyclops varicans** Sars.

VI. Subgenus EUCYCLOPS Claus.

7. **Cyclops serrulatus** Fischer.

Not described in this paper, but the most abundant form.

8. **Cyclops prasinus** Fischer.

VII. Subgenus PARACYCLOPS Claus.

9. **Cyclops phaleratus** Koch.

10. **Cyclops fimbriatus** var. **poppei** Rehberg.

In the above list, subgenus III is omitted since it only contains *C. ater* Herrick, a form not found thus far in this locality. This arrangement is taken directly from Forbes' paper of '97.

Description of *C. viridis* var. *insectus* Forbes and *C. serrulatus* Fischer are not given in this paper. The latter form is perhaps the commonest one of the genus and will not be mistaken for any other since no other American form approaches it in morphological details. Forbes has discussed the synonymy in his paper of '97, but since that time several European investigators have established new species and varieties all intimately related with the type form. A careful comparative study of these new forms will be necessary before the description of *C. serrulatus* Fischer can be brought up to date. It is known to be a most variable form. Size and stylet proportions are rarely constant in individuals taken at the same locality and even in the same collection.

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EXPLANATION OF PLATES.

PLATE I.—*Cyclops fuscus* Jurine. *Cyclops albidus* Jurine.

Fig. 1.—*C. fuscus,* adult female. Oc. 2, obj. 1. (Ocular and objective numbers refer to Leitz lenses unless otherwise noted. All drawings were made with the help of the camera lucida.)

Fig. 2.—*C. albidus*, adult female, showing the characteristic divaricate position of the egg-sacs. Oc. 1, obj. 1 (Bausch & Lomb).

Fig. 3.—Dorsal aspect of stylets and last abdominal segment of *C. fuscus*. Oc. 3, obj. 3.

Fig. 4.—Stylets and last abdominal segment of *C. albidus*. Oc. 1, obj. 3 (B. & L.).

Fig. 5.—Three proximal joints of the second female antenna, *C. fuscus*. Oc. 2, obj. 3.

Fig. 6.—Third and fourth joints of the second female antenna, *C. albidus*. Oc. 1, obj. 3 (B. & L.).

Fig. 7.—Terminal segment of first female antenna, *C. fuscus*, showing the typical deep serrations of the hyaline plate. Oc. 2, obj. 3.

Fig. 8.—Terminal segment of first female antenna, *C. albidus*. The finely serrated plate is characteristic. Oc. 3, obj. 5.

Fig. 9.—Twelfth segment of the first female antenna of *C. fuscus*, showing the armature of minute serrations and the sense-hair. Oc. 2, obj. 5.

Fig. 10.—Twelfth segment of the first antenna of a female *C. albidus*, showing rows of "thorns" and sense-club. Oc. 2, obj. 5.

Fig. 11.—*Receptaculum seminis* of *C. fuscus*. Oc. 3, obj. 3.

Fig. 12.—*Receptaculum seminis* of *C. albidus*. Oc. 3, obj. 3.

Fig. 13.—Fifth foot of *C. albidus*. Oc. 2, obj. 5.

Fig. 14.—Distal segment of the inner ramus of the fourth pair of swimming feet of *C. albidus*, showing a group of small hairs in place of the second seta of the inner side. Oc. 0, obj. 5.

PLATE II.—Figs. 1–5, *Cyclops bicuspidatus* Claus. Figs. 6–11 *Cyclops modestus*, Herrick.

Fig. 1.—An adult female (slightly extended by pressure). Oc. 0, obj. 3.

Fig. 2.—Lateral view of a stylet showing the minute serrations near the anterior end. Oc. 3, obj. 5.

Fig. 3.—The sense-club of the twelfth segment of the first female antennæ. Oc. 3, obj. 7.

Fig. 4.—A foot of the fifth pair. Oc. 3, obj. 7.

Fig. 5.—The *receptaculum seminis*. Oc. 3, obj. 3.

Fig. 6.—An adult female. Oc. 0, obj. 3.

Fig. 7.—An adult male with first antennæ folded under the cephalothorax. Oc. 0, obj. 3.

Fig. 8.—Stylets and last abdominal segment. Oc. 2, obj. 5.

Fig. 9.—A foot of the fifth pair. Oc. 1 (B. & L.), obj. 7.

Fig. 10.—Lamella of the third pair of swimming feet. Oc. 1 (B. & L.), obj. 5.

Fig. 11.—The three terminal joints of the first female antennæ showing hyaline plates and sense-hair. Oc. 1 (B. & L.), obj. 5.

PLATE III.—Figs. 1–5, *Cyclops prasinus* Fischer. Figs. 6–11, *Cyclops varicans* Sars.

Fig. 1.—An adult female. Oc. 2, obj. 3.

Fig. 2.—The stylets and last abdominal segment. Oc. 3, obj. 5.

Fig. 3.—The three terminal joints of the female first antenna showing the characteristic hyaline plates. Oc. 2, obj. 7.

Fig. 4.—The fifth foot. Oc. 2, obj. 7.

Fig. 5.—The *receptaculum seminis*. Oc. 3, obj. 5.

Fig. 6.—A mature female of *C. varicans* with eleven-jointed first antennæ: a winter transitional form. Oc. 2, obj. 3.

Fig. 7.—The stylets and last abdominal segment. Oc. 2, obj. 5.

Fig. 8.—An eleven-jointed antenna of the first pair in the female. Oc. 3, obj. 5.

Fig. 9.—The fifth thoracic segment showing the rudimentary fifth feet. Oc. 3, obj. 5.

Fig. 10.—The *receptaculum seminis*. Oc. 0, obj. 5.

Fig. 11.—A two-jointed swimming foot of the third pair. The division of the third joint is always indicated by minute rows of hairs. Oc. 2, obj. 5.

PLATE IV.—Figs. 1–4, *Cyclops phaleratus* Koch. Figs. 5–11, *Cyclops fimbriatus* var. *poppei* Rehberg.

Fig. 1.—An adult female. Oc. 0, obj. 3.

Fig. 2.—The stylets and last abdominal segment. Oc. 0, obj. 5.

Fig. 3.—The female first antenna. Oc. 2, obj. 5.

Fig. 4.—The fifth foot. Oc. 2, obj. 5.

Fig. 5.—An adult female; the first cephalothoracic segment appears somewhat foreshortened.

Fig. 6.—The stylets and last abdominal segment.

Fig. 7.—The female first antenna.

Fig. 8.—A foot of the fifth pair.

Fig. 9.—The *receptaculum seminis.*

Fig. 10.—Posterior serrated margin of the third thoracic segment.

Fig. 11.—Posterior margin of the fourth thoracic segment.

A STUDY OF THE SPECIES OF THE GENUS DICHOPETALA (ORTHOPTERA: TETTIGONIIDÆ).

BY JAMES A. G. REHN AND MORGAN HEBARD.

The possession of the extensive series of this genus secured by us in the southwestern United States in the summers of 1910 and 1912, with the acquisition by the junior author of the very important representation of the same group contained in the Bruner Collection, prompted us to make a detailed study of this interesting but previously little-known genus of long-horned grasshoppers. The scope of our work became so extended that practically all the material of the genus in American collections was finally examined. The few types contained in European collections were relatively unimportant. Our work has required the description of a number of new forms and the synonymizing of several old ones.

The color descriptions have been based on Ridgway's recent set of color standards.[1]

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1900. *Dichopetala* Scudder, Proc. Davenp. Acad. Nat. Sci., VIII, p. 67.
1900. *Dichopetala* Rehn, Trans. Amer. Entom. Soc., XXVII, p. 88.
1901. *Dichopetala* Rehn, Entom. News, XII, p. 207.
1902. *Dichopetala* Rehn, Trans. Amer. Entom. Soc., XXVII, p. 335.
1902. *Dichopetala* Scudder and Cockerell, Proc. Davenp. Acad. Sci., IX, p. 51.
1902. *Dichopetala* Morse, Psyche, IX, p. 381.
1906. *Dichopetala* Kirby, Synon. Catal. Orth., II, p. 388.
1907. *Dichopetala* Rehn, Proc. Acad. Nat. Sci. Phila., 1907, p. 56.
1909. *Dichopetala* Rehn and Hebard, *ibid.*, 1909, p. 167.
1912. *Dichopetala* Hunter, Pratt and Mitchell, Bull. 113, Bureau of Entom. U. S. Dept. of Agric., p. 50.

This genus was based on two species—*mexicana* and *emarginata* Brunner.

GENOTYPE: *Dichopetala mexicana* Brunner (selected by Kirby, 1906).

The genus is a member of the Phaneropterinæ and of the group Odonturæ, constituting with the genera *Odontura* Rambur, *Pseudisotima* Schulthess, *Epiphlebus* Karsch, *Atlasacris* Rehn, *Peropyrrhicia*

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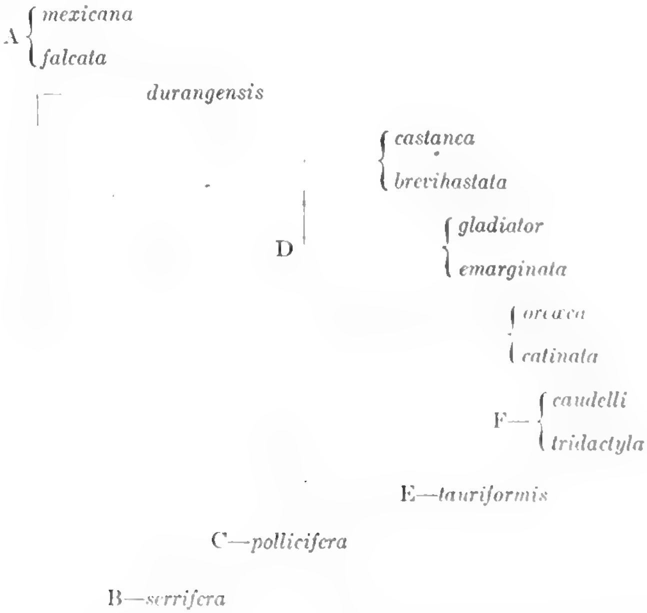
[1] Color Standards and Color Nomenclature. By Robert Ridgway. Washington, D. C., 1912.

and *Angara* Brunner a section of the group. Of these genera all are exclusively Old World except *Angara*, which is Brazilian.

Generic Description.—Fastigium of vertex more or less compressed, short, not or distinctly sublamellate, not at all sulcate or finely sulcate proximad, more or less in contact with facial fastigium. Antennæ subcrassate proximad, from two to five times the length of the body. Pronotum not at all, or more or less constricted mesad, dorsum more or less arcuate in transverse section; caudal margins of lateral lobes more or less arcuate or subtruncate. Tegmina in male abbreviate; anal field extending nearly the entire length of tegmen; sutural margin at apex of stridulating vein obtuse-angulate to rectangulate produced. Tegmina in female very short, not reaching or distinctly surpassing the caudal margin of the metanotum, overlapping, subcontiguous, or more or less decidedly remote from one another; distal margin of female tegmina arcuate to truncate. Abdomen more or less dilated; disto-dorsal abdominal segment with distal margin emarginate, bisinuate, truncate or arcuate, supra-anal plate simple or (in ♂ of *tauriformis*) bearing a dorsal erect T-shaped structure. Cerci of male incurved, acute, falciform, simple, with dorsal margin rarely serrato-dentate or with median tooth or lobe on dorsal or external face, occasionally with an accessory digitiform lobe from base. Subgenital plate of male broad and short or produced, more or less narrowed distad, free lateral margins concave, subparallel or converging, distal margin truncate or more or less deeply and completely V- or obomegoid emarginate, unicarinate or tricarinate ventrad. Ovipositor from one and one-half to three times the length of pronotal disk, more or less arcuate, apex more or less acuminate and with its margins serrato-dentate. Subgenital plate of female emarginato-truncate, arcuato-emarginate, or more or less completely divided into two halves, these more or less acute distad. Limbs more or less elongate. Cephalic femora from one and one-half to three times as long as the disk of the pronotum in the male, one and one-third to two and one-half times in the female. Caudal femora from four to nearly seven times the length of the pronotal disk in the male, from four to five and three-fourths times in the female.

Classification.—From a systematic standpoint, the characters of greatest value in the differentiation of the species are: in both sexes, general form of the body and shape of the eyes; in the male, form of the pronotum, form of the tegmina, form of the cerci and subgenital plate; in the female, form of the pronotum, form of the tegmina, relative size and width of space between the tegmina, form of the ovipositor and that of the subgenital plate. The general form is much more robust in some species than in others, the females almost always more robust than the males, in *falcata* and *pollicifera* less different in this respect than in the other forms. The outline of the eye is, in a few cases, of assistance in distinguishing females of closely allied forms, as *castanea* and *brevihastata*. The pronotum ranges from not at all constricted, to decidedly constricted mesad in both sexes. In the male sex the tegmina show modifications in the form of the margins and the width of the fields, the prominence of the stridulating vein and the projection of the sutural margin at the apex of the same vein. The tegmina of the female are as diagnostic as the more complex appendages of the male, their relative position and the interspace between the same, as well as the form of their margins, being of importance. The characters of the genitalia of the two sexes are discussed in detail below.

Morphological Notes on Male Genitalia.—The variation in structural form in the cerci of the male covers a number of types which show six different lines of development, relatively as follows:



The position of *durangensis* is more or less problematical, as we have only nymphal males.

The extremes in structural variation in the form of the cerci are a simple incurved falciform type, found in the group A, and one with a median tooth and an accessory lobe from the base, found in group F. The general cercal structure of the various groups can be presented best in tabular form.

Group A
mexicana
falcata
Simple, falciform.

Group B (*serrifera*).—Simple, dorsal margin serrato-dentate.

Group C (*pollicifera*).—With an external median tooth.

Incertæ sedis (*durangensis*).—With evidence of a dorsal median tooth.

Group D
castanea
brevihastata
gladiator
emarginata
oreœca
catinata
With a dorsal median fork, developing from a simple tooth to a large flattened lobe covering the greater portion of the distal section of the cercal shaft.

Group E (*tauriformis*).—With a greatly developed lobiform median tooth arising from the external margin of the shaft, the distal portion of the latter peculiarly modified. A transverse proximal lamella present dorsad on the shaft.

Group F
tridactyla
caudelli
With a dorsal median tooth and an accessory digitiform lobe from the base of the shaft.

The species in group D exhibit a regular development in the form of the dorsal median fork from a simple median tooth which becomes depressed and flattened, spreading laterad until it is as wide as the proximal portion of the shaft, to the other extreme which has it modified into a great inverted spoon-like plate covering the greater portion of the cercal shaft. The peculiar digitiform accessory appendage of *tridactyla* and *caudelli* springs from a proximal transverse ridge, which is apparently homologous with the more decided transverse lamella found in the same region in *tauriformis*.

From the evidence of eighteen immature males, belonging to six species (*durangensis*, *brevihastata*, *gladiator*, *oreœca*, *catinata*, and *pollicifera*), it is evident that the separation of the median fork of the cercus is never accomplished before the mature condition. Of *brevihastata* and *pollicifera* we have material representing two consecutive instars, one preceding the mature condition, the other species being represented by this stage alone. In the forms of which we have two stages no indication of the lobe is apparent in the earlier instar, while in the other stage, in all of the species represented in this condition, there is a more or less distinct indication of an incipient lobe or tooth, this being most pronounced in *durangensis* and *catinata*. In the latter this embryonic lobe is more definitely formed than in *durangensis*, consisting of an ovate vertical area of relatively large size. In the closely related *oreœca*, the incipient lobe is not vertical, but horizontal in position.

The male subgenital plate is very varied in form, the distal margin ranging from truncate with lateral styliform processes to obomegoid emarginate; the general form broad with the distal portion little produced and narrowed, the lateral angles more or less blunted, to an opposite extreme, elongate, narrow, concave laterad with the lateral angles acute, between which extremes are a number of modifications of one or the other. Quite curiously, there exists no correlation between certain forms of cerci and certain forms of the subgenital plate, forms nearly related in cercal structure, as *oreœca* and *catinata*, having very different subgenital plates.

Morphological Notes on Female Genitalia.—The ovipositor ranges in general form from the elongate, very slender, decidedly arcuate type seen in *gladiator*, and the elongate robust type with a more or less straight ventral margin as found in a number of species, to a short, moderately arcuate form seen in *castanea* and *brevihastata*. It is evident that there is considerable individual variation in the depth of the ovipositor, this being very apparent in those species represented by considerable series, so much so that the extremes have different facies, but the major portions of such series always bridge the apparent gaps. In ovipositor length there is marked variation in *gladiator* and *brevihastata*, this being most apparent in the former species, the extremes of which are quite different in appearance. We have before us ten female nymphs which we can positively refer to five species (*durangensis*, *brevihastata*, *gladiator*, *oreœca*, and *pollicifera*). Of *durangensis* we have represented the second instar preceding maturity, of *brevihastata* the two preceding maturity, and of the other three species the instar preceding maturity. From this material it is evident that the development of the ovipositor is very rapid, but in no case do the external margins acquire distal teeth until the mature condition is reached. In one specimen which is apparently on the eve of the last ecdysis (the type of *lævis*) the teeth of the enclosed ovipositor can be seen through the sheath when it is held to the light.

The subgenital plate of the female presents great diversity in development, which in its details are not always correlative with apparent affinities. These diversities can be placed in two categories, one (*mexicana*, *falcata*, *durangensis*, *castanea*, and *brevihastata*) with the plate entire, the other (comprising the remaining species) with it divided completely in two, at least as far as the chitinous portion is concerned. In the first section we have from an extreme which is very broad and short, with the distal margin emarginato-truncate, to one of a similar general form with the margin bisinuate to arcuato-emarginate. In the second section we have even greater diversity, the paired lobes varying from broad to very narrow, blunted to aciculate, the general form of the margins differing to a lesser degree. In the forms with an entire subgenital plate, the distal margin has a different appearance when the plate is flat or when it is compressed; which factor should always be considered in determining the character of this margin. For the sake of uniformity, we have endeavored to give the character of this margin from the plate were it flattened out.

Notes on Tegminal Structure.—In the male the tegmina are more ample in *oreœca* and more reduced in size in *tridactyla* than in the other species. The angle of the sutural margin is very greatly produced in *tridactyla* and on the other hand almost imperceptible in *catinata*. The stridulating vein is apparent in all the forms of the genus, but variable in strength and curvature, while the tympanum is also of variable form and definition. In the female the considerable variation in form and position indicated in the generic description is not correlated with the general relationship of the forms, as certain species with overlapping quadrate tegmina and others with nearly contiguous similarly shaped tegmina occur in sections of the genus which on sum total of characters are well removed from one another. The reduction of the female tegmina has proceeded further in *emarginata* than in any other form of the genus, as there they are decidedly lateral and very small, while the development of the tegmina in the same sex is most marked in *falcata*, where they are overlapping, covering all of the metanotum and the greater portion of the proximal dorsal abdominal segment. The venation in the female tegmina is always generalized, being more complex in *falcata* than in any of the other forms.

Color Pattern.—The color pattern of all of the forms of this genus is similar in several respects; first, in the possession of pale paired lines extending from the eye caudad to the apex of the abdomen and, second, in the general uniformity of the lateral and ventral color. In the majority of the forms the color of the dorsum between the pale lines is more or less uniform and, for convenience in describing the extent and character of the pattern, we have referred to this as the dorsal color, the ventral and lateral tones as the lateral color, and the pale paired lines and their developments as the pale pattern. The range of tone in all three of these principal components of the coloration is very considerable, the extreme on one hand having the pattern intense, the contrasts decided and the tones darker and richer, while in the other extreme the pattern is dilute, the contrasts poor and the tones paler and weaker. To facilitate reference to these extremes we have termed them the intensive and recessive extremes. In the recessive condition the pale pattern is frequently much restricted as well as weakened, while the dorsal color is often but little, in part only, or not at all different from the lateral color.

Distribution.—Extending from north-central Texas (Dallas), southern New Mexico (Dry Canyon and Mesilla Valley) and central southern Arizona (Tumamoc Hill and Sycamore Canyon), south to the upper Rio Balsas Valley in Guerrero, Mexico, on the west reaching Tepic and on the east the vicinity of the coast at Corpus Christi and Brownsville, Texas, and Tamos, Vera Cruz, Mexico. Vertically the genus ranges up to at least 6500 feet (in the Davis Mountains, Texas). It reaches its greatest diversity in southern Texas and the northern and central parts of the Mexican tableland.

History. In 1878, Brunner[2] erected the genus for two species then described, viz., *mexicana* (from Mexico) and *emarginata* (from Texas). In 1880, Bormans[3] described a species from Schoa, Abyssinia, as *Dichopetala massaiæ*, which has since been placed in the genus *Peropyrrhicia*, which is exclusively African. Scudder, in 1900, described[4] a *Dichopetala brevicauda* from California, which we now know to be an *Arethæa* and not at all related to *Dichopetala*. In 1901, Rehn[5] described a new form from Mexico as *D. pulchra*, basing it on material which he had previously recorded as *mexicana*. Scudder, in 1902, in Scudder and Cockerell's list of New Mexican Orthoptera[6] described as new a species of the genus from New Mexico, calling it *Dichopetala brevicauda*, but as that name was preoccupied, Morse, at Scudder's suggestion, renamed the species *D. brevihastata*.[7] In 1907, Rehn described a species from Arizona as *D. lævis*.[8]

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[2] *Monogr. der Phaneropt.*, p. 76.
[3] *Ann. Mus. Civ. Stor. Nat.*, Genova, XVI, p. 218, fig.
[4] *Canad. Entom.*, XXXII, p. 331.
[5] *Entom. News*, XII, p. 207.
[6] *Proc. Davenp. Acad. Sci.*, IX, p. 51.
[7] *Psyche*, IX, p. 381.
[8] PROC. ACAD. NAT. SCI. PHILA., 1907, p. 56.

Material.—In the preparation of the present paper the types of the following species have been before us:

(*Dichopetala pulchra* Rehn, synonym of *D. mexicana* Brunner.)
Dichopetala falcata n. sp.
Dichopetala serrifera n. sp.
Dichopetala durangensis n. sp.
Dichopetala pollicifera n. sp.
Dichopetala tauriformis n. sp.
Dichopetala castanea n. sp.
Dichopetala brevihastata Morse.
(*Dichopetala lævis* Rehn, synonym of *D. brevihastata* Morse.)
Dichopetala gladiator n. sp.
Dichopetala oreœca n. sp.
Dichopetala catinata n. sp.
Dichopetala tridactyla n. sp.
Dichopetala caudelli n. sp.

The entire series of the genus examined by us numbers 362 specimens. The great majority of these (239) were taken by the authors on recent trips and are located in the Hebard Collection and that of The Academy of Natural Sciences of Philadelphia. Of the remainder of the representation we have had before us, 37 specimens were from the Hebard Collection ex Brunner; 27, comprising the entire series of the genus in the United States National Museum, were examined through the kindness of Mr. A. N. Caudell; 50, forming the entire series in the Scudder Collection, were either loaned or made accessible to us by Dr. Samuel Henshaw, of the Museum of Comparative Zoölogy, and a few specimens each were loaned by the authorities of the Field Museum and the American Museum of Natural History. To the above-mentioned gentlemen and the authorities of these museums we wish to express our hearty thanks for their assistance in the work. We have, with their coöperation, been able to examine almost all of the material in America on which the records of the genus were based. Aside from the typical material of the two original species of the genus, no recorded specimens of the group exist in other collections.

KEY TO THE SPECIES.

Males.

A.—Cercus subfalciform, non-furcate.
  B.—Cercus non-serrate.
    C.—Length of pronotum equal to one-third that of cephalic femur. Subgenital plate produced into lobes .... *mexicana* Brunner.

CC.—Length of pronotum equal to two-thirds that of cephalic femur. Subgenital plate not produced into lobes...... *falcata* n. sp.

BB.—Cercus with the dorsal margin serrate. (Subgenital plate broadly subtruncate with decided lateral substyliform appendages.)...... *serrifera* n. sp.

AA.—Cercus with a median fork (either tooth or lobe). (No accessory digitiform lobe from base of cercus.)

B.—Subgenital plate little produced. (Cercus with median tooth simple. Eyes ovate.)...... *castanea* n. sp.

BB.—Subgenital plate distinctly produced meso-caudad.

C.—Subgenital plate greatly produced. Cercus with the tooth very long, as long as the remainder of the shaft, and needle-like distad ...... *tauriformis* n. sp.

CC.—Subgenital plate moderately produced. Cercus with the tooth not as long as the remainder of the shaft and not needle-like distad.

D.—Cercus with the median tooth blunt and simple. (Eyes elliptical.)...... *brevihastata* Morse.

DD.—Cercus with the median tooth depressed and lamellate.

E.—Cercus with the median lobe (*i.e.*, tooth) acute, not rounded when seen from the dorsum, placed on the external margin of the cercus. Pronotum little constricted mesad. General coloration green ...... *pollicifera* n. sp.

EE.—Cercus with the median lobe generally rounded when seen from the dorsum, placed on the dorsal face of the cercus. Pronotum moderately constricted mesad. Coloration variegated.

F.—Subgenital plate with the distal margin weakly emarginate and the lateral angles blunted...... *gladiator* n. sp.

FF.—Subgenital plate with the distal margin decidedly emarginate and the lateral angles acute (variable in degree) ...... (?) *durangensis* n. sp.

G.—Median lobe of cercus decidedly shorter than the proximal half of the cercal shaft ...... *emarginata* Brunner.

GG.—Median lobe of cercus at least as long as the proximal half of the cercal shaft, spoon-like in shape and inverted over the shaft.

H.—Margins of the cercal lobe converging distad, apex hardly truncate, ventral margin of the lobe decidedly cingulate ...... *oreœca* n. sp.

HH.—Margins of the cercal lobe hardly converging distad, the apex subtruncate, ventral margin of the lobe weakly cingulate ....*catinata* n. sp.

AAA.—Cercus with a dorsal median tooth and an accessory digitiform lobe attached at the dorsal base.

B.—Tegmina shorter than the pronotum, the portion of the anal field of former distad of stridulating vein very brief, sutural margin at apex of this vein decidedly produced. Cercus with the median tooth proportionately longer...*tridactyla* n. sp.

BB.—Tegmina longer than the pronotum, the portion of the anal field of former distad of stridulating vein normal, sutural margin at apex of this vein slightly produced. Cercus with the median tooth proportionately shorter, *caudelli* n. sp.

Females.

A.—Ovipositor very decidedly longer than the head and pronotum together.[9]

B.—Tegmina slightly overlapping mesad.

C.—Ovipositor hardly or not at all longer than half the length of the caudal femora. Subgenital plate not produced laterad into large trigonal lobes.

D.—Size large (body 21.5 mm., pronotum 6.9, ovipositor 14.5). Ovipositor slenderer ....*falcata* n. sp.

DD.—Size medium (body 15.5–18.2 mm., pronotum 4.1–4.3, ovipositor 10.2–10.5). Ovipositor more robust.................................... *durangensis* n. sp.

CC.—Ovipositor distinctly longer than half the length of the caudal femora. Subgenital plate produced laterad into large trigonal lobes. (Size medium; pronotum not sellate.)..*tauriformis* n. sp.

BB.—Tegmina not attingent or subattingent mesad.

C.—Subgenital plate compressed, truncate, shallowly arcuato-emarginate or biconvexo-emarginate distad. *mexicana* Brunner.

CC.—Subgenital plate with distal margin very profoundly triangularly emarginate or broadly divided to the base.

D.—Form slender, subcompressed. Pronotum narrow, elongate (of the type usual in the genus). Limbs and ovipositor proportionately longer than in the opposite category.

E.—Subgenital plate with lateral apices very acute, more or less spiniform.

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[9] Occasional specimens of *D. brevihastata*, which belong to the opposite category, have the ovipositor appreciably though not decidedly longer than the head and pronotum. These specimens are exceptional and do not represent the average condition of the species.

F.—Ovipositor with ventral margin nearly straight except at distal extremity. Tegmina small .... *emarginata* Brunner.
FF.—Ovipositor with ventral margin more (*gladiator*) or less (*oreœca*) arcuate. Tegmina medium sized.
G.—Size large. Ovipositor slender. Limbs very elongate .... *gladiator* n. sp.
GG.—Size medium. Ovipositor more robust. Limbs moderately elongate...*oreœca* n. sp.
EE.—Subgenital plate with lateral portions trigonal, but apices blunted, non-spiniform. (Ventral margin of lateral lobes of pronotum distinctly sinuate. Eyes relatively prominent.) .... *catinata* n. sp.
DD.—Form compact and robust. Pronotum not elongate, short. Limbs and ovipositor proportionately shorter, the ovipositor robust.
E.—Ovipositor not quite half as long as the caudal femora; subgenital plate with lobes rotundato-angulate .... *tridactyla* n. sp.
EE.—Ovipositor equal to or slightly more than half as long as the caudal femora; subgenital plate with lobes quite acute .. *caudelli* n. sp.
AA.—Ovipositor slightly or not at all longer than the head and pronotum together.
B. Tegmina separated by nearly or quite their own width. (Eyes elliptical.) .... *brevihastata* Morse.
BB.—Tegmina separated by much less than their own width.
C.—Form more robust. Ovipositor elongate, slender *pollicifera* n. sp.
CC.—Form slenderer. Ovipositor quite robust. *castanea* n. sp.

Dichopetala mexicana Brunner.

1878. *D*[*ichopetala*] *mexicana* Brunner, Monogr. der Phaneropt., p. 77, pl. I, fig. 6. [Cuernavaca, Morelos, Mexico.]
1897. *Dichopetala mexicana* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 315.
1900. *Dichopetala mexicana* Rehn, Trans. Amer. Entom. Soc., XXVII, p. 88. [Rio Cocula, Guerrero, Mexico.]
1901. *Dichopetala pulchra* Rehn, Entom. News, XII, p. 207. [Rio Cocula, Guerrero, Mexico.]

This species needs comparison only with *D. falcata* (*vide infra*), from which the male can be immediately separated by having the subgenital plate exserted in lobes, the female by having the tegmina not overlapping and both sexes by the proportionately more elongate limbs.

Types: ♂ and ♀; Cuernavaca, Morelos, Mexico. [Brunner Collection.]

We here describe a topotypic female from the Hebard Collection. (data: Cuernavaca, Mexico; January 4, 1899).

Description.—Size medium; form subcompressed. Head with the occiput subglobose, strongly descending to the antennal fossæ; fastigium compressed, short, subcultriform-lamellate dorsad, apex rounded when seen from the side and not projecting cephalad of the antennal scrobes, almost touching the facial fastigium; face, genæ, clypeus and labrum glabrous; eyes ovate in basal outline, moderately prominent; antennæ incomplete. Pronotum with the greatest dorsal length subequal to the greatest ventral width (across lobes) of same; dorsum of pronotum with the impressed transverse sulcus distinct, broadly V-shaped, placed mesad, the dorsum slightly constricted at the same point; cephalic and caudal margins of disk subtruncate; lateral lobes of pronotum with the greatest depth contained one and two-thirds times in the greatest dorsal length of the same, ventral margin subtruncate, cephalic and caudal angles of the same margin rounded, transverse sulcus marked only on the dorsal portion of the lobes and there descending obliquely ventro-cephalad. Tegmina very short, reaching the caudal margin of the metanotum, much broader than long, the greatest length contained twice in the greatest width, distal margin broadly arcuate, disto-costal and disto-sutural angles broadly rounded, sutural margins narrowly separated. Abdomen heavy; cerci very short, crassate, substyliform, the apex rather sharply attenuate; ovipositor heavy, robust, the length half that of the caudal femora, dorsal margin moderately arcuate, ventral margin straight for the median three-fourths, strongly arcuate proximad and distad,

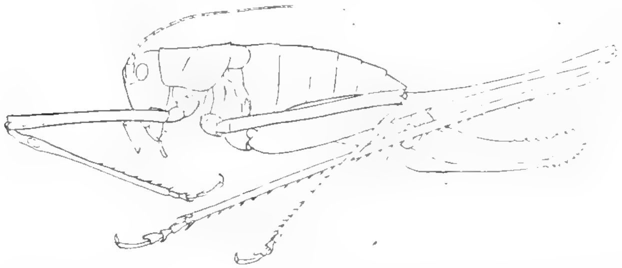

Fig. 1.—*Dichopetala mexicana* Brunner. Lateral outline of topotypic female. (× 2.)

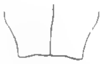

Fig. 2.—*Dichopetala mexicana* Brunner. Ventral outline of subgenital plate of topotypic female. (× 4.)

the proximal half of the whole ovipositor in consequence tapering to the middle, thence subequal in width to the subacute apex, dorsal margin strongly serrato-dentate for a third of its length from the apex, with nine to ten teeth, ventral margin armed in a similar fashion for a fourth of its distal length, with seven to eight teeth; subgenital plate moderately transverse, lateral margins broadly convergent, distal margin broadly and shallowly arcuato-emarginate, the lateral angles forming very short rectangulate lobes. Cephalic femora with the length slightly greater than the dorsal length of the ovipositor, slightly less than the ventral length of the ovipositor; cephalic tibiæ slightly longer than the femora, spined on all the margins, foramina elliptical. Median femora very slightly longer than the cephalic pair. Caudal femora about two and one-third times the length of the cephalic femora, moderately inflated proximad, ventral margins unspined, genicular lobes spined; caudal tibiæ surpassing the length of the femora by about the length of the pronotum, dorsal margins more heavily spined than the ventral ones.

Description of the Male Type (from Brunner).—Tegmina of male with the internal margin having a considerably produced angle. Cerci of male robust at base, not far from base horizontally incurved at a right angle, attenuate, compressed, acute acuminate. Subgenital plate of male very much flattened, attenuate in the middle, exserted caudad in two lobes.

Measurements (in millimeters).

	Cuernavaca, Mex.			Rio Cocula, Mex.
	♂ (Type, ex Brunner).	♀ (Type, ex Brunner).	♀ [Hebard Coll.]	♀ (Type of *pulchra*.). [A.N.S.P.]
Length of body (exclusive of ovipositor)	18.	15.	17.5	20.
Length of pronotum	3.5	4.	5.	4.5
Greatest caudal width of disk of pronotum			3.7	3.2
Length of tegmen			1.6	1.
Greatest width of tegmen			2.6	2.2
Length of cephalic femur	10.	9.	10.	11.
Length of median femur			11.4	12.
Length of caudal femur	24.	23.	25.6	24.5
Length of ovipositor		12.	12.3	11.2

Color Notes.—The original color characters given by Brunner are as follows (paraphrased): Green. Occiput rufous, with a fine median line of sulphur. Pronotum rufous, disk fuscous, marked with longitudinal lines of sulphur, approximating mesad. Tegmina of male green, disk fusco-maculate, external margin albo-vittate. All of the femora rufescent at their bases, toward the apices green, apex of the caudal femora, as well as the base of the caudal tibiæ, infuscate. Abdomen of male fuscous dorsad, marked with a black line and a broad vitta of sulphur, distal segment of male rufous. Cerci of male nigro-lineate. Subgenital plate of male light green, lobes nigro-marginate internally at termination. Abdomen of female rufo-punctate. Ovipositor with both margins rufescent at apex.

The two females before us show considerable color variation which the following description covers.

General color of the face, genæ, lateral lobes of the pronotum, pleura, and greater portion of the lateral aspect of the abdomen honey yellow to dull green yellow, ventral aspect of the body similar but inclining toward wax yellow. Dorsal aspect of pronotum, fastigium, occiput, dorsum of abdomen, and dorsal portion of lateral aspects of the latter brick red to claret red. Eyes buckthorn brown to raw sienna, crossed obliquely by a fine seal brown line; antennæ with the two proximal joints largely morocco red to claret brown, remaining joints of dorsal color; ventral portion of infra-ocular region, at base of mandibles, with a more or less distinct blotch of claret brown. Pronotum with a pair of narrow discal lines varying from honey yellow to light viridine yellow, these bordered more or less distinctly on one or both (dorsal and lateral) margins by blackish lines, the pale lines regularly diverging cephalad and caudad from the middle of the pronotum; cephalic and caudal margins of the disk more or less distinctly beaded with blackish. Tegmina with the discoidal section of the color of the dorsum of the abdomen, occasionally washed in part with blackish; marginal field of lateral color; distal margin in one specimen edged narrowly with the green of the limbs, sutural region approaching the lateral color in the other specimen. Abdomen with traces of a seal brown pattern bordering the lateral section of the dorsal color, the pattern sometimes enclosing areas of the clear dorsal color and again merely a line of seal brown; marginal beading of segments distinct dorsad, more or less distinct laterad. Ovipositor of lateral color, more or less washed with parrot green, the rufous margining extending to the base on the dorsal margin and little proximad of the armed section on the ventral margin, dorso-proximal section with the sulcus more or less blackish. Limbs absinthe green to claret brown, proximal portion of the cephalic and median femora washed with chestnut when the general color of the femora is green; apices of all the femora, or only the caudal femora, and the adjacent portion of the tibiæ blackish; caudal femora proximad with a reticulate pattern of blackish brown on the lateral face, a central line of which pattern is more or less decidedly indicated; distal portion of the caudal tibiæ and tarsi blackish.

Distribution.—The present species is known only from two localities on the slopes of the upper Rio Balsas Valley in the states of Morelos and Guerrero, Mexico. The species apparently has a range in vertical distribution extending from about 1900 to 5440 feet, from the evidence of the two localities from which it is now known.

Morphological Notes.—The ovipositor, as is usual in species of the genus, varies somewhat in length. The subgenital plate of the female shows considerable variation in the form of the distal margin, ranging from the truncate type originally described, through the moderately arcuato-emarginate condition found in our Cuernavaca topotype, to the moderately decided and distinct obtuse-angulate emarginate condition found in the Rio Cocula specimen. The tegmina of the female have a certain amount of variation in the distal margin of the same, this being more truncate in one of our specimens than in the other. There is also some little variation in the width of the interspace between the tegmina in the same sex.

Synonymy.—The senior author is responsible for the only synonym of the present species—*D. pulchra.* The female specimen on which that synonym was based was first recorded correctly by him as *D. mexicana*, but later differences in the subgenital plate were noticed which seemed of specific value, and the individual was separated as *D. pulchra*, its closest relationship being supposed to be with *D. emarginata.* The apparent difference on which this separation was made we now know to be untrustworthy, as the amount of compression of the plate produces a different form in the margins of the same. A certain amount of individual variation in the emargination of this plate is also evident from the form of it in the three known individuals of that sex.

Remarks.—Owing to our lack of male individuals of this species, the type of that sex being unique as far as known, we have placed the species in the male key from the evidence of the original description.

Specimens Examined.—2; 2 females.

Cuernavaca, Morelos, Mexico, January 4, 1899, 1 ♀. [Hebard Coll.]

Rio Cocula, Guerrero, Mexico, May 12, 1898, (Otis W. Barrett), 1 ♀. TYPE of *pulchra.* [A. N. S. P.]

Dichopetala falcata n. sp.

This species belongs to the same section of the genus as *mexicana*, but differs in the greater general size, the shorter limbs of the male, in the tegmina being overlapping in the female, the male subgenital plate being without exserted lobes, in the same portion in the female being distinctly emarginate and in the greater length of the ovipositor.

TYPE: ♂; Tepic, Mexico. (Eisen.) [Hebard Collection.]

Description of Type.—Size quite large (for the genus); form comparatively robust. Head with its greatest width contained about one and one-half times in the depth; occiput well inflated, steeply declivent to the very short, compressed, and sublamellate fastigium, the apex of which is very bluntly recurved, very slightly separated from the apex of the facial fastigium; eyes small, elliptical in outline, the length about equal to half that of the infra-ocular portion of the genæ; antennæ elongate, proximal joint subdepressed. Pronotum with the greatest dorsal length subequal to the greatest width across the ventral portion of the lateral lobes, dorsal line when seen from the side straight, the whole dorsum slightly constricted mesad when viewed from the dorsal aspect; cephalic margin of disk moderately arcuato-emarginate, caudal margin truncate; but a single complete transverse sulcus present, this entering the disk laterad at the middle and on the middle of the disk strongly arcuate caudad; lateral lobes distinctly longer than deep, the greatest depth contained one and one-half times in the length of the same, ventro-cephalic angle very narrowly rotundato-rectangulate, caudal margin obliquely rotundato-truncate,

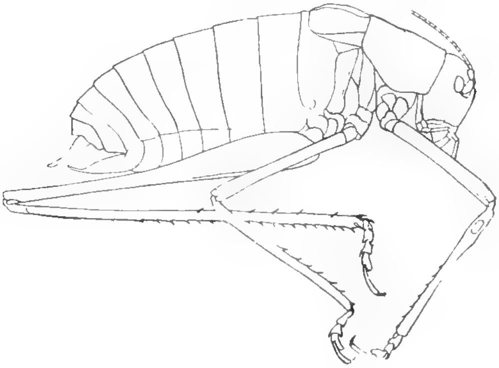

Fig. 3.—*Dichopetala falcata* n. sp. Lateral outline of type. (× 2.)

ventro-caudal angle very broadly rotundate, ventral margin slightly arcuato-emarginate. Tegmina with their exposed length about three-fourths that of the dorsum of the pronotum, broad, the greatest width slightly exceeding the length of the same, the general form subquadrate; marginal field regularly narrowing distad, distal extremity broadly arcuato-truncate, disto-costal angle narrowly rounded, sutural margin with the proximal angle distinct, subrect, thence the margin is obliquely biundulate to the distal margin; texture of the tegmina coriaceous, the principal veins poorly indicated, interstices obscurely and irregularly reticulate, stridulating vein strongly indicated. Disto-dorsal abdominal segment transverse, a rectangular depressed area present mesad; supra-anal plate transverse trigonal, the apex distinctly produced in a short slightly upturned acute process; cerci simple, depressed, falciform, the proximal third moderately broad, slightly lamellate laterad, distinctly tapering from the proximal third, the internal margin regularly arcuate, the external one with a rounded angle where the proximal lamellation disappears, the form of the whole cercus appearing bent-arcuate in consequence, apex acute; subgenital plate broad, short, narrowing distad, the apex very narrowly subtruncate. Cephalic femora about one and one-half times the length of the dorsum of the pronotum. Median femora nearly twice the length of the pronotum. Caudal femora with their length not greatly inferior to that of the body, distinctly but not greatly inflated proximad, ventral margins unarmed, genicular lobes very weakly or not at all spined; caudal tibiæ distinctly but not greatly exceeding the femora in length, dorsal spines more numerous than the ventral ones.

Fig. 4.—*Dichopetala falcata* n. sp. Outline of apex of abdomen of type seen from the dorsum. (× 3.)

Fig. 5.—*Dichopetala falicata* n. sp. Outline of ovipositor of allotype. (× 2.)

Allotype: ♀; Tepic, Mexico. (Eisen.) [Hebard Collection.]

Description of Allotype.—Differing from the type in the following characters: Pronotum with the dorsal length slightly greater than the greatest ventral width across the lobes, median constriction extremely slight, hardly evident, cephalic margin emarginato-truncate, caudal margin truncate. Tegmina shorter, their exposed length no greater than half of the pronotal length, decidedly broader than long, margins as in the male, the sutural margins overlapping for the greater portion of their length, with their form much the same as in the male. Disto-dorsal abdominal segment and the supra-anal plate similar in form to that found in the male, but the terminal tubercle of the latter is broader and less evident; cerci very short, crassate, tapering, apex acute; ovipositor with the length about one and one-half times that of the cephalic femora, moderately heavy, the dorsal margin regularly and distinctly arcuato-concave, ventral margin straight except at the extreme proximal and distal extremities, at the latter well arcuate dorsad to the subacute apex, for the distal third of the dorsal and a fourth of the ventral margins strongly serrato-dentate; subgenital plate transverse, distal margin bisarcuate emarginate, produced into brief trigonal lobes laterad. Cephalic femora slightly less than one and one-half times the length of the disk of the pronotum. Median femora about one and two-thirds times the length of the pronotum. Caudal femora with their length distinctly exceeding that of the body (exclusive of that of the ovipositor).

Measurements (in millimeters).

	Tepic, Mex.	
	♂ (Type.)	♀ (Allotype.)
Length of body	23.	21.5
Length of pronotum	5.5	6.9
Greatest ventral width of pronotum	5.7	6.3
Length of tegmen	4.2	3.3
Length of cephalic femur	8.	9.2
Length of median femur	10.	11.
Length of caudal femur	21.5	25.
Length of caudal tibia	23.	26.5
Length of ovipositor		14.5

Color Notes.—Both specimens of this species seen by us have been at some time immersed in a liquid preservative which has completely removed their original color, leaving them in general a pale ochraceous. Fortunately, however, sufficient of the pattern remains to enable us to give a few notes on the same. Caudal portion of the occiput, which area is usually covered by the pronotum, seal brown, a very fine postocular line of the same and sometimes a similar weak medio-longitudinal line on the occiput present, the post-ocular continued ventro-cephalad across the eye; antennæ irregularly but very closely and strikingly annulate with seal brown. Pronotum with the disk margined laterad with fine continuations of the postocular lines of the head, subparallel caudad to the transverse sulcus and thence distinctly but not greatly diverging (male), or regularly but very gently diverging throughout their entire length (female). Tegmina with the dorsum darker than the marginal field, the venation of the pale general color on a darker, nearly wine-colored, background, humeral trunk of the darker color. Abdomen with the dorsum of the proximal segments in the male narrowly edged cephalad with seal brown, this portion like that similarly colored on the occiput probably normally concealed; the dorsum of the abdomen separated from the sides by a more or less distinct line, which in position is continuous with the postocular line of the head and pronotum; caudal margin of the dorsal segments in the female more or less distinctly and broadly edged with darker color. Limbs more or less decidedly washed with madder brown, a slight edging of the same color on the dorsal margin of the ovipositor, the terminal teeth of the same tipped with seal brown.

Distribution.—This very striking species is only known from the type locality, the territory of Tepic, western Mexico.

Specimens Examined.—2; 1 male, 1 female.

Tepic, Mexico, (Eisen), 1 ♂, 1 ♀. TYPE and allotype. [Hebard Collection.]

Dichopetala serrifera n. sp.

On account of the peculiarly serrate cerci of the male, this species occupies a unique position, and comparison with other forms is not necessary.

TYPE: ♂; Barranca, twelve kilometers north of Guadalajara, state of Jalisco, Mexico. Altitude not less than 3,500 feet. September 13, 1903. (W. L. Tower.) [American Museum of Natural History.]

Description of Type.—Size medium; form subcompressed. Head with greatest width contained about one and one-half times in greatest depth; occiput moderately declivent to fastigium and antennal scrobes; fastigium low, acuminate, faintly sulcate dorsad, ventrad subattingent with frontal fastigium; eyes moderately prominent, reniform in basal outline, depth about two-thirds that of the infra-ocular portion of the genæ; antennæ incomplete. Pronotum moderately sellate, greatest ventral width about five-sixths that of the dorsal length of the pronotum, greatest caudal width of disk about two-thirds length of same; cephalic margin of disk very broadly and shallowly obtuse-angulate emarginate; lateral margins of disk of pronotum (as indicated by color pattern) slightly converging caudad from the cephalic margin to the middle, thence decidedly diverging to the caudal margin; transverse sulcus rather weak except at median line, crossing margins of disk mesad, broadly V-shaped on disk; lateral lobes with the greatest depth contained one and two-thirds times in the greatest dorsal length of lobes, cephalic margin straight, ventro-cephalic angle obtuse, ventral margin obliquely sinuato-truncate, ventro-caudal angle more or less broadly rounded, caudal margin obliquely subtruncate except for a short dorsal section which is truncate with the caudal margin of the disk. Tegmina subequal to four-fifths the length of the pronotal disk, width of discoidal and anal fields subequal to the caudal width of pronotal disk; marginal field broad, costal margin gently arcuate, strongly arcuate distad, distal extremity of whole tegmen obliquely truncate, sutural margin strongly obtuse-angulate produced at the apex of the stridulating vein, distad of this projection straight and rounding into the distal margin; stridulating vein decided, straight, distal portion of stridulating field with anastomosing short cross veins. Disto-dorsal abdominal segment with main portion of same truncate distad, a broad triangular impressed area indicated; supra-anal plate trigonal with the apex briefly and narrowly fissate; cerci with the proximal half robust proximad, thence decidedly tapering, at the middle the shaft is bent rather sharply meso-dorsad, subdepressed and slightly expanded at the apex, the margins proper unarmed, dorsal face with an elevated ridge bearing ten to eleven teeth of unequal width but subequal length, the distal extremity of

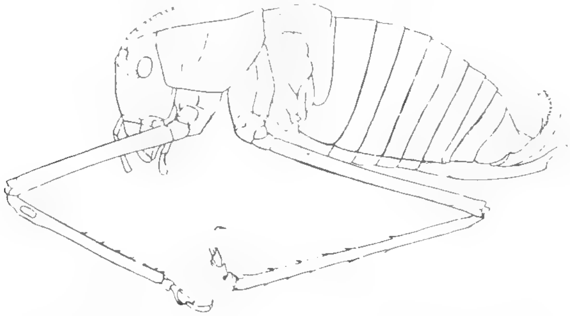

Fig. 6.—*Dichopetala serrifera* n. sp. Lateral outline of type. (× 3.)

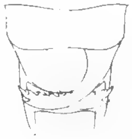

Fig. 7. — *Dichopetala serrifera* n. sp. Outline of apex of abdomen of type from dorsum. (× 3.)

the cercus proper rectangulate, distal extremity of the toothed ridge with the terminal tooth distinctly projecting, immediately proximad of which, on what is properly the lateral margin of the shaft, is placed an extra adpressed tooth; subgenital plate very ample, moderately produced, lateral margins subparallel, distal margin arcuato-truncate, lateral angles produced into considerable styliform appendages, which in length are about equal to one-half the distances between their bases. Cephalic femora slightly more than one and one-half times the length of the dorsum of the pronotum; cephalic tibiæ with foramina elliptical. Median femora one-third again as long as the cephalic femora. Caudal limbs damaged.

Measurements (*in millimeters*).—TYPE: length of body, 16.5; length of pronotum, 5; greatest dorsal width of pronotum, 3.7; length of tegmen, 4; width of discoidal and anal fields of tegmen, 3.3; length of cephalic femur, 8.2; length of median femur, 10.

Color Notes.—General color cinnamon buff. Dorsum of proximal portion of occiput, extending cephalo-laterad as far as the eyes, disk of pronotum, proximal portion of anal field of tegmina, intermarginal section of proximal third of the sutural margin of the same, greater portion of discoidal field of same and dorsum of abdomen, sharply delimited laterad, black. Medio-longitudinal region of pronotum and abdomen with a bar varying from burnt sienna to clay color, this area narrow cephalad on the pronotum, somewhat expanded caudad on same, very poorly defined on abdomen and there broad mesad. Eyes cinnamon brown flecked with blackish brown; antennæ with the two proximal joints touched with claret brown laterad, remaining joints and ventral surface of the two proximal ones black, the simpler joints narrowly annulate with the general color distad. Lateral lobes of the pronotum sparsely and weakly punctulate with bone brown. Tegmina with region of humeral trunk burnt sienna; edge of proximal third of sutural margin of general color. Lateral aspect of abdomen rather heavily punctulate with bone brown; margins of all segments more or less beaded light and dark; a pale unmarked area present on each side of abdomen in the position usually occupied, in species of the genus, by pale bands; disto-dorsal abdominal segment with the black of the dorsum limited to proximo-laterad trigonal areas. Limbs more or less weakly washed with victoria lake, the femora considerably and tibiæ less decidedly lined and speckled in linear fashion with black; tarsi black.

Distribution.—The species is only known from the type locality.

Remarks.—The type of this remarkable species is unique.

Specimens Examined.—1; 1 male.

Barranca, twelve kilometers north of Guadalajara, state of Jalisco, Mexico, elevation about 3,500 feet, September 13, 1903 (W. L. Tower), 1 ♂. Type. [Amer. Mus. Nat. Hist.]

Dichopetala durangensis n. sp.

Related, as shown by the female sex, to *D. falcata*, from which it differs in the much smaller size, the more sellate pronotum, the relatively more prominent and larger eyes, the shorter and more abbreviate tegmina, the more decidedly trigonal extremity of the disto-dorsal abdominal segment and in the much more robust ovipositor. The available males are not mature, but they show conclusively that the species has a median tooth or lobe on the cercus, while *falcata* has the same simple, aside from which the form of the subgenital plate is characteristic. As the females of all of the species except *D. serrifera* are known, we have no hesitation in describing the species without adult males, as the possibility of the present form being the female of *serrifera* is exceedingly remote.

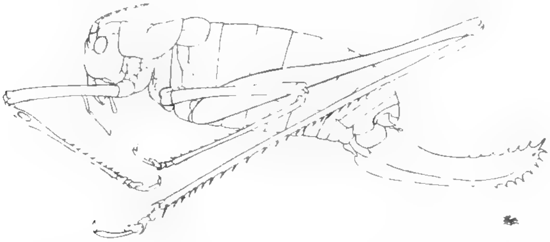

Fig. 8.—*Dichopetala durangensis* n. sp. Lateral outline of type. (× 2.)

Type: ♀; Durango, Mexico. (Palmer.) [Scudder Coll.]

Description of Type.—Size medium; form rather robust. Head with the occiput sharply declivent to the fastigium, strongly arcuate in transverse section; fastigium little elevated, slightly recurved at the apex, elongate, but little compressed, shallowly sulcate dorsad, ventrad touching the fastigium of the face; eyes moderately prominent, ovate, the depth of same at least two-thirds that of the infra-ocular portion of the genæ; antennæ incomplete. Pronotum weakly sellate, broad, the greatest ventral width but slightly surpassing the greatest dorsal length of disk; disk of pronotum with the lateral margins, which are weakly indicated structurally by calloused lines and strongly by color pattern, parallel to the transverse sulcus, which severs the same mesad, thence slightly divergent caudad; cephalic margin of disk weakly arcuato-emarginate, caudal margin of same truncate, width of disk caudad contained about one and one-third times in the length of the same; transverse sulcus forming a broad V-shaped pattern mesad on the disk; lateral lobes of the pronotum with the greatest depth contained one and two-thirds times in the dorsal length of the same, cephalic margin of same very faintly emarginate dorsad, ventro-cephalic angle rotundato-rectangulate, ventral margin moderately sinuato-truncate, ventro-caudal angle broadly rounded, caudal margin obliquely arcuato-truncate. Tegmina with the exposed portion about two-fifths the length of the dorsum of the pronotum, transverse, greatest width about twice the apparent length, considerably overlapping mesad; costal margin obliquely arcuate, sutural margin subtruncate, distal margin subtruncate, disto-sutural angle narrowly rounded; marginal field comprising about two-fifths the entire tegminal width. Supra-anal plate rotundato-trigonal, the distal margin of same slightly thickened and recurved; cerci very short, conical, apex slightly incurved; ovipositor about one-half the length of the caudal femora, moderately falciform, median depth about one-sixth of the length, dorsal margin considerably and regularly arcuate, ventral margin for about three-fourths of the length subtruncate, the distal fourth of the ventral margin strongly arcuate, dorsal margin with distal two-fifths armed with six to seven decided teeth which are well spaced and increasing in length distad, ventral margin armed on distal fourth with nine spines, which increase in length distad and are slightly recurved at the same end of series; subgenital plate small, broadly emarginato-truncate mesad, laterad with short trigonal lobes at the angles. Cephalic femora slightly shorter than length of head, pronotum and tegmina combined, very faintly clavate distad; tibiæ distinctly exceeding the femora in length, tympanum small, elliptical. Median femora one-third longer than the cephalic femora. Caudal femora moderately elongate, proximal dilation moderate, regularly tapering to the narrow subequal distal portion; caudal tibiæ exceeding the femora by about one-half the length of the pronotal disk.

Fig. 9.—*Dichopetala durangensis* n. sp. Dorsal outline of head, pronotum and tegmina. (× 2.)

Notes on Male Sex.—As all the specimens (two in number) of this sex are immature, we can give only a few notes on the genitalia as there found. The cerci are provided mesad on the dorsal surface with the beginning of what is unquestionably in the adult a very decided lobe, the distal margin of which in the nymphal condition is nearly rectangulate, the whole being considerably elevated dorsad of the shaft of the cercus. The distal portion of the cercus is little curved, robust, slightly depressed, the apex acute. Subgenital plate moderately produced, subequal in width, the distal margin deeply rotundato-emarginate, the lateral angles acute, slightly recurved toward the median line.

Paratypic Series.—We have before us two paratypic adult females, one of which is measured below.

Measurements (in millimeters).

	Durango, Mex.	
	(TYPE.) ♀	(Paratype.) ♀
Length of body (exclusive of ovipositor)	15.5[10]	18.2[10]
Length of pronotum	4.3	4.1
Greatest dorsal width of pronotum	3.2	2.9
Length of tegmen	2.	2.
Greatest width of tegmen	3.2	2.9
Length of cephalic femur	7.3	7.5
Length of median femur	8.9	9.
Length of caudal femur	20.2	....
Length of ovipositor	10.5	10.2

Color Notes.[11]—General shade ranging from old gold to oil green, on the pronotum paling (in the old-gold individual) to light viridine green. A pair of narrow lines of blackish are more or less distinctly indicated, extending from the dorsal margin of the eye caudad over the sides of occiput and along the lateral angles of the pronotal disk, margined laterad by a band of empire yellow of varying width and definition. Eyes argus brown, blotched with blackish; antennæ with the two proximal joints ranging from claret brown to burnt sienna, remaining joints blackish with narrow dull apricot yellow distal annuli; occiput more or less washed with very dull weak maroon. Dorsum of pronotum with cephalic half of disk very weakly washed with morocco red, a medio-longitudinal line of

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[10] In both of these females the abdomen has been bent ventro-cephalad and in consequence the length given above is not the real length of the insect, but only the shortest distance between the point of the fastigium and the base of the ovipositor. It is not possible to get a true measurement of length from the present material.

[11] In the present notes only the two well-preserved adults have been used, a few notes on the nymphs being placed at the end.

seal brown present, the latter finely divided cephalo-caudad by a thread of morocco red; cephalic and caudal margins of disk with more or less regular and decided beading of blackish, the whole of the pronotum with a more or less decided sprinkling of bay colored points which vary in intensity with the blackish lateral lines. Tegmina varying from apricot orange to hazel, humeral trunk hay's russet. Abdomen with the proximo-dorsal portion of each segment (these areas hidden when the abdomen is not stretched) blackish, distal margin of segments more or less beaded with blackish or prout's brown, the entire surface dorsad and laterad more or less sprinkled with stipples of the latter color. In line with the postocular line and tegminal humeral trunk there is continued to the apex of the abdomen a pattern, which is indicated by a limiting to the region between the same of the decided marginal beadings and the proximal blackish markings of the segments, or a pale line similar in color to the pale portion of the postocular line. Mesad on the abdomen is indicated more or less distinctly a line similar in color to the above-mentioned yellowish lateral ones. Limbs more or less washed with madder brown, lined and dotted in linear fashion with black; caudal femora proximad of the color of the lateral lobes of the pronotum triply lined with blackish; all tibiæ lined dorsad and laterad with blackish. Ovipositor more yellowish than the general tone, with the dorsal margin more or less maroon. The type has the general color old gold with the abdominal segments blackish proximad. One of the nymphs is nearly uniform parrot green, another ochraceous-tawny, both with pale postocular lines, and the third with the two colors combined, the first cephalad and the second caudad, the limbs and whole dorsum strongly punctulate with black and the lined pattern very decided blackish and whitish, the medio-longitudinal line continued on the head.

Distribution.—The species is only known from Durango, Mexico.

Remarks.—Of the material known belonging to this most interesting and beautiful species, one adult female has been badly damaged in the past by insect pests, so it has not been considered in the previous description. The nymphs are not perfect, but there can be no question of their identity with the adult females.

Specimens Examined.—7; 4 females, 2 male nymphs, 1 female nymph.

Durango, Mexico (Palmer), 3 ♀ (TYPE, paratypes), 2 ♂ nymphs, 1 ♀ nymph. [Scudder Coll.]

Durango, state of Durango, Mexico, November 27, 1909, (F. C. Bishop), 1 ♀. [U. S. N. M.]

Dichopetala pollicifera n. sp.

This very distinct species requires comparison with none of the other forms of the genus, the general build, nearly uniform greenish coloration, depressed external tooth on male cercus and the form of the tegmina readily distinguishing it.

Type: ♂; Brownsville, Cameron County, Texas. July 31–August 5, 1912. (Hebard.) [Hebard Collection.]

Description of Type.—Size medium; form quite robust (for the sex); surface smooth, unpolished. Head not at all elevated dorsad of the level of the disk of the pronotum, occiput roundly but rather decidedly declivent cephalad; fastigium narrow, very acute lanceolate, low, dorsum subsulcate, caudad from the base of the fastigium extends for a short distance a faint elevated line, ventral portion of the fastigium of the vertex touching the fastigium of the front; eyes very prominent, ovate, the greatest width contained about one and one-half times in the depth of the eye, the depth of the eye contained about one and one-half times in that of the infra-ocular portion of the genæ; antennæ filiform, rather heavy, in perfect specimens (the type has the antennæ broken) about three times as long as the body. Pronotum with the greatest (ventral) width but little less than the length of the dorsum of the pronotum, caudal width of the dorsum contained about one and one-third times in the length of the same, dorsum straight cephalo-caudad when viewed from the lateral aspect, appreciably arcuate in transverse section, cephalic margin of the disk emarginato-truncate, caudal margin faintly arcuate, slightly flattened with the faintest possible sinuation mesad, lateral margins of the disk indicated by the usual callous lines.

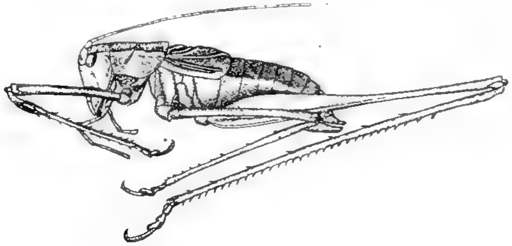
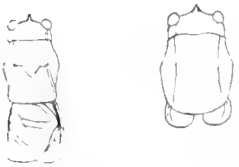


Fig. 10.—*Dichopetala pollicifera* n. sp. Lateral view of type. (× 2.)

Fig. 11.—*Dichopetala pollicifera* n. sp. Outline of apex of abdomen of type from dorsum. (× 4.)

severed once and then by the transverse sulcus, which is placed very slightly cephalad of the middle, subparallel caudad to this sulcus, thence slightly diverging to the caudal margin; transverse sulcus of a V-shaped form mesad; lateral lobes with the greatest depth contained about twice in the greatest (dorsal) length of the same, cephalic margin nearly straight, ventro-cephalic angle nearly rectangulate, ventral margin arcuato-sinuate cephalad and arcuately expanded caudad, rounding into the oblique, slightly arcuate caudal margin, transverse sulcus impressed dorsad. Tegmina with their length subequal to that of the dorsum of the pronotum, their greatest width (not flattened) subequal to their length; costal margin straight with the disto-costal angle well rounded, distal margin bluntly arcuate, passing broadly without any sign of angulation into the strongly oblique and gently arcuate distal portion of the sutural margin, proximal portion of the sutural margin obliquely truncate, at the extremity of the stridulating vein slightly produced, rotundato-rectangulate; marginal field very narrow; discoidal field with a fine, irregular network of veins; stridulating vein slightly oblique, slightly arcuate; tympanum very faintly outlined, trigonal, the sharpest angle directed meso-proximad; proximal portion of the anal field (*i.e.*, proximad of the stridulating vein) closely but rather coarsely areolate. Abdomen quite plump; disto-dorsal abdominal segment strongly arcuato-emarginate laterad by the bases of the cerci; supra-anal plate forming a transverse lappet which has its greatest length contained about three times in its greatest width, distal margin of same truncate, broadly arcuate laterad; cerci simple, heavy, slightly depressed, distal portion of the cercus and median tooth decidedly depressed, the distal portion of the cercus tapering, acute, the immediate apex very fine, clawlike and slightly hooked, median tooth placed on the external face of the cercus, broad, bluntly lanceolate, reaching about half way from the point of its origin to the apex of the cercus, closely apposed to the shaft of the cercus for the greater portion of its length; subgenital plate moderately elongate, V-shaped in section, distal half with the margins moderately and regularly convergent, distal extremity deeply V-emarginate, the emargination extending slightly more than a fourth the way to the base of the plate, laterad of the



Figs. 12 and 13.—*Dichopetala pollicifera* n. sp. Dorsal outline of head, pronotum, and tegmina of male type (12) and female allotype (13). (× 2.)

median emargination the converging lateral margins cause the lateral angles to appear as acute trigonal projections with their immediate angles blunted. Cephalic femora nearly twice as long as the dorsum of the pronotum, slender; cephalic tibiæ appreciably exceeding the femora in length, foramina elliptical. Median femora subequal to the head, pronotum and tegmina in length, similar in build to the cephalic femora; median tibiæ exceeding the femora by about the same proportion as in the cephalic limbs. Caudal femora one and one-third times as long as the body, very moderately inflated in the proximal half, slightly compressed, genicular lobes not distinctly spined, but with a minute point (sometimes absent) at the apex of each lobe; caudal tibiæ surpassing the femoral length by about four-fifths the length of the dorsum of the pronotum.

Allotype: ♀; Brownsville, Cameron County, Texas. July 31–August 5, 1912. (Hebard.) [Hebard Collection.]

Description of Allotype.—The following characters are solely those of difference from the above description of the type, features not mentioned are essentially as in the male sex.

Size large (for the genus); form robust. Head noticeably broad, the greatest width nearly equal to the depth of the head as far as the clypeal suture; fastigium very brief, slightly elevated at the extremity; eyes moderately prominent, slightly compressed, ovoid, their depth contained slightly more than one and one-half times in the depth of the infra-ocular portion of the genæ; antennæ about one and one-half times the length of the body. Pronotum heavy, the dorsum more arcuate in section than in the opposite sex, caudal width of the disk contained one and one-third times in the length of the same, greatest ventral width of the pronotum equal to about five-sixths of the length of the dorsum of the same; cephalic margin of the disk emarginato-truncate, caudal margin of the same moderately arcuate, no appreciable callous bounding lines present on the disk, which rounds into the lateral lobes; transverse sulcus weakly indicated, placed mesad and on the middle of the disk impressed in a broad, V-shaped figure; lateral lobes with the greatest depth contained one and two-thirds times in the dorsal length of the same, margins as in the males but with the ventro-cephalic angle blunter. Tegmina with their apparent length about one-fourth that of the pronotum, their greatest width nearly two and one-half times their visible


Fig. 14.—*Dichopetala pollicifera* n. sp. Outline of ovipositor of allotype. (× 4.)

length, interspace between the tegmina very slightly less than half the apparent length of the tegmina; distal extremity of the tegmina arcuato-truncate, broadly rounding to the costal margin and more narrowly to the sutural margin. Supra-anal plate very broad trigonal, apex very blunt; cerci short, conical, distal portion slightly elongate; ovipositor subequal to the combined length of the head, pronotum and tegmina, the greatest proximal depth contained slightly more than three times in the length of the same, moderately tapering in the proximal two-thirds, moderately arcuate, dorsal margin moderately arcuate, ventral margin with slightly more than the median half of its length nearly straight, considerably arcuate proximad, strongly arcuate distad, general angle of the margins distad slightly more acute than a rectangle, distal fourth of the dorsal margin with seven to eight teeth, low proximad and increasing in length distad, erect, directed disto-dorsad, ventral margin with the distal fourth armed with eight to nine spines, slightly increasing in length distad, the extreme distal ones slightly hooked; subgenital plate small, V-emarginate distad for about half of its length, the portions of the plate laterad of the median emargination present as acute trigonal lobes, the apex of which is slightly beyond the general form of the lobe. Cephalic femora about one and one-half times the length of the dorsum of the pronotum, more robust than in the male sex. Median femora about a third again as long as the cephalic femora. Caudal femora slightly more robust than in the male, but of similar proportions.

Paratypic Series.—A series of fourteen males and eight females bearing exactly the same data as the type and allotype have been selected as paratypes.

Measurements (in millimeters).

	Brownsville, Tex.		
	(Type.)	(Paratypes.)	
Length of body	16.	17.	15.
Length of pronotum	4.2	4.4	3.8
Greatest dorsal width of pronotum	3.2	3.2	3.2
Length of tegmen	4.2	4.	4.2
Greatest width of discoidal and anal fields of tegmen	3.8	3.8	3.3
Length of cephalic femur	8.	6.[12]	7.3
Length of median femur	9.5	10.6	9
Length of caudal femur	21.5	22.3	19.4

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[12] Regenerated limb. The other cephalic limb is lacking.

	♀ ♀ Brownsville, Tex.		
	(Allotype.)	(Paratypes.)	
Length of body (exclusive of ovipositor)	18.	21.	16.
Length of pronotum	5.7	5.6	5.5
Greatest width of dorsum of pronotum[13]	4.2	4.3	4.
Apparent length of tegmen	1.4	1.5	1.4
Greatest width of entire tegmen	3.	3.	2.5
Length of cephalic femur	8.4	8.1	8.9
Length of median femur	10.2	10.	10.4
Length of caudal femur	24.	23.8	23.5
Length of ovipositor	9.5	9.3	9.

In size the type represents what is the average of the entire male paratypic series, practically none but the extremes measured above varying appreciably from the more general size. The allotype is in most measurements the maximum extreme for the female sex, from which the series grades rather evenly to the minimum measurements given for that sex. The length of the body is an uncertain measurement, as it depends so largely on the stuffing of the abdomen, and, while the present series was stuffed in its entirety by the authors, a certain amount of variation in bulk is impossible to prevent. The length of the cephalic femora, particularly in the female sex, shows appreciable variation—in females of approximately the same bulk measuring 7.8 and 9.2 mm. This variation is also noticed in the median femora, while the tibiæ of the respective limbs vary proportionately. Such variation in the length of the caudal femora as is evident is of a far less degree and not disproportionate to the general bulk variation. The tegmina of the male show some variation in length, never being shorter than the pronotal length, but occasionally surpassing the same.

Color Notes—The general pattern of the male sex consists of a dorsal shade covering the dorsum of the head, disk of the pronotum; another covering the tegmina (aside from the marginal field and region of the principal veins); a paler lateral color involving the face, sides of head, lateral lobes of the pronotum, and sides of the abdomen; an area covering the dorsal surface of the abdomen either concolorous with or darker than the dorsal shade of head, pronotum and tegmina, and a pair of pale, narrow postocular lines extending along the angle

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[13] Owing to the poor definition of the dorsum of the pronotum in the female, this measurement is of less value than in the male, but it is here given to cover relatively the same portion as that measured in the other sex.

of the tegmina, involving the whole marginal field of the tegmina and dividing the dorsal and lateral colors of the abdomen. The female sex is so unicolorous that it has no pattern distinctive enough to describe. The color of the dorsum of the head, pronotum, discoidal and anal fields of the tegmina and the limbs of the male ranges from yellowish oil green to cosse green,[14] occasionally lined along the internal margin of the pale lateral pronotal lines with maroon, and in all thickly and more or less regularly sprinkled with very minute points or stipples of the same color. Discoidal and anal fields of the male tegmina varying from lettuce green to serpentine green;[15] area of the principal veins (*i.e.*, humeral trunk) more or less broadly and strongly lined with a shade varying from morocco red to maroon. Paired pale lines in the male (also covering the marginal field of the tegmina) varying from cream-white to light green-yellow, less prominent on the abdomen in some specimens than in others. Dorsal color of the abdomen sometimes the same as the dorsal color of the pronotum, again as dark as the major portion of the tegmina, and in a fair proportion ranging through pompeian red to madder brown, such brownish tones being due to a great increase in number of the overlying stipple points of those colors, similar to the condition found on the dorsum of the pronotum. These points are also present in individuals having an apparently uniform greenish dorsal tone on the abdomen, but they are so few that they do not affect the general shade. Lateral color in the male ranging from javel green to cosse green, sulphine yellow in a single individual.[16] General color of female varying from uniform lettuce green to snuff brown dorsad, all finely and more or less thickly stippled with garnet brown to maroon (one specimen), paling into court gray on the sides of head, pronotum, and pleura; tegmina of the dorsal color with marginal field pale and a line of maroon present on the principal veins. Pale lines indicated but weakly in a few specimens on head and pronotum, not present on abdomen. Limbs unicolorous with the dorsum of the pronotum in both sexes. Eyes in both sexes varying from russet brown to hazel, crossed obliquely dorsad of the middle by a fine line of chestnut brown, which touches the caudal margin of the eye at the ventral margin of the pale postocular line. Antennæ in both

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[14] Frequently the pronotum is in part paler than these shades, but this is apparently due to the stuffing and drying, so that no importance is here attached to such fluctuation in the color of the dorsum of the pronotum.

[15] The latter in but one specimen, the remainder between lettuce green and spinach green.

[16] The latter shade may be due to drying, as it is found in but a single specimen

sexes ranging from olive ochre to lime green, the proximal joints more or less speckled with maroon. Tibial spines tipped with black. Ovipositor of the general color tone and usually of the dorsal shade, finely stippled with garnet brown and dorsal margin more or less washed with same.

Distribution.—The present species is known only from three localities in the arid tropical Tamaulipan region of southern Texas, Brownsville, Piper Plantation (along the Rio Grande about ten miles southeast by east of Brownsville), and Lyford (in the same county about forty-seven miles north of Brownsville). It doubtless ranges over an adjacent section of Mexico.

Biological Notes.—At Brownsville and Piper Plantation the present species was scarce and local, occurring in tangles of *Clematis* (probably *C. reticulata*) growing over the ground and on low mesquite and huisache. Individuals, when disturbed, endeavored to hop, crawl, or drop into recesses of these vines, where they are so well protected by their coloration that beating was the best method of securing them. At Lyford the single specimen was taken with *D. gladiator* in a weedy field which had a low cover of sand spur (*Cenchrus* sp.) and grasses. This species was found to be by far the least active of any of the forms of the genus taken by the authors.

Morphological Notes.—In the female sex the interspace between the tegmina varies from one extreme, in which the sutural margins are touching, to one in which the space separating them is nearly half of the width of a single tegmen.

Remarks.—The possibility of confounding this very peculiar species with any other form of the genus is very remote. It is interesting that in a region which has been examined as often as the Brownsville section, as striking a species as this should have been overlooked, for which the character of its habitat is probably responsible.

Specimens Examined.—43; 17 males, 9 females, 17 nymphs.

Brownsville, Cameron County, Tex.; July 31–August 5, 1912; (H.); 16 ♂, 9 ♀ (TYPE, allotype, paratypes), 6 ♂ nymphs, 9 ♀ nymphs.

Piper Plantation, near Brownsville, Cameron County, Tex.; August 3, 1912; (R. & H.); 2 ♀ nymphs.

Lyford, Cameron County, Tex.; August 6–7, 1912; (R. & H.); 1 ♂.

Dichopetala castanea n. sp.

1912. *Dichopetala brevihastata* Hunter, Pratt and Mitchell (not of Morse), Bull., 113, Bureau of Entom., U. S. Dept. of Agr., p. 50. (Part) [Corpus Christi and Maverick County, Texas.]

This species differs from its nearest ally—*D. brevihastata* Morse—in the broad, hardly produced subgenital plate of the male, in the more spiniform and strongly incurved distal portion of the male cercus, in the slightly deeper lateral lobes of the pronotum in both sexes, in the broader and more approximate tegmina of the female, in the less tapering ovipositor, which has the ventral margin straighter, and in the broader, more ovate, and less elliptical eye.

TYPE: ♂; Laguna del Gato, three miles west of Sam Fordyce, Hidalgo County, Texas. Elevation 175–200 feet. August 6, 1912. (Rehn and Hebard.) [Hebard Collection.]

Description of Type.—Size medium; form moderately slender; surface subglabrous. Head with the occiput not elevated dorsad of the level of the pronotum, gently arcuate; fastigium compressed, lamellate, barely touching the frontal fastigium; eyes prominent, ovate, the greatest width contained less than one and one-half times in the length, the length of the eye contained about one and one-third times in the infra-ocular length of the genæ; face moderately flattened; antennæ over three and one-half times as long as the body, filiform. Pronotum with the dorsum subdeplanate, strongly narrowed mesad, the margins of the same regularly converging caudad from the cephalic margin and from the middle somewhat more strongly diverging toward the caudal margin, the median width not more than half that at the caudal margin, the width of the latter equal to slightly more than half of the length of the disk, cephalic and caudal margins of the disk subtruncate, transverse broad V-shaped sulcus placed slightly caudad of the middle, caudad of which sulcus there is laterad on the disk slight indication of another sulcus; lateral lobes with the greatest depth contained nearly twice in the dorsal length of the

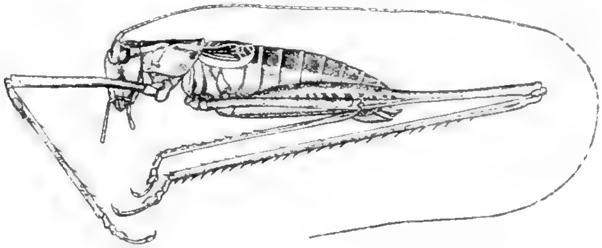


Fig. 15.—*Dichopetala castanea* n. sp. Lateral view of type. (× 2.)

Figs. 16 and 17.—Outline of left cercus of males (types) of *Dichopetala castanea* (16) and *D. brevihastata* (17). (× 10.)

same, ventro-cephalic angle subrectangulate, ventral margin moderately sinuato-emarginate cephalad, ventro-caudal angle broadly rounded, caudal margin oblique-truncate, transverse sulcus well impressed dorsad, lateral shoulders slightly indicated in the humeral region. Tegmina very slightly shorter than the dorsal length of the pronotum, the distal extremity slightly surpassing the margin of the proximal abdominal segment, costal margin moderately arcuate, distal margin truncato-arcuate, the lateral angle rounded, sutural margin rotundato-rectangulate at the apex of the stridulating vein, the margin obliquely subtruncate thence to the distal extremity; marginal field narrow, discoidal field expanding from the middle of the tegmen, with a number of irregular areas, stridulating vein nearly transverse, gently arcuate caudad, speculum proper with the greatest length exceeding the greatest width. Abdomen subfusiform; disto-dorsal abdominal segment with the median impressed area transverse and arcuate; supra-anal plate trigonal with a broad median V-shaped emargination; cerci with the proximal portion straight, robust, cylindrical, distal portion tapering, gently curving mesad, the distal fourth straight, spiniform and at a right angle to the thickened proximal portion, tooth placed at the junction of the proximal portion and the tapering section, on the dorsal section of the cercus toward the external face, moderately acute, subdepressed, little divergent dorsad from the general plane of the cercus, not more than a third the length of the distal half of the main cercal shaft; subgenital plate broad, transverse, the greatest width considerably exceeding the length of the plate, lateral margins straight convergent in the proximal two-thirds of their length, thence parallel for a very short distance, the width of the subequal section about half that of the greatest width of the proximal section, distal margin with a V-shaped emargination mesad, this occupying slightly more than a quarter of the median length of the plate, laterad of this emargination the distal margin is nearly truncate, thus forming lateral angles slightly more acute than a rectangle, a moderately distinct median carina present on the ventral surface of the plate. Cephalic femora subequal in length to the head, pronotum and tegmina, very slender; cephalic tibiæ distinctly exceeding the femora in length, foramina small, elliptical. Median femora slightly longer than the cephalic femora;

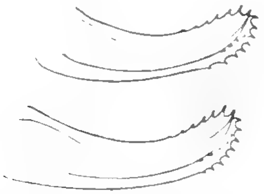
Figs. 18 and 19.—Outline of subgenital plate of males (types) of *Dichopetala castanea* (18) and *D. brevihastata* (19). (× 4.)

median tibiæ nearly half again as long as the femora. Caudal femora about a third again as long as the body, moderately inflated in the proximal three-fifths, genicular lobes unispinose; caudal tibiæ surpassing the femora by about the length of the pronotum.

Allotype: ♀; Laguna del Gato, three miles west of Sam Fordyce, Hidalgo County, Texas. Elevation 175–200 feet. August 6, 1912. (Rehn and Hebard.) [Hebard Collection.]

Description of Allotype.—Characters not specifically mentioned are not markedly different from the male sex.

Size medium: form moderately robust. Pronotum much less compressed, the median width of the disk of the pronotum contained less than three times in the length of the same. Tegmina much broader than the apparent length, apices hardly surpassing the margin of the metanotum, the distal margin rotundato-truncate, the interspace between the tegmina not more than half the width of a single tegmen; venation irregular. Cerci very short, conoid; ovipositor nearly equal to the length of the head and pronotum together, tapering in the proximal two-thirds, the proximal depth slightly more than a third of the length, moderately arcuate, ventral margin appreciably flattened for a portion of its length, dorsal margin more arcuate distad than proximad, apical margins proper slightly more acute than a rectangle, armed on the distal third of the dorsal margin with seven erect teeth, increasing in length distad, ventral margin strongly arcuate distad, armed with nine spines, the proximal several of which are smaller than the others, the distal ones distinctly recurved; subgenital plate brief, strongly transverse, distal margin obtusely brace-shaped (⏟) emarginate. Cephalic femora slightly exceeding the combined length of the head, pronotum and tegmina, slightly more robust than in the male. Median femora as robust as the cephalic pair. Caudal femora a fourth again as long as the body (exclusive of the ovipositor), appreciably more robust than in the male, the proximal dilation slightly more extensive.



Figs. 20 and 21.—Outline of ovipositor of females (allotypes) of *Dichopetala castanea* (20) and *D. brevihastata* (21). (× 4.)

Paratypic Series.—A paratypic series of five males and eight females from Laguna del Gato has been selected, the measurements of the same being given below.

Measurements (in millimeters).

	♂♂ Laguna del Gato, Tex.			
	(Type.)	(Paratypes.)		
Length of body	17.7	20.	18.	17.3
Length of pronotum	4.2	4.5	4.5	4.3
Greatest width of dorsum of pronotum	2.6	3.	2.3	2.5
Length of tegmen	3.9	4.	4.	4.
Greatest width of discoidal and anal fields of tegmen	3.2	3.3	3.3	3.3
Length of cephalic femur	9.2	9.7	9.5	8.5
Length of median femur	9.8	10.8	10.	9.2
Length of caudal femur	20.	22.	22.	19.6

	♀♀ Laguna del Gato, Tex.			
	(Allotype.)	(Paratypes.)		
Length of body (exclusive of ovipositor)	18.7	16.8	18.5	19.
Length of pronotum	5.	4.8	5.1	5.2
Greatest width of dorsum of pronotum	3.6	3.	3.	3.2
Apparent length of tegmen	1.3	1.6	1.4	1.5
Greatest width of tegmen	2.7	2.9	2.4	2.3
Length of cephalic femur	8.6	8.	8.2	8.2
Length of median femur	9.2	8.9	9.	9.
Length of caudal femur	21.5	20.	21.	21.2
Length of ovipositor	7.2	7.5	7.1	7.5

Measurements of extreme individuals.

	♂ Southwest Texas. (Schaupp) [Hebard Coll.]	♂ Victoria, Tamaulipas, Mex. [Hebard Coll.]	♀ Southwest Texas. (Schaupp) [Hebard Coll.]	♀ Tamo, Vera Cruz, Mex. (Bishop) [U. S. N. M.]
Length of body	15.	23.5	16.8	21.
Length of pronotum	4.	4.7	4.9	6.1
Greatest caudal width of dorsum of pronotum	2.6	3.2	3.	4.1
Length of tegmen	3.	3.4	1.2	2.7
Greatest width of discoidal and anal fields of (♂), or entire width of (♀) tegmen.	3.	3.8	2.2	2.8
Length of cephalic femur	7.3	9.	7.5	11.
Length of median femur	8.	10.	8.3	12.9
Length of caudal femur	18.	21.5	20.	29.
Length of ovipositor	....	....	6.7	10.

The variation in size appears to be purely individual aside from the possible presence of a larger race at the southern extreme of the range of the species. The individuals from Victoria, Tamaulipas, are of peculiar interest in this connection, the pronotum in both sexes being shorter and broader than in the other specimens of the species, while the legs are somewhat thicker and more robust than in by far the greater portion of the Texas series, but their length proportions are matched in other individuals. The tegmina in the Victoria male are shorter and broader than in any other individual of the same sex seen, the distal portion being much less produced with the margin decidedly truncate. The size of the tegmina is seen to vary somewhat in the female sex, the width of the interspace between the two also fluctuating, but the latter is never wide enough to cause any difficulty in determining the species. The Tamos female is unique in its great dimensions, aside from which it is perfectly typical of the species. We doubtless have here parallelism to the condition of sporadic giantism found in the next species, under which the matter is discussed. It is possible that in this case the variation is geographic, but our material from Mexico is too meager to make any definite assertions.

Color Notes.—The following color notes are all based on stuffed specimens, all of which, with the exception of two individuals, were prepared by the authors and have retained in practically its entirety the original coloration.[17]

The general pattern of the male has the dorsum of the head, pronotum, and abdomen dark and generally uniform, paired pale lines extending from the caudal margin of the eye, marking the boundaries of the disk of the pronotum, involving the whole marginal field of the tegmina and present as broader lateral bars on the abdomen. The abdominal segments have pale beaded margins caudad, these rarely outlined proximad with blackish. In the male the general color of the venter and of the lateral aspects of the pronotum, pleura, abdomen and proximal portions of the femora vary from honey yellow to parrot green in shade and also considerably in intensity. The color of the dorsum of the head, pronotum, and abdomen in the same sex ranges from clear mahogany red through argus brown to nearly clear pyrite yellow. This color is usually

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[17] Three males and eight females listed in the summary of specimens have not been stuffed and are disregarded in the remarks given above. They are all much browner than any of the freshly prepared individuals collected by the authors and in three cases have the color pattern much intensified on the abdomen.

purest on the disk of the pronotum, on the dorsum of the abdomen being solid, bounded by the pale marginal lines on the segments, frequently bisected by an adventitious pale medio-longitudinal line or divided by a broad median area of the lateral color and in the extreme condition only present laterad in the neighborhood of the pale lines. Head of the male with the cephalic and lateral aspects slightly paler than the lateral color, varying from baryta yellow to chalcedony yellow, an infra-ocular bar of indian red frequently present, rarely observed, and then but faintly, in the paler specimens; eyes varying from light buff to seal brown, this apparently due in part to the drying of the insect; antennæ varying from raw sienna to kaiser brown, the proximal joint in greater part of the color of the face. Pronotum of male with the pale lateral lines varying from nearly pure white to buff yellow in one extreme and viridine yellow in the other, always broader cephalad and caudad than mesad, generally severed once and sometimes twice at the point of greatest constriction; lateral lobes of pronotum with a trace of the dorsal color present cephalad and caudad contiguous to the pale bars. Tegmina of the male with the underlying color varying from bay to maroon, the venation and marginal field similar to the pale lateral bars of the pronotum in color; base of the narrow discoidal field entirely suffused with weak mahogany red or bright chestnut, the pale veins of the distal portion of the same field sharply contrasted. Disto-dorsal abdominal segment of the male washed with yellow, varying from pale cadmium to mars yellow, the cerci wholly of the same color. Cephalic and median femora of the male with more or less of their length ochraceous-orange, occasionally green without any of the former color; cephalic and median tibiæ with green the underlying color, more or less suffused with ochraceous-orange or occasionally (Victoria, Tamaulipas, specimens only) almost wholly blackish, the region of the tympanum almost invariably (but a single exception) touched dorsad with blackish. Caudal femora of male with the proximal three-fifths parrot green[18] with a medio-lateral stippled pattern of blackish; distal extremity of femora blackish brown of variable intensity, rarely very weak, remainder of distal two-fifths of the femora varying, with the general tone, from mustard yellow to zinc orange. Caudal tibiæ of male with their ventral color agreeing with the yellowish distal portion of the femora, but dorsad

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[18] Even in the specimens with honey-yellow lateral aspects (Victoria, Tamaulipas) the femora are parrot green, which would lead one to the conclusion that green was the natural coloration of the greater portion of the whole insect.

more or less washed with blackish brown, very strongly and decidedly so in the Victoria, Tamaulipas, pair. The type is of a well-contrasted color form only surpassed in intensity by the Victoria individuals.

The stuffed Victoria, Tamaulipas, female is practically a color duplicate of the male from that locality, the following comments being based on the remainder of the stuffed females.

The general pattern of coloration of the females differs from the pattern of the male only in that the pale lateral lines are not indicated on the tegmina and the beaded character of the marginal coloration of the dorsal abdominal segments is less frequent. The lateral and ventral color of the females is, in the stuffed individuals, always green, varying from light yellow-green to parrot green. The dorsal color as indicated in the male is rarely developed at all in the female, and then mostly indicated only on part of the pronotum and extreme lateral sections of the dorsum of the abdomen. A narrow medio-longitudinal line varying from victoria lake to english red is indicated more or less distinctly on a part or all of the pronotum in a portion of the females, while in one specimen the dorsum of the pronotum is weakly suffused with the last-mentioned color. Head of the female colored as in the opposite sex, but antennæ ranging from oil yellow to mars yellow. Pronotum of the female with the lateral lobes colored as in the male; the usual pale lateral lines of the pronotum are subobsolete in about half of the specimens, being indicated on the head in several which have them almost lacking on the pronotum. Tegmina of the female varying from cream white to baryta yellow, the interstices of the dorsal section occasionally slate color, the median section proximad with a variable but always weak narrow line of hay's russet. Abdomen of the female with the lateral pale lines washed with the lateral color as in the male, occasionally very weak, sometimes relatively broad and frequently with the portion on each individual segment roughly elongate trigonal. Ovipositor passing from courge green at the base to ivy green at the apex, washed along the dorsal margin with the color of the median line of the dorsum of the pronotum when that line is present; teeth of the ovipositor pitch brown. Limbs of the female varying from a type like that of the majority of the males to one in which they are practically course or light bice green, the pattern of the external face of the caudal femora always, although often very faintly, indicated. The presence of the blackish near the tympanum of the cephalic tibiæ is exceptional and not the rule in the female.

The allotype is about midway between the extremes here described, having a short median line on the pronotum, very weak incomplete pale pronotal lines and practically uniform limbs, without blackish near the tympanum of the cephalic tibiæ.

The Victoria, Tamaulipas, individuals stand apart from the other specimens, having an intensified pattern surpassing in contrast anything else belonging to the species seen by us. Certain structural peculiarities may compel the separation of these, as a distinct race, at a later date when more Mexican material is accessible, so that the following comments do not include them. The female from Maverick County has a very intensive coloration, with the dorsum of the pronotum and lateral portions of the dorsum of the abdomen suffused with garnet brown. The Laguna del Gato series is as a rule weaker in color contrasts than Uvalde, Del Rio and Mission individuals of both sexes, the type alone excepted. San Antonio specimens stand about intermediate in color intensity. That color is of little geographic significance is shown by the fact that the two lots taken closest together (about eighteen miles apart), *i.e.*, Laguna del Gato and Mission, are nearly as widely divergent as any examined.

Distribution.—The range of this species extends from an undetermined point on the Pecos River, probably near the New Mexican line,[19] east to the vicinity of Corpus Christi and south as far as Tamos, Vera Cruz, Mexico. Aside from the uncertain Pecos record and that from Tamos, the range of the species is approximately co-extensive with the area called the Rio Grande Plain by Bray.[20] While the Pecos locality is more elevated, the highest points at which we have noted the species (Del Rio and Uvalde) are at an elevation of 1,100 feet, while the Corpus Christi and Tamos individuals were taken almost at sea-level. It is probable that the Victoria, Tamaulipas, specimens were taken at a higher elevation than 1,100 feet, but we have no definite information to this effect, the general region, however, being near the 500 meter (approximately 1,640 feet) contour. At Mission the species was taken just below the line of gravel hills, while the Laguna del Gato series was taken in these hills. At Del Rio and Uvalde it occurred on the rolling plateau country, while

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[19] The data with this specimen is "Pecos, Aug. 18." As the specimen came to Scudder through Uhler, we can, judging by analogy with other specimens similarly credited by Scudder, probably consider it one of Capt. Pope's collecting. Capt. Pope's camps along the Pecos reached from above the New Mexican line to considerably below the same, but the dates were all in March. The specimen is in poor shape, having been dried from a liquid preservative. It is possible, however, that the specimen was taken much later near the present town of Pecos, Texas.

[20] *Botan. Gazette*, XXXII, p. 116, fig. 6.

at San Antonio it was taken in the hilly country immediately north of the city. Tamos, the southern limit of the species, is near Tampico, on the Rio Panuco, in the extreme northern part of Vera Cruz.

Biological Notes.—At Laguna del Gato the present species was taken on a low, very green rhamnaceous shrub (probably *Condalia obovata*), where it was common locally. At Mission five individuals were heard at night in bushes, several as much as five feet from the ground. At San Antonio the species was very local, not at all common and hard to find in a low, stout, green rhamnaceous bush. On the hill slopes at Uvalde it occurred on the low *Acacia berlandieri*, which there replaced the ubiquitous mesquite, while at the foot of the hills it was taken on tall rank green weeds. On the Del Rio hills, which were clothed with low *Acacia*, numerous other thorny bushes, occasional arborescent yuccas, and several species of *Opuntia*, the present species was secured in catclaw (*Mimosa* sp.) and other thorny bushes. The specimens taken by Pratt at San Antonio were from *Opuntia lindheimeri*, while at Corpus Christi and in Maverick County it occurred on plants of the same genus.

Synonymy.—The erroneous determination of the species as *brevihastata* by Hunter, Pratt and Mitchell, we have corrected by an examination of the original material.

Remarks.—The most striking diagnostic characters of this species are, the abbreviate subgenital plate of the male and the combination of a short ovipositor and the narrow interspace between the tegmina in the female. The latter space never equals the width, and rarely as much as half the width, of a single tegmen. The male subgenital plate is seen, when compared with that of *brevihastata*, to be broader, not at all produced mesad, except that the plate is in general narrowed in that direction, the distal margin is V-emarginate mesad with slight subtruncate sections laterad, which are flanked at the angles with very short blunt subobsolete tubercles. The cercus has the extremity more acute than in *brevihastata*, also more elongate, with the character of the median tooth slightly different. The ovipositor has the ventral margin straighter, the proximal depth less in proportion to that of the apex and the apex slightly more acute. The more ovate eye is immediately apparent on comparison.

Specimens Examined.—54; 21 males, 33 females.

Pecos. August 18, 1 ♀, [Scudder Coll.].

Del Rio, Valverde Co., Texas, elev. 900–1,100 feet, August 22–23, 1912, (R. and H.), 3 ♂, 1 ♀.

Uvalde, Uvalde Co., Texas, elev. 1,000–1,100 feet, August 21–22, 1912, (R. and H.), 3 ♂; last week of July, 1 ♂, [Scudder Coll.].

San Antonio, Bexar Co., Texas, August 15–16, 1912, (R. and H.), 2 ♂, 5 ♀; October 29, 1905, and June 16, 1908, (F. C. Pratt; on *Opuntia lindheimeri*), 3 ♀, [U. S. N. M.].

Southwest Texas, November, 1884, (Schaupp), 1 ♂, 3 ♀, [Hebard Coll.].

Maverick Co., Texas, May 15, 1906, (J. D. Mitchell; on *Opuntia*), 1 ♀, [U. S. N. M.].

Carrizo Springs, Dimmit Co., Texas, June, 1885, May, 1886, (A. Wadgymar), 1 ♂, 1 ♀, [Hebard Coll.].

Corpus Christi, Nueces Co., Texas, October 20, 1905, (F. C. Pratt), 1 ♂, 1 ♀, [U. S. N. M.].

Ringgold Barracks (now Rio Grande City), Starr Co., Texas, (Schott), 1 ♂, [Scudder Coll.].

Laguna del Gato, Hidalgo Co., Texas, elev. 175–200 feet, August 6, 1912, (R. and H.), 6 ♂, 9 ♀. TYPE, allotype and paratypes.

Mission, Hidalgo Co., Texas, elev. 138 feet, August 5–6, 1912, (R. and H.), 2 ♂, 3 ♀.

Victoria, Tamaulipas, Mexico, July, 1 ♂, 1 ♀, [Hebard Coll.]; December 10, 1909, (F. C. Bishop), 2 ♀, [U. S. N. M.].

Tamos, Vera Cruz, Mexico, December 7, 1909, (F. C. Bishop), 1 ♀, [U. S. N. M.].

Dichopetala brevihastata Morse.

1902. *Dichopetala emarginata* Scudder and Cockerell (not of Brunner, 1878), Proc. Davenp. Acad. Sci., IX, p. 51. [Mesilla Park, New Mexico.]

1902. *Dichopetala brevicauda* Scudder (not *Dichopetala brevicauda* Scudder, 1900), *Ibid.*, p. 51, pl. IV, fig. 1. [Riley's Ranch, Mesilla Valley, New Mexico; Mesilla Park, New Mexico; Mexico.]

1902. *Dichopetala brevihastata* Morse, Psyche, IX, p. 381. (To replace *D. brevicauda* Scudder, 1902.)

1907. *Dichopetala brevihastata* Rehn, Proc. Acad. Nat. Sci. Phila., 1907, p. 56. [Carr Canyon, Huachuca Mts., Arizona.]

1907. *Dichopetala lævis* Rehn, *Ibid.*, p. 56, fig. 10. [Carr Canyon, Huachuca Mts., Arizona.]

1909. *Dichopetala brevihastata* Rehn and Hebard, *Ibid.*, 1909, p. 167. [Mouth of Dry Canyon, Sacramento Mts., New Mexico.]

This species needs comparison with no form of the genus except *castanea*, under which species the important differential characters are given.

TYPES: 1 ♂, 2 ♀. Riley's Ranch, Mesilla Valley, New Mexico, August 16 (Cockerell); College campus, Mesilla Park, New Mexico, on *Atriplex canescens*, August 2 (*nec* 7), (Cockerell); Mesilla Park, New Mexico, September 11 (Cockerell).

Single Type here Designated: ♂; College campus, Mesilla Park, Donna Ana County, New Mexico. August 2, 1898. (Cockerell; on *Atriplex canescens.*) [Scudder Collection.]

Description of Type.—Size medium;[21] form moderately slender; surface subglabrous. Head with the greatest width of the eye contained more than one and one-half times in the length of the same; antennæ[22] (in perfect individuals) five times the length of the body. Pronotum with the caudal section of the same equal in width to about two-thirds the length of the disk, transverse V-shaped sulcus placed on the middle of the disk; lateral lobes of the pronotum with the greatest depth contained slightly more than one and one-half times in the dorsal length of the same, cephalic margin of the lateral lobes slightly arcuate, ventro-caudal angle and caudal margin of the lobes moderately arcuate. Tegmina slightly longer than the dorsal length of the pronotum, distal margin obliquely arcuato-truncate, the lateral angle moderately rounded; stridulating vein slightly oblique. Disto-dorsal abdominal segment with a recurved trigonal production which is very deeply V-shaped emarginate mesad, laterad of which this production is rounded; supra-anal plate trigonal with the apex narrowly truncate; cerci as in *castanea* in the form of the proximal portion and general curve of the distal section, median tooth slightly less divergent dorsad from the main body of the cercus, distal extremity of the cerci moderately produced, caniniform, but not spiniform; subgenital plate longer than the proximal width, lateral margins moderately rect-convergent for the greater portion of their length, thence briefly subparallel, the width of the subequal portion about half of the broad proximal portion, distal margin wholly V-emarginate, only narrowly rounded lobes remaining laterad, a very weak medio-longitudinal carina present ventrad. Cephalic femora proportionately as in *castanea*, but slightly slenderer. Median femora very slender. Caudal limbs as in *castanea*.

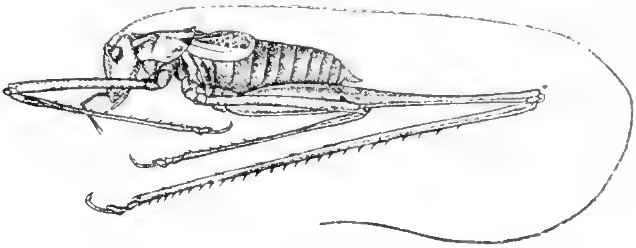

Fig. 22.—*Dichopetala brevihastata* Morse. Lateral view of type. (× 2.)

Allotype here Selected: ♀; Riley's Ranch, Mesilla Valley, Donna

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[21] On account of the close relationship of this species to *castanea*, only characters showing some difference from those of the latter species are here mentioned.

[22] Imperfect in type.

Ana County, New Mexico. August 16, 1898. (Cockerell.) [Scudder Collection.]

Description of Allotype.—Characters not specifically mentioned are not markedly different from those of the male sex or of the female of the closely allied *D. castanea.* Pronotum with the whole form slightly more compressed than in *castanea.* Tegmina small, little broader than the apparent length of the same, reaching the caudal margin of the metanotum, distal margin broadly rotundato-rectangulate, the interspace between the tegmina subequal to the width of a single tegmen. Ovipositor slightly surpassing the length of the head and pronotum together, considerably arcuate, proximal depth distinctly less than a third of the length of the ovipositor, ventral margin moderately arcuate, not at all flattened, dorsal margin very slightly more arcuate distad than proximad, apical margin proper acute-angulate, armed on the distal third of the dorsal margin with seven teeth, ventral margin considerably arcuate distad, armed with nine spines, those of both margins similar to those found in *castanea;* subgenital plate with the lateral angles produced into distinct spiniform lobes equal in length to the main depth of the plate, median emargination of the plate much as in *castanea.* Cephalic femora slightly inferior to the combined length of the head, pronotum and tegmen. Caudal femora slightly longer than the body, appreciably weaker than in *castanea.*

Paratypic Series.—We have examined all three specimens on which Scudder based the species, one being selected as the single type, another as the allotype, the third (Mesilla Park, September 11, Cockerell) remaining as a paratype.

Measurements (in millimeters).

	Mesilla Park, N. M. (TYPE).	♂♂ Sycamore Canyon, Pima Co., Ariz.	Average of three; Tumamoc Hill, Pima Co., Ariz.
Length of body	15.5[23]	14.8	13. (12.5-13.6)
Length of pronotum	4.3	4.	3.9 (3.8 - 4.)
Greatest caudal width of disk of pronotum	3.	2.7	2.5 (2.2- 3.)
Length of tegmen	4.4	4.2	3.8 (3.5- 4.1)
Greatest width of discoidal and anal fields of tegmen	3.5	3.1	2.9 (2.9- 3.)
Length of cephalic femur	9.2	10.	8.3 (7.7- 9.2)
Length of median femur.	10.3	10.8	9. (8. -10.)
Length of caudal femur	21.3	22.8	19.1 (17. -21.3)

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[23] Scudder's original measurements of this specimen are: body, 14; pronotum, 3.7; cephalic femur, 11; caudal femur, 21. The discrepancy in body length is

♂♂

	Carr Canyon, Cochise Co., Ariz.	Average of six; Marathon, Brewster Co., Tex.	Average of six; Laguna del Gato, Hidalgo Co., Tex.
Length of body	13.	15.8 (13.7–17.7)	16.3 (13.8–18.)
Length of pronotum	3.9	3.8 (3.6– 4.)	4. (3.9– 4.2)
Greatest caudal width of disk of pronotum	2.6	2.5 (2.5– 2.6)	2.5 (2.3– 2.7)
Length of tegmen	4.	4.1 (3.9– 4.4)	4. (3.9– 4.5)
Greatest width of discoidal and anal fields of tegmen	3.1	3. (2.9– 3.2)	2.8 (2.7– 3.)
Length of cephalic femur	9.	8.9 (8.5– 9.5)	9.5 (9.1– 9.9)
Length of median femur	9.8	9.4 (9. –10.1)	9.9 (9.1–10.3)
Length of caudal femur	20.3	19.9 (19.3–20.5)	21. (19.9–22.2)

♂♂

	Average of three; Montelovez, Coahuila, Mex.
Length of body	14.8 (12.8–16.3)
Length of pronotum	4.3 (4. – 4.7)
Greatest caudal width of disk of pronotum	2.8 (2.7– 2.9)
Length of tegmen	3.7 (3.4– 4.2)
Greatest width of discoidal and anal fields of tegmen	3.1 (3. – 3.3)
Length of cephalic femur	9.6 (8.9–10.)
Length of median femur	10.6 (9.8–11.)
Length of caudal femur	22.5 (21. –23.5)

♀♀

	Riley's Ranch, New Mex. (Allotype.)	Mesilla Park, New Mex. (Paratype.)
Length of body (exclusive of ovipositor)	20.5	18.3
Length of pronotum	5.	6.4
Greatest dorsal width of pronotum	3.	3.9
Apparent length of tegmen	1.5	1.4
Greatest width of tegmen	2.	2.1
Length of cephalic femur	8.	9.
Length of median femur	8.5	10.5
Length of caudal femur	21.5	24.
Length of ovipositor	8.2	8.8

probably due to the same being taken from different points, that of the cephalic femur on account of his measurement including the coxa, but the pronotal difference is incomprehensible to us. The only explanation which seems at all likely is that the length was taken along the lateral angles of the disk instead of along the median line, as we are accustomed to take the latter measurement to get the maximum.

	♀♀	
	Average of three; Sycamore Canyon, Pima Co., Ariz.	Average of three; Tumamoc Hill, Pima Co., Ariz.
Length of body (exclusive of ovipositor)	20.7 (20. –21.5)	21.4 (20.7–22.7)
Length of pronotum	5.2 (5. – 5.5)	5.3 (5.1– 5.5)
Greatest dorsal width of pronotum	3.1 (3. – 3.2)	3.1 (3. – 3.2)
Apparent length of tegmen	1.2 (1. – 1.3)	1.2 (1. – 1.6)
Greatest width of tegmen	2. (1.8– 2.2)	2.2 (2.1– 2.6)
Length of cephalic femur	8.7 (8.5– 8.9)	9. (8.8– 9.3)
Length of median femur	9.9 (9.7–10.)	9.6 (9.2–10.)
Length of caudal femur	23. (21.9–23.7)	23.3 (23. –24.1)
Length of ovipositor	8.8 (8.7– 9.)	8.6 (8.5– 8.9)

	♀♀
	Average of six; Marathon, Brewster Co., Tex.
Length of body (exclusive of ovipositor)	20.2 (17.8–22.)
Length of pronotum	5.3 (5. – 5.8)
Greatest dorsal width of pronotum	3.2 (3.1– 3.5)
Apparent length of tegmen	1.2 (1.1– 1.5)
Greatest width of tegmen	2.1 (2. – 2.2)
Length of cephalic femur	8.9 (8. – 9.7)
Length of median femur	8.9 (8. – 9.7)
Length of caudal femur	22.8 (21.9–24.)
Length of ovipositor	8.7 (7.8– 9.)

		♀♀		
	Uvalde, Uvalde Co., Tex.	Beeville, Bee Co., Tex.	Gregory, San Patricio Co., Tex.	Laredo, Webb Co., Tex.
Length of body	21.9	19.	20.2	18.7
Length of pronotum	6.	5.4	5.7	5.
Greatest dorsal width of pronotum	3.7	3.	3.5	3.5
Apparent length of tegmen	1.2	1.7	1.	1.4
Greatest width of tegmen	2.5	2.	2.	1.9
Length of cephalic femur	10.4	9.	9.1	8.2
Length of median femur	12.	10.	10.3	9.2
Length of caudal femur	26.7	23.	22.8	21.2
Length of ovipositor	9.	8.5	8.5	7.6

	♀♀	
	Average of six; Laguna del Gato, Hidalgo Co., Tex.	Average of three; Montelovez, Coahuila, Mex.
Length of body	20.5 (18.5–23.)	18.1 (15.3–21.)
Length of pronotum	5.6 (5. – 6.)	5.8 (5.2– 6.2)
Greatest dorsal width of pronotum	3.4 (3.3– 3.6)	3.5 (3.2– 3.8)

	♀♀	
	Average of six; Laguna del Gato, Hidalgo Co., Tex.	Average of three; Montelovez, Coahuila, Mex.
Apparent length of tegmen	1.2 (1.1–1.5)	1.4 (.8–1.8)
Greatest width of tegmen	2.2 (2.1–2.3)	2.4 (2. –2.7)
Length of cephalic femur	9. (8.7–9.3)	9.4 (8.8–10.)
Length of median femur	10.2 (9.8–11.)	10.3 (8.7–11.2)
Length of caudal femur	23.3 (22.4–24.7)	24.6 (23.3–26.5)
Length of ovipositor	8.2 (7.7–8.7)	9.1 (8.6–9.8)

	♀♀
	Average of four; Jaral, Coahuila, Mex.
Length of body	20.8 (20. –21.5)
Length of pronotum	5.3 (5.2–5.8)
Greatest dorsal width of pronotum	3.3 (3.2–3.5)
Apparent length of tegmen	1. (.8–1.1)
Greatest width of tegmen	2.3 (2. –2.5)
Length of cephalic femur	8.4 (8. –9.)
Length of median femur	9.3 (9. –10.1)
Length of caudal femur	21.1 (20.6–22.2)
Length of ovipositor	8.1 (8. –8.3)

From the above measurements it is evident that considerable variation, both geographic and individual, is present in this species. The geographic evidence shows that material from southern Arizona and the elevated portions of western Texas averages smaller than the series from southern Texas (Laguna del Gato) and Coahuila, Mexico, particularly in the femoral length. The Jaral, Coahuila, females are not, however, of the same general proportions as the Montelovez, Coahuila, specimens of that sex, and, although we are unable to locate the latter locality, possibly altitude may be responsible, Jaral being near the four-thousand-foot contour line. It is possible that the character of cover and richness of same may be a factor in determining the amount of geographic variation. The individual variation is considerable in all of the series, but the only really puzzling feature is the occurrence of large females with heavy pronoti. In the Montelovez series these are more numerous (three out of four) than elsewhere, but the paratypic female from Mesilla Park and to a lesser degree the Uvalde specimen are of this type. This point is treated in greater detail under *Remarks.*

Color Notes.[24]—The series of this species exhibits a very considerable

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[24] The remarks here set forth on color variation have been made entirely from material which has been stuffed or which is considered by the authors to have retained in a great measure the color tones of the living insect.

amount of variation in intensity of color pattern and color tone. The pattern is considerably recessive and intensive in the male, but in the female the recessive extreme is even greater than in the male, although the intensive is not as decided. The normal pattern as found in both sexes is as follows: a dorsal color involving the occiput, fastigium, dorsum of pronotum, and dorsal surface of the abdomen; pale postocular bars extending to the dorsal base of the cerci; a lateral and ventral color involving face, genæ, lateral lobes of pronotum, pleura, and lateral and ventral aspects of abdomen. In intensive individuals the dorsal color is decidedly darker than the lateral and ventral color, in average individuals in part at least so, in recessive individuals nearly (♂) or quite (♀) similar in tone. Strongly intensive individuals generally have the distal extremity of the caudal femora infuscate, but this is not a rule, as occasionally average and rarely moderately recessive individuals have this marking present.

Male. Dorsal color ranging from ochraceous tawny and sudan brown to claret brown and maroon, solid and uniform on head and pronotum, generally restricted to the lateral sections of the dorsum of the abdomen and in intensive individuals blackish next to the pale lateral lines, the distal margins of the abdominal segments edged with the pale color of the lateral bars, this edging subobsolete in the recessive specimens and narrowing mesad in all, a more or less distinct dark beading characterizing the same margins. Pale lateral bars ranging from cream white to very pale orange yellow always indicated in the male. Lateral and ventral color ranging from cream buff and pinkish buff to brownish olive, the green complimentary phase ranging to civette green. Face in the extreme green condition with broad paired vertical bars of the pale color of the lateral bars placed ventrad of the eyes and antennal bases, the median pair weakly continued to the clypeus; eyes varying from cameo brown to bay; antennæ varying from raw sienna and mars yellow to madder brown, weaker distad. Lateral lobes of the pronotum with a broad margin of the pale lateral color on the ventral and greater portion of the caudal margin, the dorsal section of the lateral lobes washed more or less with the dorsal color; pale paired lines more or less severed at the median sulcus. Tegmina with the marginal field of the color of the pale lines; region of the humeral trunk varying from orange rufous to morocco red; remainder of tegmina with the base color blackish brown, the venation of the same tones as the pale lines. Limbs of the lateral color more or less washed with the dorsal color, in intensive individuals decidedly so, the blackish-brown infuscation of the distal extremity of the caudal femora (when present) being generally correlated with a similar infuscation of the dorsal face of the caudal tibiæ, the caudal femora, which are infuscate distad, having the adjacent section of the distal half more or less inclined toward tawny or yellow ochre. Pattern of caudal femora always present.

Female. Dorsal surface varying from being concolorous with the lateral color through buffy citrine to russet, the intensive type having the abdominal coloration largely produced by stipplings. The segments of the abdomen in these contrasted specimens are marked as in the male, but with decided blackish lateral patches which extend more or less toward the median line proximad on each segment. Color of the pale lines (when present) varying from cream white to pale lumiere green and warm buff. Lateral color varying from clay color (in this specimen pale chalcedony yellow on head and pronotum) through course green to hellebore green, the extreme recessive green condition being without distinct pale margins to the lateral lobes and having the whole coloration uniform except for a darkening of the distal margins of the ovipositor. Eyes and antennæ as in the male. Limbs varying as in the male, but in the recessive green type uniform with the general coloration and with the paginal pattern weak. Tegmina varying from a type nearly uniform with the lateral color, to one with the costal and distal margins of the color of the pale lines, humeral trunk claret brown and remainder blackish brown with pale venation. Ovipositor varying from uniform with mass color (recessive green and brown types) with margins edged distad with clove brown to blackish brown to elm green washed dorsad with hazel and teeth blackish (extreme intensive type).

Geographically considered, the coloration of the species shows plasticity in some localities and constancy in others. The Arizona and New Mexico individuals are all more or less recessive, the large Laguna del Gato series decidedly so, while the Marathon series is about evenly divided (recessive, intermediate, and intensive). The five Garden Springs adults are chiefly intensive, as are four of the five Kent individuals. The Uvalde and Laredo specimens are recessive, while the Beeville and Gregory representatives are average. The Montelovez and Jaral individuals are almost all intensively colored.

From the basis of the Arizona, Marathon, Kent, Garden Springs, and Laguna del Gato series it seems possible that direct and reflected light may be a factor in determining the intensity of the color pattern, the percentage of intensive specimens being greatest from those localities known to us where the cover is densest, more light resistant and the surface conditions less favorable for reflecting light.

Distribution.—This species has the widest distribution of any in the genus, its range extending from southern New Mexico (Sacramento Mts.), south to southern Coahuila, Mexico (Jaral), west to the Baboquivari Mts., central southern Arizona, and east to the Texas coast at Gregory (San Patricio Co.). Its vertical range is from practically sea-level at the last-mentioned locality to as high as 4,800 feet in the Sacramento Mountains. Its zonal range appears to be entirely Lower Sonoran. As far as known, it does not extend into the region of the Edwards Plateau in central Texas and does not occur in the mountains of Trans-Pecos, Texas. Scudder in his original description stated that he had specimens from Mexico, this probably referring to the Montelovez specimens examined by us, as these were contained in his collection.

Biological Notes.—The present species was fairly numerous on creosote-bush (*Covillea tridentata*) at Dry Canyon, Sacramento Mountains, New Mexico, and occurred on the same plant on Tumamoc Hill, Arizona, while at the latter locality it was also found on the ground in short, dry, yellow grass. On the slopes of Sycamore Canyon, Baboquivari Mountains, Arizona, it also occurred in grasses and was taken from *Acacia* sp. At Marathon, Texas, it was generally common in various low bushes and grasses, the males, particularly, often sprawled out in a loose manner somewhat reminding one of phalangids or harvest-men, while at Kent and Garden Springs it occurred in similar situations. At Beeville and Uvalde it was taken from green weedy plants, at Gregory it was found in the green tangle about a mesquite clump, while it was beaten from a low bush on a sandy slope at Laredo. At Laguna del Gato it was taken rather commonly with *D. castanea* on a low, very green rhamnaceous shrub (probably *Condalia obovata*).

A correlation of the dates on the present series brings out some very interesting points on the time of maturity of the species. The earliest dates on which adults were secured are July 28 at Beeville, July 30 at Gregory, August 6 at Laguna del Gato, August 7 at Mesilla, August 10–12 at Laredo, and August 16 at Mesilla. At Dry Canyon, New Mexico (elevation 4,800 feet), on July 13 nymphs not more than half grown were not uncommon, while at Marathon and Garden Springs on August 26–27 and September 2, respectively, nothing but nymphs were seen, while on September 11 both nymphs and adults were taken at Garden Springs, and adults outnumbered the nymphs at Marathon on September 12–13. From this it is apparent that in the low, warmer Rio Grande Plain and interior valleys (Mesilla) the species matures at least a month earlier than in the higher regions of the plateau. The latest date is November 1–3 at Jaral, Coahuila.

Morphological Notes.—The subgenital plate of the male varies in the depth of the emargination of the distal margin and also in the degree of acuteness of the flanking angles of the same, in some examples these latter being quite acute and in others appreciably rounded. The ovipositor varies slightly, almost inappreciably, in general curvature of the margins and little in length, but the relative depth varies very decidedly, particularly in all of the Mexican specimens, which, however, are almost or quite equalled in this respect by individuals of the sex from Kent and Garden Springs. The lateral angles of the subgenital plate of the female vary in the degree of angulation, in one extreme being practically rectangulate, in the other with subspiniform extremities. While this latter variation is frequently correlated with that in the depth of the ovipositor, the rectangulate type with the deeper ovipositor, the more spiniform type with the narrower ovipositor, this relationship is not at all absolute.

Synonymy.—By an unfortunate lapse, Scudder, when originally describing this species, applied to it the same name (*Dichopetala brevicauda*) that he had given two years previously to a species now known to belong to the genus *Arethæa*, as explained by Morse who renamed the present form. The name *brevihastata*, proposed by Morse to replace the preoccupied *brevicauda*, cannot, in our opinion, be credited to Scudder, notwithstanding Morse's statement that the name was suggested by him, as the note is entirely by Morse without a direct quotation from Scudder. The naming of a species by proxy does not seem possible under present-day rules. In the same paper in which the last *D. brevicauda* was described, Scudder and Cockerell recorded *D. emarginata* from Mesilla Park on *Atriplex*, a locality and situation from which they, a few lines below, described *brevicauda*. There are no specimens in the Scudder Collection labelled *emarginata* from Mesilla Park or in the National Museum, and Prof. Cockerell can give me no additional information. In view of these facts and also that true *emarginata* is not found within hundreds of miles of that locality, as far as known only *brevihastata* occurring in that region, it seems perfectly logical to assume that the determination of Mesilla material as belonging to two species is due to a compilation of determinations made at different times, one before the recognition of *brevihastata,* and that both records relate to the same species.

The species *D. lævis,* erected by the senior author on a single female, is a synonym of the present species. The peculiarities of the ovipositor of the type of *lævis,* the unarmed margins of which suggested the specific name, we now know are due to the immaturity of the individual. The latter is in the stage immediately preceding maturity and its proper relationship to the other material now in hand is very evident. The more robust character of the limbs and smaller size of the type of *lævis* are similarly explained.

Remarks.—The variation in the length of the pronotum as found in certain females has been touched upon above under the measurements, this being the most decided fluctuation from the more general type found in the species. After considerable study and consideration from different view points, we have concluded that this phase cannot be separated from the more typical one of *brevihastata,* that it is a fluctuation occurring anywhere in the range of the species, although more numerous in certain regions than in others, and is approached by a few specimens not typical of the same and again not exactly similar to the type of *brevihastata.* There is, of course, a possibility that future work may show the advisability of recognizing the larger pronotum type as distinct, but we do not feel that the necessary evidence will be forthcoming.

Specimens Examined.—103; 47 males, 46 females, 4 male nymphs, 6 female nymphs.

Sycamore Canyon, Baboquivari Mts., Pima Co., Arizona, elev. 3,700–4,700 feet, October 6–9, 1910, (R. and H.), 2 ♂, 3 ♀.

Tumamoc Hill, Tucson Mts., Pima Co., Arizona, elev. 2,400–3,092 feet, October 3–4, 1910, (R. and H.), 3 ♂, 3 ♀.

Carr Canyon, Huachuca Mts., Cochise Co., Arizona, August, 1905, (H. Skinner), 1 ♂, 1 ♀ nymph. TYPE (♀ n.) of *D. lævis,* [A. N. S. P.].

Riley's Ranch, Mesilla Valley, New Mexico, August 16, (Cockerell), 1 ♂. TYPE, [Scudder Coll.].

Mesilla Park, New Mexico, August 7 and September 11, (Cockerell), 2 ♀. Allotype and paratype, [Scudder Coll.].

Dry Canyon, Sacramento Mts., Otero Co., New Mexico, elev. 4,800 feet, July 13, 1907, (R. and H.), 1 ♀ nymph.

Marathon, Brewster Co., Texas, elev. 3,900–4,160 feet, August 26–27 and September 12–13, 1912, (R. and H.), 16 ♂, 14 ♀, 2 ♂ and 2 ♀ nymphs.

Garden Spring, Brewster Co., Texas, September 2 and 11, 1912, (R. and H.), 3 ♂, 2 ♀, 2 ♀ nymphs.

Kent, Culberson Co., Texas, elev. 3,900–4,200 feet, September 17–18, 1912, (R. and H.), 3 ♂, 2 ♀.

Uvalde, Uvalde Co., Texas, elev. 1,000–1,100 feet, August 21–22, 1912, (R. and H.), 1 ♀.

Beeville, Bee Co., Texas, July 28, 1912, (R. and H.), 1 ♀.

Laredo, Webb Co., Texas, elev. 500–550 feet, August 10 and 12, 1912, (R. and H.), 1 ♂, 1 ♀.

Gregory, San Patricio Co., Texas, July 30, 1912, (H.), 1 ♀.

Laguna del Gato, three miles west of Sam Fordyce, Hidalgo Co., Texas, elev. 175–200 feet, August 6, 1912, (R. and H.), 11 ♂, 8 ♀, 1 ♂ and 1 ♀ nymph.

Montelovez, Coahuila, Mexico, September 20, (Palmer), 6 ♂, 4 ♀, [Scudder Coll. and U. S. N. M.].

Jaral, Coahuila, Mexico, November 1–3, 1909, (J. Friesser), 4 ♀, [Field Museum of Natural History].

Dichopetala gladiator n. sp.

1901. *Dichopetala emarginata* Rehn (not of Brunner), Trans. Amer. Entom. Soc., XXVII, p. 335. [Texas.]

1912. *Dichopetala emarginata* Hunter, Pratt and Mitchell (not of Brunner), Bull. 113, Bureau of Entom., U. S. Dept. of Agric., p. 50. [Hebbronville, Texas.]

1912. *Dichopetala brevihastata* Hunter, Pratt and Mitchell (not of Morse), *Ibid.*, p. 50. (Part) [Alice, Texas.]

The present form is closely related to the following species, *D. emarginata* Brunner, from which, however, it can easily be separated by the more ample tegmina of the male, the more longitudinal lateral lobes of the pronotum of the same sex, the less crassate tooth to the male cercus, the less deeply and sharply angulato-emarginate apex of the subgenital plate of the same sex, the proportionately longer limbs of both sexes and the much longer, slenderer, and more arcuate ovipositor.

Type: ♂; Lyford, Cameron County, Texas. August 6–7, 1912. (Rehn and Hebard.) [Hebard Collection.]

Description of Type.—Size rather large; form moderately elongate. Head with the occiput but little declivent to the fastigium and antennal scrobes; fastigium moderately compressed, sublamellate at the apex, subsulcate proximad, extremity partially in contact with facial fastigium; eyes prominent, ovate, their depth contained one and one-third times in that of the infra-ocular portion of the genæ; antennæ with the proximal joints rounded, very long, over four times as long as the body. Pronotum subsellate, the dorsum bisinuate when seen from the lateral aspect; disk of the pronotum very narrow mesad, the median width about half the caudal width of the same; lateral margins of the disk regularly converging to the middle of the same, thence regularly diverging caudad, indicated caudad by a rounded angle, but elsewhere by color only, in section the cephalic portion of the disk is arcuate, the caudal section deplanate; cephalic margin of disk truncate, caudal margin of same gently arcuate, distinctly elevated; transverse sulcus V-shaped, obliquely severing the margins of the disk mesad, on the lateral lobes extending considerably ventrad; lateral lobes with the greatest depth contained twice in the dorsal length of the same, cephalic margin subtruncate, ventro-cephalic angle rotundato-rectangulate, ventral margin arcuato-sinuate, slightly emarginate cephalad, ventro-caudal angle and caudal margin gently arcuate, dorsad rounding into the caudal margin of the disk, the surface of the lobes strongly drawn in to the lateral margins of the disk. Tegmina slightly longer than the disk of the pronotum, greatest width of the discoidal and anal fields of the tegmina subequal to the length of the anal field; costal margin moderately arcuate, distal margin obliquely arcuato-truncate, disto-caudal (literally apical) angle well rounded, sutural margin arcuate-obtuse-angulate, slightly sinuate distad of the extremity of the stridulating vein; marginal field moderately broad, discoidal field

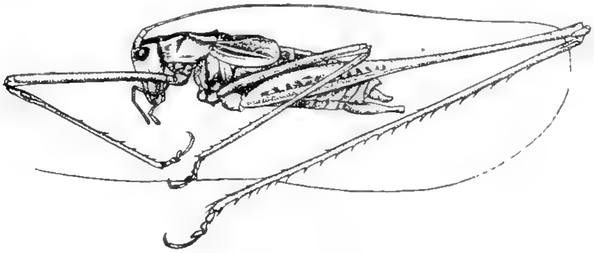


Fig. 23.—*Dichopetala gladiator* n. sp. Lateral view of type. (× 2.)

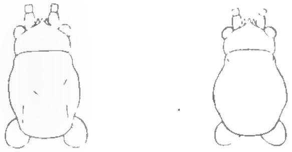
Figs. 24 and 25.—Outline of left cercus of topotype of *Dichopetala emarginata* (24) and type of *D. gladiator* (25). (× 10.)

not particularly broad, expanding distad, anal vein moderately arcuate, stridulating vein strongly arcuate proximad, straight distad, tympanum proper rather large, subtrigonal. Abdomen with the disto-dorsal abdominal segment having the margin sinuately arcuato-truncate, moderately arcuato-emarginate laterad; supra-anal plate tongue-shaped; cerci regularly arcuate inwards, the proximal portion of the shaft rather heavy, somewhat tapering, median lobe placed on the dorsal surface, short, depressed, slightly concave ventrad, when seen from the dorsum with the external margin arcuate, internal margin straighter, distal extremity of the lobe weakly subtruncate, the lobe narrowing along the same lines as the proximal portion of the shaft of the cercus, distal portion of shaft more sharply arcuate, subdepressed, acute subaciculate, the distal portion (distad of tooth) subequal in length to the proximal portion; subgenital plate moderately produced, elongate, lateral margins moderately converging on median half, subparallel on distal fourth, distal margin with a V-shaped median emargination which occupies not more than one-half of the margin, laterad of the emargination subtruncate, distal portion of the ventral surface of plate tricarinate, mesad and laterad, the lateral carinæ following the lines of the distal fourth of the lateral margins, the oblique portion of the lateral margins thickened and subcarinate. Cephalic femora about two and one-half times the length of the disk of the pronotum; cephalic tibiæ with the foramina elliptical. Median femora but slightly less than twice the length of the head and pronotum. Caudal femora nearly one and one-half times the length of the body, moderately inflated in proximal half.

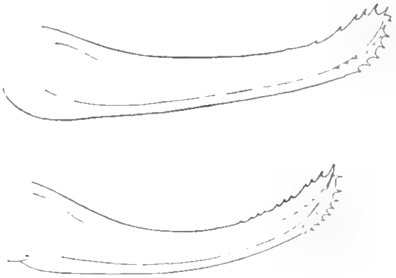
Figs. 26 and 27.—Ventral outline of subgenital plate of topotype of *Dichopetala emarginata* (26) and type of *D. gladiator* (27). (× 4.)

Allotype: ♀; Same data as the type.

Description of Allotype.—The following characters are those of difference from the type. Size large; form moderately robust. Head with eyes slightly less prominent and more elliptical than in the male, their depth contained one and one-half times in that of the infra-ocular portion of the genæ. Pronotum with the disk less deplanate than in the male and nearly straight when seen from the lateral aspect, form of disk similar to that of male but less constricted mesad; cephalic margin emarginato-truncate, caudal margin moderately arcuate; lateral lobes with their greatest depth contained slightly less than twice in the dorsal length of the same, margins of the lateral lobes as in the male. Tegmina semi-ovate, reaching the caudal margin of the metazona, the greatest width distinctly greater than the apparent length, interspace between the tegmina about two-thirds that of a single tegmen. Cerci brief, conical, acute; ovipositor subequal to the median femora in length, arcuate in general form, moderately slender, tapering in proximal two-thirds, ventral margin less arcuate than the dorsal one aside from a decidedly arcuate distal portion, distal third of dorsal margin with eleven to twelve teeth increasing in size distad, ventral margin with nine to ten teeth on distal fifth, the extreme distal one slightly recurved; subgenital plate almost divided to the base by a V-shaped emargination, the lateral sections developed into very acute trigonal lobes. Cephalic femora slightly less than twice as long as the disk of the pronotum. Median femora twice the length of the disk of the pronotum. Caudal femora almost two and one-half times the length of the cephalic femora.



Figs. 28 and 29.—Dorsal outline of head, pronotum, and tegmina of topotype of *Dichopetala emarginata* (28) and allotype of *D. gladiator* (29). (× 2.)



Figs. 30 and 31.—Outline of ovipositor of topotype of *Dichopetala emarginata* (30) and allotype of *D. gladiator* (31). (× 4.)

Paratypic Series.—We have before us a paratypic series of twenty-three males and twenty females from the type locality—Lyford, Cameron County, Texas.

Measurements (in millimeters).

	Lyford. (TYPE)	Average and extremes of six Lyford spec. (Type and Paratypes)
Length of body	16.	16.7 (15.9–17.8)
Length of pronotum	4.5	4.4 (4.2– 4.6)
Greatest dorsal width of disk of pronotum	2.6	2.7 (2.5– 3.)
Length of tegmen	4.6	4.4 (4.3– 4.8)
Greatest width of discoidal and anal fields of tegmen	3.5	3.4 (3.2– 3.5)
Length of cephalic femur	10.3	10.4 (10. –10.9)
Length of median femur	11.1	11.1 (10.8–11.4)
Length of caudal femur	23.3	23.3 (22.8–23.8)

♂♂

	Cotulla. [U.S.N.M.]	Wades. [U.S.N.M.]	Carrizo Springs. [Hebard Coll.]
Length of body	17.4	17.	16.2
Length of pronotum	4.8	4.7	4.7
Greatest dorsal width of disk of pronotum	2.9	2.4	2.9
Length of tegmen	4.1	4.	4.4
Greatest width of discoidal and anal fields of tegmen	3.2	3.4	3.2
Length of cephalic femur	10.2	9.2	9.7
Length of median femur	11.2	10.	10.3
Length of caudal femur	23.2	22.5	22.5

♀♀

	Lyford. (Allotype)	Average and extremes of six Lyford spec. (Allotype and Paratypes)
Length of body (exclusive of ovipositor)	22.	21.9 (20.2–22.6)
Length of pronotum	5.7	5.9 (5.6– 6.3)
Greatest dorsal width of disk of pronotum	3.1	3.3 (3.1– 3.6)
Apparent length of tegmen	1.4	1.4 (1.2– 1.7)
Greatest width of tegmen	2.1	2.2 (2.1– 2.3)
Length of cephalic femur	10.5	10.8 (10.3–11.1)
Length of median femur	11.3	12. (11.3–12.7)
Length of caudal femur	27.	27.4 (25.5–28.5)
Length of ovipositor	11.2	11. (10. –11.8)

	♀ ♀ Carrizo Springs. [Hebard Coll.]		
Length of body (exclusive of ovipositor)	20.5	18.	20.8
Length of pronotum	6.8	6.2	6.5
Greatest dorsal width of disk of pronotum	3.7	3.4	3.7
Apparent length of tegmen	1.7	1.6	1.
Greatest width of tegmen	2.6	2.4	2.3
Length of cephalic femur	11.3	10.3	
Length of median femur		11.6	
Length of caudal femur	28.	26.2	25.7
Length of ovipositor	15.4	14.5	14.5

Males from Wades, Cotulla, and Carrizo Springs have the pronotum slightly longer, tegmina slightly shorter, and femora very slightly shorter than Lyford males. Females from Carrizo Springs have the general size slightly less, the pronotum appreciably longer and ovipositor distinctly longer than in Lyford individuals of the same sex. The most striking variation in measurements is in the length of the ovipositor, which varies geographically more than individually, the Carrizo Springs females having this actually and proportionately far exceeding the measurement of the Lyford specimens.

Color Notes.—The following notes have been based wholly on material which was stuffed in the field or which we have every reason to believe has retained its original coloration. The recessive and intensive extremes are considerably different—in fact, decidedly different in the male sex. Instead of describing a dorsal and lateral color, it seems best in the present species to speak of the tones as a general color, a pronotal wash, a pale pattern, and an abdominal infuscation.

General color of male varying from cinnamon buff to yellow ochre, passing in certain individuals to apple green. The pronotal wash varies from uniform with the general color through sanford's brown to claret brown, the area covered by the same consisting of the occiput, disk of the pronotum, more or less of the dorso-cephalic and dorso-caudal portions of the lateral lobes of the same, the tegminal humeral trunk and more or less of the discoidal field and vicinity of the anal vein of the tegmina. The pale pattern consists of the usual postocular bars outlining the disk of the pronotum, the greater portion of the margins of the lateral lobes, the marginal field of the tegmina, paired lateral bars on the abdomen, transverse edgings on the segments of the same, and an adventitious medio-longitudinal abdominal thread. The tone of this pattern varies from barita yellow (in the recessive extreme where it is very poorly contrasted) to buff yellow, in the generally greenish individuals running to whitish with the transverse edgings of the abdominal segments cendre green. The abdominal infuscation varies in intensity with the general condition of the coloration, in the extreme recessive condition being absent and in the other extreme covering the entire dorsum of the abdomen (except for the medio-longitudinal thread) and the dorsal portion of the lateral faces of the same, between which types are regular graduations in the dorsal width of this shade, the lateral patches decreasing in size toward the average and recessive condition. The tone of this infuscation is always blackish. Eyes varying from terra cotta to vandyke brown; antennæ lightly more intense than the general color. Pronotum with the pale borders of the lateral lobes somewhat variable in width. Tegmina with the greater portion of the anal field and much of the discoidal field with the base color varying from wood brown to seal brown, the venation and a large proximal patch on the anal field varying from sulphine yellow to raw sienna, frequently more or less washed with greenish. Abdomen with a dorsal medio-longitudinal bar of from sulphine yellow to antique brown in those specimens approaching the intensive extreme which have the dorsum of the abdomen not solidly infumate, the medio-longitudinal thread of the pale pattern of course dividing this bar; segments with the pale pattern edging narrowing mesad, broadest where they bisect the lateral bars of the same pattern, in the intensive extreme a suggestion of beading of the same margin is due to the breaking of the pigment into regular though subcontiguous patches; disto-dorsal abdominal segment varying from deep chrome to sanford's brown; cerci and subgenital plate ranging from deep chrome to orange rufous. Cephalic and median limbs of the general color, more or less suffused with orange rufous distad on the femora and all of the tibiæ, the latter in the intensive condition becoming blackish brown distad. In one of the recessive specimens the cephalic and median femora are dusky olive green distad. Caudal femora of the general color, pattern always distinctly indicated, the distal extremity always with a blackish area occupying about one-seventh the femoral length, the distal half otherwise varying from light orange yellow to mars yellow, passing into the color of the proximal half; caudal tibiæ more or less deeply and almost wholly suffused with blackish brown, with a brief genicular section of the general color.

Female with the general color varying from sulphine yellow to cosse green, the dorsum of the abdomen in intensive individuals ranging to dilute raw sienna. The pronotal wash is only indicated in the extreme intensive condition, never as extensive as in the male and only solid on the occiput and the cephalic half of the pronotal disk. Pale pattern in the extreme recessive type but faintly indicated on the head and pronotum, in the extreme intensive condition much as in the male, but the transverse edgings to the abdominal segments are narrower and decidedly beaded by blackish intervals. Marginal field of tegmina always solidly whitish. Abdominal infuscation represented only in intensive specimens by blackish areas of variable size placed dorso-laterad at the bases of the segments. Antennæ varying from apricot yellow to ochraceous orange. Ovipositor of the general color, strongly olive green distad, edged there with blackish brown, the dorsal margin of proximal half washed with raw sienna. Limbs of general color, in the intensive extreme approaching viridian green proximad on caudal femora, distad on same sulphine yellow, distal infuscation usually present only in the intensive individuals;[25] tibiæ of the general color, distal extremity of the same and tarsi touched with buffy brown.

The type is an average male, while the allotype is an extremely intensive female. In the Lyford series we have both extremes in both sexes and every intermediate, so it is evident that the color variation has no geographic significance.

Distribution.—This large species is known from seven localities in the Rio Grande Plain of Texas (*vide* Bray), its range extending east to Corpus Christi, south to Lyford, north to Wades and Cotulla, and northwest to Carrizo Springs. Its distribution probably extends south of the Rio Grande into Mexico, but we have no material from that country. Its vertical distribution is limited, extending from or near sea-level at Corpus Christi and Lyford to about seven hundred and fifty feet at Carrizo Springs.

Biological Notes.—The present species, from data on the specimens, was taken on cotton at San Diego (nymphal individuals) and on prickly pear (*Opuntia*) at Hebbronville and Alice. At Lyford we found the species fairly common but somewhat local in fields of high weeds, which had a low cover of sand spur (*Cenchrus*) and grasses. Its stridulation, which was heard at night and with the aid of which specimens were taken, is very faint.

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[25] One exception, a recessive female from Lyford has them indicated.

The material from San Diego taken April 30 is all nymphal, while at Carrizo Springs nymphs were taken in May and adults only in June. At Wades and Cotulla adults were taken May 21 and 12, respectively, while at Lyford, August 6–7, but a few nymphs were secured, although the adults were numerous. At Hebbronville the species was pairing August 29.

Morphological Notes.—In the male there is some variation in the relative size of the tegmina and some slight differences in the character of the margin of the median lobe of the cerci, but the variation in the genitalia of that sex, including the distal margin of the subgenital plate, is extremely slight. The really noteworthy feature in the form variation is that of the ovipositor, as it varies some in form as well as dimensions. The even curve of the latter is appreciably flattened mesad in certain individuals. This latter condition, however, is never decided enough to cause the ventral margin to appear wholly or in part straight. The caudal margin of the disk of the pronotum varies in the female from truncate to slightly but distinctly arcuate.

Synonymy.—The misidentifications of this species, first as *D. emarginata* by Rehn in 1901, and second by Hunter, Pratt and Mitchell in 1912 as *D. emarginata* and in part as *brevihastata*, we are able to correct, having the material before us. The first error can be explained by the absence of any material for comparison of the closely allied *emarginata*, while the same reason was doubtless responsible for its determination as *brevihastata*, only female individuals having been at hand, aside from an alcoholic male from Hebbronville.

Remarks.—There exists a possibility that the acquisition of more material from the western part of the range of the species may make desirable the separation of a western race based on the more elongate ovipositor, but our present representation is too limited to convince us of the desirability of that action. This form is complemental to *D. emarginata*, living in the main in a different region although in much the same situations.

Specimens Examined.—65; 29 males, 29 females, 3 male nymphs, 4 female nymphs.

Lyford, Cameron Co., Texas, August 6–7, 1912, (R. and H.), 24 ♂, 21 ♀, 3 ♀ nymphs. TYPE, allotype and paratypes.

Corpus Christi, Nueces Co., Texas, July 29, 1912, (H.), 1 ♀ nymph; October 20, 1905, (F. C. Pratt), 2 ♀, [U. S. N. M.].

Wades, Nueces Co., Texas, May 21, (E. A. Schwarz), 1 ♂, [U. S. N. M.].

Alice, Nueces Co., Texas, August 28, 1908, (J. D. Mitchell; on *Opuntia*), 1 ♀, [U. S. N. M.].

San Diego, Duval Co., Texas, April 30, (E. A. Schwarz; on cotton), 2 ♂ nymphs, [U. S. N. M.].

Hebbronville, Duval Co., Texas, August 29, 1908; on *Opuntia*, 1 ♂, 1 ♀, [U. S. N. M.].

Cotulla, La Salle Co., Texas, May 12, 1906, (F. C. Pratt), 1 ♂, [U. S. N. M.].

Carrizo Springs, Dimmit Co., Texas, May and June, 1885, (A. Wadgymar), 2 ♂, 3 ♀, 1 ♂ nymph, [Hebard Collection].

Texas, 1 ♀, [A. N. S. P.].

Dichopetala emarginata Brunner.

1878. *D*[*ichopetala*] *emarginata* Brunner, Monogr. der Phaneropt., p. 77, [Texas.]

1897. *Dichopetala emarginata* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 315. [Texas.]

This species constitutes with *D. gladiator* (*vide supra*) a section of the genus readily recognized by genital characters of both sexes. These characters are emphasized in the keys, and in the foregoing description of *gladiator* the differential features of the two forms are also given.

TYPES: ♂ and ♀; Texas. [Brunner Collection and Geneva Museum.[26]]

Description of Male (Dallas, Texas; U. S. N. M.).—Size medium; form as usual in the genus. Head with occiput moderately declivent; fastigium moderately compressed, low, subcontiguous with the facial fastigium; eyes moderately prominent, ovate, greatest depth contained one and one-third times in the greatest depth of the infra-ocular portion of the genæ; antennæ with proximal joints not depressed. Pronotum not sellate, dorsum subdeplanate, on cephalic half slightly rounding laterad; disk with lateral margins slightly indicated by angles caudad, by color for their whole length, decided and regularly narrowed mesad, the median width about one-half that of the caudal margin of the disk; cephalic margin of disk truncate, caudal margin of same considerably arcuate, slightly flattened mesad; transverse sulcus bisecting the lateral margins of the disk mesad, on the disk forming an obomegoid figure caudad of the middle; lateral lobes of the pronotum with the greatest depth contained

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[26] From the information given by Saussure and Pictet we learn that this material, or at least the portion of it in the Geneva Museum, was collected by Boll. We have examined fourteen specimens collected by Boll at Dallas, so we consider Dallas material typical.

about twice in the dorsal length of the same, cephalic margin of lobes straight, ventro-cephalic angles narrowly rotundato-subrectangulate, ventral margin very slightly oblique, sinuato-truncate, ventro-caudal angle roundly obtuse-angulate, caudal margin obliquely arcuato-truncate, the dorsal portion of the margin passing into the arcuation of the caudal margin of the disk. Tegmina over three-fourths the length of the disk, the greatest width of the discoidal and anal fields little inferior to the tegminal length; costal margins moderately arcuate, rounding into the slightly oblique subtruncate distal margin, sutural margin subrectangulate, the angle at the extremity of the stridulating vein broadly rounded, the distal section of the same margin slightly sinuate; marginal field narrow, discoidal field regularly expanding distad, anal vein arcuate, anal field with its greatest length subequal to its greatest width, stridulating vein decidedly arcuate, tympanum proper poorly developed. Disto-dorsal abdominal segment with the margin truncate distad; supra-anal plate trigonal, acute, the lateral margins of same slightly arcuate; cerci with the proximal portion moderately robust, slightly flattened dorsad, median lobe placed on dorsal surface, depressed, broad, when viewed from the dorsum the margin of the lobe is broadly rounded on the external and bluntly angulate on the internal side, shaft proper arcuate inwards from proximad of middle, tapering, acute, subaciculate, slightly curved dorsad; subgenital plate with proximal width slightly less than greatest length, moderately produced, distal half with margins converging for the greater portion of their length, then subparallel, distal margin rectangulate emarginate, the lateral angles very faintly blunted, ventral surface weakly tricarinate distad. Cephalic femora somewhat shorter than the combined length of the head, pronotum and tegmina; foramina of cephalic tibiæ elongate elliptical. Median femora slightly exceeding the combined length of head, pronotum, and tegmina. Caudal femora slightly more than

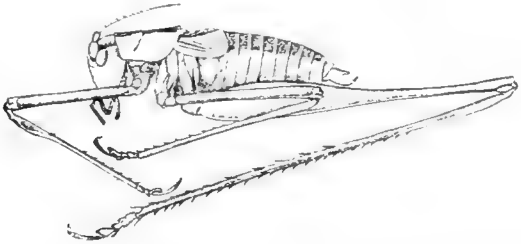

Fig. 32.—*Dichopetala emarginata* Brunner. Lateral view of male topotype. (× 2.)

twice the length of the median femora, considerably robust in the proximal three-fifths.

Description of Female (Dallas, Texas; U. S. N. M.).—The following points are those of difference from the male. Size rather large. Eyes slightly more elliptical than in the male; proximal antennal joints slightly deplanate. Pronotum with the lateral margins of disk marked nowhere by angles and only indicated by color, shape of color margins as in male, but median width slightly more than half the caudal width of the disk; lateral lobes with greatest depth contained less than twice in the greatest length of same. Tegmina distinctly laterad, separated by more than their own width, in form semi-ovate, not reaching to caudal margin of the metanotum, humeral trunk indicated. Disto-dorsal abdominal segment subtruncate; supra-anal plate slightly broader than long, rounded subtrigonal. Ovipositor elongate, more than twice the length of the pronotal disk, moderately robust, dorsal margin moderately arcuate, slightly flattened mesad, ventral margin straight except for a short and decided arcuation distad, dorsal margin armed on distal fifth with six spines, ventral margin armed on same section with six to eight spines, the extreme ones of latter series slightly recurved; subgenital plate with chitinous portion divided in two, these present as lateral subpyriform lobes with very acute apices. Cephalic femora slightly and median femora decidedly exceeding the combined length of head, pronotum, and tegmina. Caudal femora slightly less than twice the length of median femora.

Measurements (in millimeters).

	♂♂ Dallas, Texas.			
	(Described spec.; U. S. N. M.)	(Scudder Coll.)	(U. S. N. M.)	Average of three specimens.
Length of body	15.3	........[27]	13.2	14.2
Length of pronotum	4.2	3.6	4.	3.9
Greatest caudal width of disk of pronotum	3.	2.5	2.7	2.7
Length of tegmen	3.7	3.5	3.4	3.5
Greatest width of discoidal and anal fields of tegmen	3.2	2.5	3.1	2.9
Length of cephalic femur	8.9	....	....	....
Length of median femur	9.9	....	9.4	9.6
Length of caudal femur	20.	15.	19.7	18.2

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[27] This specimen is so badly shrunken that we have not considered the body length.

	Texas. (TYPE meas., ex Brunner)	Gregory, Tex.	Beeville, Tex.	Uvalde, Tex.
Length of body	14.	17.6	15.7	16.7
Length of pronotum	4.5	4.1	4.	3.9
Greatest caudal width of disk of pronotum		2.7	2.3	2.7
Length of tegmen		4.	3.6	3.6
Greatest width of discoidal and anal fields of tegmen		3.2	3.	3.
Length of cephalic femur	9.5	10.	9.4	10.
Length of median femur		11.2	10.	10.7
Length of caudal femur	20.	23.	21.8	22.5

	♀♀ Dallas, Texas.		
	(Described spec., U.S.N.M.)	(Scudder Coll.)	(Scudder Coll.)
Length of body	18.6	13.	16.
Length of pronotum	6.	5.	6.
Greatest caudal width of disk of pronotum	3.2	3.	3.4
Apparent length of tegmen	1.4	.7	1.
Width of entire tegmen	2.	2.1	1.6
Length of cephalic femur	9.3		
Length of median femur	10.2		
Length of caudal femur		20.8	23.8
Length of ovipositor	10.3	11.1	12.7

	♀♀ Dallas, Texas.		
	(U.S.N.M.)	Average of four specimens.	Texas. (TYPE meas., ex Brunner.)
Length of body	17.2	16.1	15.
Length of pronotum	5.5	5.6	5.
Greatest caudal width of disk of pronotum	3.	3.1	
Apparent length of tegmen	1.2	1.	
Width of entire tegmen	2.	1.9	
Length of cephalic femur	8.4	8.8	9.
Length of median femur	9.	9.6	
Length of caudal femur	21.	21.8	22.
Length of ovipositor	11.3	11.3	13.

The Dallas male from the Scudder Collection is the smallest of seven of that sex from the same locality, while the two females from the same series represent the extremes of six females contained therein. It is quite evident that considerable individual variation is present in the species, this being pronounced in the Dallas representation, which is the only series of any size. Too little material is available to consider possible geographic variation in size.

Color Notes.—But two of the specimens before us have been stuffed, these (both males) forming the basis of most of the following notes. As usual there is a dorsal color, a lateral color, and paired pale lateral lines in the male, while in the female the dorsal and lateral colors are nearly or quite uniform and the pale lines hardly or but weakly indicated.

Lateral and ventral color of male ranging from lumiere green to apple green, in unstuffed specimens ranging to old gold. Dorsal color consisting of an overlying tint running from chestnut through burnt sienna to orange rufous (in unstuffed specimens), covering the lateral portions of occiput, all or nearly all of disk of pronotum and lateral portions of dorsum of abdomen. Pale paired lines in male extending from eye to base of cercus, ranging from pale viridine yellow to creamy white. Head with fastigium and occiput bearing a narrow medio-longitudinal line of the color of the pale lines, finely bordered with lines of the dorsal color; eyes ochraceous tawny to liver brown, crossed obliquely by an irregular slightly darker line. Pronotum in some specimens with the color dilute caudo-laterad, in tone approaching the lateral color, the pure dorsal color being restricted to a median band; lateral lobes more or less suffused dorso-caudad with the dorsal color; ventral margins edged with the color of the pale lateral lines. Tegmina with the marginal field of the color of the pale lateral lines, humeral trunk chestnut, discoidal field and large part of the anal field blackish brown, the venation varying from buff yellow to neva green, the latter tone only present on the discoidal field, the venation of the proximal half of anal field in all specimens approaching buff yellow. Dorsum of abdomen with the median section very close to the lateral color, the margins of all the segments finely and closely beaded with the dorsal color on an edging of the tone of the pale lateral bars. Limbs with the femora of the lateral color, distad becoming infuscate with ochraceous-orange, the tibiæ entirely of the latter color; cephalic tibiæ with the vicinity of the foramina narrowly lined with blackish, a disto-genicular area on the median tibiæ more or less marked with the same, tarsi of the same limbs more or less clouded with bone brown. Caudal femora with distal eighth more or less solidly blackish brown, pattern on external face more or less distinct in all, medio-longitudinal in position; caudal tibiæ more or less completely infuscate with bone brown.

General color of female (unstuffed specimens) olive ochre to honey yellow, finely punctulate with maroon, these punctulations thickest on the dorsum of the abdomen and practically absent from the face, genæ, and lateral lobes of the pronotum. Limbs varying from uniform apple green to the general color, more or less suffused with vandyke brown. Pale lateral bars hardly indicated or weak in the female, tegmina almost wholly of the same tone. Ovipositor of the general color, suffused distad with sepia to brownish black.

Distribution.—The range of this species covers a considerable area of Texas south and east of the Edwards Plateau and plateau plains, being known from four localities, viz., Dallas, Gregory, Beeville, and Uvalde. Dallas constitutes the northern and eastern limit of its known range, Gregory the southern, and Uvalde the western. The vertical range of the species is from practically sea-level at Gregory to eleven hundred feet elevation at Uvalde.

Biological Notes.—All we know regarding the habits, etc., can be taken from our own notes, based on the capture of three specimens. At Gregory we obtained the species from a green tangle about a mesquite clump, where *D. brevihastata* was also secured; at Beeville it occurred in weeds near a tangle of low vine-covered bushes, while at Uvalde it occurred with *D. castanea* on *Acacia berlandieri* growing on the low hill slopes.

Morphological Notes.—The male cerci seem to be very constant in form, but the distal margin of the male subgenital plate shows considerable variation, in some specimens (Dallas) considerably approximating *D. gladiator* in this respect, from which species, however, cercal and other characters readily separate them. This variation is due to a certain amount of plasticity in the shape of this margin, which ranges from distinctly rectangulate emarginate (as it is in the majority of specimens) to a type which has the angulation obtuse with the lateral angles much more rounded than in the typical form.

In the female the ovipositor shows some variation in the straightness of the ventral margin, this being slightly arcuate in three Dallas individuals, but this arcuation is not as decided as in *gladiator*, the general form and robustness of the ovipositor being different from that found in the latter. In two Dallas females the tegmina are hardly visible beyond the pronotum, but the specimens are unquestionably adult. The tegmina project slightly caudad of the adjacent (lateral) margins, but not (or hardly) caudad of the dorsal margin of the pronotum (caudal margin of disk).

Remarks.—There can be little doubt of the correctness of associating Brunner's name with this species, as apparent discrepancies between the description and present material seem to be entirely color differences or else due to a different conception of terms and the relativity of such. The evidence we have of the probable source of the original material and locality of the same assists one considerably in locating the species, as but one form of the genus is, so far as known, found in the Dallas region.

Specimens Examined.—21; 12 males, 9 females.

Dallas, Texas, (Boll), 7 ♂, 6 ♀, [Scudder Collection]; 1 ♂, [U. S. N. M.].

Dallas, Texas, 1 ♂, 2 ♀, [U. S. N. M.].

Texas, (Belfrage), 1 ♀, [Scudder Collection].

Gregory, San Patricio Co., Texas, July 30, 1912, (H.), 1 ♂.

Beeville, Bee Co., Texas, July 28, 1912, (H.), 1 ♂.

Uvalde, Uvalde Co., Texas, elev. 1,000–1,100 feet, August 21–22, 1912, (R. and H.), 1 ♂.

Dichopetala oreœca[28] n. sp.

Closely related to but a single species—*D. catinata* (*vide infra*)—from which it can immediately be separated by the lobe of the male cercus having the margins converging distad, by the ventral margin of the same with a distinctly indicated longitudinal cingulum, the narrower subgenital plate of the male, which has the lateral margins subparallel distad, and by the more ample tegmina in the same sex, while in the female sex the ventral margin of the lateral lobes are straighter in the present species, the ovipositor is more elongate, with the dorsal margin more regularly arcuate and the distal teeth of same more numerous, and the apices of the subgenital plate spiniform, while in both sexes the eyes are less prominent in *oreœca*.

TYPE: ♂; Canyon behind Pulliam Bluff, Chisos Mountains, Brewster Co., Texas. Elev. 4,600–5,000 feet. September 7, 1912. (Rehn and Hebard.) [Hebard Collection.]

Description of Type.—Size medium; form moderately elongate. Head with the occiput full, but little declivent to the fastigium and antennal scrobes; fastigium compressed, lamellate, in contact with the fastigium of the face; eyes prominent, ovate in outline, infra-ocular portion of the genæ but little longer than the eye; antennæ

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[28] 'Ορέιοικος, mountain-dwelling.

about four and a half times as long as the body, proximal joints cylindrical. Pronotum very faintly sellate, dorsal line weakly ascending caudad when seen from the side; form of disk as usual in the genus, the median width hardly more than half that of the caudal margin of the same, regularly diverging cephalad and caudad, more sharply so cephalad; lateral margins of disk indicated on metazona by rounded angles, by color alone on prozona; cephalic margin of disk subtruncate, caudal margin of disk almost imperceptibly arcuate; transverse sulcus broadly V-shaped mesad on disk, severing the lateral margins of the disk mesad; lateral lobes of the pronotum with the greatest depth contained one and one-half times in the dorsal length of the same, cephalic margin sinuato-truncate, ventro-cephalic angle blunt, nearly rectangulate, ventral margin arcuato-truncate, gently rounding into the oblique arcuato-truncate caudal margin. Tegmina in length nearly equal to that of the combined head and pronotum; costal margin gently arcuate, disto-caudal angle quadrantiform, distal margin obliquely passing into the distal portion of the sutural margin, the latter roundly obtuse-angulate at the extremity of the stridulating vein, obliquely arcuato-sinuate distad of the same; marginal field moderately wide, discoidal field regularly widening in the distal two-thirds, anal field with the greatest length little more than the greatest width, stridulating vein gently

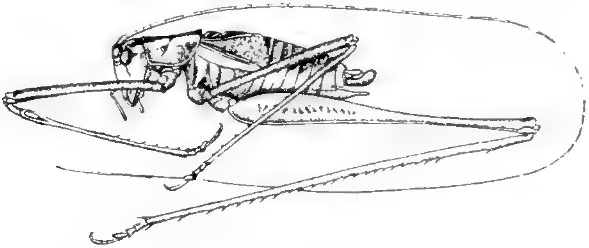
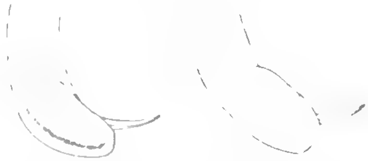


Fig. 33.—*Dichopetala oreœca* n. sp. Lateral view of type. (× 2.)



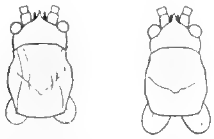
Figs. 34 and 35.—Outline of cercus of males (types) of *Dichopetala oreœca* (34) and *D. catitana* (35). (× 10.)

arcuate, tympanum unequally trigonal, anal vein moderately arcuate. Abdomen with the disto-dorsal segment having the distal margin proper sinuato-truncate; supra-anal plate broad, rotundato-trigonal, with folded rounded lateral flaps; cerci with proximal portion moderately robust, cylindrical, lobe diverging proximad of the middle of the shaft, expanding into a broad convex structure like an inverted spoon, the dorsal margin arcuato-truncate, ventral margin considerably arcuate and with a distinct marginal longitudinal cingulum, apex rather narrowly rounded, whole lobe directed dorso-mesad, remainder of shaft acute, tapering, aciculate, triquetrous in section, arcuate, lying under the lobe and following the same general curve; subgenital plate rather ample, distal half with lateral margins moderately converging, thence straight and subparallel to the tips, distal margin nearly rectangulate emarginate, the lateral angles moderately acute, the ventral surface with a distal medio-longitudinal carina. Cephalic femora about one and two-thirds times as long as the length of the head and pronotum together; cephalic tibiæ with the foramina elongate elliptical. Median femora subequal to the median pair in length. Caudal femora slightly more than twice the length of the cephalic femora, moderately inflated proximad.

Figs. 36 and 37.—Ventral outline of subgenital plate of males (types) of *Dichopetala catinata* (36) and *D. oreæca* (37). (× 4.)

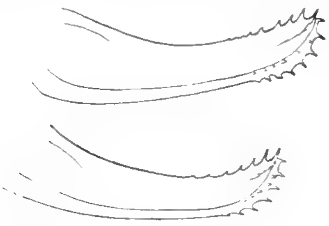
Allotype: ♀; Moss Well, Chisos Mountains, Brewster Co., Texas. Elev. 4,700 feet. September 5-8, 1912. (Rehn and Hebard.) [Hebard Collection.]

Description of Allotype.—The following characters are those of difference from the male sex. Form rather robust. Antennæ about twice the length of the body. Pronotum not at all sellate, the dorsal line nearly straight when seen from the side; median width of the disk proportionately greater than in the male; lateral margins of the disk indicated almost wholly by color; cephalic and caudal margins of the disk as in the male; lateral lobes as in the male except that the ventral margin is subsinuate. Tegmina lateral, very small, rotundate, distal margin slightly flattened, interspace between the tegmina subequal to width of a single tegmen. Disto-dorsal abdominal segment with the distal margin subarcuate, arcuato-emarginate



Figs. 38 and 39.—Dorsal outline of head, pronotum, and tegmina of females (allotypes) of *Dichopetala oreæca* (38) and *D. catinata* (39). (× 2.)

laterad; supra-anal plate broadly tongue-shaped; ovipositor about twice the length of the disk of the pronotum, moderately robust and arcuate, tapering in proximal two-thirds, dorsal margin very considerably and regularly arcuate to the very apex, ventral margin very faintly arcuate except for the distal fourth which forms a quadrant, dorsal margin with seven to eight distal teeth, increasing in length distad, ventral margin with nine to ten distal teeth increasing in length distad and with the apical ones somewhat recurved; subgenital plate almost divided in two (chitinous portion completely divided), lateral sections elongate acute, the tips aciculate, slightly curved toward the median line of the body. Cephalic femora about one and two-thirds times the length of the head and pronotum together. Median femora slightly longer than the cephalic femora. Caudal femora about two and one-half times the length of the cephalic femora.



Figs. 40 and 41.—Outline of ovipositor of allotypes of *Dichopetala oreœca* (40) and *D. catinata* (41). (× 4.)

Paratypic Series.—We have selected as paratypic eight males: two from canyon behind Pulliam Bluff (locality of Type) and the remainder from Moss Well (locality of Allotype).

Measurements (in millimeters).

		♂♂	
	Canyon behind Pulliam Bluff, Chisos Mts., Tex. (Type)	Average of six specimens from Chisos Mts., Tex. (Type and Paratypes)	Average of four specimens from Davis Mts., Tex. (Paratypes)
Length of body	15.8	15.8 (14. –16.9)	15.1 (14.3–16.)
Length of pronotum	3.9	3.7 (3.5– 3.9)	3.9 (3.8– 4.)
Greatest caudal width of disk of pronotum	2.5	2.6 (2.5– 2.9)	2.8 (2.6– 3.)
Length of tegmen	5.3	4.8 (4.3– 5.3)	4.7 (4.6– 5.)
Greatest width of discoidal and anal fields of tegmen	3.2	3.3 (3.2– 3.8)	3.4 (3.3– 3.5)
Length of cephalic femur	10.2	9.7 (8.9–10.3)	8.8 (8.4– 9.5)
Length of median femur	10.1	10.1 (9.2–11.)	9.5 (9.2–10.1)
Length of caudal femur	21.5	21.1 (19.6–22.5)	20.3 (19.5–21.8)

♀ ♀

	Moss Well, Chisos Mts., Tex. (Allotype)	Marathon, Tex. (Paratype)	Average of four specimens from Davis Mts., Tex. (Paratypes)	Montelovez, Coahuila. [Scudder Coll.]
Length of body (exclusive of ovipositor)	16.3	21.5	19.9 (19. –21.3)	15.5
Length of pronotum	5.	5.	5.1 (5. – 5.3)	4.4
Greatest caudal width of disk of pronotum.	3.1	3.9	3.2 (3.1– 3.5)	3.
Apparent length of tegmen	1.1	1.	1. (.9– 1.5)	.7
Greatest width of tegmen	2.	2.2	1.9 (1.9– 2.)	1.2
Length of cephalic femur	9.7	10.2	9.3 (9. – 9.5)	
Length of median femur	10.4	11.3	10.2 (10. –10.5)	8.2
Length of caudal femur	24.	24.6	23.5 (23.2–24.)	20.
Length of ovipositor	10.4	10.9	10.8 (10.5–11.6)	9.

From the very small size of the Montelovez female it would seem that at the southern end of its known range the species is quite under the proportions of Texan specimens, although it is best to make such a statement guardedly, as it would appear from the evidence of the Texan material that size variation is, in large part at least, individual. In the Texan series our individual lots are not of sufficient size to be really comparable, although the Marathon female appreciably exceeds individuals of the same sex taken at higher elevations, while in the male sex the measurements so overlap in the Chisos and Davis series that the differences appear to be purely individual. Probably a series from Marathon would show as much size variation as similar representations from other localities.

Color Notes.—The intensive and recessive extremes of this species are considerably different, the latter being more decided in the female than in the male. The components of the pattern are the usual dorsal latero-ventral, and pale pattern colors, the first two being wholly or in large part indistinguishable in the recessive females, the pale pattern almost completely lacking in the same and weaker than usual in recessive males. In the more or less intensive males and females the pale pattern is very broad, in fact broader than in any of the other forms of the genus.

Dorsal color in recessive males limited to the sides of the dorsum of the head, cephalic two-thirds of the disk of the pronotum, humeral trunk, vicinity of the anal vein and part of the anal field of the tegmina, indicated on the abdomen only by a lineation margining the pale lines dorsad; in the intensive males coloring the occiput, the dorsum of the pronotum, greater portion of the tegmina and generally the dorsum of the abdomen except mesad. The tone of the dorsal color varies from claret brown to maroon, in the intensive extreme blackish laterad on the abdomen. Lateral color in the male varying from lettuce green to oil green, in the recessive extreme coloring the middle of the occiput and the greater portion of the dorsum of the abdomen with oil green, in the intensive extreme the latter is represented by a median section of oil yellow, occasional individuals having this mars yellow and antique brown. The pale pattern varies in tone from flat white to pale orange-yellow (on the abdomen only), occasionally tinged with greenish, the pattern coloring the usual areas and in the intensive individuals almost as wide on the pronotum as on the tegmina, the ventral margin of the lateral lobes edged with the same in intensive specimens. Head with a mediolongitudinal occipito-fastigial thread of the pale color, faintly tinged with the encompassing color; broad vertical infra-ocular and infra-antennal bars of the pale pattern rather strongly (intensive) or weakly (recessive) contrasted; antennæ of the dorsal color (intensive) or orange (recessive); eyes varying from auburn to bay. Tegmina with the ground color of the discoidal field and much of the anal field blackish brown, the overlying venation and solid paler section of the anal field of the lateral color (recessive) or mars yellow (intensive). Abdomen with the dorsal section of the segments more or less decidedly edged distad with the pale pattern; disto-dorsal abdominal segment largely of the dorsal color; cerci varying from greenish proximad and weak mahogany red distad to entirely orange rufous. Limbs of the lateral color, not at all (recessive) or more or less (intensive) washed with burnt sienna on the tibiæ and the distal extremities of the femora; genicular region of the caudal femora blackish in intensive individuals; pattern of the pagina of the caudal femora restricted, decided in intensive and weak in recessive individuals, ventro-lateral face of caudal femora flat white in intensive specimens; foramina of cephalic tibiæ whitish with a seal brown figure.

The recessive females are nearly uniform old gold to biscay green, passing into civette green on the limbs, the head pale green yellow with no markings except a faint postocular pale bar and an edging of claret brown dorsad to the same; pronotum more or less parrot green caudad, the pale lines weak; tegmina claret brown mesad, marginal field of the pale pattern; abdomen with weak narrow paired pale lines, more or less distinctly edged dorsad by a line of claret brown; ovipositor touched with pinkish proximad, the teeth black tipped. Intensive females with the dorsal color covering most of the occiput (not mesad), the cephalic and at least part of the caudal section of the disk of the pronotum, in tone varying from claret brown to mahogany red. The lateral color varies, in intensive individuals (stuffed specimens) from olive green to ochraceous-tawny, passing into variscite green on the pleura and coxæ of ochraceous-tawny specimens, the lateral color covering the dorsum of the abdomen and limbs as well as the lateral and ventral aspects. Pale pattern in intensive specimens broad, very broad on abdomen. Head in intensive specimens with the vertical bars described in the male rather weakly indicated, otherwise as in that sex. Pronotum with the color of the caudal portion of the disk passing from the dorsal color into that of the lateral regions, the pale bars outlined dorsad more or less distinctly with blackish; lateral lobes occasionally washed with hoary white. Tegmina of intensive females with the base color of the discoidal field blackish. Abdomen with the lateral coloration more or less sprinkled with claret brown stipplings; lateral pale bars more or less washed with flesh pink to rose pink, sharply outlined dorsad on each segment by semi-lunate edgings of black, which form continuous series conforming in arcuation to the form of the abdomen; ovipositor in intensive specimens strongly garnet brown to victoria lake on proximal two-thirds of dorsal margin. All limbs with the genicular region more or less strongly and sharply suffused with claret brown; all tarsi blackish. Caudal limbs with the pattern as in intensive males, in one individual the dorsal section of the proximal half of the femora is largely whitish.

Both the type and allotype are intensive individuals. With a single exception, all of the nymphs seen are in or approaching the intensive condition, the exception being about midway between the two extremes.

Distribution.—The present species has a very limited range, being found so far as known only at certain elevations in western Texas and at an unlocated point in Coahuila, Mexico. Aside from Marathon, Texas, the species is known only in that State from the Davis and Chisos Mountains, the former range beginning about forty miles northwest of Marathon, the latter lying seventy-five miles due south from the same point. At Marathon (where it was very infrequent and occurred with *D. brevihastata*) it was taken between 3,900 and 4,160 feet, while in the Davis Mountains it occurred in Lower Limpia Canyon at 4,900 feet, at Maguires Ranch in Upper Limpia Canyon at 5,600 feet and on the slopes of Pine Mountain at 6,500 feet. In the Chisos Mountains it was secured at Moss Well at 4,500–5,300 feet, in the canyon behind Pulliam Bluff at 4,600–5,000 feet and on the slopes of Lost Mine Peak at 6,000 feet. The vertical range of the species is thus seen, at least in Texas, to extend from about 3,900 to 6,500 feet.

Biological Notes.—This peculiar species has been found in a number of situations, on bare rock, in grasses and weeds, in a number of species of shrubby plants and in low trees, once in a nogal or walnut tree (*Juglans rupestris*). In such places they climb gingerly about, at night giving occasionally a very faint lisping stridulation, of a tinkling, sibilant character, which can be represented by *zip-a zip-a zip-a zip-ip-ip-ip*, the last portion being given infrequently and then very rapidly. This note can scarcely be heard at a distance greater than six feet.

Morphological Notes.—In the male the greatest morphological variation appears to be that in the angulation of the distal margin of the subgenital plate, this being more broadly obtuse-angulate in many specimens than in the type, while the bottom of the emargination is nearly rounded in one individual. The male tegmina vary somewhat in bulk, this causing the disto-sutural margin to appear nearly straight in those having the longest tegmina and more or less arcuate (or subangulate) at the apex of the anal vein in those with shorter tegmina. The caudal margin of the disk of the pronotum is truncate in some and feebly emarginate in other specimens, but weakly arcuate (as in the type) in the majority. The female tegmina vary considerably in proportionate size, and the interspace between the same consequently shows an equal amount of variation, ranging from but little over half to that of a whole tegmen width. The ovipositor exhibits similar variation in depth to that seen in certain other species of the genus, in the majority of specimens the distal half being subequal in depth and tapering only in the proximal half, although the form of the margins remains practically the same. The spines at the distal extremity of the ovipositor vary in number from seven to nine dorsad and seven to ten ventrad.

Remarks.—The peculiar characters of the male of this form immediately separate it from all of its congeners except *catinata*, from which it can readily be distinguished by the lobe of the cercus not being subtruncate at the apex and having the margins of the same converging distad. The female is not so readily separated, but it is hardly likely to be confused with anything but *catinata*, the characters of difference from which are given in the diagnosis. This is peculiarly a mountain form, the Marathon locality being very close to the foot of mountains in conditions not at all desert-like. The last-mentioned locality was the only place in Texas where it was found associated with another species of the genus (*D. brevihastata*), which there far outnumbered the present form. The large tegmina of the male are quite characteristic of *oreœca*, which in the male sex and in the intensively colored female is remarkably pretty.

Specimens Examined.—30; 13 males, 7 females, 1 male nymph, 9 female nymphs.

Pine Mountain (slopes), Davis Mountains, Jeff Davis Co., Texas, elev. 6,500 feet, August 29, 1912, (R. and H.), 1 ♂.

Maguires Ranch, Upper Limpia Canyon, Davis Mountains, Jeff Davis Co., Texas, elev. 5,600 feet, August 29, 30, 1912, (R. and H.), 3 ♂, 3 ♀.

Lower Limpia Canyon, Davis Mountains, Jeff Davis Co., Texas, elev. 4,900 feet, August 31, 1912, (R. and H.), 1 ♀.

Marathon, Brewster Co., Texas, elev. 3,900–4,160 feet, September 12, 13, 1912, (R. and H.), 1 ♀.

Moss Well, Chisos Mountains, Brewster Co., Texas, elev. 4,500–5,300 feet, September 5–8, 1912, (R. and H.), 6 ♂, 1 ♀ (paratypes and allotype), 5 ♀ nymphs.

Canyon behind Pulliam Bluff, Chisos Mountains, Brewster Co., Texas, elev. 4,600–5,000 feet, September 7, 1912, (R. and H.), 3 ♂ (Type and paratypes), 4 ♀ nymphs.

Lost Mine Peak, Chisos Mountains, Brewster Co., Texas, elev. 6,000 feet, September 6, 1912, (R. and H.), 1 ♂ nymph.

Montelovez, Coahuila, Mexico, September 20, 1 ♀, [Scudder Coll.].

Dichopetala catinata n. sp.

Closely related to only *D. oreœca* (*vide supra*), under which the differential diagnostic characters are set forth.

Type: ♂; Brownsville, Cameron Co., Texas. July 31, 1912. (Hebard.) [Hebard Collection.]

Description of Type.—It seems necessary only to state characters not fully in accord with those of *oreœca*. Size moderate. Eyes very prominent, ovate, their depth contained one and one-third times in that of the infra-ocular portion of the genæ. Pronotum hardly sellate; disk of pronotum with median width very slightly more than half that of the caudal margin of the same; lateral margins of the disk regularly diverging cephalad and caudad; transverse sulcus with an impressed subobomegoid figure; lateral margins of the disk with a more or less distinct angle everywhere except mesad; cephalic and caudal margins of the disk arcuato-truncate; lateral lobes of the pronotum with the ventral margin distinctly sinuate and the caudal margin less oblique. Tegmina not longer than the pronotal disk, general form as in *oreœca*, but with the sutural margin rotundato-rectangulate at the apex of the stridulating vein; marginal field narrow, discoidal field regularly expanding for nearly its whole length, anal field with its greatest width about two-thirds of its length, stridulating vein arcuate, slightly bent near the proximal third, tympanum poorly defined, but with the general form much as in *oreœca*. Disto-dorsal abdominal segment with the distal margin slightly emarginato-truncate, subrectangulate laterad of the same and deeply and sharply arcuato-emarginate at the bases of the cerci; supra-anal plate quadrate with rectangulate angles; cerci in general much as in *oreœca*, but the lobe is larger, the margins subparallel, and the apex arcuato-truncate, while but a trace of the ventral cingulum is present; subgenital plate ample, produced, arcuate in transverse section, lateral margins concavely emarginate, distal margin arcuate V-emarginate, lateral angles moderately acute, diverging, ventral surface with a low median carina distad. Cephalic femora about one and two-thirds times as long as the head and pronotum together. Median femora slightly longer than the cephalic femora. Caudal femora about twice the length of the median femora.

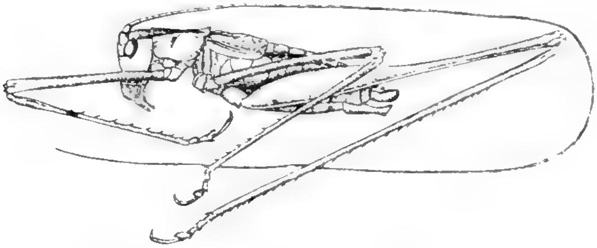


Fig. 42.—*Dichopetala catinata* n. sp. Lateral view of type. (× 2.)

Allotype: ♀; Brownsville, Cameron Co., Texas. August 1, 1912. (Rehn and Hebard.) [Hebard Collection.]

Description of Allotype.—The following characters are those of difference from the female of *oreœca*. Pronotum with the disk broad mesad, at least three-fourths the caudal width of the same; cephalic and caudal margins of disk subtruncate; lateral lobes of the pronotum with the ventral margin sinuato-emarginate dorsad of the coxæ. Tegmina more dorsal than in *oreœca,* semi-ovate, separated by an interval less than half the width of a single tegmen. Disto-dorsal abdominal segment with the distal margin subtruncate; supra-anal plate transverse, rounded; ovipositor slightly less than twice the length of the pronotal disk, moderately robust, margins as in *oreœca,* the extremity of the dorsal margin with six, that of the ventral margin with seven spines; subgenital plate with the chitin divided in two, the lateral sections elongate, sublanceolate, the immediate apex blunted. Cephalic femora about twice the length of the disk of the pronotum. Median femora slightly longer than the cephalic femora.

Paratypic Series.—We have before us two paratypes, one an imperfect adult male, the other an immature male, both taken at Brownsville, July 31–August 5.

Measurements (in millimeters).

	Brownsville, Texas.		
	♂ (Type)	♂ (Paratype)	♀ (Allo-type)
Length of body	17.6	15.4	16.2
Length of pronotum	4.	4.	4.5
Greatest caudal width of disk of pronotum	2.7	2.7	3.
Length of tegmen	4.	3.7	1.5
Greatest width of discoidal and anal fields of tegmen (♂) or of entire tegmen (♀)	2.8	2.7	2.1
Length of cephalic femur	9.8	10.5	8.8
Length of median femur	10.8	11.	9.5
Length of caudal femur	22.		22.
Length of ovipositor			8.9

Color Notes.—As but the type and allotype of *catinata* have fully retained their original coloration, the following notes are based entirely on them.

Male (Type). General pattern consisting of a dorsal color, a latero-ventral color and a pale pattern, the first covering the occiput, the dorsum of the pronotum, humeral trunk, discoidal and greater portion of anal fields of the tegmina and greater portion of the dorsum of the abdomen. The tone of this color is between burnt sienna and chestnut, that of the latero-ventral color cosse green, while the pale pattern runs from creamy on the head to white on the tegmina and pinard yellow on the abdomen, the latter pattern limited to a medio-longitudinal occipital and fastigial thread, and paired bars extending caudad from the eyes along the lateral margins of the disk and margining laterad the dorsal color of the abdomen. Head with the face, mouth-parts, genæ, and much of the postocular region maize yellow; eyes bay; antennæ of the dorsal color proximad, passing into antique brown with a few well-spaced moderately broad annuli of seal brown. Pronotum with the pale bars slightly tinged with greenish, in the vicinity of the angle the caudal margin of the disk and of the lobes is blackish. Tegmina with the marginal field wholly of the pale color, the distal portion of the discoidal field with the base color blackish brown and the vein pattern of the general dorsal color, anal field with the vicinity of the proximal two-thirds of the anal vein broadly blackish brown, the proximal portion of the sutural margin edged with same, median section of the anal field washed with barita yellow. Dorsum of the abdomen with the median portion of the segments having the base color weak and each segment with a proximal area of pinard yellow (most decided proximad), laterad the dorsal color is outlined with blackish, this latter oblique and independent on each segment, the contiguous yellowish portion of the pale pattern broken up in consequence. Disto-dorsal abdominal segment of the dorsal color, cerci mars yellow. Cephalic limbs mars yellow, passing into the latero-ventral color proximad, the tarsi clove brown. Median femora largely of the lateral color passing into mars yellow, tarsi clove brown. Caudal femora of the lateral color, passing distad into mars yellow with a decided genicular area of blackish, pattern of pagina pronounced, but not extensive; caudal tibiæ seal brown dorsad, honey yellow ventrad, caudal tarsi seal brown.

Female (Allotype). Nearly uniform light yellowish olive (probably more vivid in life), passing into light bice green on the limbs, approaching forest green on the medio-longitudinal portion of the caudal femora, the ventral carina of the same whitish. Pale lines feebly indicated on the head and the cephalic portion of the pronotum; caudal margin of the pronotum with blackish as in the male; disk of the pronotum with a faint medio-longitudinal thread of auburn, which is intersected by a black spot at the crossing of the transverse sulcus; eyes auburn; antennæ aniline yellow passing into pyrite yellow distad with a few scattered weak annulations. Tegmina weakly suffused with antique brown mesad. Abdomen with the tegmina covering a blackish blotch.

Distribution.—The present species is only known from the vicinity of Brownsville in the arid tropical Tamaulipan section of the lower Rio Grande Valley, Texas. The range of the species unquestionably extends south into Mexico.

Biological Notes.—This form was numerous in vine-covered hedges and tangles near old Fort Brown, Brownsville, where they were heard stridulating at numerous points about dusk, but they were extremely difficult to secure, owing to their surroundings, as they always sought refuge within the tangled hedges when approached. The stridulation is a faint *tsikh*, repeated at intervals of about twice the length of the note.

Morphological Notes.—From the evidence of the two males, the median width of the disk of the pronotum is seen to vary somewhat, in the paratype this being as much as two-thirds the caudal width of the disk.

Specimens Examined.—4; 2 ♂, 1 ♀, 1 ♂ nymph.

Brownsville, Cameron Co., Texas, July 31–August 3, 1912, (R. and H.), 2 ♂, 1 ♀, 1 ♂ nymph. TYPE, allotype and paratypes.

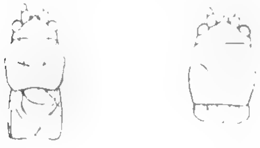
Dichopetala tauriformis n. sp.

This is a very peculiar and distinct species having no close relationship to any other form in the genus, in the female sex showing some affinity to *falcata* and in the male sex approximating *pollicifera* more nearly than anything else. The peculiar appendage of the supra-anal plate of the male, the anomalous cerci, the strongly depressed median section of which, together with the elongate aciculate tooth which is peculiarly curved, and the unusual structure of the distal section of the shaft, as well as the very decided peculiarities of the subgenital plate at once distinguish the male sex, while in the female the ovipositor is proportionately the longest and heaviest in the genus, the subgenital plate with its lateral trigonal lobes also being quite different from that found in *falcata*.

TYPE: ♂; Mountains twelve leagues east of San Luis Potosi, Mexico. (Palmer.) [Scudder Collection.]

Description of Type.—Size above the average for the genus; form moderately slender. Head with the occiput rather strongly declivent to the fastigium and antennal scrobes; fastigium low, slightly compressed, weakly sulcate dorsad, not touching the frontal fastigium; eyes prominent, elongate ovoid, their length two-thirds that of the infra-ocular portion of the genæ. Pronotum weakly sellate, the dorsum moderately deplanate in transverse section; disk with the lateral margins indicated by a weak angle as well as by color, angle weakest mesad, arcuate inbowed, most approximate at the transverse sulcus which is slightly cephalad of the middle; greatest caudal width of dorsum about two-thirds the greatest length of same; cephalic margin subtruncate, very weakly emarginate mesad, caudal margin very gently arcuato-emarginate; transverse sulcus impressed in an obomegoid figure mesad, faint cephalic and caudal traces of a longitudinal sulcus; lateral lobes of the pronotum with greatest depth contained one and two-thirds times in the greatest dorsal length of same, cephalic margin straight, ventro-cephalic angle narrowly rounded rectangulate, ventral margin gently arcuato-emarginate, the greatest depth of the lobes caudal, ventro-caudal angle and caudal margin moderately arcuate except the dorsal portion of the latter which is truncate. Tegmina somewhat inferior to pronotum in length; costal margin straight, disto-costal angle well rounded, distal margin slightly oblique, truncato-arcuate, sutural margin rectangularly produced at the extremity of the stridulating vein, distal portion of the same margin obliquely sinuato-truncate; marginal field rather narrow, discoidal field regularly expanding from the proximal third, anal vein straight and not arcuate, anal field with the greatest length but little more than greatest width, stridulating vein slightly arcuate, tympanum proper poorly defined. Abdomen with lateral margins subparallel, disto-dorsal abdominal segment strongly transverse, the greatest length of the same not more than one-fifth its greatest width,

Fig. 43.—*Dichopetala tauriformis* n. sp. Lateral outline of type. (× 2.)



Figs. 44 and 45.—*Dichopetala tauriformis* n. sp. Dorsal outline of head, pronotum and tegmina of male (type: 44) and female (allotype: 45). (× 2.)

caudal margin of the segment arcuato-sinuate, slightly produced mesad into a low truncate lobe, which is the hinge of the supra-anal plate, the latter with the length subequal to the greatest proximal width, lateral margins approximating distad, distal margin broadly V-emarginate, lateral angles slightly acute, from the dorsal surface of the supra-anal plate immediately proximad of the apex is erected a structure like the Greek letter ϒ, but with the cross bar slightly straighter; cerci very complex, having first a semicircular transverse lamellate ridge proximad, distad of which the whole cercus is depressed, obliquely and strongly so toward the internal margin, that which we consider the shaft proper directed meso-caudad, narrowing, strongly depressed, the distal extremity bent inward at a right angle, apex acute, tooth developed from the external margin but little distad of the base, depressed proximad, there lamellate, becoming aciculate distad, curving dorsad and mesad, as long as the shaft; subgenital plate greatly produced, reaching nearly to the tips of the cerci, lateral margins regularly arcuato-concave, the distal extremity distinctly broader than the median width, distal margin with a decided median quadrate emargination, laterad of which the margin is obliquely truncate, angles acute with the immediate angle blunted. Cephalic femora subequal to the length of the head, pronotum, and tegmina; cephalic tibiæ with elliptical foramina. Median femora half the length of the caudal femora. Caudal femora longer than the body, moderately inflated, very gradually tapering distad.

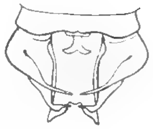


Fig. 46.—*Dichopetala tauriformis* n. sp. Dorsal outline of apex of abdomen of male (type). (× 4.)

Fig. 47.—*Dichopetala tauriformis* n. sp. Ventral outline of subgenital plate of male (type). (× 4.)

Allotype: ♀; same data as the type.

Description of Allotype.—The following points are those of difference from the type. Head with the occiput more roundly declivent. Pronotum with the dorsum broader, the lateral margins of the disk (which are indicated almost wholly by color) nearly parallel to the transverse sulcus, thence moderately diverging; cephalic margin with the emargination more decided, that of caudal margin less decided; disk with almost no traces of

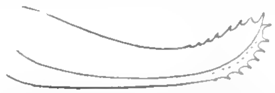


Fig. 48.—*Dichopetala tauriformis* n. sp. Outline of ovipositor. (× 3.)

pattern of transverse sulcus; lateral lobes as in male. Tegmina very short, broad, sutural margins decidedly overlapping, distal margin somewhat oblique, arcuato-truncate. Supra-anal plate rotundato-trigonal; cerci short, conic, apices slightly elongate, acute; ovipositor very robust, elongate, about two-thirds as long as the caudal femora, dorsal margin considerably arcuate, more sharply so distad, ventral margin straight except distad where it is decidedly arcuate, dorsal margin with eight to nine teeth on the distal third, ventral margin with seven to nine teeth on the distal fourth, those on the latter faintly recurved distad; subgenital plate with the chitinous portion completely divided, the lateral sections developed as acute trigonal lobes slightly longer than broad. Cephalic femora very slightly longer than the head and pronotum together. Median femora subequal to the length of the head, pronotum, and tegmina together. Caudal femora subequal to the length of the body, moderately robust (for the genus).

Fig. 49.—*Dichopetala tauriformis* n. sp. Ventral outline of subgenital plate of female (allotype). (× 4.)

Paratypic Series.—We consider all of the material before us, other than the type and allotype (three males and seven females), paratypic.

Measurements (in millimeters).

	♂♂				
	Twelve leagues east of San Luis Potosi, Mex.		Sierra de San Miguelito, Mex. (Paratypes.)		Average of three paratypes.
	(Type.)	(Paratype.)			
Length of body	16.5	15.2	16.	17.3	16.1
Length of pronotum	3.9	3.7	4.	3.7	3.8
Greatest caudal width of disk of pronotum.	3.	3.	2.6	2.5	2.7
Length of tegmen	3.5	3.5	3.3	3.3	3.3
Greatest width of discoidal and anal fields of tegmen	3.2	3.1	2.8	2.6	2.8
Length of cephalic femur.	7.9	7.3	7.	7.6	7.3
Length of median femur	9.9	9.5	8.7	9.	9.1
Length of caudal femur	19.7	18.5	17.7	19.	18.4

	♀ ♀ Twelve leagues east of San Luis Potosi, Mex.		
	(Allotype.)	(Paratypes.)	
Length of body	17.	19.2	21.5
Length of pronotum	4.	4.6	4.7
Greatest caudal width of disk of pronotum	3.3	3.7	4.
Length of tegmen	1.3	1.5	1.2
Greatest width of tegmen	3.	3.2	3.
Length of cephalic femur	6.	7.1	8.
Length of median femur	7.4	8.6	9.5
Length of caudal femur	17.	18.2	20.6
Length of ovipositor	10.8	12.	12.8

	Alvarez, Mex. (Paratype.)	♀ ♀ Sierra de San Miguelito, Mex. (Paratypes.)		Average of five paratypes.
Length of body	20.4	15.5	16.8	18.7
Length of pronotum	4.5	4.3	4.4	4.5
Greatest caudal width of disk of pronotum	3.5	3.3	3.4	3.6
Length of tegmen	1.5	1.7	1.2	1.4
Greatest width of tegmen	3.	2.6	2.9	2.9
Length of cephalic femur	7.1	7.3	7.5	7.4
Length of median femur	8.2	8.4		8.6
Length of caudal femur	17.2	19.2	18.5	18.7
Length of ovipositor	12.3	11.	11.3	11.8

Color Notes.—This species has the usual intensive and recessive extremes, the former of which has a dorsal color much darker than the lateral one, in the recessive extreme there being almost no difference in tone between the lateral and dorsal colors. As far as present material goes, the extremes are almost equally marked in the two sexes and the tones are very similar in both. We here give the colors as found in the material, but as none of it has been stuffed there is a strong probability that the greens, at least, have lost much of their intensity. Dorsal color varying from sulphine yellow (extreme in the females alone) to dull maroon (intensive of both sexes), traces of the latter being present in the recessive males,[29] while this color is solid and pure on the head and disk of the pronotum of intensive individuals of both sexes. On the dorsum of the abdomen

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[29] Possibly the recessive condition in the male is wholly due to desiccation, the original dorsal color being left in patches. We, however, do not feel convinced that this is the case, as the general tonal correlation of what we consider the recessive male is essentially the same as in the undoubtedly recessive females.

this intensive color is only pure laterad, mesad the tone being aniline yellow to sulphine yellow, thickly and closely stippled with maroon. The lateral maroon bordering lines are narrowly present in even the recessive males as well as faintly indicated in the recessive females. Lateral color varying from sulphine yellow to buffy citrine, the males being almost all sulphine yellow, particularly pure in the intensive males. Pale lateral lines very narrow, more or less indicated in all, varying from creamy white to maize yellow, rarely touched with orange pink, extending from the caudal margin of the eye to the base of the cercus. Eyes varying from chamois (recessive male) and buffy citrine (recessive female) to old gold (intensive male) and cinnamon brown (intensive female). Antennæ varying much the same as the dorsal color. Tegmina of male largely oil green, the proximal portion of the humeral trunk blackish, large portion of anal field washed with warm sepia, marginal field shell pink; temina of female with discoidal field oil green, anal field similar, occasionally (intensive female [allotype]) washed with maroon, marginal field shell pink to ochre red. Ovipositor varying with the dorsal color. Limbs varying from pois green to grape green, occasionally washed with purplish vinaceous on median and cephalic pair in recessive specimens, of the same greatly suffused, lined and spotted with maroon in intensive individuals. The latter condition is very decided in its extreme, the femora having nearly solid pregenicular patches dorsad, while the distal extremities of the tibiæ and all of the tarsi are suffused with maroon. The type and allotype are in the extreme intensive condition, which is shared or approximated by several other specimens.

Distribution.—The present species is known only from three localities in the state of San Luis Potosi in the east-central portion of the Mexican tableland: Sierra de San Miguelito, mountains twelve leagues east of San Luis Potosi city, and mountains at Alvarez. The first-mentioned locality we are unable to locate, so its altitude cannot be given, but it probably has much the same elevation as the other localities, which range between five and six thousand feet. Alvarez is on the upper course of the Rio Verde, a head tributary of the Rio Panuco, east of the city of San Luis Potosi.

Morphological Notes.—The tegmina of the male show variation in the angulation of the sutural margin and in the character of the distal margin. The latter is more arcuate in one specimen than in the type and in one paratypic male it is more truncate. The curve of the stridulating vein also varies somewhat. The stalked process on the male subgenital plate in one paratype is similar to that of the type, while in the others the head of the process is more or less expanded with the distal margin arcuate. The anomalous cerci seem to vary little or not at all, while the subgenital plate varies only in that the quadrate emargination of the distal margin is replaced by a V-shaped emargination in one paratype. The female shows variation chiefly in the robustness of the ovipositor, although this is not as pronounced as in some other species of the genus.

Remarks.—The structure of the apex of the abdomen in the male of this species and the very heavy ovipositor of the female are characters which serve to easily distinguish the present peculiar form. There is no approach to the genital structure of the male in any of the other forms of the genus, except that the tooth springs from the external margin of the shaft of the cercus in this and in *pollicifera*, which similarity is somewhat augmented by the general form of the pronotum and tegmina, but there the analogy ceases, as the details of the abdominal appendages and of the tegmina are quite different. The female sex, however, shows no close affinity to *pollicifera*, while it does have much in common with *falcata*, to which the male sex shows no affinity.

Specimens Examined.—12; 4 males, 8 females.

Mountains twelve leagues east of San Luis Potosi, Mexico, (Palmer), 2 ♂, 4 ♀. TYPE, allotype, and paratypes. [Scudder Collection.]

Sierra de San Miguelito, state of San Luis Potosi, Mexico, (Palmer), 2 ♂, 3 ♀. Paratypes. [Scudder Collection.]

Mountains at Alvarez, state of San Luis Potosi, Mexico, (Palmer), 1 ♀. Paratype. [Scudder Collection.]

Dichopetala tridactyla n. sp.

This species can be immediately separated in the male sex from all of the species of the genus, except *D. caudelli*, by the peculiar appendiculate character of the cercus, while from *caudelli* it can be separated in the male sex by the shorter tegmina, the very brief distal portion of the anal field of the same, by the sutural margin of the tegmina being strongly produced at the apex of the stridulating vein and by the more elongate median tooth of the cercus. In the female sex *tridactyla* can be separated from *caudelli* by the shorter ovipositor and blunter apices to the lobes of the subgenital plate.

TYPE: ♂; Camacho, Zacatecas, Mexico. November, 1877. (Lawrence Bruner.) [Hebard Collection.]

Description of Type.—Size small. Head with the occiput well rounded, regularly descending to the fastigium and antennal scrobes; fastigium slightly elevated, compressed, linear, rounded at the apex when seen from the side, not touching the frontal fastigium; eyes very prominent, subglobose, depth about one and one-half times that of the infra-ocular portion of the genæ; antennæ with the proximal joints large, slightly depressed. Pronotum sellate, dorsal length little greater than caudal width of dorsum of same and distinctly less than greatest ventral width of pronotum across lateral lobes; cephalic margin subtruncate, caudal margin very slightly arcuato-emarginate; lateral margins of disk slightly marked caudad by rounded angles, elsewhere by color only, the general form of same considerably narrowed mesad; transverse sulcus severing lateral margins of disk mesad, represented on the disk by a median transverse impression placed at the caudal third, but not connected with the sulci severing the lateral margins of the disk; lateral lobes with greatest depth contained about one and one-half times in the dorsal length of the same, cephalic margin of the lobes arcuato-emarginate,

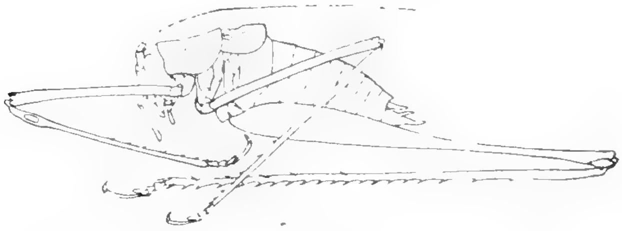
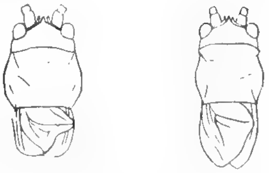


Fig. 50.—*Dichopetala tridactyla* n. sp. Lateral outline of type (male). (× 3.)

ventro-cephalic angle narrowly rotundato-rectangulate, ventral margin slightly sinuato-truncate, ventro-caudal angle and caudal margin very broadly arcuate. Tegmina slightly shorter than the pronotum, broad, the width of the discoidal and anal fields subequal to the tegminal length; costal margin slightly arcuate, disto-costal angle rounded, distal margin moderately arcuate, passing into the sutural margin, latter strongly rotundato-rectangularly produced at the apex of the stridulating vein, distal portion of the sutural margin strongly oblique; marginal field rather narrow, discoidal field short, strongly expanding distad, anal field very broad. Abdomen with lateral margins of segments subparallel, proximal segments subtectate; disto-dorsal abdominal segment with the distal margin arcuato-truncate, considerably arcuato-emarginate at the dorsal base of the cerci; cerci trifid, from the dorsal base projects an arcuate subequal blunt digitiform lobe, which in general follows the curve of the shaft of the cercus when seen from the dorsum and when viewed from the lateral aspect is subparallel with the same, not quite reaching the apex of the median tooth, latter diverging proximad of the middle, moderately acute, tapering, slightly depressed, diverging moderately disto-dorsad, subequal to half the length of the shaft of the cercus distad of the tooth, shaft very robust proximad of the divergence of the tooth, falciform, strongly depressed, triquetrous, margins sharp, apex acute, tapering for a short distance proximad of apex; subgenital plate large, cymbiform, moderately produced, distal margin broadly and rather deeply V-emarginate, lateral angles moderately acute. Cephalic femora slightly less than half the length of the caudal femora; cephalic tibiæ with tympanum elliptical. Median femora subequal to one-half the length of the caudal femora. Caudal femora about one and one-half times the length of the body, moderately inflated proximad.



Figs. 51 and 52.—Dorsal outline of head, pronotum and tegmina of males (types) of *Dichopetala tridactyla* (51) and *D. caudelli* (52). (× 3.)

Figs. 53 and 54. Outline of left cercus of males (types) of *Dichopetala tridactyla* (53) and *D. caudelli* (54). (× 8.)

Allotype: ♀; data the same as the type.

Figs. 55 and 56.—Ventral outline of subgenital plate of males (types) of *Dichopetala tridactyla* (55) and *D. caudelli* (56). (× 8.)

Description of Allotype.—Size medium; form robust (for the genus). Head broad, form of occiput and fastigium as in the male, the latter, however, not as compressed; eyes prominent, more ovate than in the male, depth of eye contained about one and one-half times in that of the infra-ocular portion of the genæ. Pronotum in general form similar to that of the male, but less sellate, non-depressed mesad; caudal margin of disk subtruncate; lateral margins of disk hardly indicated even caudad; transverse sulcus as in male, the median discal remnant of same less distinct and V-shaped; lateral lobes with greatest depth contained nearly one and one-half times in greatest dorsal length of same, margins of lobes as in male, but the cephalic truncate and not emarginate. Tegmina very short, over twice as wide as the apparent length, costal margin arcuate with the distal portion more or less truncate; interspace between tegmina slightly more than half the width of a single tegmen. Abdomen somewhat compressed, proximal segments tectate dorsad; supra-anal plate moderately produced, rounded; cerci very short, conic; ovipositor slightly surpassing the length of the median femora, moderately arcuate, more sharply so distad, robust, dorsal margin faintly flattened mesad, distal third of same margin armed with six distinct teeth, increasing in length distad, ventral margin very weakly arcuate except in the distal third where the arcuation is decided, there armed with six to seven short slightly recurved teeth; subgenital plate divided into two parts, as far as the chitinous structure is concerned, these connected mesad for a third of their length by soft integument, the lateral halves of the plate subovoid-trigonal, the apices bluntly angulate. Cephalic femora about one and two-thirds times the length of the disk of the pronotum. Median femora slightly less than half the length of the caudal femora. Caudal femora robust (for the genus), considerably inflated.

Figs. 57 and 58.—Ventral outline of subgenital plate of females (allotypes) of *Dichopetala tridactyla* (57) and *D. caudelli* (58). (× 5.)

Figs. 59 and 60.—Outline of ovipositor of females (allotypes) of *Dichopetala tridactyla* (59) and *D. caudelli* (60). (× 4.)

Paratypic Series.—All of the material belonging to this species now before us, in addition to the type and allotype, is considered paratypic—four males, fifteen females.

Measurements (in millimeters).

	Camacho, Mexico.	
	(Type)	Average of four paratypic
Length of body	10.8	11.3 (11.2-11.7)
Length of pronotum	2.8	3. (2.9- 3.1)
Greatest dorsal width of pronotum	2.1	2.5 (2.5- 2.6)

	Camacho, Mexico.	
	(Type) ♂	Average of four paratypic ♂♂
Length of tegmen	2.6	2.6 (2.5–2.6)
Greatest width of discoidal and anal fields of tegmen	2.3	2.6 (2.4–2.7)
Length of cephalic femur	7.	7.1 (7. –7.5)
Length of median femur	7.5	8. (7.4–8.4)
Length of caudal femur	15.	16.3 (15.2–17.1)

	Camacho, Mexico.	
	(Allotype) ♀	Average of four paratypic ♀♀
Length of body (exclusive of ovipositor)	15.5	15.3 (14.7–17.)
Length of pronotum	4.3	3.8 (3.4–4.)
Greatest dorsal width of pronotum	3.7	3.1 (2.9–3.2)
Apparent length of tegmen	.9	1. (.9–1.1)
Greatest width of tegmen	2.1	1.9 (1.8–2.)
Length of cephalic femur	7.1	6.7 (6.5–7.)
Length of median femur	8.2	7.6 (7.1–8.3)
Length of caudal femur	18.2	17.1 (16.3–18.3)
Length of ovipositor	8.3	8.1 (7.8–8.8)

From these measurements it is evident that the type is distinctly under the average in size, while the allotype is considerably over the average for the female sex, both showing in certain proportions the minimum and maximum proportions, respectively, for their sexes. The selection of the type and allotype was based solely on the condition of the specimens, so no size factors were considered in the matter. It is apparent from the above evidence that there is considerable individual variation in size in the species.

Color Notes.—As none of the material belonging to this species has been stuffed, we are compelled to take the colors found at their face value, although doubtless some have altered very materially. The pattern of both sexes consists of a more or less uniform dorsal color involving a variable portion of the occiput, dorsum of the pronotum, dorsal portion of the lateral lobes of the pronotum and dorsum of the abdomen, and a pale lateral color which involves the face, genæ, ventral portion of the lateral lobes, and lateral aspect of the abdomen, the latter color always (♂) or frequently (♀) modified in extent and tint.

Male. Dorsal color varying from prout's brown to clove brown, most decided near its lateral borders on the abdomen. Lateral color varying from buckthorn brown to dresden brown, the ventral half of the lateral lobes of the abdomen and the marginal field of the tegmina creamy white in intensive specimens; paired lateral lines on the abdomen (in the usual position of pale lines in the genus) contrasted with a wash of the dorsal color on the proximo-ventral portion of the abdomen. Head with narrow postocular lines and a medio-longitudinal thread on the occiput and fastigium creamy white, in intensive individuals the dorsal color covering much of the postocular portion of the genæ; eyes varying from dresden brown to cinnamon brown; antennæ ferruginous dorsad, ventral surface mahogany red to chestnut. Pronotum with the caudal section of the disk washed with auburn, continuations of the postocular lines, converging to the transverse sulcus and diverging caudad of the same, subobsolete near the caudal margin, varying from creamy white to buff yellow; dorsal color more or less strongly clouding an obliquely delimited dorsal section of the lateral lobes, ventral section of same creamy white. Tegmina with the discoidal and anal fields with a blackish-brown base, over which the veins are outlined in ochraceous orange, the greater portion of the sutural margin washed with hay's russet. Distal half of the appendiculate lobe of the cerci infuscate with the dorsal color in intensive individuals. Limbs varying from old gold to olive lake, more or less generally infuscate with chestnut brown, most decided ventrad and there linear in pattern; caudal femora with a pair of fine blackish lines on the ventral portion of the lateral face; tibiæ more or less lime green.

Female. Dorsal color ranging from argus brown to dark mummy brown; lateral color ranging from creamy white to dresden brown, the latter in recessive individuals and there very poorly separated from the dorsal shade. Head with pale lines less distinctly indicated than in the male sex, the extreme intensive individual having the greater portion of the head opaline green. In the average individuals the abdomen has no decidedly indicated lateral bars dorsad margining the dorsal color, but in the intensive specimens these bars are decided creamy white, of variable width and the lateral base of the abdomen is contrastingly washed with the dorsal color. Pronotum as in the male, but nearly uniform in recessive individuals. Tegmina varying from nearly uniform with the lateral color to blackish brown, with the venation of the lateral color, in the intensive extreme having the costal portion of the latter color. Ovipositor varying from citrine to orange-citrine, distal portion infuscate in some specimens. Limbs varying from viridine green (in this the femora pale bluish white proximad) to cosse green, marked much as in the male, but with the infuscation more or less tessellate or marmorate, linear and punctate in character.

Distribution.—The present species is only known from two localities in the central portion of the Mexican tableland—Camacho, Zacatecas, and Jimulco, Coahuila. Its vertical distribution is apparently from somewhat below five thousand to about six thousand feet.

Morphological Notes.—In the male sex the only morphological variation worth noting is that of the degree of arcuation of the margins of the distal excision of the subgenital plate. In the type these margins are straighter than in the others of the sex, but in all they are more or less arcuate toward the angles. In the female sex the ovipositor varies appreciably in robustness without correlation with the general size.

Remarks.—The present species and *D. caudelli* constitute a very distinct section of the genus, having no close relationship to any of the other forms.

Specimens Examined.—21; 5 males, 16 females.

Camacho, Zacatecas, Mexico, November, 1887, (Lawrence Bruner), 5 ♂, 14 ♀. TYPE, allotype, and paratypes. [Hebard Collection.]

Jimulco, Coahuila, Mexico, November, (Lawrence Bruner), 2 ♀. Paratypes. [Hebard Collection.]

Dichopetala caudelli n. sp.

This species is close to *D. tridactyla*, but can be readily separated in the male sex by the distinctly longer tegmina, the more normal distal portion of the anal field of the same, the sutural margin of which is but little produced at the apex of the stridulating vein and by the shorter median tooth of the cercus, while in the female the slightly longer ovipositor and acute apices to the lobes of the subgenital plate enable one to distinguish the present form. The species is similar to *tridactyla* in the majority of the characters, so we have made our description in large part comparative. When not mentioned specifically, the structure is understood to be similar to that in *tridactyla*.

TYPE: ♂; San Luis Potosi, state of San Luis Potosi, Mexico. (Palmer.) [Scudder Collection.]

Description of Type.—Size and form as in *tridactyla*. Head as in *tridactyla*. Pronotum with the caudal margin of the disk very slightly arcuate, disk itself (indicated by color) broader mesad than in *tridactyla*, the lateral borders of the same less sharply diverging cephalad and caudad; transverse sulcus severing the lateral borders of the disk mesad, forming a V-shaped figure near the caudal third of the disk; caudal margin of the lateral lobes of the pronotum obliquely subtruncate, ventro-caudal angles of lobes rounded. Tegmina appreciably longer than the dorsum of the pronotum, width of discoidal and anal fields slightly less than the length of same; costal margin considerably arcuate, distal margin obliquely arcuato-truncate, sutural margin obtuse-angulate at the extremity of the stridulating vein, appreciably sinuate distad of the same; discoidal field less sharply expanded than in *tridactyla*. Cerci with the appendicular lobe straighter than in *tridactyla*, slightly expanded distad, median tooth short, depressed, when seen from the dorsum with the margin rounded and not acute, acute distal extremity of the shaft of the cercus slightly shorter and more regularly tapering than in *tridactyla*; subgenital plate with distal margin more deeply V-emarginate than in *tridactyla*, the margins of the excision slightly arcuate, the lateral angles quite acute. Limbs as in *tridactyla*, but cephalic and median femora very slightly slenderer.

Fig. 61.—*Dichopetala caudelli* n. sp. Lateral outline of type (male). (× 3.)

Allotype: ♀; Mountains twelve leagues east of San Luis Potosi, state of San Luis Potosi, Mexico. (Palmer.) [Scudder Collection.]

Description of Allotype.—Differing from the allotype of *tridactyla* in the characters here described. Form and size as in *tridactyla*. Head as in *tridactyla*. Pronotum as in *tridactyla*, but with the disk broader mesad, the margins (indicated almost wholly by color) very slightly narrowing to the transverse sulcus, thence moderately diverging caudad; caudal margin of disk gently arcuate; transverse sulcus more continuous than in *tridactyla*, but weak mesad; lateral lobes of the pronotum shallower than in *tridactyla*, the greatest depth contained nearly twice in the greatest dorsal length of the same, margins similar. Tegmina similar to those of *tridactyla*. Abdomen very similar to that of *tridactyla*; ovipositor slightly more robust and slightly more elongate, teeth of distal portion slightly longer; subgenital plate completely divided to the base, lateral halves narrower than in *tridactyla* and more acute distad. Cephalic femora almost twice the length of the disk of the pronotum. Median femora slightly more than twice the length of the pronotal disk. Caudal femora very slightly more than twice the length of the median femora.

Paratypic Series.—We have designated as paratypes two males and two females from the type locality, and one male and four female from the mountains at Alvarez, San Luis Potosi, Mexico.

Measurements (in millimeters).

	♂♂ San Luis Potosi, Mex.				
	(Type.)	(Paratypes.)		Alvarez, Mex. (Paratype.)	Average of three paratypes.
Length of body	11.	11.6	12.3	14.	12.6
Length of pronotum	2.9	3.	2.9	3.	3.
Greatest caudal width of disk of pronotum	2.2	2.5	2.2	2.5	2.4
Length of tegmen	3.2	3.4	3.3	3.3	3.3
Greatest width of discoidal and anal fields of tegmen	2.7	3.	2.7	3.	2.8
Length of cephalic femur	8.	.....	..	..	.....
Length of median femur	8.9	.....	8.9	9.	8.9
Length of caudal femur	16.2	16.3	18.3	18.4	17.6

	♀♀	
	Twelve leagues east of San Luis Potosi, Mex. (Allotype.)	San Luis Potosi, Mex. (Paratype.)
Length of body (exclusive of ovipositor)	15.	16.5
Length of pronotum	4.	4.1
Greatest caudal width of pronotum	3.2	3.
Length of tegmen	.8	1.2
Greatest width of tegmen	1.5	2.
Length of cephalic femur	7.7	
Length of median femur	9.	8.4
Length of caudal femur	19.	19.
Length of ovipositor	8.5	8.5

	♀♀ Alvarez, Mex. (Paratypes.)			Average of four paratypes.
Length of body (exclusive of ovipositor)	15.	16.	15.2	15.6
Length of pronotum	4.1	4.2	4.3	4.2

	♀♀			
	Alvarez, Mex. (Paratypes.)			Average of four paratypes.
Greatest caudal width of pronotum	3.4	3.4	3.2	3.2
Length of tegmen	1.	1.	1.1	1.
Greatest width of tegmen	1.8	1.8	2.	1.9
Length of cephalic femur	7.4	7.6	7.4	7.4
Length of median femur	8.5	9.	8.9	8.7
Length of caudal femur	18.5	18.8	18.1	18.6
Length of ovipositor	9.	9.2	9.	8.9

Color Notes.—In recessive individuals this species is unicolorous, while in intensive individuals the dorsal color is distinctly darker than the lateral, and pale paired bars are more or less decidedly indicated in all but the extreme recessive specimens. The extreme recessive condition is represented by one female, closely approached by another of the same sex and less closely by a male. The extreme intensive condition is represented by one male and one female and approached by three other females. The type is nearly intermediate between the extremes, but slightly nearer the intensive condition; the allotype approaches the intensive condition, but is not typical of it. The extreme recessive condition (♀) is uniform light brownish olive except for the tegmina. The extreme intensive condition in the male has the dorsal color maroon along the lateral margins of the area on the head, disk of pronotum, and abdomen, paling to cedar green and weak buff yellow (on abdomen only) mesad, while in the female the general tone of the dorsum is tawny, washed with claret brown caudad on each abdominal segment and margined laterad by the same. The suffusing color of the dorsum is largely produced by stippling and the extreme margins of the pronotum and abdominal segments are of the color of the pale lateral lines beaded with the suffusing tone. The dorsal color of the male ranges through old gold with weakly indicated blackish lateral margins, of the female through kildare green finely sprinkled with maroon. Pale lateral lines varying from chalk white to weak orange pink (in part only and in the intensive male), narrow in the female and broad in the male, cover the entire marginal field of the tegmina in both sexes. In the male these lines are crenulate on the abdomen, while in the female they are more or less obliquely offset on each segment. Lateral color of male varying from yellowish olive green (intensive extreme) to chamois (recessive extreme), in the female from the recessive extreme with it uniform with the dorsum to the intensive extreme which has it sayal brown, the segments of the abdomen stippled and beaded as on the dorsum, the lateral lobes of the pronotum touched with mignonette green in this type. Head with the eyes varying from cinnamon buff to snuff brown. Pronotum with the lateral lobes edged with the color of the pale bars in all but the recessive females, in one of the intensive females there being a considerable area of chalky white on the ventral portion of the lobes. Tegmina of male with the humeral trunk claret brown to bay, discoidal field varying from yellowish olive green to cosse green, anal field sharing the same tone, but more or less oil green mesad with the proximal portion more or less mahogany red. Tegmina of the female divided between the dorsal and lateral color with the region of the humeral trunk claret brown to bay. Limbs almost wholly of the lateral color, occasionally more greenish in tone, in intensive individuals more or less washed, lined and stippled (particularly on cephalic and median pair) with claret brown. Dorsal aspect of the cerci of male washed with claret brown. Ovipositor with teeth blackish.

Distribution.—This species, as far as known, has a limited range in the east-central portion of the Mexican tableland, occurring at three localities in the state of San Luis Potosi: San Luis Potosi City and hills near the same, mountains twelve leagues east of San Luis Potosi and mountains at Alvarez. The latter locality is south of the upper course of the Rio Verde, a tributary of the Rio Panuco which empties into the Gulf of Mexico near Tampico. As far as we are able to determine from several topographic maps, the localities are situated between five thousand and six thousand two hundred feet elevation.

Morphological Notes.—In the female sex there is some little variation in the shape of the caudal margin of the disk of the pronotum, this ranging from gently arcuate to sinuato-truncate. The interspace between the tegmina also varies considerably in width in the same sex, in the greatest extreme being subequal in width to a single tegmen. The ovipositor varies slightly but appreciably in depth and in the number of teeth on the dorsal margin (6 to 8).

Remarks.—We take pleasure in dedicating this species to Mr. A. N. Caudell, of the United States National Museum, who called our attention to the peculiar cerci of the male sex.

Specimens Examined.—12; 4 males, 8 females.

San Luis Potosi, Mexico, (Palmer), 3 ♂, TYPE and paratypes, 1 ♀. [Scudder Collection and U. S. N. M.]

Hills near San Luis Potosi, Mexico, October 15, (Palmer), 2 ♀. Paratypes. [Scudder Collection.]

Mountains twelve leagues east of San Luis Potosi, Mexico, (Palmer), 1 ♀. Allotype. [Scudder Collection.]

Mountains at Alvarez, San Luis Potosi, Mexico, (Palmer), 1 ♂, 4 ♀. Paratypes. [Scudder Collection and U. S. N. M.]

MIMICRY IN NORTH AMERICAN BUTTERFLIES: A REPLY.

BY EDWARD B. POULTON, D.SC., M.A. OXON.

CONTENTS.

Certain criticisms of the theories of mimicry and warning colors have recently appeared in the publications of The Academy of Natural Sciences of Philadelphia, and it is, I think, a convenience that the controversy should be continued in the same channel. The occasion also enables me to contribute in, I hope, an appropriate way to the publications of the great and learned society with which I have the honor and pleasure of being specially associated.

In the present paper I propose to deal with the friendly criticisms contained in Dr. Henry Skinner's paper (**32**). It will be most convenient, I think, to consider the author's arguments under separate heads, which I have arranged as far as possible in the same order as that adopted in his memoir.

1. THE ATTACKS OF BIRDS ON BUTTERFLIES AND THE THEORIES OF MIMICRY.

The believers in these theories, both Batesian and Müllerian, will cordially agree with Dr. Skinner as to the paramount importance of showing "that birds are in the habit of eating butterflies and that some butterflies are poisonous or nauseous to them and others not." (**32**, p. 121.) It must be admitted also that we require vastly more evidence than we at present possess. But evidence is accumulating steadily, and some of the best has been forthcoming in recent years. I may refer especially to Mr. S. A. Neave's observation (**30**) on January 12, 1912, of a Wagtail devouring Lycænid and Pierine butterflies, but rejecting an *Acraea*, in the bed of a forest stream near Entebbe, Uganda.

Dr. Skinner, in a more recent paper (**34**, p. 25) refers to the fact that the Biological Survey of the United States examined fifty thousand bird stomachs and only found butterflies in five of them. Mr. C. F. M. Swynnerton has quite lately thrown much light on this method of investigation (**33**). He is convinced, as the result of recent work at Chirinda, Gazaland, southeast Rhodesia, "that conclusions based on stomach-examination are likely to be fallacious, unless that examination has been so thorough and minute that even such small objects as the scales of Lepidoptera must have been detected if present, even in small numbers, in either stomach *or intestines*, unless a very large series has been so examined for each species, and unless, finally, a note had been made at the time of the shooting of each specimen as to the probable proportions in which insects of various kinds were present at the moment." Mr. Swynnerton's paper was especially intended as a reply to Mr. G. L. Bates (**25**), whose statements are quoted by Dr. Skinner (**32**, p. 122). I have treated this subject very briefly and inadequately because I hope to return to it in a later paper dealing with the attacks made by Mr. W. L. McAtee in a memoir (**28**) written in a very different spirit from that of Dr. Skinner.

2. HAASE'S NAME "PHARMACOPHAGUS" AND HIS HYPOTHESIS THAT MIMICKED BUTTERFLIES (MODELS) DERIVE NAUSEOUS QUALITIES FROM THE LARVAL FOOD-PLANTS.

Dr. Skinner, influenced by my use of Haase's term "*Pharmacophagus*," is apparently under the impression that I am a convinced follower of his hypothesis. This is by no means the case. In a review (**14**) of Haase's work (**13**) I expressed the opinion, to which I still adhere, that the hypothesis is probably true—although as yet quite unproved—for some distasteful species, but that it is certainly not true of others. Rothschild and Jordan (**20**, 433–4), following Horsfield (**1**) and Haase (**9**), have shown that the *Papilioninæ* are divisible into three well-marked sections differing in larval, pupal and imaginal characters. They give descriptive titles to each of the sections, but do not suggest names which can be used at any rate provisionally as genera. In the meantime, it is highly inconvenient to include in the genus *Papilio* the species of all three groups. For this reason, and for this reason alone, I provisionally adopted Haase's *Pharmacophagus* for the "Aristolochia swallowtails," his *Papilio* for the "Fluted swallowtails," and his *Cosmodesmus* for the "Kite swallowtails."

I am quite ready to abandon any or all of these when it is proved that the three groups may be referred to by other names with a prior claim, and, under any circumstances, Haase's terms cannot, with their present meaning, permanently stand for genera, because, as I learn from Dr. Jordan, each of the three sections is a much larger group which must itself be split up into genera. Furthermore, I do not, as Dr. Skinner states on p. 124, accept any conclusions or use any argument based on the meaning of the word when I provisionally employ "*Pharmacophagus*" as the name of a genus of the Papilios, and I do not think that any words of mine can be quoted which will bear out Dr. Skinner's interpretation.

Inasmuch as Haase's hypothesis occupies so large a place in Dr. Skinner's memoir, I venture to offer a few remarks upon the idea itself as well as upon some of the author's criticisms.

The great majority of the pigments possessed by plant-eating insects are built up in the laboratory of the living organism, in spite of the fact that the larval food is rich in chlorophyll. Nevertheless, this color exists ready-made, and certain insects have been specially adapted to avail themselves of it and thus to gain certain pigments. I proved this many years ago by spectroscopic examination as well as in other ways (**3**, **4**), including experiments in which larvæ were fed upon parts of leaves devoid of chlorophyll (**10**)—experiments recently repeated with confirmatory results upon different species by Prof. W. Garstang (**24**). I think it probable that nauseous or poisonous substances, when they exist in a plant or in a group of allied plants, may be employed by certain species which are restricted to it or them; but as yet the proof is wanting. Among the most probable instances, and those which should first be tested by chemical means, are the *Danainæ* feeding on the Asclepiads and the "*Pharmacophagus*" swallowtails feeding on *Aristolochia* and its allies. I may here remark that Dr. Skinner is mistaken in supposing that Haase in his hypothesis drew any distinction between the *Danainæ* and the section of the Papilios to which he gave the name *Pharmacophagus*. He maintained that both of them, and the *Ithomiinæ* and *Acræinæ* as well, derived their distasteful qualities direct from the larval food-plants. I refer to the following passage in which Dr. Skinner is speaking of *Danaida plexippus* (**32**, p. 126):

"The protective idea in this case is the same as in the so-called pharmacophagus butterfly, the imago of *plexippus* which is said to be repugnant to birds but the repugance is not based on the idea of the butterfly feeding on a poisonous plant (*Asclepias*) in the larval stage."

As regards the specially protected and much-mimicked group of the *Acræinæ*, the recent hitherto unpublished researches of my friend Mr. W. A. Lamborn upon their larvæ in the Lagos district strongly suggest that the butterflies do not derive the nauseous qualities, which they undoubtedly possess, in the manner assumed by Haase; for the food-plants belong to varied groups. In a letter written July 16, 1913, and received as I am preparing this paper, Mr. Lamborn states: "By far the most common *Acræa* here [the neighborhood of Ibadan, S. Nigeria, W. Africa] is *terpsichore*. Its larvæ abound, and seem, like so many other distasteful caterpillars, to have a wide range of food-plants."

The facts brought forward by Dr. Skinner do not appear to me to affect the probability of Haase's hypothesis. It is well known that insects feeding on a great variety of plants commonly include among these species with poisonous qualities. Haase's hypothesis only refers to certain insects *confined to* poisonous or acrid food-plants. I say "certain" insects, for the power of utilizing the poisonous quality, if it exist at all, is undoubtedly a special adaptation by no means necessarily present in any larva which feeds on the plant possessing the quality. The other fact alluded to by the author, that the acrid principle may be present in very small quantity, is, I think, equally devoid of bearing on the hypothesis. If the adaptation exist at all, we should expect small quantities to be stored up and concentrated. The percentage of lime in a leaf is very small, yet the larva of *Clisiocampa neustria* reserves enough to render its cocoon opaque with minute crystals of the carbonate in the form of aragonite (**5**) and *Eriogaster lanestris* enough to make its eggshell-like cocoon out of the oxalate (**8**).

Haase's hypothesis cannot be proved or disproved by discussion. It is the work of the chemist that is needed. The most appropriate field in the world for this work is North America with its hundreds of skilled chemists and its well-equipped laboratories, and with two abundant species—*Danaida* (*Anosia*) *plexippus* feeding on Asclepiads and *Pharmacophagus* (*Papilio*) *philenor* feeding on Aristolochias—by which to test the validity of Haase's hypothesis.

3. Indirect Evidence that Pharmacophagus philenor is a Model possessing Distasteful Qualities.

I have myself only seen this insect alive on one or two occasions, and have certainly never had the opportunity of observing it in relation to its natural enemies, nor do I know of any such observations. Scudder states (**6**, 1248–9) that the larvæ are gregarious when young and semigregarious in later life, that the perfect insect is very tenacious of life, and he quotes Edwards for the observation that it has a strong and disagreeable scent. These qualities, especially the two latter, are generally characteristic of distasteful species; but Skinner states (**32**, p. 124) that later specially directed observations have failed to confirm Edwards. Skinner also records (p. 125) the fact that the larvæ are attacked by parasites, but this is commonly true of *Danainæ*, *Acræinæ*, and other distasteful much-mimicked groups. Haase is, so far as I am aware, the only writer on the subject who has supposed that the immunity of models is complete, and probably in all cases protection from insectivorous vertebrates is to a large extent balanced by exceptional exposure to the attacks of parasites and certain other insect enemies, such as Asilid flies and Hemiptera (**19**).

I quite agree with Skinner (p. 125) that the principal attacks are made during the earlier stages of an insect's life—and think of the elaborate protective adaptations which are common in these stages—yet I do not doubt that the imago is subject to severe persecution from enemies of many kinds. Furthermore, it must be remembered that each imago, the heir of all the other stages, and especially each female, is of far greater value to the species than a single pupa or larva and often hundreds of times as valuable as an ovum.

Although I must admit that there is no direct evidence to prove that *P. philenor* is nauseous to birds (p. 123), I believe that much might be learned if American naturalists would offer large numbers of this swallowtail to many species of insectivorous birds in confinement, offering at the same time other butterflies with a procryptic under-surface, such as *Vanessa milberti* or species of *Grapta* (*Eugonia*). The North American Danaine models might be tested at the same time. Although the records of field observations are greatly to be preferred to this method of experiment, yet in the absence of such observation much may be learned by comparing the behavior of the same individual bird with different species of insects.

The indirect evidence that *Ph. philenor* acts as a model and possesses the qualities of a model seems to me extremely strong. On this hypothesis many facts receive their interpretation; without it they are unexplained and meaningless. *Philenor* is one of the "Aristolochia swallowtails," a section which is abundantly represented in tropical America and in the Oriental Region, but, with the exception of *Ph. antenor* in Madagascar, absent from the Ethiopian Region. The mimicry we observe in North America is not only repeated in both Regions where these swallowtails are abundant, but repeated in a more convincing manner, because the patterns are often far more elaborate, and because an "Aristolochia swallowtail" may break up into numerous geographical races with distinctly different patterns which are mimicked in each locality by corresponding races of the "Fluted swallowtails" and, in the Neotropical Region, of the "Kite swallowtails." A good example is the Oriental *Ph. aristolochiæ* with its subspecies mimicked by the females of *Pap. polytes.* Furthermore, there is in this case experimental evidence that *aristolochiæ* is distasteful, and its slower, more flaunting flight has often been remarked upon. In the Oriental Region species of *Pharmacophagus* are also sometimes mimicked by day-flying moths, and, in the Neotropical Region, not only by these, but by "Kite swallowtails" (*Cosmodesmus*) and Pierines. Throughout the whole range, as in North America, the mimicking "Fluted swallowtails" are as a rule females, while on the other hand the "Kite swallowtails" are mimetic in both sexes (23). Just as the other much-mimicked groups—the *Danainæ*, *Ithomiinæ*, *Heliconinæ*, and *Acræinæ*—are themselves specially subject to mimicry—the genera or sections of the same subfamily superficially resembling each other and also resembling those of the other subfamilies—so is it in both respects with the South American "Aristolochia swallowtails." In every way these butterflies behave like the great distasteful groups supplying the best known models for mimicry. If we had no experimental or other evidence that the *Danainæ* are unpalatable, the indirect evidence is strong enough to warrant at any rate a provisional acceptance of the hypothesis that they possess some peculiar means of defence which renders them specially advantageous as models. For wherever they are indigenous in the Old World they are mimicked by butterflies of other groups, and even in North America, where there are only three forms, each one of them is mimicked. It is not as if the models for mimicry were distributed indiscriminately among the butterflies. They are furnished by a few genera here and there among the *Nymphalinæ, Pierinæ*, etc., but the vast majority of them are concentrated in the four subfamilies mentioned above and in the "Aristolochia swallowtails." Until these remarkable and very numerous facts are explained by some other hypothesis or until something stronger than negative evidence is forthcoming, we are justified in accepting the hypothesis of advantageous resemblance to a specially defended model. I should be the last to rest content with indirect evidence, however strong, and for many years I have urged naturalists, and especially those in the tropics, to make observations and to undertake experiments. As a result of much work, a considerable body of direct evidence, which cannot be ignored by any fair-minded opponent, has been steadily accumulating, especially from Africa; but I freely admit that more is greatly needed, and I shall continue to urge my friends to seek for it.

4. The Attempt to explain Mimetic Resemblance as due to Affinity between Model and Mimic.

Dr. Skinner appears to adopt the above interpretation of the likeness between the Papilios and *Pharmacophagus* when he says "The three species, *glaucus*, *asterius*, and *troilus*, do bear a resemblance to *philenor* but this happens in any aggregation of species in a genus." (**32**, p. 125.) This interpretation does not bear inspection. In the first place, the butterflies do not in any real sense belong to the same genus, and it is for this very reason that I have provisionally adopted Haase's *Pharmacophagus* for *philenor*. In the second place, the three mimetic species are placed by Rothschild and Jordan in three different groups of the section "*Papilio*" ("Fluted swallowtails"). In the third place, it is clear that the true affinity is shown by the non-mimetic patterns rather than by the mimetic ones—by the upper surface of the male *asterius* and by the males and *glaucus* females of *glaucus*.

Darwin suggested that mimicry began "long ago between forms not widely dissimilar in color," and Scudder adopts the same hypothesis in the following passage:

"The process has been a long one, so that . . . . , we may readily presume far less difference between mocker and mocked when the mimicry between them first began, than now exists between the mocked and the normal relatives of the mocker." (**6**, p. 715). It is obvious that this interpretation of the resemblances borne by other insects to the stinging Hymenoptera cannot be thus explained, and, within the Lepidoptera themselves, the study of detail has often furnished a refutation. Thus Prof. Gowland Hopkins (**12**, p. 680) writes: "The mimicking Pierid retains the characteristic pigments of its group, while those of the mimicked Heliconid are quite distinct. This would seem wholly to refute the argument that in such cases the likeness may spring from a real affinity between the two insects." (See p. 176.)

5. Sexual Dimorphism (Antigeny of Scudder) and Mimicry.

The mimetic butterflies of North America, as in other parts of the world, are in large part mimetic in the female sex only, forming a special subsection of the far wider group of sexually dimorphic or antigenetic species. Dr. Skinner seeks to explain the special subsection and the inclusive group by an appeal to the same general law. Thus, speaking of the mimetic females of North American Papilios, he says on p. 125: "These differences [between the sexes] occur in numerous species and it seems logical to consider that they are governed by a general law rather than that a few of them are caused by protective resemblance." He uses the same argument concerning the female *Argynnis diana*, which Scudder maintains in the most positive terms to be a mimic of *Limenitis* (*B*) *astyanax*. (**6**, I, pp. 266, 287, 718; III, p. 1802). Comparing this Argynnid with five other sexually dimorphic species of the genus in North America, Skinner says on p. 126: "It does not seem consistent to pick out one species (*diana*) and say that its antigeny is due to tertiary mimicry. How can the dimorphism of the other species be explained?" But the female *diana* is, according to two eminent North American entomologists, Scudder and Edwards, picked out by nature and distinguished among the other antigenetic females by the fact that it resembles a species of a very different Nymphaline genus. I agree with them—although my opinion is worth very little as compared with theirs, for I have never seen the species alive—and I was seeking to place a resemblance which puzzled Scudder, in its true position among the mimetic butterflies of the Region. The far wider question of sexual dimorphism in general did not fall within the scope of my paper. Again, referring to the mimetic female *Papilio*, I do not know why it is specially logical to seek to explain by the same general law two very different categories, viz., the sexually dimorphic females that closely resemble other species and those that bear no such resemblance. I doubt whether Dr. Skinner would venture to apply the same argument to the polymorphic mimetic females of the Ethiopian *Papilio dardanus* or to many other examples that could be cited. The North American females are not nearly so striking as these, but their patterns are explained by the theories of mimicry and by no other theories as yet suggested.

There are doubtless certain general principles which underlie the whole phenomenon of sexual dimorphism. One of these is obvious—the linking of color, pattern and structure (as we see in the shape of the wings or in the forefeet of so many butterflies) with sex—a linking which is so apt to occur in insects as well as in several other groups, and is so specially conspicuous in the Lepidoptera Rhopalocera. To this principle I think another may be added, at any rate so far as the butterflies are concerned—the greater variability of sex-limited patterns in the female (**23**). But these general principles do not explain the different categories of antigenetic females, although they may, and I think do, explain the fact that there is material out of which these categories have been built by selection. They would also, of course, account for any antigenetic characters, if such there be, that have not been subject to selection. They are the nearest approach to a general law governing antigeny as a whole that can be offered in the present state of our knowledge.

Beyond these principles we have, I submit, to look for special explanations rather than for general laws.

(1) The mimetic females are probably to be explained, as Wallace suggested (**2**, p. 22), by the special needs and special habits of the sex, but also by the fact that the difference in pattern variability may be such that the evolution of mimicry is initiated in one sex and prevented in the other (**23**, p. 132).

(2) A second class of female patterns is procryptic, meeting the special needs of the sex by promoting concealment.

(3) In a third class the whole or a certain proportion of the females of a species retains ancestral patterns (or structures like the fore feet mentioned above) which have been lost or become more degenerate in the males.

(4) Finally the fact that males are so often distinguished from their females by brilliant tints which are pigmentary in some species and structural in others and by scent-producing organs of many kinds strongly suggests an important fourth class due to the operation of sexual selection.

The summary briefly set forth in the last paragraphs will, I think, show the hopelessness of any attempt to bring all the examples of sexual dimorphism under any single law except one which expresses the two principles explained on p. 169. The complexity of the subject is still further increased by the fact that different elements in the pattern of a species will often fall into more than one class. Thus Dixey has maintained that the female of *Argynnis diana* belongs to the third of the above classes except as regards "the large expanse of blue ground colour," which is mimetic and belongs to the first class (**7**, p. 106, footnote).

In his later paper (**34**) Dr. Skinner has still further developed his objections to any special interpretation of the various classes of sexual dimorphism in butterflies. He speaks of velvety patches on the fore wings of male *Satyrinæ* and brands on the wings of male *Hesperidæ*. The researches of Fritz Müller (**29**) show that these structures are scent-producing organs, and there is no doubt that they are of use in courtship, or epigamic. The law that would be so comprehensive as to explain at once an epigamic scent-patch, the more rudimentary anterior foot of a male Nymphalid and the mimetic pattern of its female, would be so very general that it would not carry us any distance in the attempt to understand each of these different facts.

Concerning *Papilio glaucus glaucus* and its dark *turnus* female (I adopt Rothschild and Jordan's synonymy, **20**, p. 582), which some naturalists at least regard as mimetic of *Ph. philenor*, Skinner says (**34**, p. 25) in criticism of Edwards: "There is also an assumption to which I take exception. Does anyone know which one [the dark or the male-like female] appeared first and why?" With regard to the last word "why," Edwards had expressly disclaimed knowledge, for he speaks of "some unknown influence" causing the appearance of the black female, and we can say no more than this to-day. With regard to the other part of the question, I think it may be shown that Edwards took the reasonable view in supposing that the dark female appeared later than the male-like one. The male pattern is shown to be ancestral, because it bears an intimate relationship to the pattern of other allied Papilios.

This is the argument used by Scudder (**6**, p. 534) in the following passage: "In *Jasoniades glaucus*, where we sometimes have a black female, it is more difficult to decide what should be considered the normal color, owing to diversity of view upon the relationship of many of the swallowtails; but, to judge only from those agreed by all to be most nearly allied to it, there can be no question whatever that the striped character prevails."

The *turnus* female is a partially melanic variety, but the lines of the male pattern can be detected beneath the overspreading pigment. It also exhibits many features in its pattern which have received no interpretation except that they are mimetic of *philenor* or secondarily mimetic of the other Papilionine mimics of *philenor* (**21**, 467–471). No doubt there are examples in which it is probable that melanic females preserve something of an ancestral pattern, as in *Argynnis diana* or the *valesina* form of our British *A. paphia* (**7**, 103–5, 119–21), but I do not think that anyone has maintained that this is true of the melanic females of Papilios. It is, I submit, unreasonable to suppose that the male-like pattern first appeared almost hidden under the melanism of the *turnus* female, and that the full pattern became evident by the clearing up of the dark pigment; whereas the opposite view, that the partial melanism appeared later, obscuring but not completely hiding a pre-existing male-like pattern, seems to me entirely probable. Such partial melanism, in my opinion, provided the foundation on which the details of the mimetic resemblance were gradually built.

As regard this same species, Dr. Skinner's final conclusions (**34**, p. 26) are comprised in the following statement: "The evidence in favor of *glaucus* being brought about by mimicry is almost nil, while the evidence against it is very considerable. The species swarms in countless thousands in the north where *glaucus* does not exist." When we add to these last words the fact that the model *P. philenor* is also non-existent in the north, Dr. Skinner's argument seems to support the view he is attacking. *P. philenor* only enters New England and Southern Canada as a straggler and barely overlaps the range of the northern subspecies of *P. glaucus glaucus*, which Rothschild and Jordan distinguish under the name of *P. glaucus canadensis* (**20**, p. 586). As regards the closely allied *P. rutulus*, the same great authorities give reasons for considering it a distinct species. The whole range of *glaucus glaucus*—Florida to New England and westward to the Mississippi basin—lies within that of *P. philenor*, and over this whole range the dark *turnus* female occurs intermingled with male-like females—the latter preponderating in the north, the former in the south. The evidence based on geographical distribution seems to me strongly to support Edwards' conclusions. And we may add that there are, as I have already said, details in the pattern of the dark females which are not explained by any other hypothesis. Objections based on the great abundance of the non-mimetic ancestor are considered on pages 178, 179.

6. THE FEMALE OF NEOPHASIA TERLOOTI, ANOTHER NORTH AMERICAN MIMIC OF DANAIDA PLEXIPPUS.

Dr. Skinner remarks (**34**, p. 27): "What is the cause of the extraordinary antigeny seen in *Neophasia terlooti?* The male in this species is white and the female orange. The female of the species was once sent to me as a 'little *Danais*' and it really looks like one. Here would be a good opportunity to build up a mimicry theory."[1] At the time when I read these words I had never seen the species, but Dr. Skinner has now very kindly sent me a male and female from Reef, Arizona (Nov. 2, 1903: Biederman). There can be no doubt that the female *is* a mimic of *D. plexippus*. The comparison between the yellow of the under surface exposed in the position of rest and the orange of the upper surface, the blackening of the veins on the upper surface of the hind wing and other details to be described below are quite inexplicable on any other hypothesis. The mimicry is rather rough and there is no approximation in the shape of the wings. In both respects this female stands in about the same position as the females of the Neotropical *Perrhybris* ("*Mylothris*"). I am greatly indebted to my friend for this opportunity of examining and writing on what is to me an entirely new example of butterfly mimicry in North America—another result of its invasion by the Old World genus *Danaida*. My friend Commander J. J. Walker, who has had an intimate experience of the allied *Neophasia menapia* in Vancouver Island, tells me that during flight the latter is one of the feeblest of Pierines and that it suddenly appears upon the wing in immense numbers. He has kindly permitted me to make use of the following unpublished extracts from his journal, on H. M. S. "Kingfisher" at Esquimalt, Vancouver Island:

1882, August 7: "Day still, hot, and cloudless. During the forenoon I was agreeably surprised by the appearance of a good number of specimens of a very pretty "White" butterfly. . . . It seems to come very near to *Leucophasia*, by the elongate shape and delicate texture of its wings, as well as by the rather short antennæ and hairy palpi. . . . They were flying sluggishly in the sunshine over the water, and the signalman and I caught 15 on the poop in a very short time [the ship being about 300 yards off shore]. . . . Landed at 4 P. M.; the *Leucophasia*? was still on the wing, and I

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[1] Dr. F. A. Dixey remarked of *N. terlooti* in 1905 (*Proceedings of the Entomological Society of London*, p. xx): "This latter butterfly is especially interesting as possessing a female which closely resembles some of the mimetic forms of *Euterpe*."

caught 15 or 16 (at flowers of *Matricaria*), all in the most exquisite condition, like those taken on board ship. They all appeared to have emerged from the pupa on that day, as I had been on the lookout for some days past, and certainly did not see one on the wing yesterday."

August 8: "Went on shore this forenoon at 11.30, to get a few more of the *Leucophasia* [*Neophasia*] while it remained in good condition. . . . . I had no difficulty in getting as many as I wanted . . . . a day, however, had made a perceptible difference in its condition, as a good many were getting somewhat worn and chipped. They were very easy to catch, flitting from flower to flower in the open places [among the pines] and of very weak and sluggish flight."

August 14: The first ♀ was taken on this date. "I beat it out of a fir-tree."

The fact that the only Pierine mimic in the Nearctic Region belongs to a genus with the characteristics described by J. J. Walker suggests an interpretation on the lines of Fritz Müller's hypothesis.

I now propose to institute a detailed comparison between the colored pigments of *Neophasia menapia* and *terlooti*.

THE FEMALE OF NEOPHASIA MENAPIA.—*Under surface of hind wing.*—A colored spot, roughly triangular in shape, is found in the black marginal band of areas 2, 3, 4, 5, and 6. The spots, as well as the other markings described below, were orange in 4 females, orange-red in 2, and a rather pale vermilion in one. The tint in some individuals tends to deepen towards the base of the wing—especially along the costa. Beyond vein 7, viz., in areas 7 and 8, the pigment is continued at first as a narrow marginal line, which filling area 8 except at its very base, broadens with it toward the base of the wing. In the opposite direction, beyond vein 2, area 1c bears two spots, of which the upper is sometimes roughly diamond-shaped. These spots are placed one on each side of the dark line, representing a lost vein, which divides the area longitudinally into two sections. Below vein 1b a narrow marginal orange line extends over about $\frac{1}{3}$ of the breadth of area 1b.

In addition to these marginal orange markings, there is also an internervular development of the same pigment starting from the base of the wing, especially distinct in the lower or inner marginal section of area 1c, which in favorable examples is highly colored over more than half its length starting from the base. In strongly marked females a few scattered orange scales are also seen in area 7 and in the upper section of area 1c, and they could probably be found in other areas of certain individuals.

Upper surface of hind wing. Most of the above-described marginal features appear, but far more faintly, on the upper surface. The other orange marks are not represented on the upper surface of those females that I have examined, nor did they appear anywhere upon either surface of the fore wing.

THE MALE OF NEOPHASIA MENAPIA.—*Under surface of hind wing.*—Sixteen examples were examined and of these about half had a comparatively few dull orange or sometimes yellow scales in one or more of areas 6, 7, and 8. When present they are precisely in the position of the marginal markings of the female.

Since writing the above I have had the opportunity of examining 6 beautiful specimens from Esquimalt, in Commander J. J. Walker's collection. Well-developed marginal markings appeared on all females: on (1) a beautiful cinnabar red; on (2) a pale cinnabar red, a little deepened at the anal angle, apex, and costa; on (3) orange, becoming orange-red in the same positions. Of the 3 males, two possessed pale cinnabar scales at the apex and along the costa, one of them bearing a few at the margin of the upper section of area 1c and still fewer—only 2 or 3 scales—in the lower section. The third male had pale yellow marginal scales at the apex and costa, a few becoming faintly reddish, especially at the apex.

Commander Walker tells me that these butterflies were all "set" immediately after capture, and that they have never been "relaxed" and "reset." Inasmuch as Prof. Gowland Hopkins has shown (**11**, **12**) that the pigments of *Pierinæ* are soluble in water, it is probable that Walker's specimens more truly represent the colors of the living insect than do any of the others here described, for all of these have been "relaxed" at least once.

THE MALE OF NEOPHASIA TERLOOTI.—*Under surface of hind wing.*—The marginal markings of the female *menapia* are represented on the male of *terlooti*, smaller indeed, but with a far richer color, being of a bright, rich vermilion tint. In the single specimen I have had the opportunity of examining these markings are solely marginal. They are wanting from area 4 and so slightly developed in all areas except 6, 7, and 8 (where they are purely linear and do not fill the last-named area as in the ♀ *menapia*) that it would be easy to count the constituent scales with a lens. In the specimen before me there are only 3 vermilion scales in area 5 on the left side and only 5 on the right, but they are more numerous and usually far more numerous in all the other markings. Although the dark pigment is comparatively weakly developed in the male, area 1c is divided very distinctly by a strongly marked linear streak, and the 2 orange spots of the female *menapia* are represented by 2 marginal groups of vermilion scales, one in each section of the area. Vermilion scales occur nowhere else on the specimen, although those described above can be distinctly seen through the translucent scales of the upper surface.

THE FEMALE OF NEOPHASIA TERLOOTI.—*Under surface of hind wing.*—The vermilion markings are developed almost precisely in the positions of the orange markings of the female *menapia*—more strongly at the margin and the extreme base of the wing, but much less so elsewhere. The lower section of area 1c is, however, richly marked with vermilion for ½ of its length from the base. The rest of the colored markings are light yellow of an ochreish tint, rather distinctly different from that seen elsewhere on the wings.

Under surface of fore wing.—The marginal markings and the marginal part of the chief orange patch are also light yellow, but of a lemon tinge. The orange of the chief marking and of scattered scales forming a linear mark in the cell is very rich and deep in tint: the mark in the cell is in fact better described as orange-red. The two marks at the end of the cell, in areas 5 and 6, are transitional in tint between the yellow marginal and the more central orange markings, and there is transition to be observed between the yellow margin in areas 1a and 1b and the rest of the chief orange marking. These changes in color are effected by a gradual increase in the number of orange scales and not by any real transition between the yellow and orange pigments, although if we study the wings as a whole we find several tints of orange and yellow.

Upper surface of hind wing.—The vermilion markings are represented by comparatively few scales. Within these markings the submarginal spots and the ground-color of the rest of the wing are deep orange, but of a duller tint than that of the fore wing. The submarginal spots of the outer (hind) margin are slightly less deep in tint, while along the costa, where the surface is concealed beneath the fore wing, the orange scales are gradually replaced by yellow, and again, at the extreme margin, by black, with perhaps a trace of the vermilion which is so distinct on the opposite surface. The vermilion scales could not be properly investigated because of the overlap of the wings.

Upper surface of the fore wing.—The colors are nearly as on the under surface, but, except at the apex, the submarginal spots and the margin of the principal marking are distinctly less pale and therefore much nearer to the tint of the orange ground-color of the rest of the wing. The transition here does not appear to be effected by a gradually increasing number of deep orange scales, but by a gradual increase in the depth of the tint. The two marks at the end of the cell are nearly as rich an orange as in the expanse below the cell, and the transition towards yellow is, on the upper surface as compared with the lower, shifted towards the costal margin, occurring in the two spots of the same series placed *above* the end of the cell in areas 10 and 11. The linear spot in area 11 is yellow with thinly scattered orange scales, which are far more thickly placed on the spot in area 10.

7. The Colored Pigments of the Pierinæ as Illustrated by Neophasia.

Professor F. Gowland Hopkins has shown (**11**, **12**) that the white pigment of Pierines is an impure uric acid, and that the yellow orange and probably the red pigments are a derivative of uric acid which he calls "lepidotic acid." No pigments of similar constitution were found in any other butterflies. Therefore, when a Pierine mimics an Ithomiine or, as in *N. terlooti*, a Danaine, the resemblance is effected by the production of an entirely different coloring matter. Gowland Hopkins believes that the yellow, orange, and red Pierine pigments are chemically nearly allied and may pass one into the other by slight changes perhaps in the degree of oxidation. He observed that one tint was represented by another in corresponding markings of opposite sexes or allied species. Thus he remarks (**12**, p. 678):

"It is interesting to note, by comparing various allied species of *Delias*, that the red marginal spot may become more yellow, while the yellow area usually found at the root of the wing may become more red, till both may exhibit a uniform orange colour, or the change may go farther and red and yellow change places without the general color-plan of the wing being altered."

These conclusions are strongly supported by a careful study of *Neophasia*, where it has been shown that in different individuals of the same sex of *menapia* the same markings may be either orange, orange-red, or pale vermilion, while in the opposite sex they may be absent or feebly represented in dull orange or yellow. Again in the allied *terlooti* the corresponding markings are a rich deep vermilion in both sexes. We are led to realize that it is very easy for *Neophasia* to produce any shade between a pale lemon-yellow and a rich vermilion. The colored markings of *menapia* cannot be regarded as mimetic, and, if *Danaida plexippus* had never entered America, it is highly improbable that anything more than the corresponding colored markings would have been evolved on the wings of the female *terlooti*. The range of tints in the markings common to *menapia* and *terlooti* gives an indication of the variational material out of which selection built up the mimetic pattern. The peculiar shade of yellow of the under surface of the hind wing, the rich orange of the central parts of the upper surface, the paler tints of the marginal markings, especially at the apex of the fore wing, the emphasis by black pigment of the veins of the hind wing upper surface, are all elements in producing the result—a somewhat rough but at a distance almost certainly a deceptive mimetic likeness to *D. plexippus*.

The same considerations help us to understand the prevalence of Pierine mimicry in tropical America as compared with other parts of the world—because of the predominant *Ithomiinæ* and *Danainæ* with warning patterns made up of reds, yellows, whites, and blacks. Such patterns are mimicked by the Pierine genera *Dismorphia* (in the broad sense), *Perrhybris* ("*Mylothris*"), *Archonias*, *Hesperocharis*, and we can now add the North American *Neophasia*.

8. The Restriction of Sex-limited Inheritance to the Mimetic Pattern of Neophasia terlooti.

The older colored markings common to the females of *menapia* and *terlooti* are only partially sex-limited, being inherited in a very reduced form by some of the males of the former species and probably by all of the latter. The more modern mimetic pattern of the female *terlooti* is strictly sex-limited. The facts harmonize with the hypothesis that female mimicry is largely due to the great variability of this sex in Lepidoptera and the freedom with which it offers to selection a wide range of sex-limited colors and markings, but that when a pattern has been long established it tends to be transferred to the opposite sex.

The older non-mimetic marginal markings suggest that the transformation of uric into lepidotic acid is especially easy in this part of the hind wing and invite comparison with the number of mimetic Neotropical Pierines in which marginal or submarginal reds have been developed in the same position, viz., on the under surface of the hind wing—a study that would carry me too far from the subject of the present paper.

9. The Evolution of Limenitis (Basilarchia) archippus from an Ancestor with a Pattern like that of L. (B.) arthemis.

The origin of *archippus,* suggested in the title of this section, is due to Scudder (**6**, 277–8, 714). All I have done is to support the published views of this distinguished naturalist by making a careful analysis of the markings of *archippus* and *arthemis,* by this means demonstrating that the details of the mimetic pattern are accounted for on his hypothesis. I am sorry to find that neither Scudder's hypothesis nor the results of my analysis carry any conviction to Dr. Skinner, who uses the following words: "*Arthemis* and *weidemeyeri* [with a very similar pattern] have flourished prosperously in the struggle for existence, and it is difficult to understand why *archippus* should be so specially favored. The statements attempting to prove the evolution of *archippus* from an ancestral form (*arthemis*) seem to me very inconclusive" (**32**, p. 127). Dr. Skinner makes no alternative suggestion as to the origin of the mimetic species. The doctrine of evolution—for it is hardly necessary to discuss the ancient belief which would assume that *archippus* was originally created in its present form—leaves us only two hypotheses. Either *archippus* was evolved from some form of *Limenitis* which has entirely disappeared or from one which is more or less closely represented by a species still in existence. The former alternative abandons the problem as insoluble, and abandoned it must be if there is no sufficient evidence that the ancestor can be reconstructed from any existing form. I agree with Scudder in preferring the counsel of hope to the counsel of despair. *L.* (*B.*) *arthemis* and *weidemeyeri* present us with an ancestral pattern wide-spread in the genus and found not only in North America, but also with little change in the Old World section of the temperate circumpolar zone. *Archippus* is so closely related to *arthemis* that the larval and pupal stages are almost identical, and although the imaginal patterns are so different, Scudder indicated, and I have attempted to trace in detail, the manner in which one pattern may be derived from the other. I really think that if Dr. Skinner, with specimens of *archippus* and *arthemis* before him, will verify the details of the account in my earlier paper (**21**, pp. 456–459), he will find that many minute features on the wings of the mimetic species are interpreted and correlated in a satisfactory manner. And a hypothesis that interprets stands, until replaced by another that interprets better.

With regard to Skinner's inference that inasmuch as *arthemis* flourishes prosperously, it is unlikely that a mimetic form would arise from it, this is an objection which at once arises when mimicry is studied in the original monograph of its founder, published long before Fritz Müller had thought of his hypothesis. According to Bates, mimicry was a refuge for the destitute, a last means of escape for a hard-pressed and dying species. It was this very conclusion which was Müller's stumbling-block; for the majority of the mimics in southeast Brazil where he lived were clearly successful and abundant species, and the same is true of the majority of mimicking species wherever they are thoroughly known. Nor is there any reason to suppose that these successful forms originally arose from rare and hard-pressed non-mimetic ancestors. Want of space prevents the discussion of more than a single example. I refer to *Tirumala* (*Melinda*) *formosa*, an Oriental invader into the Ethiopian Region (**18**, **31**). This species, abundant east of the Victoria Nyanza, near Nairobi, is there beautifully mimicked by the Ethiopian *Papilio rex*. The invading Danaine has transformed an indigenous species just as in North America. West of the great lake *T. formosa* is represented by an equally flourishing daughter species, *T. mercedonia*, with a pattern darker than its parent and one much further removed from the allied Oriental *Danainæ*. *Papilio rex* west of the lake becomes *P. mimeticus*, as beautiful a mimic of *T. mercedonia* as *rex* is of *formosa*. The two Danaine models are now distinct species, but their Papilionine mimics, connected by intermediates (*P. commixtus*) in the intermediate geographical area northeast of the Victoria Nyanza, are certainly a single interbreeding community. Similarly, in North America *Danaida plexippus* is a very distinct species from *D. berenice* and *D. strigosa*, although these latter may be geographical races of one species. The three forms of *Limenitis* are, on the other hand, all probably mimetic modifications of a single species, although *L. obsoleta* is probably distinct from *archippus* and *floridensis*. To continue the history of the African invading Danaines: Further westward the flourishing and prosperous *T. mercedonia* has given rise to a still darker species, *T. morgeni*, which has altogether lost the appearance of an Oriental *Tirumala* and has become the most perfect mimic of the African Danaine genus *Amauris*.

Here, then, we have a species so dominant that it is mimicked by a butterfly of a different family. It gives rise to another species and the mimic undergoes corresponding changes. Finally, in spite of these evidences of prosperity, it becomes itself a singularly perfect mimic. All these changes are far less abrupt than that from *arthemis* to *archippus*, and I do not think that any naturalist who recognized the traces of the pattern of *mercedonia* still lingering almost invisible on the surface of *morgeni* or concealed by the overlap of the wings would doubt that the former is the ancestor of the latter and that the model has become itself a mimic.

Finally, it must be remembered that *L. archippus* has a far wider range than *arthemis*, and it is reasonable to suppose that this advantage has been conferred by its mimetic pattern. *Arthemis* is confined to Canada east of the Rockies and to the northeastern States, while *archippus* is "found over very nearly the same area as *Anosia plexippus*" (**6**, 278).

10. THE RELATION OF THE PATTERN OF LIMENITIS OBSOLETA (HULSTI) TO THAT OF ARCHIPPUS, ARTHEMIS AND WEIDEMEYERI.

When I wrote the paper criticised by Dr. Skinner (**22**), as well as an earlier paper, in some respects more detailed (**21**), I had never been given the opportunity of examining a series of the Arizona and Utah mimic, *Limenitis obsoleta* (*hulsti*), and my brief account was founded on the excellent fig. 5 on plate VII of Dr. W. J. Holland's work (**17**.) In January, 1909, when I had the honor of representing my country at the Darwin centenary in America, my friend Dr. F. A. Lucas, Director of the American Museum, Central Park, New York, showed me a series of *obsoleta* together with its model, *Danaida strigosa*. The specimens were in the Brooklyn Museum, of which Dr. Lucas was then Curator. I saw at once that the form was very variable and that my work required the study and comparison of a long series of individuals. Dr. Lucas very kindly obtained a few specimens of the model and mimic for me and put me in communication with Dr. R. E. Kunzé, of Phœnix, Arizona, who has generously provided me with a fine mass of material. The following account has been drawn up from the study of 24 males and 9 females from Phœnix and 2 males and 1 female from Tucson. Thirty-three specimens bear the precise date of capture, one the month and year, one a month of which the interpretation is uncertain, and one for which the month is not recorded. Omitting these last two, the dates of capture are given in the following table. The three 1896 specimens were captured at Tucson (2,400 feet) in southern Arizona, the remaining 31 at Phœnix (1,100 feet) in the valley of the Salt River, southern Arizona.

Apr. 9, 1896	1 ♀	June 6, 1896	1 ♂
Apr. 10, 1896	1 ♂	Apr. 22, 1897	1 ♂

Apr. 17, 1909	1 ♀	July 30, 1910	1 ♂
Sept. 21, 1909	1 ♂	Oct. 5, 1910	4 ♂[2]
Sept. 30, 1909	1 ♀	Oct. 7, 1910	3 ♂ 1 ♀
Oct. 27, 1909	1 ♂	Apr. 11, 1911	1 ♀
Oct. ......, 1909	1 ♂	Apr. 15, 1911	1 ♂
Mar. 26, 1910	1 ♂ 1 ♀	Apr. 22, 1911	2 ♂
Mar. 27, 1910	1 ♂	Sept. 5, 1911	1 ♀
Mar. 29, 1910	1 ♀	Sept. 11, 1911	1 ♀
Apr. 1, 1910	1 ♂	Sept. 21, 1911	1 ♂
Apr. 4, 1910	1 ♂	Sept. 24, 1911	1 ♂
Apr. 6, 1910	1 ♂	Oct. 4, 1911	1 ♂

The existence of two broods, one emerging between the end of March and the end of April, the other in September and October, are clearly shown. The two specimens in June and July, respectively, were probably representatives of a third brood.

The model, *Danaida strigosa*, appears to be much rarer than its mimic at Phœnix—at any rate, in the localities where Dr. Kunzé collected. From this place I have only received 2 males, captured July 2 and 6, 1912; from Tucson—1 female May 26, 1 male June 7, 1 female June 9, 1 male August 19, all in 1896; from Prescott (5,400 feet), in western Arizona—2 males and 1 female July 15, 1912.

Dr. R. E. Kunzé, of Phœnix, Arizona, who has had a long and intimate experience of the butterfly fauna of the State, kindly informs me that, in the Phœnix (1,100 feet) and Tucson (2,400 feet) districts and between them, *L. obsoleta* is almost exclusively found in the valleys, along the river-bottoms, and by the canals, where its larval food-plant, a willow, grows.[3] It is commoner in the river-bottoms, especially near the streams, than by the canals. *Danaida strigosa* flies with it in these situations and is indeed commoner there than elsewhere, but, unlike the mimic, it is also found in other places. It is impossible to state the relative proportions of Danaine and *Limenitis*, but by the rivers and canals the mimic is the commoner in the ratio of about twelve or fifteen to one. The proportions at Tucson and Phœnix seem to be the same.

Danaida plexippus occurs, but is scarce in the Salt River valley at Phœnix. Dr. Kunzé estimates that it may exist in the ratio of one to fifteen of *D. strigosa*, but in some seasons he does not meet with

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[2] The armatures of two of these males were studied by Dr. Eltringham (p. 190).

[3] Dr. Kunzé adds in his letter of August 5, 1913: "I should say that *obsoleta* has here [Phœnix] from 3–4 broods in a season, from April 1st up to November 1st, in a mild autumn, of course. I think the last brood oviposits on cottonwood, our *Populus fremonti* and other species, because its leaves keep green till latter part of December, whereas willow drops leaves earlier."

it at all. At Prescott, Arizona (5,350 feet), 135 miles north of Phœnix, *strigosa* flies in the company of *plexippus* from July to September, the latter being the commoner of the two. *D. strigosa* extends as far south as Galveston, Texas, and may also occur in some parts of Mexico, near the northern boundary. *Limenitis obsoleta* does not occur at Prescott.

The fine series of *L. obsoleta* (*hulsti*) tabulated on p. 180 at once made clear to me that the Arizona form is not, like *floridensis* (*eros*) in Florida, a local race of *L. archippus* transformed by mimicry of the dominant local Danaine, but the bearer of an ancestral pattern which preserves features lost by the two other mimetic races. I therefore desire to correct my former conclusion, founded on the figure of a single specimen, that *obsoleta* is a modified form of *archippus* (**21**, p. 460, **22**, pp. 171–2). At the same time I remarked in the latter paper (p. 172): "I have not yet had the opportunity of ascertaining whether this hypothesis is supported by evidence derived from a careful study of the pattern."

The hind wing.—The most prominent ancestral features of *obsoleta* are the traces of the white discal band derived from an ancestor with a pattern like that of *arthemis* or *weidemeyeri*. In *archippus* and *floridensis* a trace of the white band is found on the under side of the hind wing in some specimens, but so far as my experience goes never on the upper surface. In *obsoleta* some trace of it is always present on both surfaces, but when, as in the majority of specimens, there is a difference in the degree of development, it is stronger upon the under side. It is more strongly developed in the females than the males, and this is the general rule with the ancestral features of the species, as it appears to be in *archippus*, of which a certain proportion of the males in the Albany district, but no females, have entirely lost the black discal stripe from the upper surface of the hind wing (recorded by Mr. John H. Cook, **22**, pp. 211–212). Thus the white stripe, together with its black outer border, is evanescent on the upper surface of the hind wing of 2 female *obsoleta* from Phœnix and small in the female from Tucson, whereas the same feature is evanescent in half the males from Phœnix and but slightly developed in others. The evanescent feature in both males and females is more strongly represented, generally far more strongly, on the under surface. The degree of development of the black band is generally related to that of the white, the two being usually evanescent together or well developed together, but the range of variation is much greater in the white than in the black, corresponding with the entire disappearance of the former but not of the latter from the upper surface of the allied *archippus*. On the other hand, the development on the under as compared with the upper surface is greater in the black than the white. In both sexes there is a tendency, as in *archippus*, to throw the white spots on the under surface of the hind wing into relief by an inner edging—a darkened shade of the ground-color in areas 2, 3, 4, and 5, still darker and often black in areas 6 and 7. This feature probably represents the black inner border of the white discal band in the non-mimetic ancestor.

When the 32 specimens, omitting the 2 taken in June and July, recorded in the table on p. 180, are arranged according to their two broods—the 15 March and April specimens together and the 17 September and October together—it is seen that there is a small but distinct seasonal difference in the development of the trace of the white discal band of the hind wing and its black outer border. The spring brood is in this respect distinctly the more ancestral, bearing on the average stronger traces of the pattern of *weidemeyeri* and *arthemis*. This is true of the females as well as the males, as may be inferred from the following statement:

Females (spring brood = 4, autumn brood = 5).—The only 2 specimens with evanescent band and border bear the dates Sept. 11, 1911, and Oct. 10, 1910. The most reduced band of the spring brood is seen in the Tucson specimen, April 9, 1896. In all the remaining 4 spring females, the band and, in all but one, the border is distinctly stronger than in either of the 2 remaining autumn females.

Males (spring brood = 10, autumn brood = 13).—It is extremely difficult to classify the degree of development of the band and border—there is a complete and gradual transition. There is, however, a marked difference at both ends of the scale between the two broods. The most evanescent white bands are seen in 6 autumn males. In all these the feature is more reduced than in any spring male. Very small and reduced bands are found in 3 males of each brood. Beyond these there is the most gradual transition to the highest degree of development found in the sex, and among these we find by far the highest in a specimen captured April 22, 1911, while 2 other spring males are rather beyond any of the autumn brood. Considering the black border separately, the difference is even more marked, for this feature is evanescent in 4 of the autumn brood and none of the spring, while the next 4 are equalled and on the whole slightly exceeded by the 4 spring specimens in which the feature is least developed. The black border is more highly developed in 4 of the spring brood than in any of the autumn. This detailed comparison has been extraordinarily difficult to make, because of the perfect transition and the minute shades of difference. When the attempt was made to express the difference, the specimens grouped themselves into fours in an irritating and unnatural manner. It might perhaps have been wiser to attempt no analysis of so transitional a feature, but to be contented with the statement that a distinct difference exists at both ends of the scale, the band and border of the most strongly marked specimens being decidedly more developed in the spring brood, while the reduction of these features in the least strongly marked specimens was carried distinctly further in the autumn brood. I cannot but think, however, that my attempts at an analytical comparison, whatever faults there may be in the details, are a truer expression of the facts.

An interesting difference between the upper surface of *obsoleta* and that of *archippus* is common to both fore and hind wings, viz., the far more heavily blackened veins gained by the latter in mimicry of *D. plexippus. Floridensis* here shows its origin from *archippus*, for it retains the darkening along the veins, although out of place in a mimic of *D. berenice*. No such evidence of having passed through an *archippus* stage is to be seen on the upper surface of *obsoleta*. The veins are heavily blackened on the under surface of the hind wing in all three mimics, in evident likeness to their respective models, although *obsoleta* in this respect is less darkened and a less perfect mimic than the other two.

In certain specimens of *obsoleta* there is to be seen on the hind wing under surface two largish rich brown sharply outlined patches, one in the cell and one near the base of area 7. On the basal side of each patch is a white spot and a white suffusion commonly surrounds the projection of the precostal into area 8. These elements tend to become evanescent together and distinct together, acting like a single feature. Slight traces of these markings can probably be found on every fresh specimen. They were remarkably pronounced in the female taken Sept. 5, 1911 (p. 181). These vestiges, except in one respect, resemble the well-known basal pattern of *arthemis* far more closely than that of *weidemeyeri*. The pale elements are, however, for the most part blue in *arthemis*, but nearly white in *weidemeyeri*, and therefore in this respect nearer to *obsoleta*. *Archippus* has advanced further from the ancestral forms than *obsoleta*, for "the basal red patches have vanished, but the pale blue marks in and on the costal side [area 7] of the base of the cell are retained, and, lightened in tint, represent the two more conspicuous white spots occupying nearly the same position in *Anosia* [*Danaida*]" (**21**, 456–7). Now that I have had the advantage of studying *obsoleta*, and have re-examined *archippus* in the light of the new experience, I find that a few examples do possess a very faint trace of the reddish patches of *arthemis*. In these vestiges as in so many other features in the pattern we are led to conclude that *obsoleta* represents an older stage in the evolution of *archippus*.

The fore wing.—The inner edge of the angulated black outer border of the white band of *arthemis* and *weidemeyeri* runs from the costa to the inner margin of the wing, near but well within the posterior angle, although it is broadened so far that its outer edge enters this angle; in most specimens of *archippus* it runs to the junction of the middle and posterior third of the outer (hind) margin (**21**, p. 457). Some females, however, approach the condition of *obsoleta*, which is generally far nearer in this respect to the pattern of *arthemis* and *weidemeyeri*. In *obsoleta* the direction of the vestigial black outer border, which, except near the costa, is evanescent on the upper surface, can be easily traced by fixing the attention on the outer ends of the four prominent white spots in areas 3, 4, 5, and 6. With this as guide, the eye is led on to an evanescent white spot nearly always present in area 2, and in certain individuals to the faint continuation of the black line towards the posterior angle. The angle made with the costa is very different from that of *archippus*. The black line is usually far more distinct on the under surface, and here it may be seen in many specimens that the direction changes abruptly in area 1b, becoming parallel with the outer margin and leading to a termination on the inner margin within, and often well within the posterior angle. In well-marked specimens, especially in the females, the black line is seen to lead to the outer end of a white linear mark close to the inner margin in area 1a (see p. 186). Faint vestiges of the former white band can even be made out in 1b on the under surface of a few individuals. There is great variation in the position of the black line in 1b. In most males it unites with and continues as a broadening of the black margin.

The white spots which represent the costal half of the white band of *arthemis* and *weidemeyeri* are far better developed in *obsoleta* than in *archippus*. In the latter the spots are 2 to 4 in number, the last being very small. In *obsoleta* there are always 4 large and distinct spots, especially well developed in the female, while a minute 5th spot, already mentioned as placed in area 2, is nearly always present and often more strongly marked on the under surface. A trace of it could be made out on the upper surface of all the females and on 17 of the males; from one or both sides of the remaining males it was absent, but it is likely that when these were fresh examination with a lens would have led to the detection of a few white scales. It is clear that the trace of the original discal band is more shortened in *archippus* than in the Arizona form, and that the 4th spot in area 3, or in other individuals the 3rd in area 4, is now in the position of the minute trace of a 5th spot in area 2 of *obsoleta*. Furthermore, the black discal marking retains in *obsoleta* more of its original appearance as an outer edging to the white band than in *archippus*—an appearance still more fully sustained upon the hind wing. In the fore wing of *archippus* it is obviously much developed, especially at the costal end, in mimicry of the model *plexippus*.

The trace, on the costa itself, of the anterior end of the white band of the fore wing, already described as generally to be found in *archippus* (**21**, p. 457), was present in all the females and 19 males of *obsoleta*, but in some of these it was barely visible. This feature is apparently more often wanting altogether from *archippus*, but the two forms have reached nearly the same level, and I think that in both examination with a lens would reveal the presence of some trace of the marking in most or perhaps all fresh specimens.

I have already incidentally mentioned on p. 185 the most interesting ancestral feature in the fore-wing pattern of *obsoleta*, and one entirely wanting from *archippus*, viz., a distinct trace in area 1a of the inner marginal end of a white discal band like that of *arthemis* or *weidemeyeri*. This linear mark was present, varying in the degree of its development, in all the females and 23 males, and traces might probably have been found on all when fresh. The mark is also to be found on the under surface where the fore wing is overlapped by the hind, but for this reason it was only examined in a few specimens; in these it did not stand out on the paler ground-color as conspicuously as on the upper surface. It has been already pointed out on p. 185 that the outer end of the mark coincides with the point on the inner margin indicated by the direction of the vestige of the black outer border in some individuals, viz., a point well within the posterior angle of the fore wing. In a single female (Apr. 17, 1909), unfortunately rather worn, the mark in 1a apparently extends to the black margin at the posterior angle. The same relationship to a mark stopping short of the angle is also indicated, especially in fresh specimens of the female, by a distinctly paler shade of the ground-color outside the discal black stripe on both surfaces of both wings. The change of shade follows the suggested direction of the black line to the inner margin of the fore wing, although near this border it is not sharply demarcated as on the rest of the wing. Such an abrupt change in the depth of the color is very rarely to be seen on the upper surface of *archippus*. Scudder has looked on the reddish spots of *arthemis,* occupying the very position of this paler shade in *obsoleta,* as the foundation from which the mimetic form arose (**6**, p. 714), and I have followed him (**21**, **22**). If we are right, and the transformation occurred first in this area and only later in the area inside the white discal stripe, it is easy to understand why there should be a difference in the shade of the ground-color for natural selection to seize upon. The Arizona *Danaida strigosa* is also paler on the outer than it is on the inner part of the wings, although the transition is gradual and not sharp as in *obsoleta*. On the under surface of the fore wing *archippus* is, in this very respect, more strikingly ancestral than *obsoleta,* the pattern of the model having been such as to emphasize the feature. *Archippus* is also commonly ancestral as compared with *obsoleta* in the distinct indication by a reddish-brown tint of the red submarginal spots on the under surface of both wings (**21**, p. 456).

The white mark in area 1a of the fore wing has this further interest, that it indicates the point at which the outer edge of the discal band of the hind wing met that of the fore, reconstructing for us a pattern like that of *weidemeyeri* and *arthemis* in which the band of the hind wing is placed much further from the outer margin than it is in the other wing. The evolution of the marginal pattern of both surfaces of both wings of *obsoleta* from a condition like that of *arthemis* appears to have been the same as in *archippus* (**21**, pp. 456–459) and to have reached nearly the same result. The slight differences correspond with those between the respective models and are doubtless due to mimicry.

The two white spots in the fore wing cell on the under side were present in all the males of *obsoleta*. The females showed greater variability, the basal spot being sometimes absent, but generally much larger than in the males. On the upper surface of the same wing the distal spot was large, for this feature, in 6 females, small in 3, minute in 1. In 14 males it was sharp and distinct, though small, and it could be detected in 8 of the others. In the remainder the triangular black mark in which the white spot lies could be made out by looking carefully for it. White scales were probably originally present on this mark in some of the worn specimens that do not now possess them. This white spot can be far more frequently detected on the upper surface of *obsoleta* and *archippus* than on that of *arthemis* and probably more often than in *weidermeyeri*, although it may attain great relative size in this species (**21**, Pl. XXV, fig. 1). Its frequent appearance in the two mimics points to an origin from an ancestor of the existing North American species that was in this respect nearer in pattern to *L. lorquini*, in which the spot is almost invariably well developed (**21**, 479, 480, Pl. XXV, figs. 6–8). At the same time the redevelopment of an ancestral feature by means of mimicry must not be lost sight of as a probable interpretation. The pattern of *D. strigosa* is such that the spot in the fore-wing cell of *obsoleta* probably adds to the likeness, at any rate during flight. The strong development of the feature in the females—in this species the more ancestral sex—favors the former hypothesis. As regards the traces of the *Limenitis* pattern persisting in the fore-wing cell on the under surface and their transference to the upper surface, *obsoleta* and *archippus* have reached nearly the same stage. The most strongly marked individuals of the former are, however, more ancestral, in that the white spot on the upper surface and the two spots below are larger and more conspicuous than in any examples of *archippus*.

The seasonal differences on the fore wing were not so well marked as on the hind. Furthermore, the relationship was reversed, the autumn brood being more ancestral than the spring. The difference, however, was barely detectable except in one feature where it was very distinct—the minute white spot in the fore-wing cell. This was sharp and distinct in 11 out of 13 autumn males and only 2 out of 10 spring males. It was also on the whole better developed in the autumn females.

Temperature experiments on the pupæ and, if possible, on the ova and larvæ would be well worth trying on this form as well as on *archippus* and *floridensis*. Considering what has been done by Dorfmeister, Weismann, Merrifield, and Standfuss, remembering also that Lamborn has recently brought evidence which suggests, although it does not prove, that vestiges of "tails" can be brought back to the hind wings of the tailless mimetic females of *Papilio dardanus* (**26**), it is quite probable that some increase in the pattern derived from a non-mimetic ancestor might be induced by the shock of heat or cold applied to the pupal or both larval and pupal stages. And the fact that there are certainly some seasonal differences in the ancestral elements of *L. obsoleta* renders such experiments especially hopeful.

An experiment made by Edwards and quoted by Scudder (**6**, p. 278) is also encouraging. The black band of the hind wing of *archippus* was widened in two butterflies which emerged from pupæ subjected to cold, being in one specimen, a female, nearly three times the normal width.

It is necessary, in conclusion, to point out in a few words some special effects of the Danaine model, *D. strigosa*. Most prominent among these is the peculiar shade of the ground-color of *obsoleta*, so different from that of *archippus* and *floridensis* and so strikingly like that of the model. The triangular shape of the discal spots of the fore wing, especially pronounced in those of areas 3 and 4, has evidently been produced in mimicry of the characteristic-looking triangular and diamond-shaped spots of the model. The direction of the line of these spots in *obsoleta* which has been shown on p. 185 to be more ancestral, viz., more like that of *arthemis* and *weidemeyeri*, than in *archippus*, has doubtless been stereotyped by the model, in which four of the most conspicuous white spots in areas 1b, 2, 3, and 4 are parallel with the outer margin of the fore wing. It is also probable, as suggested in a former paper (**21**, p. 460), that the retention of the white spots representing the discal band on the hind wing upper surface, and it may be added the linear mark in area 1a of the fore wing, has been aided by "a general likeness" [during flight] "to the pale-streaked hind-wings of *strigosa*." Here, too, the relative development of the feature in the female favors a different interpretation; for, as already pointed out (p. 182), the female is slightly the more ancestral and the male the more advanced mimic in this species. The fact that the traces of the black border of the white discal band, which undoubtedly interfere with the mimetic resemblance, on the whole follow the white spots in the degree of development (p. 182) is also in favor of the supposition that the entire marking is an ancestral feature which has not yet been got rid of.

In order to prove that *obsoleta* is, as its pattern strongly suggests, ancestral as compared with *archippus*—that it stands in a position intermediate between the latter form and the non-mimetic species of *Limenitis*—*arthemis* and *weidemeyeri*—it is necessary to seek for another line of evidence.

11. THE MALE GENITAL ARMATURE OF THE NORTH AMERICAN FORMS OF LIMENITIS.

In former years I have felt, with many other naturalists, some suspicion of the conclusions based on a study of the male genitalia of Lepidoptera. The organs are so complex and in parts so thin-walled, so liable to be deformed by twisting and pressure, that it seemed unlikely that they could escape alteration in the processes of manipulation and mounting. Their shapes are such that a slight difference in the angle at which a drawing is made or a photograph taken makes all the difference to the result. I have, however, been converted by my experience of the work of my friends Dr. Karl Jordan and Dr. H. Eltringham. I have seen the latter naturalist preparing and studying the same parts in different individuals again and again until he was able to determine with complete certainty the actual form that is characteristic of the species or race. I therefore asked him if he would kindly help me by preparing and drawing the genitalia of the North American forms of *Limenitis*. In asking this favor, I was, all unconsciously, making ready for a most valuable test of the validity of the method and its results. At the time when Eltringham made his drawings we had no copy of Scudder's great work (**6**) available, but, when they were finished, I borrowed the volumes from the library of the Entomological Society of London. I turned at once to Plate 33, representing the genitalia of the Canadian and eastern North American species of *Limenitis*, and found that the four figures (9, 11, 12, 15), prepared by Edward Burgess for Scudder, might almost have been copied from Eltringham's drawings or the drawings from the figures! Two careful pieces of work carried out independently have led to precisely the same result. It will therefore be admitted that we may safely accept the six figures on the accompanying Plate V as the expression of the true structural relationships in the different species.

Figures 4, 5, and 6 on the right side of Plate V represent the male genital armatures of species also figured by Scudder, save that his *L. astyanax* (fig. 15) represents the eastern race and Eltringham's (fig. 4) that from Arizona. But the form of the genitalia is nearly the same, as may be seen by comparing the figures, allowing of course for the difference in magnification. Eltringham's figures also show with Scudder's the close resemblance between *astyanax* and *arthemis* (fig. 5, Scudder's fig. 9). The two representations of *L. archippus* are almost identical, save that Scudder (figs. 11 and

12) represents the end of the terminal hook as obliquely truncated, Eltringham (fig. 6) as a simple point.

Figures 1, 2, and 3 on the left of the plate represent forms of *Limenitis* from an area outside the limits of Scudder's monograph. The claspers of *L. lorquini* (fig. 1) are seen to differ markedly from those of all the other forms. *Weidemeyeri* (fig. 2), on the other hand, closely resembles *arthemis* and *astyanax*, although it is of a stouter build. The main interest of the series of figures is, however, concentrated in *obsoleta* (fig. 3). Just as the pattern of this species was seen to be intermediate in many details between that of *archippus* on the one hand and *arthemis* and *weidemeyeri* on the other, so is it with the form of its claspers. To make sure that the appearance represented in fig. 3 was not an individual peculiarity, Dr. Eltringham made a second preparation, but with precisely the same results. The comparison between figs. 2 and 3 suggests that the mimetic form arose from an ancestral species with claspers more like those of *weidemeyeri* than *arthemis*. Looking at these figures, some naturalists may be inclined to suppose that *obsoleta* sprang from *weidemeyeri* in the southwest, while *archippus* developed independently from *arthemis* in the east and north. Such a conclusion seems to me improbable. It is unlikely that independent lines of evolution would have led to structures with the essential similarity that is to be recognized between the forms shown in figs. 3 and 6—I refer especially to the hook below and the strong teeth above the end of the organ—and still more improbable that such independent evolution would have led to the resemblances in minute detail that have been shown to exist between the patterns of *obsoleta* and *archippus*.

Remembering that these conclusions are founded on small differences between organs that are themselves very variable, Dr. Eltringham has confirmed his results by making preparations from 3 individuals of *archippus*, 2 of *obsoleta*, 2 of *weidemeyeri*, and 2 of *astyanax arizonensis*. He finds that the fine points or teeth are not only variable in different individuals, but that they vary on the two sides of the same individual. This he has shown by the careful drawings reproduced on Plate V, where this want of symmetry is apparent in nearly all the figures. The second specimen of *weidemeyeri* has rather fewer teeth than the one figured. In a single specimen of *archippus floridensis* (*eros*) the organs were somewhat larger than in *archippus* and the clasper points were a little less acute. In spite of great individual variability and the want of symmetry, the claspers of the individuals shown in Plate V exhibit recognizable characters common to other individuals of each species examined by Eltringham and, as regards three of them, by Burgess.

Knowing my own want of experience in the comparative study of these male abdominal appendages, I submitted Dr. Eltringham's drawings to my friend Dr. Jordan, who wrote, Aug. 15, 1913: "*Archippus* appears to be a later modification of *obsoleta*, as you say. *Astyanax arizonensis*, *weidemeyeri*, and *arthemis* are also closely related to one another."[4] Dr. Eltringham also agrees that the comparative study of the armatures supports the conclusions arrived at from a study of the patterns.

Considering together pattern and the structure of the claspers, there are strong reasons for believing that the mimetic forms arose from a North American *Limenitis* with the pattern of *arthemis* and *weidemeyeri*, but including a white spot in the fore-wing cell upper side now seen most commonly in *lorquini* among North American species, and with claspers like those of *weidemeyeri* and *arthemis*, but probably nearer to the former.

I trust that Dr. Skinner will consider that this evolutionary history, if not convincing before, has been rendered so by the fresh evidence now produced.

12. SIMILAR ENVIRONMENTAL CONDITIONS VERSUS MIMICRY AS AN INTERPRETATION OF COLOR RESEMBLANCES.

With regard to the resemblance of *Limenitis* (*Basilarchia*) *floridensis* to *Danaida berenice* in Florida and of *L.* (*B.*) *obsoleta* (*hulsti*) to *D. strigosa* in Arizona, Skinner suggests (**32**, p. 127) that "similar environmental conditions explain these color resemblances better

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[4] The remainder of Dr. Karl Jordan's letter contained an interesting and suggestive criticism of Scudder's conclusion that *proserpina* is a hybrid between *arthemis* and *astyanax*.

"The differences in the genitalia between *astyanax* and *arthemis* might render copulation a little difficult, but are too insignificant to prevent it. According to Scudder, *proserpina* is the hybrid between *astyanax* and *arthemis*. If that is the case, the genitalia should be intermediate. As they are identical (teste Scudder) with those of the northern insect, I do not believe that *proserpina* is a hybrid. The offspring of a ♀ *proserpina* were partly *proserpina*, partly *arthemis*. This also points in the direction that *astyanax* has no part in the production of *proserpina*. Scudder appears to rely particularly on *this* point—*proserpina* inclines towards *astyanax* where the latter prevails, and towards *arthemis* in the places where this insect is abundant. But such an agreement in coloration may simply be due to the two occurring side by side. It is not necessarily evidence for hybridization. I have only looked at Scudder's book, not at the specimens; my opinion is therefore worth very little, but I incline to the belief that *arthemis* assumes the pattern of *astyanax* where it comes into contact with the latter, *i.e.*, that *proserpina* is a southern modification of *arthemis*, not a hybrid. It would be advisable, however, to examine the genitalia of a series of specimens of all three insects."

than the hypothesis of mimicry." He does not venture to suggest this interpretation for the resemblance of *L.* (*B.*) *archippus* to *Danaida plexippus;* for the great environmental changes endured by both model and mimic in their extensive north and south range make any such suggestion untenable. With regard to the detailed likeness of three forms of *Limenitis* to three Danaine butterflies in North America, I may fairly retaliate on my friend and point out in his own words, *mutatis mutandis,* that "it seems logical to consider that they are governed by a general law rather than that two of them, but not the third, are caused by similar environmental conditions." I have already many years ago dealt with this supposed interpretation of mimetic resemblance by an appeal to the forces of the environment, and the arguments then brought forward (**15**) have, so far as I am aware, never been met. Dr. Skinner does not attempt to meet them, nor does he even allude to the peculiarly strong evidence furnished by these very North American mimics against the hypothesis of environmental conditions. Although this evidence is clearly set forth in the paper which Dr. Skinner was discussing (**22**), as well as in earlier publications of mine (**16, 21**), I will repeat the substance of it on the present occasion.

The three Danaines of North America are modern invaders from the Old World, quite isolated and out of place in the New, while the genus *Limenitis* is an ancestral element in the North American fauna. My own experience of insect systematics is very limited, and I could not with any confidence or authority attempt to weigh the value of characters which have been described as generic. Knowing these limitations only too well, I applied to my friend Dr. K. Jordan, and he, after making fresh investigations into the male genitalia and carefully studying Moore's generic characters, came to the conclusion that the Old World *Limnas* and *Salatura* and the New World *Anosia* and *Tasitia* could not be sustained as separate genera, but that all four were to be properly included in the single genus *Danaida.* This genus is nearly related to several much-mimicked groups of *Danainæ* in the Old World, but the two species from which the few American geographical forms have been derived are aliens in the New World.

Dr. G. B. Longstaff has recently shown that in the gregarious instinct, as manifested by hanging in festoons and clusters from trees, the Old World *Danaida genutia* (*plexippus*) resembles its New World representative *D. plexippus* (**27**, pp. 75, 76), in which the same habit has often been observed (**6**, pp. 730, 734–7)

Even in pattern there is but little difference between the most nearly allied Asiatic and American species of *Danaida*, and if, as Dr. Skinner believes, color and pattern are the expression of environmental conditions, then they are the expression of an Old World, and not of a New World environment. On Dr. Skinner's view, the Old World invader, when it became exposed to the new environment, should have come to resemble the New World resident. Instead of this, the resident has come to resemble the invader.

In concluding the present paper I may quote an opinion expressed to me by Professor Svante Arrhenius. A few years ago I asked my friend whether he thought it possible to explain by the incidence of physico-chemical forces, such as those of the environment, the superficial resemblance of one form to another when that resemblance required, as in the development of a complex pattern, the co-operation of many different factors. He replied, as I expected, that he did not consider the explanation possible; for the building up of such a likeness was inconceivable except by the aid of selection. This was the argument I advanced in 1898 (**15**), after an analysis which showed that mimetic resemblance often requires the co-operation of many different factors; and it was a great satisfaction to find the conclusion confirmed by an authority with Professor Arrhenius' broad outlook on the sciences in their relation to one another and to mathematics.

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EXPLANATION OF PLATE V.

Genital armatures of male North American *Limenitis* (*Basilarchia*). Figures drawn by H. Eltringham. All the figures are magnified about fourteen diameters.

Fig. 1.—*Limenitis lorquini.*
Fig. 2.—*L. weidemeyeri.*
Fig. 3.—*L. obsoleta.*
Fig. 4.—*L. astyanax arizonensis.*
Fig. 5.—*L. arthemis.*
Fig. 6.—*L. archippus.*

February 17.

Dr. Benjamin Sharp in the chair.

Fourteen persons present.

The Publication Committee reported the reception of the following contributions to the Proceedings:

"On a collection of mammals from Ecuador," by Witmer Stone (January 24).

"The olfactory sense of Hymenoptera," by N. E. McIndoo, Ph.D. (January 27).

"Description of a Tsantsa in the ethnological collection of the Academy with notes upon another specimen," by H. Newell Wardle (January 30).

"Description of a new echinoderm," by Henry A. Pilsbry (January 31).

R. A. F. Penrose, Jr., Amos P. Brown, Frederick Prime, Edgar T. Wherry, and Charles D. Walcott were appointed to constitute the Committee on the Hayden Memorial Geological Award.

Joseph McFarland, M.D., was elected a member.

The following were ordered to be printed:

DESCRIPTION OF A TSANTSA IN THE ETHNOLOGICAL COLLECTION OF THE ACADEMY, WITH NOTES ON ANOTHER SPECIMEN.

BY H. NEWELL WARDLE.

The little mummified human heads, known by their native name of *tsantsa*, and made by the Jibaro tribes dwelling in the eastern Andean valleys around the head waters of the Amazon, have been known to science for half a century,[1] yet the specimens are still sufficiently rare for each to merit a full description.

The Academy has recently received a fine tsantsa, as a gift from Dr. Thomas Biddle (Plate VI). It was formerly in the possession of the Museum Umlauff of Hamburg, and bears the tag of that institution with the inscription,

"h No. No. 826
23182 Equador
Jivaros."

The head is in fine condition, the flesh being firm and hard, though apparently not brittle.

The skin is devoid of wrinkles, despite the excessive shrinkage it has undergone. It shows that peculiar chocolate-brown tone characteristic of the tsantsa, the portions in relief, such as lips, nostrils, and zygoma, being highly polished and lighter in color, with a distinctly reddish tinge. There are no traces of tattooing observable.

The measurements follow:

	m.
Horizontal circumference	.240
Transverse supra-auricular curve	.154
Maximum antero-post. diameter (inion-glabella)	.093
Maximum occipito-labial diameter	.115
Maximum transverse diameter	.048
Total length of face	.080
Maximum bizygomatic diameter	.037

The above measurements show that the Academy's specimen

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[1] Dr. Moreno-Maiz, Tête d'Indien jivaro (Pérou oriental) conservée et momifiée par un procedé particulier, avec quelques renseignements sur les Jivaros. *Bulletins de la Société d'anthropologie de Paris,* t. III, p. 185, 1862.

possesses the characteristic, narrow, elongated form, with strongly marked prognathism and considerable asymmetry.

Behind the temples is the usual deep depression, which, especially on the right side, almost amounts to a breaking in of the surface, and gives to the forehead a somewhat conical form. The whole facial region also is narrow and flattened laterally. The cheeks, while not sunken, are depressed below the level of the zygomatic arch and of the muscles of the mouth.

The eyebrows are apparently asymmetrical in the arrangement of the hairs—the right supercilium having its inner corner close to the glabella, while that of the left is well round toward the side. The head would seem to have suffered loss at these points during the process of preparation. The hairs are comparatively short—4 to 5 mm. in length. Considering the great contraction of the piliferous tissue, the growth is not heavy. No eyelashes are visible.

The eyelids have been inverted and stitched together, the stitches from the right eye being continued to close a gash on the right surface of the root of the nose. The line of the crack is traceable across the root of the nose to a corresponding break on the left side which is not sewed. This is found in other tsantsas and doubtless results from the method of preparation which forces the nose forward and upward.

The naso-buccal region is strongly projected, which, together with the slightly receding chin, gives to the lower face a snout-like aspect.

The nostrils, which are rudely circular and distended, are directed almost straight to the front, in a manner suggestive of a double-barreled gun. The orifices show a sufficient supply of vibrissæ. The septum has been broken away in the interior of the nasal passage, which extends straight backward into the cavity of the head. The contour of the nose shows a moderate convexity between root and tip.

The lips are proportionately heavy and are pressed forward in a horizontal curve and held together by three vertical stitches of vegetable cord. The holes through which these cords pass are circular, as if made with an awl, or kept open during the shrinkage process by round skewers, such as appear on the Murato tsantsa of Colini,[2] which apparently was in process of preparation when collected. The lip decoration of pendant cords attains a length of

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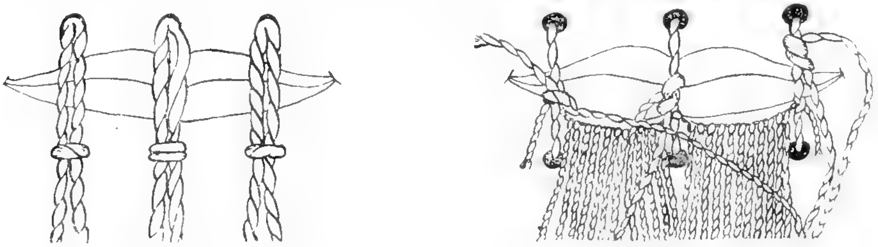
[2] Dr. G. A. Colini, Osservazioni etnografiche sui Givari. *Real Accademia dei Lincei*, anno cclxxx, 1882–1883. *Memorie della Classe di scienze morali, storiche, e filologiche*, vol. XI, tav. 1, fig. 1.

30 centimeters. It is composed of three two-strand cords in the natural color, which, doubled in the middle, is passed downward through one of the piercings, whereupon its projecting loop is traversed by the free ends after crossing the lips. This is the simplest form of loop knot. The three cords form individual entities at the lips, and, unlike the labial ornaments figured by Dr. Rivet,[3] there are no connecting loops with pendant cords. Twenty-one and a half centimetres below the lips, one of the ends of the left-hand cord has been broken off. All the remaining strands are gathered together at a point 30 cm. below the lips and, treated as a single strand, tied in a simple knot. Below this they resume their individuality. Both ends of the central cord and the remaining end of that on the left are formed into a kind of uncut tassel by turning back the ends and tying them in a single knot. The other three cord-ends were possibly united by a similar knot, though at present one of the strands is looped back and knotted upon itself. These cords are generally believed to be more than mere decoration, having a mnemonic value, after the manner of the Peruvian quipu (fig. 1).



Cords of the lip decoration: Fig. 1. The Academy's tsantsa; Fig. 2. The Castner tsantsa.

The chin is rounded and slightly receding, though the latter appearance is considerably enhanced by the artificial protraction of the lips. Two incisions have been made in it—one on the left side extending almost vertically downward and following the curve from the edge of the lower lip to a point corresponding to the gnathion or slightly posterior to it, the other extending forward from the severed edge of the neck to a point below the right angle of the mouth, where the gash turns upward. These cuts were doubtless made to facilitate the extraction of the lower maxillary bone and were then sewed up with twisted fibre. In the lower seam, the stitches remain in place, but those of the downward incision, with

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[3] Dr. Rivet, Les Indiens Jibaro; etude geographique, historique et ethnographique, *L'Anthropologie*, t. XIX, p. 79.

the exception of a single stitch, have evidently been cut away from the surface, leaving two parallel rows of stub ends of fibre visible on the opposite sides of the crack.

The ears, though reduced to a length of 3 cm., are apparently in nowise distorted. The lobule of each is pierced with a round hole, through which passes the soft cord of two twisted strands, which ties on the pendant ear ornament. These are of unequal length, that of the right ear being only 22 cm., while the left one measures 42 cm. from its fibre proximal end to the tip of the hair tuft in which it terminates. These cylindrical ear ornaments are formed of a heavy rope of twisted fibre, coarser and more woody than the cords through the ears and lips, and tightly bound with fibre at both ends. To the distal end has been attached, partly by gumming and partly by fibre wrapping, first a heavy tuft of hair, apparently human, 10 cm. long on the longer, and 5 cm. on the shorter pendant. Above this, with more gum and more encircling strands, was laid a circle of small yellowish-green feathers, 4 cm. long. Above these come the overlapping, iridescent scales which have entirely covered the foundation and consist of the green elytra of a tropic beetle, *Mallaspis antennatus*, each sewed by a single horizontal stitch of very fine twisted fibre, passing through the two perforations in its proximal end. Occasionally there is but one perforation, but even in that case the stitch is usually horizontal, passing over the opposite edge.[4]

The head has been severed at a point level with the lower line of the chin. The orifice has an oval form, being compressed laterally, in conformity with the whole head. At the section, the thickness of the flesh varies from 3 mm. to 9 mm.

By ordinary day light, the hair is of an ebony-black, but in sun light shows considerable iridescence with a marked reddish cast in the shorter hair of the fore part of the head. In character, it is moderately fine, wavy, and rather stiff. Much of it, upon the top and sides of the head, is short; the longest at the back reaches a length of 40 cm. Probably much has been removed for the scalp-belt—a trophy the Jibaro esteems only second to the tsantsa.

The scalp is seamed from what was, before distorting in desiccation, the posterior median line of the neck to a point midway to the vertex.

At the crown of the head, there is a single circular perforation,

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[4] Dr. Colini (*opera cita*, tav. II, figs. 10 and 10 bis) figures ear pendants of this type and ascribes them to the Muratos, a division of the Jibaros.

through which passes the doubled suspension cord. The free ends of this cord are knotted within the head around a small stick laid in anterior-posterior position beneath the vertex. Some 8 cm. above the point of issuance, the doubled cord is drawn into an incomplete knot, *i.e.*, the end is not pulled through, but doubled back upon itself. A centimeter farther and the doubled cord is again knotted. From this point it continues without further interruption, 335 mm., the loop thus formed of 671 mm. being of sufficient size to permit of passage over the head of the former Jibaro owner, when the tsantsa was worn suspended around the neck.

This suspension cord is not twisted, but woven, or rather plaited, with a fairly uniform width of 4 mm. The cut end within the head shows ten strands, and the technique is unquestionably that of the five-loop plaiting described by Dr. Roth.[5] It possesses the attractive arrangement of strands and the flat under-surface, with slightly convex upper face characteristic of this peculiar process, and a series of experiments in ten-strand cord plaiting failed to reproduce it exactly, until the Warrau five-loop plaiting was tried. The result was more than satisfactory, for rather rapid work with this method gave all the peculiarities seen in the Jibaro cord—the occasional overlapping of one of the strands of the loop by its mate, thus concealing the lower, the consequent thickening and narrowing of the cord with the obscuring of the pattern—points which do not appear in Dr. Roth's beautifully regular drawing. It is of interest to note the occurrence of this technique—which would seem to be unrecorded elsewhere—in two such widely separated localities as the Amazonian slopes of the Andes in Ecuador and the Pomeroon District of British Guiana; employed, in the one case, by the Jibaros, a tribal group of as yet undetermined affinities,[6] and, in the other, by the Warraus, whose relationships also remain to be fixed; and the question arises as to whether this five-loop plait is made also by the people of the far-flung Carib stock.

While engaged in the study of the Academy's tsantsa, another of these little mummified heads came under the writer's notice, and it was deemed advisable to include a brief description of it (Plate

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[5] Dr. Walter E. Roth, Some Technological Notes from the Pomeroon District, British Guiana. *Journal of the R. Anthropological Institute of Great Britain and Ireland,* vol. XL, p. 27, Plate VI, figs. 1–5.

[6] Dr. Rivet, *Journ. citu,* t. XVIII, p. 338, footnote, promises a detailed study of the language of the Jibaros, based on vocabularies in his possession. Previously available evidence of its affinities was not sufficient to permit of assigning the tribal group to any stock.

VII, *a* and *b*). This trophy is owned by Mr. Samuel Castner, Jr., of Philadelphia, and was obtained by him in 1903 at a sale of the collection of Arthur H. Little, where it was wrongly ascribed to Oceanica. It is a typical Jibaro tsantsa, in excellent condition.

The skin is of the same chocolate-brown color, but without the lighter tones which distinguish the prominences in the one already described. It is smooth and shows no traces of tattooing.

The measurements follow:

	m.
Horizontal circumference	.260
Transverse supra-auricular curve	.160
Maximum antero-post. diameter (inion-glabella)	.087
Maximum occipito-labial diameter	.105
Maximum transverse diameter	.060
Total length of face	.075
Maximum bi-zygomatic diameter	.045

Comparing the two specimens, it is evident that the gain in both the horizontal circumference and in the transverse supra-auricular curve, of the Castner piece, is due to the greater width of the head, both the longitudinal diameters being actually shorter. The face also is broader and shorter, with very slight prognathism.

The head is not noticeably asymmetrical and possesses the characteristic deep depressions behind the temples. The cheeks are rounded out, so that the muscles of the mouth and the position of the zygomatic arch are not brought into relief.

The eyebrows are symmetrical and fairly heavy, with individual hairs reaching a length of 10 mm. No eyelashes are visible, the eyelids being inverted but not stitched.

There is no break across the root of the nose, but a deep crease, due to the protraction of the bucco-nasal region. The nasal contour is marked by a moderate curve from tip to root. The nostrils are directed horizontally forward and show numerous vibrissæ. Neither septum nor allæ have been perforated.

The lips, which are proportionately heavy, show three vertical piercings, each occupied by a short twisted cord which traverses both lips and is knotted in front, leaving short pendant ends. To these cords, just above the point of issuance from the perforation in the lower lip, a horizontal cord is attached, which, in turn, bears the characteristic lip decoration of long, pendant cords—twenty-two in number and separated into two groups by the knotting of the horizontal sustainer around the central vertical cord. The long twisted cords of both groups fall straight to a length of m. .367 (fig. 2).

The chin is rounded, but not receding; it falls into a vertical line with the lower forehead. No incisions are visible, only a deep furrow from the neck to behind the position of the maxilla on the left side. In this, as in other details, the Castner tsantsa shows the work of a more skilful preparator than was the Jibaro from whose hand the Academy's specimen came.

The ears are considerably distorted so that an accurate measurement is not possible. Both have been pierced through the lobule, though the right one alone bears an ornament—a section of bird (?) bone, hung by a doubled cord of twisted fibre drawn through it, the knotted loop end being pulled back within the hollow bone.

The head has been severed by a diagonal cut, which passed close to the head on the right, but left a portion of the neck on the left side. The flesh at the section varies from 4 to 2 mm. in thickness.

The hair is of a beautiful ebony-black, fine and wavy, and reaches a length of 56 cm. The seaming of the scalp extends from the neck in the posterior median line almost to the vertex, where the single perforation occurs through which the suspension cord is passed. This latter has a length of only 50 cm. from the point of issuance from the perforation to its re-entry therein. The width of the cord is 3 mm., and the technique is evidently the same five-loop plaiting noted in the suspension cord of the Academy's tsantsa.

Comparison with the table of measurements of the eleven mummied heads studied by Dr. Rivet,[7] shows that in both the tsantsas here described the horizontal circumference, the transverse supra-auricular curve, and the maximum antero-posterior diameter rise above the average, though not reaching the maximum measurements. In maximum transverse diameter, the Academy's piece falls within 3 mm. of the minimum, while the Castner head is above the average; in total height of face, the Academy's approaches the maximum, with a bi-zygomatic diameter below the minimum, while the height of the Castner specimen is below the minimum and its width at the zygoma somewhat below the mean.

Reference should be made to the preparation of these trophy heads, because of its relation to the structure and condition of the finished product. Three methods have been described by reliable travellers, and it is probable that all are, in the main, correct, the differences being due to local variation of practice among the Jibaro tribes.

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[7] Dr. Rivet, *Journ. citu*, t. XIX, p. 76.

Dr. Rivet,[8] following Lubbock and other writers, gives the following procedure. After the extraction of the cranium through the posterior incision, the skin with adherent flesh is boiled in an herb decoction. Withdrawn from this, it is placed around a spherical stone, superheated, and, after shrinkage, upon a smaller stone, and then upon a third yet smaller. Meanwhile, another hot stone is passed back and forth over the surface, thus facilitating the shrinking and drying of the tissue. The lips, and sometimes the eyelids also, had previously been carefully sewed to prevent the retraction in desiccation, causing them to gape.

According to the engineer Von Hassel,[9] after the substitution of the hot stone for the cranium, the head is hung in the smoke of a palm-root fire, but there is no mention of boiling. The lips are "deformed—by means of a cord and a little piece of chonta" (wood).

The third description of the method pursued, which was given Lieut. Safford by Señor Tirado[10]—an eye-witness—is an interesting blending of the two preceding. According to this statement, immediately after the extraction of the skull, the scalp is sewed up, and the hole in the vertex pierced and supplied with its cord. Afterwards the head is dipped in the hot infusion of herbs, "care being taken not to allow the roots of the hair to enter," though how this latter precaution is possible is not readily conceivable. Dried by the introduction of hot stones, it is then smoked over the cooking-fire, the hair being wrapped in leaves for protection. After three or four months of curing in the smoke, the lips are pierced and the decorations added.

None of these descriptions makes mention of any lashing or means of holding the cranial envelope in position during the curing process. Yet the Murato tsantsa of Colini,[11] which is evidently a head obtained before the finishing touches had been added, shows a slender spike of wood passed backward through the nostrils and out through the perforation at the vertex. A cord is lashed around the ends of this stick and over the forehead, thus forcing the nostrils forward and

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[8] Dr. Rivet, *Journ. citu*, t. XIX, p. 71; also Sir John Lubbock, Note on the Macas Indians. *Journal of the Anthropological Institute of Great Britain and Ireland*, vol. III, p. 30. Sir John, however, states that the bones were removed through the neck *after* the boiling.

[9] Jorge M. von Hassel, Las Tribus salvajes de la región amazónica del Perú. *Boletin de la Sociedad Geográfica de Lima*, XVII, 1905, pp. 56–57.

[10] Dr. Walter Hough, Prepared Human Head. *American Anthropologist*, vol. XIV, p. 406.

[11] Dr. G. A. Colini, *opera citu*, p. 362 *et seq.*, tav. 1, fig. 1; also Dr. Rivet, *Journ. citu*, t. XIX, p. 82, Pl. 1, fig. 3.

upward, and causing the deep bend at the root of the nose, which is characteristic of all genuine tsantsas, and, in the Academy's example, has resulted in an actual breaking of the integument.

The three piercings of the lips are also occupied by skewers lashed in place; another stick is thrust into the auditory meatus and the neck is secured to a wooden ring by stitching.

The lips, then, in this unfinished trophy, are already pierced and held together by skewers, which fix them rigidly in the desired position. Together with the spike through nostril and vertex, they form an essential part of the taxidermy and account for the characteristic protraction of the lips. Certainly in both specimens herein described, the perforations of the lips, like those of the lobules, were accomplished while the flesh was comparatively soft. On the other hand, the stick thrust into the auditory meatus would seem not to have been a constant feature of the preparation, as the small hole made by it is found only occasionally.

Some sort of device must have been in use for keeping open during desiccation the flaccid skin of the neck, and the wooden circle of Colini's tsantsa would have admirably served this purpose. The Academy's specimen shows at the section of the neck certain fine grooves, running from the outer to the inner surface of the flesh, as if it had been traversed by stitches and had later been cut or broken away along the plane of the piercings, leaving the grooves exposed.

It seems to be certain that, whether the preparation occupied one day, one week, or several months, whether it was by means of alternate steaming and drying or by smoking, or by a combination of both methods—as seems probable—the seaming of the scalp, the piercing of the vertex and of the lips, and the insertion of the wand from nostril to vertex must have been done while the flesh had not yet hardened; but, apparently, when the last of these operations took place, the trophy was already reduced practically to its final dimensions and, in the case of the Academy's tsantsa, had lost some of its flexibility.

EXPLANATION OF PLATES VI, VII.

PLATE VI.—Tsantsa, mummified human head, prepared by the Jibaro Indians of Ecuador. A. N. S. P., No. 15,048.

PLATE VII.—Tsantsa: *a*, front view; *b*, lateral view. Owned by Mr. Samuel Castner, Jr.

DESCRIPTION OF A NEW ECHINODERM.

BY HENRY A. PILSBRY.

Several years ago the Academy received from Mr. Clarence Bloomfield Moore specimens of a fossil sea-urchin, which had been obtained from material dredged from near the mouth of the Withlacoochee River, Florida, in an area mapped as Pliocene. The specimens represent an undescribed species, which may be called—

Eupatagus mooreanus n. sp. Plate VIII.

The outline is broadly ovate, slightly emarginate in front, tapering a little, and abruptly, vertically truncate behind. The upper surface is moderately convex, highest at the posterior third of the length: lower surface nearly flat, slightly concave at the sides and anteriorly close to the peristome,

The ambulacral centre is at the anterior six-tenths of the length. Unpaired ambulacral area indistinct, without large pores. Paired ambulacral areas petaloid, nearly straight-sided, closed at the distal ends. Those of the posterior pair are a little longer than the anterior. They form an acute angle with one another and right angles with the areas of the anterior pair. The poriferous zones are depressed, with equal, circular pores in pairs connected by furrows. The four genital pores are equal, round, the anterior pair much closer than the posterior pair. The peripetalous fasciole is distinct, not sinuous. The tubercles in the interambulacral areas are very unequal. The larger ones stand in about five waved concentric series and occupy slight depressions. The posterior interambulacral area is convex and not distinctly tuberculate, having a quite distinct median suture.

The peristome is in form of a transverse oval, flattened posteriorly. It is situated at the anterior third of the length. The periproct opens at the summit of the flattened posterior area, is shortly oval, somewhat higher than wide, and a little angular at the ends. The base is closely and strongly tuberculate, the tubercles becoming much smaller at the periphery. There is a smooth raised segment from the peristome to the posterior end.

Length 61, transverse diameter 51, alt. 29 mm.

This species is about the size of *E. clevei* Cotteau, from which it differs by the narrower ambulacral petals, the vertically truncate posterior end, wider peristome, equal genital pores, and the different arrangement of the tubercles.

The largest specimen is 64 mm. long. The type is No. 1147 A. N. S. P.

EXPLANATION OF PLATE VIII.

Upper, lateral and basal views of *Eupatagus mooreanus* Pils.

MARCH 17.

MR. CHARLES MORRIS in the Chair.

Eleven persons present.

The Publication Committee reported the reception of the following papers as contributions to the PROCEEDINGS:

"Fishes collected by the Princeton Expedition to North Greenland in 1899," by Henry W. Fowler (February 14).

"Description of a new Blenny from New Jersey, with notes on other fishes from the Middle Atlantic States," by Henry W. Fowler (February 24.)

"Fresh-water mollusks of the Oligocene of Antigua," by Amos B. Brown and Henry A. Pilsbry (March 9).

The deaths of the following members were announced:

Thomas Wistar, M.D., September 27, 1913.
N. Roe Bradner, M.D., February 6, 1914.
Charles S. Welles, February 24, 1914.
Walter Rogers Furness, February 27, 1914.
Edwin J. Houston, March 1, 1914.
Stuart Wood, March 2, 1914.

The following were ordered to be printed:

FRESH-WATER MOLLUSKS OF THE OLIGOCENE OF ANTIGUA.

BY AMOS P. BROWN AND HENRY A. PILSBRY.

In a recent paper by one of us[1] reference has been made to the deposits carrying these fresh-water shells, which were first noted by Nugent.[2] His collection of Antigua fossils, including, no doubt, specimens of these fresh-water mollusks, is still preserved in the collections of the Geological Society of London, now in the British Museum. These deposits were later described by Purves[3] as his division E, under the name of the "Lacustrine or fresh-water chert." These beds are mapped by Purves as extending completely across the island, in the central plain from Corbizon Point and Dry Hill in the northwest to near Willoughby Bay and Falmouth Harbor in the southeast. His observations on the fossils appear to have been made at Dry Hill and at Corbizon Point. M. Purves records the following genera as occurring in these cherts: *Melania*, *Zonites*, *Nematura* or *Amnicola*, *Planorbis*, *Melampus*, *Neritina*, *Truncatella*, *Pomatias*. He also states that the specific descriptions of these shells will be published later, but this seems never to have been done.

The species described in this paper were collected from the sea cliffs at Dry Hill, where these flinty beds, carrying fresh-water species, outcrop on the seashore and where they have weathered out by the action of the rains and the salt water dissolving away the calcareous material and leaving the silicified shells intact in a remarkably good state of preservation. When these beds were seen inland at several points, the weathered surfaces of the layers exposing the shells were not so well preserved as at Dry Hill or at Corbizon Point, only sections being found in most cases, as the shells were imbedded in the compact flint. This was, of course, the case at the two localities above noted, likewise; the hard, compact flint layers, varying in thickness from one to four inches, being frequently crowded with these fresh-water shells that showed only in sections upon the frac-

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[1] Brown, Notes on the Geology of the Island of Antigua, *Proc. A. N. S. P.*, 1913, pp. 584–616. See also p. 596 of the same paper.

[2] Nugent, A Sketch of the Geology of the Island of Antigua, *Trans. Geol. Soc. London*, ser. 1, Vol. V, (1821), pp. 459–475.

[3] Esquisse géologique de l'Ile d'Antigoa, *Bull. Mus. Roy. Hist. Nat. Belg.*, Vol. III, 1884–85, pp. 273–318.

tured surfaces. Where the sea had been eating into the cliff, and detaching slabs of the hard, flinty layers, the surfaces of these flint slabs were completely covered with the flint pseudomorphs of the shells, these in most cases having the finest sculpture perfectly preserved The relation of these beds to the other members of Brown's division 3 as given in his *Notes on the Geology of the Island of Antigua* is shown in the section of the rocks at Dry Hill, on page 595,[4] and there it will be seen that the *lacustrine or fresh-water chert* layers immediately overlie the *Volcanic Sands* which form the lower 23+ feet of the section. The same sequence of deposits is also seen at Corbizon Point, where the *fresh-water chert layers with silicified wood* occur along the shore immediately above these same *Volcanic Sands* that are found at Dry Hill. Near the Botanic Station, just east of St. John's, the flinty layers with fresh-water shells are found, but the shells are imbedded in the flint and only show in sections in the hard, compact rock. The reddish beds of the *Volcanic Sands* are absent at this locality east of the Botanic Station or are only represented by sandy nodules in the white tuffs. No silicified wood was seen at this place.

The species described below belong to the genera *Hemisinus*, *Bythinella*, and *Planorbis*. The genus *Hemisinus* is undoubtedly what Purves has called *Melania* and indeed he mentions *Hemisinus* as being found living in Cuba. These species of *Hemisinus* are described below. The *Bythinella* is probably what Purves referred to *Nematura* or *Amnicola;* we have described one species. The one *Planorbis* which we describe is the only representative of this genus in the collection. We found no representatives of *Melampus*, *Truncatella*, *Pomatias*, *Zonites*, and *Neritina*, mentioned by Purves.

Hemisinus antiguensis n. sp. Pl. IX, figs. 1, 3, 5, 6.

The shell is slender, diameter contained nearly three times in the length; whorls rather numerous, probably at least fifteen in a perfect shell, as a young one 12.5 mm. long has twelve whorls, the upper part of the spire being very slender. Whorls convex, sculptured with many rounded ribs, as wide as their intervals, somewhat curved, the concavity forward and somewhat protractive. There are about 25 ribs on a whorl. Above the lower suture of each whorl there are two or three spiral cords, the lower one strongest. On the last whorl the ribs extend to the periphery where they disappear, the peripheral region and the base having numerous spiral cords. The aperture

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[4] Brown, *loc. cit.*

is but rarely preserved, but in the best examples the peristome seems to be somewhat effuse at the base of the columella.

Length 16.5, diam. 6 mm., 8 whorls remaining.
" 19.5, " 6.4 " 8 " "

The sculpture of longitudinal ribs with basal spirals is characteristic. The same type of sculpture occurs in various South American species of *Hemisinus*. It could readily be matched also in *Melania* and related forms or in the *Pleuroceratidæ*.

There seems to be variation in the development of the spirals. Many specimens show weak traces of impressed spirals over the ribs throughout, and this seems to be the normal condition; but in some examples the ribs appear to be smooth except near their lower ends.

This species, like the associated forms, has the basal sinus or notch obsolete, as in part of the recent species.

Hemisinus siliceus n. sp. Pl. IX, fig. 2.

The shell is Melaniiform, regularly tapering, the diameter of last whorl contained about 2⅓ times in the total length. The whorls are convex, and apparently without any sculpture except growth-lines. The last whorl has fine, reversed sigmoid growth striæ, which retract somewhat below the suture, then advance, as in *H. cubaniana*. In the type specimen a former peristome, indicating a period of growth arrest, appears as a sigmoid varix on the last whorl. This indicates a more strongly sigmoid outer lip than in the recent Antillean species.

Length 26 mm., about 6 whorls remaining, the summit lost; diam. 10.8 mm.

No entirely perfect aperture was found on the slabs collected, but so far as we can judge, it seems to be much like that of *Hemisinus cubanianus* (Orb.). It is not unlikely that *H. siliceus* is ancestral, or at least a collateral species not far removed from the ancestral stock of the smooth Antillean species of *Hemisinus*.

There is, of course, a possibility that this Antigua species belongs to the genus *Pachycheilus*, which is represented in the recent fauna of Cuba by *P. conicus* (Orb.) and *P. violaceus* Prest.; but the straighter columella does not, in our opinion, favor this view.

The type has lost the shell from the spire by conversion into flint, but the surface has been preserved in perfection on the last whorl.

Hemisinus latus n. sp. Pl. IX, fig. 4.

This form is represented by somewhat numerous internal casts, of which the largest has been selected for illustration. It differs from the associated species by its decidedly broader figure. The diameter of last whorl is contained about $2\frac{1}{8}$ times in the estimated total length. The whorls, of which somewhat over 5 are preserved in the type, are shorter and broader than in *H. siliceus.* Very little of the shell is preserved and the sculpture is unknown. It is probably smooth. The aperture is largely concealed by another shell, the thin, arcuate, outer lip alone remaining visible.

Length of broken specimen 17 mm.; diameter 8.5 mm.

Bythinella antiguensis n. sp. Text fig. 1.

The shell is oblong, pupiform, smooth; outlines of the spire convex, the apex conspicuously obtuse. Whorls 4, very convex, aperture vertical, shortly ovate, its length contained $2\frac{1}{2}$ times in that of the shell; peristome in one plane, thin.

Length 1.8, diam. 1.1, length of aperture 0.7 mm.

This very minute form is not rare. It has the very obtuse summit and the pupiform shape of the species usually referred to *Bythinella,* rather than the shape of *Paludestrina,* if, indeed, the two groups are distinct. Of course, any generic reference of a minute fossil Amnicoloid shell of this sort is purely provisional, unless it is from a region where the recent fauna and its antecedents are well known.

Planorbis siliceus n. sp. Pl. IX, figs. 1*a*, 3*a*, 5*a*, 6*a*.

This is a species of the section *Tropicorbis.*[5] The shell is rather thick, with the periphery rounded, more convex towards the right side. The two sides are about equal in width of the concavity, but that on the right side penetrates more deeply, being vortex shaped. The last whorl is rounded on this side. On the left side the last whorl is subangular and the cavity is less infundibuliform.

Diameter 3.5, greatest alt. 1.7 mm.
" 5 " " 2.1 "

This species belongs to a widely spread group of the modern tropical American fauna.

Paleogeographic Results.

The species of *Hemisinus,* as of related genera, are river snails. They do not inhabit intermittent streams, ponds, or lakes, except as the latter may form part of a stream system; and they are equally unknown in brackish water. The occurrence of several well-differentiated species therefore implies the presence of rivers or permanent

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[5] *Tropicorbis* n. section, type *P. liebmanni* Dkr.

streams. Melanians are not likely to be distributed by adventitious means from stream to stream, as *Physa*, *Anodonta*, and some other fresh-water mollusks are. Their egg capsules are not gelatinous or likely to adhere to the feet of water fowl, but are firmly fixed to stones, shells, or the like. Wherever their distribution has been studied in detail, it has been found remarkably consistent and explicable by actual stream connections or such as have probably existed within the life of the species or group in question. As the relationships of the Antiguan species are with South America (*H. antiguensis*) and with Cuba (*H. siliceus*), it seems probable that (1) at the stage of the Oligocene when this bed was formed, a considerable land surface existed in the Antiguan area, and (2) that this area was, or had been, connected with the South American main.

It seems likely that the present *Hemisinus* species of Cuba and Jamaica are descendants of the same South American stock. There is in Cuba, however, another totally distinct genus of Melanians, *Pachycheilus*, represented by *P. nigrata* (Poey) and *P. violaceus* Prest. of the recent fauna, which are apparently traceable to a Central American connection.

The other fresh-water snails of the silex bed are not significant. The *Planorbis* belongs to a group widely spread in the recent Neotropical fauna and the "*Bythinella*" is an ambiguous form of unknown relationships.[6]

Explanation of Plate IX.

Figures 1, 3, 5, 6.—Slabs strewn with *Hemisinus antiguensis* n. sp. At the positions marked *a* are seen specimens of *Planorbis siliceus* n. sp., the type being 6 *a*.

Fig. 2.—*Hemisinus siliceus* n. sp.

Fig. 4.—*Hemisinus latus* n. sp.

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[6] The generic characters of the fresh-water Rissoids are often not expressed in the shell. A fossil form of simple structure cannot be located generically with any degree of certainty, unless in a region where the characteristics and affinities of the associated fauna have been thoroughly worked out.

TWO NEW SARCOSPORIDIA.

BY HOWARD CRAWLEY.

Sarcocystis leporum sp. n.

The material on which the present study is based consists of the arm and shoulder of a very old male rabbit shot at Bowie, Md., on December 13, 1913. The presence of *Sarcosporidia* in rabbits has been recorded from time to time in the literature, and there are four specimens of this parasite in the collection of the Zoological Division of the Bureau of Animal Industry, the localities of which were Maryland, Pennsylvania, New York, and Illinois. No description of the organism has ever been published, nor has it received a name. With regard to this latter point certain authors have of late assumed that the *Sarcosporidia*, like other parasites, are in the case of each species capable of dwelling in any one of several hosts, and there is a certain amount of experimental evidence that this is true. Nevertheless, in the event of a duplication of names, it is very easy to relegate one of them to synonymy, whereas it is extremely awkward to be obliged to refer to a parasite as the sarcosporidian found by a certain author in a certain animal from a certain locality on a certain date. Hence it seems best to make a new species, and I propose to call this parasite *Sarcocystis leporum.*

In the fresh tissue the parasitic cysts were visible as short, delicate threads or rods lying in the muscles. They were about two millimeters long, and the diameter measured in paraffin sections was from 200 to 250 microns. It may incidentally be mentioned, however, that the size of a sarcosporidian cyst is of no diagnostic value, since it is wholly a function of the age, and the cysts of this particular specimen were probably much under the possible maximum size.

Compared with the infestations seen in rats, mice, and ducks, that of the rabbit here under consideration was very slight, and a casual glance at the flesh would probably not have revealed anything amiss. Data as to how heavily rabbits may become infested are, however, wholly lacking.

The cysts, in paraffin sections, showed nothing noteworthy. The cyst wall was from 5 to 6 microns thick, and seen under low powers presented the typical striated appearance. Under high magnification, however (500 to 1000), it was easy to see that the wall was composed of a great number of papilliform processes, standing closely packed together upon a sort of basement membrane and with their outer ends wholly free. That is, the cyst wall, at least in this case, does not consist of a membrane pierced by pores, nor of a congeries of rods bounded both without and within by a membrane, but of rods or papillæ projecting freely from a basement membrane. Furthermore, in this case, there was nothing to show that any part of the cyst wall was derived from the surrounding host tissue.

As already stated, the papillæ rested upon a basement membrane with which they were apparently continuous. Within there was to be seen the structure usual for sarcosporidian cysts; that is, a division of the central space into compartments, the walls of which were a continuation of the membrane inclosing the cyst. Finally, in the central portions of the cysts there was a small area free of spores, and here the coarsely alveolar structure of the frame work could readily be seen. This is in itself an indication that these cysts were young rather than old, since it is a matter of common observation that in old cysts there is always present a central space of considerable extent in which there are no spores.

As is usual, the cysts were closely packed with spores which showed a certain disposition to be arranged in files, radiating from the centre to the periphery.

A study of the spores themselves revealed data of considerably greater interest. Several mounts were prepared by smearing out the contents of the cysts on slides, drying, fixing in absolute alcohol and staining in Giemsa. As thus prepared, the spores measured about 13μ long by 5μ wide, the precise figures for the average of 20 specimens measured being 13.14μ long by 5.16μ broad. The longest spore measured was 16μ long, the broadest 6μ wide. The figure given for the length, however, is a trifle too small, since the measurement was taken in a straight line, no allowance being made for the curvature. Furthermore, it is not unlikely that the fixed spores are too wide, since they are quite large enough to be flattened in the process of fixation.

The spores, although possessing the typical banana-shape, are not quite symmetrical, it being generally possible to distinguish between a narrower, more pointed and a broader, more rounded end. This narrower end, which may be regarded as anterior, is occupied by a very solid mass of homogeneous cytoplasm, which has but little affinity for the stain and contrasts very sharply with the deeply staining cytoplasm of the remainder of the spore. Thus, when viewed with powers of only 200 to 300, the spores show two very clear-cut oval areas, the nucleus in the posterior half and the differentiated area in front, and this latter is sometimes so faintly stained that the complete outline of the spore cannot be followed.

The clear region is sometimes oval, sometimes truncated behind, as shown in the figure. It may be spoken of as the rostrum of the spore. Behind it, the cytoplasm abruptly assumes the character which it possesses in the remaining portion of the spore where it is densely staining and conspicuously alveolar. It is to be noted, however, that the cytoplasm nearest the rostrum shows the coarsest alveoli, while backward the alveoli become smaller and smaller, so that in many cases the cytoplasm in the posterior half of the spore becomes very dense, on account of the excessive minuteness of the alveoli. In other cases, however, the alveoli are distinctly visible throughout the entire extent of the dense spongioplasm of the cell. At times, also, the spongioplasm encroaches somewhat upon the homogeneous cytoplasm of the rostrum, there being here visible one or more alveoli or one or more strands of spongioplasm. There is, finally, often to be seen one or two clearer regions in the cytoplasm between the rostrum and nucleus, but it is not believed that these represent morphological entities.

Spores of *Sarcocystis leporum*. × 3500.

Following the rule for the spores of *Sarcosporidia*, there is no membrane, the spores being naked masses of protoplasm.

The nucleus may occupy nearly any position in the cell, but it is usually placed near the posterior end. Although, as already stated, it stands out very clearly when the spores are viewed with rather low powers, it seems for the most part to be no more than a clear space in the cytoplasm, and it is only occasionally that a definitive nuclear membrane can be demonstrated. Within it is normally provided with a number of chromatin granules. These granules vary a good deal in size. At times they are quite minute and occur in clusters and chains. More frequently, however, they are quite large, round, or elongated, and appear to be wholly free in the nuclear sap. At times, also, there is a more or less typical chromatin net. Whereas these differences may have some significance, it is perhaps best to regard them merely as variants of some fundamental plan.

The spores of certain species of the *Sarcosporidia* which attack mammals are described and figured as being liberally provided with rather densely staining granules, concerning which there has been a good deal of theoretical discussion. Frequently, also, such spores have been described as showing a differentiated area at one end, and attempts have been made to correlate this area with the polar capsules of the spores of the *Myxosporidia*. In the case in hand, the spores of *Sarcocystis leporum*, there is at least no question about the structure, which is remarkably clear cut and perfectly obvious. And the rostrum of this spore, whatever may be its homologies, is clearly the analogue of the rostra of the sporozoites and merozoites of *Coccidia*. Moreover, it seems an entirely safe assumption that its function is to enable the spore to drill its way into the intestinal epithelium of its host, without prejudice as to whether this host be an invertebrate, another rabbit, or some carnivorous mammal or bird which preys upon the rabbit.

Sarcocystis setophagæ sp. n.

Stiles (1895 c)[1] notes that Dr. Hassall, of the Bureau of Animal Industry, discovered a sarcosporidian in the muscles of a redstart (*Setophaga ruticilla*), and a description of this parasite was promised at the time. This description, however, was never published, and the material, consisting of two cysts embedded in paraffin, was recently given to me by Dr. Hassall.

Based upon the number of sections yielded by the cysts, their length was about 2.5 mm., while the largest cross sections measured about 1 mm. in diameter. Hence the cysts are thick in proportion to their length, which seems characteristic for *Sarcosporidia* of birds. The cysts were divided into the usual compartments.

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[1] Stiles. 1895 c.—New American finds of Sarcosporidia (Notes on parasites. 28.) *Vet. Mag.*, Phila., v. 1 (11) (Nov., 1894), Jan. 17, pp. 728, 729.

Unfortunately, the material was not in good condition for cytological study, and very little could be made out as to the structure of the spores. As well, however, as could be determined, the form was that shown by the spore of *Sarcocystis rileyi*, that is, one end was rounded, the other pointed. The spores were sometimes straight, sometimes curved, but in the latter case the curvature was slight, which also seems characteristic for avian *Sarcosporidia*. Within, in a few of the better preserved specimens, it was possible to make out a vacuole in which was a chromatin granule. This structure is probably to be interpreted as a vesicular nucleus.

The spores were small, measuring from 4 to 5 microns long by .75 to 1.00 micron broad.

A NEW DIATOM.

BY CHARLES S. BOYER, A.M.

Chætoceros elmorei n. sp. Plate X.

Prof. C. J. Elmore, of Grand Island College, Nebraska, sent me recently a slide containing a form of *Chætoceros*. On first examination, the species appeared to resemble *C. wighamii* Br. On receipt, however, of material which was subjected to a closer examination, I have concluded that the species is new. The material had been dried upon blotting paper and it was necessary to soak it for a long while to secure filaments of the proper size, it being impossible, of course, to resort to the proper methods of cleaning. The character of the chromatophores is not known. I have, however, succeeded in mounting a number of slides which show quite clearly the structure of the valves and spores.

All species of the genus *Chætoceros* have heretofore been considered as marine, and have not been found inland except in the Caspian Sea. The species about to be described is found in Devils Lake, North Dakota.

It may be of interest to give a brief description of the locality from the *Second* and the *Sixth Biennial Reports of the State Geological Survey of North Dakota*, of the years 1903 and 1912, respectively. In the *Report* for 1903, from an article by Mr. E. J. Babcock, *Water Resources of the Devils Lake Region* (p. 208), and also from an article by Mr. Howard E. Simpson, *The Physiography of the Devils-Stump Lake Region*, in the *Report* for 1912 (p. 105), the following information is obtained:

Devils Lake is in Lat. 48° N., Long. 99° W. It is a glacial lake and "occupies a basin formed largely by morainic ridges." Its length is "about twenty-four miles, and the width averages, perhaps, between four and seven miles." It lies at an elevation of about fourteen hundred feet, and its greatest depth is not more than twenty-nine feet. No streams of any size enter the lake, its chief source of supply being the annual rainfall from the surrounding ridges, and it has no outlet. Although originally a large fresh-water lake, it is now much reduced in size, and its waters "may be termed alkaline and brackish, since they show a salinity of about one per cent., of which magnesium and sodium salts constitute a considerable portion."

The following is the diagnosis of the form:

Filaments straight, 23μ wide.

Cells rectangular with sharp angles; valves slightly convex; foramina narrowly linear, irregular, bipartite.

Setæ straight, hollow, approaching each other at an acute angle and crossing at a right angle near the corners of the valves, about ten times the length of the valve. In valve view they diverge from each other at an angle of about 80°.

Terminal setæ shorter than the others, somewhat curved in the direction of the filament.

Spores with the primary valve arcuate, secondary valve produced into a subconical frustum. Rarely in free spores the primary valve is covered with minute spines.

The valves are joined together near one side by a tubular commissure, from six-tenths to eight-tenths of a *micron* in thickness, situated near the edge of the valve, usually at unequal distances from each end, and, so far as noticed, is found near the margin on the same side of all valves in the filament.

The presence of the connecting tube and the unusual locality combine to render this form a unique species, which I take pleasure in naming after Prof. Elmore.

An examination of fig. II, *i* and *k*, in Plate III, in Schütt's article (*Ueber die Diatomeengattung Chætoceros, Bot. Zeitung,* 1888) offers an interesting suggestion as to the origin of the commissure. In the genus *Thalassiosira* the cells are connected by mucilaginous threads which are central. In the present species of *Chætoceros* the commissure is eccentric and appears to be tubular. In *C. simile* the valves touch each other, and in several species, such as *compactum,* the centre of the valve is produced or considerably elevated, but in no previously described form has the union of the frustules been consummated, except by the interlacing of the awns.

The other diatoms sparingly found in the waters of the lake include species of *Fragilaria, Gomphonema, Epithemia,* and *Surirella.* Owing to the presence of great quantities of small crustacea, the material is mounted with difficulty.

EXPLANATION OF PLATE X.

Fig. 1.—A short filament consisting of seven cells. The filaments usually contain twenty or more cells. In filaments showing the spores, the width is quite constant, but in vegetative cells the width varies considerably, many of them being much wider.

Fig. 2 shows the accidental separation of two adjacent cells and the division of the commissure.

Fig. 3 is a diagrammatic representation of the position of the commissure near one side of the cell. The valves are frequently in close contact in the middle, making the foramen bipartite.

Fig. 4.—Represents the usual position of the commissure, although the distance from the edge of the valve is somewhat variable. Sometimes the commissure is in the middle of the side, but more frequently nearer one end.

Fig. 5 is a valve view of the secondary valve as seen in the cell.

Fig. 6 shows a form rarely found of a free spore much more developed than the others and having the surface of the primary valve partly covered with spines, somewhat as in *C. wighamii* Br. Specimens of the latter in my collection, however, show spores which are smaller, more circular, and with the surface more evenly covered with spines.

Fig. 7 represents two adjacent cells, as frequently seen, containing spores with their secondary valves opposed.

The figures represent a magnification of 1,200 diameters.[1]

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[1] I am indebted to Mr. F. J. Keeley for sketches from which some of the drawings are made.

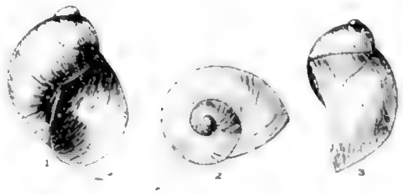
LAND AND FRESH-WATER SHELLS FROM EASTERN CANADA.

BY E. G. VANATTA.

The following species of shells were taken by Mr. Bayard Long while collecting plants in the Magdalen Islands and Prince Edward Island in the Gulf of St. Lawrence. The snail fauna seems to be the usual northern type with the addition of the European *Helix hortensis* Müll., *Hygromia hispida* L., and a new *Succinea* related to western American forms.

Succinea bayardi n. sp. Figs. 1, 2, 3.

Shell rather small, oval, globose, thin, polished, apex red, obtuse, body whorl translucent amber colored, with a few growth striæ, whorls about 2½, convex, rapidly increasing; suture impressed. Aperture more than half the altitude, very broadly oval, parietal callous, thin, outer and basal lips thin and evenly arched, columella very narrow below, expanded above into a translucent white fold.



Alt. 5.7, diam. 4.3, aperture alt. 3.8, diam. 2.8 mm.

Locality.—Indian River, Kensington, Prince Edward Island. Collected on August 29, 1912. The types are No. 106,651 in the collection of the Academy of Natural Sciences of Philadelphia.

This shell is very closely related to *Succinea oregonensis* Lea, but has a lower and more obtuse spire and is a smaller species. It differs from *Succinea chrysis* West by lacking the opaque streaks, is not green or reddish, and is smaller. I take pleasure in naming this shell after Mr. Bayard Long, the botanist, who collected it.

Helix hortensis Mull.

Nineteen specimens were collected at Basin Island near Coffin Id., Magdalen Islands, of which ten were the form 12345, two (12)345, one (123)(45), two (123)45, one 1(2345), one (12345), one 10305, and one 00000; at Grindstone, Grindstone Island, M. I., nine specimens were taken representing the following forms, four 12345, two 1(23)45, two (12)345, (123)45; four specimens from Alright Island, M. I., all are the form 12345. This species was collected at three locations on Prince Edward Island as follows, one form 12345 from Douglas, four 00000 from Souris and five 00000 from Bloomfield.

Hygromia hispida L.

Eight specimens were collected at Charlottetown, Prince Edward Island.

Pupilla muscorum L.

One specimen taken at Basin Island near Coffin Island, M. I.

Bifidaria pentodon Say.

Collected in alder thickets at Grindstone, M. I., and Tignish, Prince Edward Island.

Vertigo ovata Say.

Taken along a rill at Summerside and on knolls in alder thickets at Tignish, Prince Edward Island.

Vertigo ventricosa Morse.

Collected in woods on Basin Island off Coffin Island, M. I.; and in alder thickets at Tignish, Prince Edward Island.

Vertigo gouldi Binn.

Taken in the woods at Grindstone, Grindstone Id., M. I., and at Mt. Stewart, Prince Edward Island.

Columella edentula Drap.

Five specimens taken on Basin Id., M. I.

Acanthinula harpa Say.

One specimen found near Campbell's Pond, Darnley, Prince Edward Island.

Vallonia pulchella Müll.

One specimen taken in coniferous woods at Charlottetown, Prince Edward Island.

Cochlicopa lubrica Müll.

Plentiful in the woods on Basin Id., M. I., one specimen being very tall; also found in alder thickets at Grindstone, M. I., and at Tignish, Prince Edward Island.

Vitrina limpida Gld.

In a low wet calcareous woods on Basin Id., M. I.

Vitrea hammonis Ström.

Collected in a meadow and in alder thickets on Grosse Isle, M. I.; in the woods on Basin Id.; in the thickets and woods at

Grindstone, M. I.; and in the woods and thickets at the following places on Prince Edward Island: Bloomfield, near Campbell's Pond at Darnley, along the Indian River at Kensington, Mt. Stewart, Tignish, and around Lake Verde. One specimen from a wet birch woods at Lake Verde is so deficient in lime that the shell collapsed on drying.

Vitrea binneyana Morse.

Several specimens were taken in a rich wet thicket along a brook at Grindstone, Grindstone Id., M. I.

Striatura milium Morse.

Collected at Bloomfield, near Campbell's Pond at Darnley, and around Lake Verde, Prince Edward Island.

Striatura exiguum Stimp.

Collected on Basin Id., in the woods and thickets at Grindstone, M. I., and at Bloomfield and near Campbell's Pond at Darnley, Prince Edward Island.

Euconulus fulvus Müll.

Taken on Basin Id. and at Grindstone, M. I.

Zonitoides arborea Say.

Collected on Grosse Isle, Basin Id., at Grindstone, M. I., and on Prince Edward Island at Tignish, near Campbell's Pond at Darnley, and in Fullerton's Marsh at Bunbury.

Agriolimax agrestis L.

Collected at Bloomfield, on Brackley Point Road near Charlottetown, Charlottetown, and near Campbell's Pond at Darnley, Prince Edward Island.

Arion circumscriptus Johns.

Taken at Charlottetown, Prince Edward Island.

Pyramidula cronkhitei anthonyi Pils.

Collected on Grosse Isle; Basin Id.; East Cape, Coffin Id.; at Grindstone, Grindestone Id., M. I.; at Bloomfield, near Campbell's Pond at Darnley, along Indian River at Kensington, and Tignish, Prince Edward Island.

Pyramidula (Planogyra) asteriscus Morse.

Several specimens taken in thickets at Grindstone, M. I., and one at Bloomfield, Prince Edward Island.

Helicodiscus parallelus Say.

In the woods and thickets on Basin Id., at Grindstone, M. I., and at Bloomfield and around Lake Verde, Prince Edward Island.

Punctum pygmæum Drap.

Collected in thickets at Grindstone, M. I., and along Indian River, at Kensington, Prince Edward Island.

Succinea ovalis Say.

Was collected at Basin Island, M. I.; Etang du Nord on Grindstone Id., M. I.; between Brackley Point and Charlottetown, also at Bloomfield on Prince Edward Island.

Succinea retusa Lea.

Was taken in a larch swamp on Grindstone Island, M. I.; and at North Lake and Tignish on Prince Edward Island.

Succinea avara Say.

One specimen found in a larch swamp on Grindstone Island, M. I.

Succinea bayardi n. sp.

On grass stems in a salt marsh just above the water along Indian River, Kensington, Prince Edward Island.

Planorbis trivolvis Say.

East Point Ponds and ponds east of East Cape, Coffin Island; Grand Tracadie and Dundee, Prince Edward Island.

Planorbis antrosus Conr.

Was taken at Moncton, New Brunswick, Canada.

Planorbis exacutus Say.

From a brook in a meadow, Grindstone Island, M. I.

Planorbis deflectus Say.

Was taken at East Point Ponds and ponds east of East Cape, Coffin Id.; Etang du Nord and in two brooks on Grindstone Id., M. I.; North Lake, Black Pond, Lower Sea Cow Pond, Tignish, stream between Brackley Point and Charlottetown, and in a brook at Charlottetown, Prince Edward Island.

Planorbis parvus Say.

Was collected at Etang du Nord, Grindstone Id.; pools near the Narrows, Alright Id., M. I.; Lake Verde and in a stream between Brackley Point and Charlottetown, Prince Edward Island.

Lymnæa palustris Müll.

Was collected in ponds east of East Cape, Coffin Id.; Etang du Nord, Hospital Pond and nine other pools on Grindstone Island, M. I.; North Lake, Grand Tracadie. Bloomfield, Fullerton's Marsh at Bunbury, Dundee, Lower Sea Cow Pond at Tignish, in a stream between Brackley Point and Charlottetown, Hillsborough River at

St. Andrews, and below the mill pond at Southport, Prince Edward Island.

Lymnæa humilis modicella Say.

Was taken at Etang du Nord, Grindstone Island, M. I.

Physa gyrina Say.

East Point Ponds and ponds east of East Cape, Coffin Island; Etang du Nord and several small pools on Grindstone Island, M. I.; Black Pond, Tignish, East Lake at Bothwell, Dundee, stream between Brackley Point and Charlottetown, in a brook at Charlottetown, below the mill pond at Southport, Prince Edward Island; Moncton, New Brunswick.

Carychium exiguum Say.

In a swampy alder thicket at Grindstone and in a larch swamp on Grindstone Island, M. I.; on knolls in an alder thicket at Tignish, Prince Edward Island.

Pisidium abditum Hald.

Was collected on Grosse Isle; in ponds east of East Cape, Coffin Id.; Etang du Nord, Grindstone, Grindstone Id., M. I.; and at Charlottetown, Prince Edward Island.

Pisidium variabile Prime.

Was found in pools near The Narrows, Alright Id., M. I., and in a pond at Tignish, Prince Edward Island.

Anodonta cataracta Say.

Was collected in the stream above Adams' Pond at Darnley, Prince Edward Island.

April 21.

Mr. Charles Morris in the Chair.

Eleven persons present.

The Publication Committee reported the receipt of contributions to the Proceedings under the following titles:

"Two new Sarcosporidia," by Howard Crawley (March 18, 1914).

"A new diatom," by Charles S. Boyer, A.M. (March 21).

"Land and fresh-water shells from eastern Canada," by E. G. Vanatta (March 21).

"Montana shells," by E. G. Vanatta (March 25).

"The vascular system of the Florida alligator," by Albert M. Reese (March 27).

"The method of progression in Truncatella," by Henry A. Pilsbry and Amos P. Brown (April 11).

"List of land and fresh-water mollusks of Antigua," by Henry A. Pilsbry and Amos P. Brown.

The deaths of the following members were announced:

Charles Sumner Williamson, March 23, 1914.
George E. Kirkpatrick, March 26, 1914.
Curwen Stoddart, Jr., April 1, 1914.
Ernest Comly Dercum, April 10, 1914.

The Council reported that Messrs. John Cadwalader, Charles B. Penrose, Witmer Stone, and J. Percy Moore had been appointed to constitute the Standing Committee on By-Laws.

On the unanimous nomination of the Committee on the Hayden Memorial Geological Award, the gold Hayden Memorial Medal was conferred on Henry Fairfield Osborn, Sc.D., LL.D., in recognition of his distinguished work in vertebrate palæontology.

Henry Fairfield Osborn was born at Fairfield, Conn., August 8, 1857. He was educated at Princeton College (1877, 1880), Cambridge University under Balfour (1879), and the Royal College of Science under Huxley (1879–80). He has received the following degrees: Princeton A.B. 1877, Sc.D. 1880; Hon. LL.D. Trinity College 1901, Princeton 1902, Columbia 1907; Hon. D.Sc. Cambridge 1904; Hon. Ph.D. Christiania 1911, Upsala 1913.

Dr. Osborn began his palæontological explorations in Wyoming in 1877, and has continued them to the present time in various parts of the United States, in Europe and Egypt. From 1877 to 1890 he was connected with the Princeton University expeditions and the Museum of Geology, and between 1891 and 1914 he has directed the American Museum explorations in vertebrate palæontology.

His own researches and those of his students fill five volumes of papers from the American Museum *Memoir* and *Bulletin*. His publications and papers in vertebrate palæontology embrace 197 titles, including *Evolution of Mammalian Molar Teeth,* published in 1907, and *The Age of Mammals,* published in 1910, beside the American Museum volumes above referred to. They cover contributions to the history of the extinct fishes, reptiles, and mammals. Dr. Osborn succeeded Edward D. Cope as Vertebrate Palæontologist of the Geological Survey of Canada between the years 1900–1904. In 1900 he was appointed successor to Othniel C. Marsh as Vertebrate Palæontologist of the United States Geological Survey, and is still engaged on the series of palæontological monographs which were left unfinished by Marsh, especially those on the titanotheres and the Sauropoda.

Among the most important of his investigations are the following: the evolution of the ungulate foot, the evolution of the types of molar teeth of the mammals, the evolution of the perissodactyl ungulates, especially the rhinoceroses, horses, and titanotheres, the correlation of the Tertiary geological horizons of Europe and North America, the principles of the evolution of the skull in mammals, and the laws of evolution as observed in palæontology.

Dr. Osborn's administration of the Department of Vertebrate Palæontology in the American Museum of Natural History has been instrumental in assembling the most extensive collection of vertebrate fossils in existence, including the complete vertebrate fauna of more than half of the Tertiary horizons of the West and the complete phyletic evolution of many of the most important types of mammals. This administration has been notable also in establishing the American Museum as a training school in vertebrate palæontology from which have issued many of the leading vertebrate palæontologists of the younger generation in this country and abroad. There have been corresponding advances in palæontological technique and the educational methods of palæontology, so that the fossil collections in the American Museum have become a standard for the same work in other institutions.

In addition to these palæontological and geological activities Dr. Osborn has held many educational and administrative positions, including the professorship of comparative anatomy at Princeton (1883–1900) and the professorship of zoölogy at Columbia University (1891–1914). Since 1890 he has been instrumental in the development of the American Museum of Natural History and the founding and development of the New York Zoological Park. His contributions on the administration of the Museum and the Zoological Park number twenty-six titles.

His total contributions to science cover a broad field, embracing in the 390 titles beside vertebrate palæontology researches and addresses on zoölogy, embryology, neurology, psychology, odontology, zoogeography, geology, biology, antropology, biography, and education.

The Chair announced the following elections:

MEMBERS:

William J. Davis.
Arthur W. Sheaffer.
John S. Sharp.

CORRESPONDENTS:

Shibasaburo Kitasato, M.D., of Tokyo, Japan.
Charles T. Ramsden, of Guantanamo, Cuba.
Marie Curie, of Paris.
N. Charles Rothschild, of London.
Gerritt S. Miller, of Washington, D. C.
Edmund Heller, of Washington, D. C.
Charles W. Richmond, of Washington, D. C.
Frank M. Chapman, of New York.
Edgar A. Mearns, of Washington, D. C.

The following were ordered to be printed:

FISHES FROM THE RUPUNUNI RIVER, BRITISH GUIANA.

BY HENRY W. FOWLER.

In the fall of 1912 the Academy received a collection of freshwater fishes from the Rupununi River, in the highlands of British Guiana. The specimens were purchased from Mr. J. Ogilvie, who collected them during the same year and in 1911. Mr. Ogilvie informs me, in lieu of the name of any settlement or town, they were approximately secured in North Latitude 2° to 3°, and West Longitude 50° 20′. A number are apparently new or undescribed, while others are not only new records for the Rupununi, but also for Guiana as well. The figures are all drawn to scale, each number over the accompanying line signifying millimeters.

SELACHII.

DASYATIDÆ.

Potamotrygon hystrix (Müller and Troschel).

One young fœtal example. Color pale uniform brown. Six papillæ on floor of mouth. Body mostly smooth, without prickles or warts. Length 145 mm., disk width 60 mm.

TELEOSTOMI.

OSTEOGLOSSIDÆ.

Osteoglossum bicirrhosum Agassiz. Fig. 1 (young).

One 273 mm. Also three young with yolk-sacs still adherent. According to Mr. Ogilvie, this fish carries its young in its mouth until they wholly absorb the yolk and they are able to fend for themselves.

CHARACIDÆ.

CURIMATINÆ.

Curimatus cyprinoides (Linnæus).

One example, which agrees with my Ambyiacu River examples in the absence of gill-rakers, and with my figure.[1]

Dr. Eigenmann rightly corrects my use of *Curimata*[2] to the present

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[1] *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 301, fig. 6.

[2] *Amer. Nat.*, XLI, 1907, p. 768.

form, as I overlooked Oken, though he wrongly identifies[3] the examples I recorded as *Psectrogaster ciliatus* within the genus *Curimatus*.

They are undoubtedly members of the genus *Psectrogaster*, as their spinescent scales show, and cannot be identified with the diagnosis he gives for the species *Curimatus ciliatus*, and this after he had examined the type of *Anodus ciliatus* Müller and Troschel in Berlin. If this species is found identical with *Curimatus cyprinoides* (Linnæus), this latter name will, of course, supersede. Contrary to my arrangement in 1906, I now believe my Ambyiacu and Upper Amazon specimens to belong to *Psectrogaster amazonicus* Eigenmann and Eigenmann.

Subgenus CYPHOCHARAX Fowler.

Back not elevated, but upper profile nearly straight from above eye to near dorsal. Scales large, 36 or less in lateral line, and in nearly even longitudinal series.

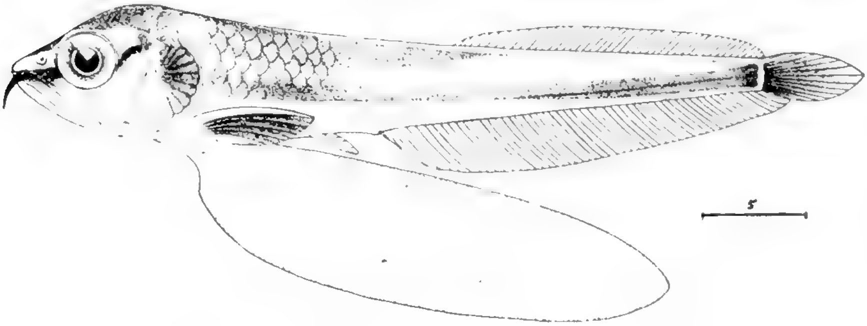

Fig. 1.—*Osteoglossum bicirrhosum* Agassiz. (Young.)

This diagnosis is recast, as the species I identified with the designated type is certainly different.

Curimatus spilurus Günther.

One example 93 mm.

CHILODINÆ.

Chilodus labyrinthicus rupununi subsp. nov. Fig. 2.

Head $3\frac{3}{5}$; depth $3\frac{1}{4}$; D. IV, 9, I; A. IV, 7, I; P, I, 14; V, I, 8; scales 27 in l. l. to caudal base, and 4 more on latter; 5 scales above l. l.; 4 scales below l. l. to ventral origin; 3 scales below l. l. to anal origin; about 8 predorsal scales; head width $1\frac{1}{2}$ its length; head depth at occiput $1\frac{1}{3}$; snout 3; eye $3\frac{1}{5}$; maxillary $3\frac{1}{4}$; interorbital $2\frac{1}{4}$; first

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[3] *Mem. Carnegie Mus.*, V, 1912, p. 269.

branched dorsal ray trifle longer than head; first branched anal ray $1\frac{3}{4}$ in head; pectoral $1\frac{1}{2}$; ventral $1\frac{1}{5}$.

Body elongate, robust, moderately compressed, and deepest at dorsal origin. Predorsal with slight or obsolete keel just before dorsal origin, other edges of body all convex, and that of preventral broad and flattened, or only very obsolete keel or ridge along outer boundaries. Lower profile evenly convex. Caudal peduncle compressed, small, about long as deep.

Head robust, somewhat pyramidal, upper surface slightly depressed, and lower broadly convex, convex sides not especially converging below. Upper profile slightly convex, less inclined than lower. Snout broadly triangular as seen from above, surface convex, and length about half its width. Eye large, circular, high, and a little anterior in head. Adipose-eyelid broad, exposes most of very broad pupil. Mouth small, terminally inferior, and seen below transversely crescentic. Upper jaw with single series of small weak filament-like teeth, none in lower jaw. Maxillary small, upper edge slips below preorbital, and slightly expanded distal end reaches opposite posterior nostril. Mandible small, shallow, each ramus well elevated inside mouth. Tongue well back, large, depressed, free. Nostrils well developed, superiorly lateral, together, in last third of snout length, anterior with well-developed cutaneous rim

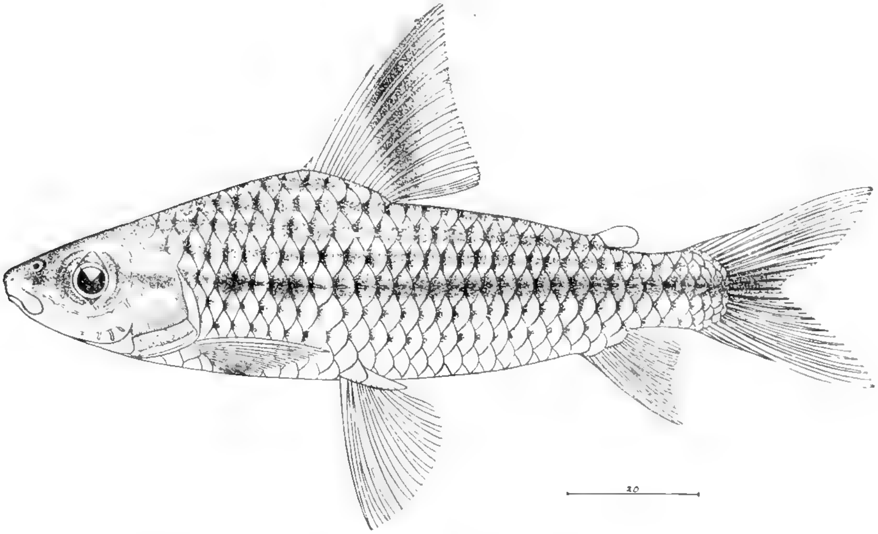

Fig. 2.—*Chilodus labyrinthicus rupununi* Fowler. (Type.)

and posterior exposed as crescent. Interorbital broad, flattened. Infraorbital large, covers most of cheek, surface with radiating striæ. Opercle striate, and subopercle projects moderately posteriorly, both with striate surfaces. Occipital fontanel well developed, extends forward nearly to front of eyes.

Gill-opening extends forward for last third in head. Gill-rakers about 10 + 20 weak flexible filaments, about $\frac{1}{3}$ length of gill-filaments, and outer series separated by high cutaneous or cartilaginous partition. Gill-filaments about 2 in eye. Isthmus broad. Branchiostegals with inner shortest and outer longest.

Scales large, firm, well exposed, in regular horizontal series, entire, and more or less uniform except smaller ones on caudal base. Surface of exposure of each scale pitted or with variously shaped shallow cavities, not interfering with general smoothness to touch. Long pointed free scaly flap in axil of ventral. Lateral line complete, midway along side, of simple tubes and each opening by pore at middle of scale exposure.

Dorsal origin midway between that of adipose fin and snout tip, first branched ray longest with fourth simple but slightly shorter, and fin depressed slightly more than half way to caudal base. Adipose fin inserted about midway between depressed dorsal tip and caudal base, fin small. Anal inserted slightly before adipose fin, first branched ray longest, lower edge of fin slightly emarginated, and when depressed reaches caudal base. Caudal well forked, lobes broad, apparently (damaged) equal. Pectoral low, pointed, reaches about $\frac{9}{10}$ to ventral, and latter inserted behind second branched dorsal ray base, reaches $\frac{2}{3}$ to anal. Vent close before anal.

Color in alcohol largely pale brownish, ground color mostly uniform. Above lateral line four lengthwise deeper brownish bands; upper three, together with additional median dorsal band, much broader than lower ones, and each extending over median portions of scales. L. l. in a broad underlaid pale slaty to dusky band, not quite equal to pupil diameter in width, and extending posteriorly out on median rays of caudal to their tips. Each scale in dark longitudinal bands, besides those in l. l. and for most of extent of two lengthwise series of scales below l. l., with deep dusky-brown spot formed at its base. Dark median lateral band of trunk continued on head across opercle and in front to snout tip. Head brown above, pale like belly below. Eye slaty. Above pectoral in course of dark lateral band two ill-defined dusky spots, subequal, and each about long as pupil. Fins all pale or whitish in general tint, though dorsal with broad vertical dusky band, slightly narrowing below, and upper posterior edge of fin slightly dusky. Caudal, except as stated above, pale and uniform. Adipose fin pale brownish. Lower fins all pale or whitish.

Length 136 mm. (caudal tips damaged).

Type, No. 39,306, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Only the type known. This differs from *Chilodus labyrinthicus* (Kner)[4] in coloration, that species having but one blackish spot above the depressed pectoral fin.

(Named for the Rupununi River.)

HEMIODONTINÆ.

Hemiodus semitæniatus Kner.

One example 83 mm. long (caudal tips damaged), agrees with Kner's account. The depth ($4\frac{1}{2}$) is probably due to age, as all the other characters are in accord. The scales (according to the pockets) are 55 in l. l. to caudal base and 3 more on latter, besides 9 above l. l. Eigenmann identifies examples from Konawaruk and Gluck Island with this species,[5] though they are likely wrongly so called, as they show the depth 4 to $4\frac{1}{2}$ and the scales 44 or 45 in l. l., with only 7 above.

Hemiodus quadrimaculatus Pellegrin.

Two examples, one 115 mm. and the other 32 mm.

Anisitsia notata (Schomburgk).

One 147 mm. long and another 157 mm.

PYRRHULININÆ.

Pyrrhulina filamentosa Valenciennes.

One 70 mm. Eigenmann mentions "adipose brick-red," certainly an error if referring to an adipose fin.[6]

NANNOSTOMINÆ.

Characidium blennioides Eigenmann.

One example 47 mm. (caudal damaged).

Characidium fasciadorsale sp. nov. Fig. 3.

Head $3\frac{4}{5}$; depth $5\frac{1}{4}$; D. III, 8; A. III, 7; P. III, 8; V. I, 8; scales 34 in lateral line to caudal base and 2 more on latter; 5 scales above

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[4] *Microdus labyrinthicus* Kner, *Denk. Ak. Wiss. Wien*, XVII, 1859, p. 149, Pl. 3, fig. 5. Rio Branco and Barra do Rio Negro.

[5] *Mem. Carnegie Mus.*, V, 1912, p. 276, Pl. 36, fig. 3.

[6] *L.c.*, p. 279.

l. l.; 3 scales below l. l. to ventral origin; 3 scales below l. l. to anal origin; 9 scales before dorsal; head width $2\frac{1}{6}$ in its length; head depth at occiput $1\frac{1}{2}$; snout 4; eye $3\frac{2}{5}$; maxillary $4\frac{2}{5}$; interorbital $4\frac{1}{4}$; length of dorsal 1; least depth of caudal peduncle $2\frac{1}{2}$; upper caudal lobe $1\frac{1}{16}$; pectoral 1; ventral $1\frac{1}{5}$.

Body elongate, slender, moderately compressed, greatest depth at dorsal origin, profiles similar and edges rounded. Caudal peduncle well compressed, least depth about $1\frac{3}{4}$ its length.

Head attenuated, compressed, flattened sides but scarcely converging below, upper profile convex and lower concave. Snout conic, protruding slightly, compressed, long as broad. Eye rounded, little longer than deep, high and slightly anterior. Mouth small, transverse. Teeth small, invested with membrane, conic, simple, pointed. Maxillary small, free, well inclined, reaches midway in space between front and hind nostrils. Tongue depressed, free in front. Mandible shallow in front, and rami well elevated inside mouth. Nostrils well separated, anterior about midway in snout length, and posterior close before front eye edge, both simple pores. Preorbital triangular, length about $\frac{3}{5}$ of eye. Interorbital broadly convex. Infraorbitals narrow. Opercle moderate, surface smooth. Subopercle extended posteriorly and with broad cutaneous flap.

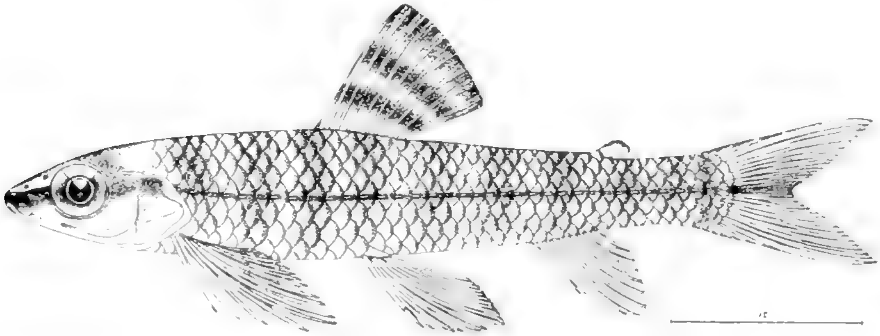

Fig. 3.—*Characidium fasciadorsale* Fowler. (Type.)

Gill-opening extends forward about opposite hind edge of pupil. Gill-rakers about 4 + 10? short weak points, about $\frac{1}{3}$ length of filaments and latter about $2\frac{1}{2}$ in eye. Isthmus moderately broad. Branchiostegals moderate.

Scales mostly uniform in size, in even longitudinal series parallel with l. l., well exposed, and each showing about six horizontal striæ on exposures. Ventral axilla with rather short pointed free scaly flap. L. l. complete, midway along side, and of simple tubes which at first extend half way over exposure of scale and posteriorly about three-quarters.

Dorsal origin about midway between snout tip and end of adipose fin, first branched ray highest, extends almost as far posteriorly as tip of last, and depressed fin reaches but slightly less than half way to caudal base. Adipose fin small, inserted about midway between end of depressed dorsal and caudal base. Anal inserted close behind depressed dorsal tip, and fin extends about two-thirds to caudal base. Caudal well forked, sharply pointed lobes about equal. Pectoral pointed, with median rays longest, and fin reaches almost to ventral origin. Ventral inserted about opposite middle of dorsal base, fin reaches four-fifths to anal. Vent close before anal.

Color in alcohol with very pale brown ground color, scarcely paler below. A narrow brownish lateral band, about equal to diameter of pupil in width on head, though on trunk reduced to narrow line, extends from snout tip to caudal base where it ends in small detached dusky spot. Head pale brownish above, whitish or paler beneath. Lips and front half of maxillary dusky, though posterior half of maxillary contrasted pale or whitish like lower surface of head. Eye slaty. Trunk with ten transverse deep brownish bands, a little broader than interspaces, and within area of each edge of each scale deeper brown. Dorsal and caudal dull grayish, with at least three transverse or horizontal dusky streaks across former. Pectoral, ventral and anal pale and uniform. No dark median dorsal streak.

Length 47 mm.

Type, No. 39,307, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Also Nos. 39,308 and 39,309, same data, paratypes. These show: Head $3\frac{2}{5}$ and $3\frac{4}{5}$; depth 5 and $5\frac{1}{2}$; D. III, 9 and III, 7; scales 32 ? (injured) in l. l. to caudal base and about 3 more on latter; 5 scales above l. l.; 3 scales below l. l. to anal origin; 9 predorsal scales; snout $4\frac{2}{5}$ and 4; eye $3\frac{1}{4}$ and $3\frac{1}{2}$; maxillary 4 and $4\frac{1}{8}$; interorbital $4\frac{1}{4}$ and 4; length 35 and 42 mm., respectively. The smaller example differs from the others in having the pectoral extending slightly beyond the ventral origin and the latter fin reaching the anal origin.

This species is related to *Characidium etheostoma* Cope[7] in coloration, but is much more slender, thus approaching *Characidium*

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[7] *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 323, fig. 17. Type.

catenatum Eigenmann.[8] From the latter it differs chiefly in the dark horizontal cross-bands on the dorsal fin, that species being figured and described as having a uniform dorsal.

(*Fäscia*, streak; *dorsalis*, of the back; with reference to the streaked dorsal fin.)

ANOSTOMINÆ.

Leporellus vittatus (Valenciennes).

Two examples, one 195 mm. and the other 126 mm. Compared with the example from the Peruvian Amazon,[9] I find they differ only according to age. I cannot find that the species has been recorded from Guiana previously. The following notes may be of value: Head $3\frac{3}{7}$; depth $4\frac{1}{2}$; D. III, 9, I or III, 10, I; A. III, 8, I; scales 37 to 39 in l. l. to caudal base and 4 or 5 more on latter; 6 scales above l. l.; 5 scales below l. l. to anal origin; 11 predorsal scales; snout $2\frac{1}{3}$ in head; eye 5 to 6; maxillary 3 to $3\frac{1}{2}$. In color these examples show a dark or dusky spot on each scale of sides and back. Dark spots on head large and irregular on front and snout, small and less numerous on cheek and opercle. Dorsal with large broad distal blackish blotch, and another blackish streak transversely subbasally. Broad dark lateral band includes l. l. and extends out on median caudal rays to their tips. Each caudal lobe with two blackish transverse horizontal bars. Adipose fin pale, lower edge blackish. Other fins pale, ventrals and anal with median dusky shade.

Anostomus anostomus (Linnæus).

Three examples, 81 to 85 mm. (caudals damaged).

Leporinus nigrotæniatus (Schomburgk).

Five examples, 142 to 190 mm.

Leporinus friderici (Bloch).

One example 210 mm. in length, and a smaller one 120 mm. long.[10]

Leporinus alternus Eigenmann.

Two examples, 70 to 73 mm. in length. The only point at variance in the original account is the statement "four graduated, obliquely-pointed teeth in each jaw," my examples, however, showing eight teeth in each jaw.

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[8] *Mem. Carnegie Mus.*, V, 1912, p. 293, Pls. 38, figs. 5–6. Warraputa, Rockstone and Crab Falls.

[9] *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 327.

[10] The Parahyba example which I identified with *Salmo fasciatus* Bloch, in *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 328, I feel certain is identical with *Leporinus conirostris* Steindachner, *Sitz. Ak. Wiss. Wien*, LXXI, I, 1875, p. 233, Pl. 4.

Leporinus paralternus sp. nov. Fig. 4.

Head $3\frac{7}{8}$; depth $4\frac{1}{8}$; D. iii, 10, i; A, iii, 8; P. i, 16; V. i, 8; scales 36 in lateral line to caudal base, and 3 more on latter; 6 scales above l. l.; 5 scales below l. l. to ventral origin; 5 scales below l. l. to anal origin; 13 predorsal scales; head width 2 in its length; head depth at occiput $1\frac{2}{3}$; snout $2\frac{1}{4}$; eye $4\frac{1}{2}$; maxillary 4; interorbital 3; first branched dorsal ray $1\frac{1}{5}$; first branched anal ray $1\frac{3}{5}$; upper caudal lobe 1; least depth of caudal peduncle $2\frac{1}{2}$; pectoral $1\frac{1}{2}$; ventral $1\frac{1}{2}$.

Body moderately long and slender, compressed, deepest at dorsal origin, and edges all convexly rounded. Caudal peduncle well compressed, about long as deep.

Head rather conic, compressed, sides flattened slightly though about evenly curving over above and below. Snout elongate, conic, long as broad. Eye rounded, a little high, centre about midway in head. Adipose-eyelid very slight. Mouth small, nearly terminal, or but slightly inferior, so that upper jaw only protrudes very little. Maxillary moderately inclined, small, extends a little beyond anterior nostril, though not to posterior. Lips thick, fleshy, entire. Eight teeth in each jaw, graduated forward to median which are longest, and all ending in a point on cutting-edge. Inner buccal membrane above quite broad. Tongue little distinct. Mandible shallow in front, short rami well elevated in mouth. Anterior nostril lateral, in small cutaneous tube reaching back nearly to posterior, which latter simple and about last $\frac{2}{5}$ in snout length, also lateral. Interorbital evenly convex. Suborbitals of moderate width. Preopercle

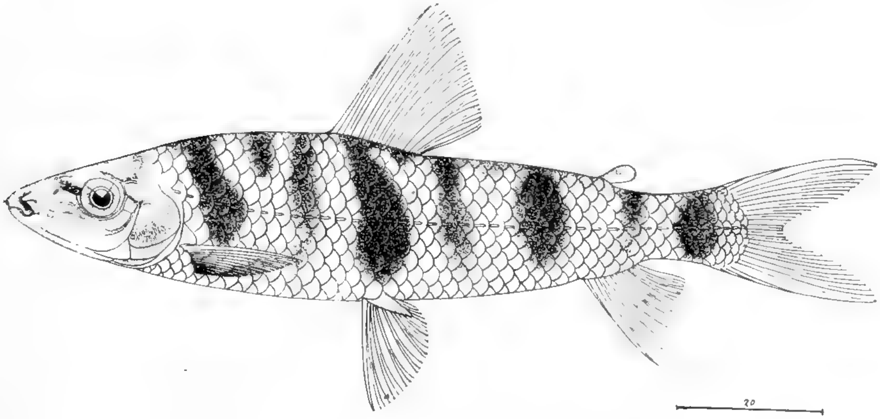

Fig. 4.—*Leporinus paralternus* Fowler. (Type.)

edge inclined forward. Opercle moderately large, with a few radiating striæ on its lower edge.

Gill-openings lateral, extend forward about opposite hind preopercle edge. Gill-rakers about 11 + 9 points, about 3 in gill-filaments, and latter $1\frac{1}{3}$ in eye. Isthmus broad. Branchiostegals large, subequal.

Scales large, well exposed in longitudinal series parallel with l. l., more or less uniform in size, though a little smaller on breast and caudal base. Scales ensheath bases of dorsal and anal, though not extending on the fins. Ventral with free pointed axillary scale trifle less than half length of fin. Lateral line complete, midway along side, extends on caudal base, and formed of simple tubes extending well over scales.

Dorsal origin a little nearer hind edge of adipose fin than snout tip, first branched ray longest, and depressed fin extends $\frac{3}{7}$ to caudal base. Anal inserted well behind depressed dorsal, first branched ray longest and reaches caudal base. Caudal well forked, pointed lobes equal. Adipose fin about $\frac{4}{5}$ of eye, inserted about midway between caudal base and hind edge of depressed dorsal fin. Pectoral small, low, extends $\frac{4}{7}$ to ventral origin. Ventral inserted behind second branched dorsal ray base, fin extending trifle more than half way to anal origin. Vent at last third in space between depressed ventral tips and anal origin.

Color in alcohol largely pale uniform brownish above, below, or on belly and abdomen, paler and whitish. Head brownish above, sides and below paler. Lips pale. Iris slaty. Trunk with nine dusky to blackish transverse cross bands, of which first or that just after occiput, fourth or that below dorsal, seventh or that just before adipose fin, and last at caudal base, broader or much more expanded than others. Second intermediate, also fifth intermediate transverse streaks entirely dorsal and only extend down each side half way to lateral line. Fins all pale or uniform, dorsal and caudal slightly darker, and adipose fin with a little grayish.

Length 120 mm.

Type, No. 39,320, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Nos. 39,321 to 39,323, paratypes, same data. Head $3\frac{1}{2}$ to $3\frac{2}{3}$; depth 4 to $4\frac{1}{4}$; D. III, 10, I; A. III, 8, I; scales 36 or 37 in l. l. to caudal base and 3 or 4 more on latter; 6 scales above l. l.; 5 scales below l. l.; 13 predorsal scales; snout $2\frac{2}{5}$ to $2\frac{1}{2}$ in head; eye 4 to $4\frac{1}{8}$; maxillary $4\frac{1}{4}$ to $4\frac{2}{3}$; interorbital 3; length 75 to 82 mm. These examples all agree with the type in the constancy of their color patterns.

The present species is distinguished from its ally, the preceding, by the presence of an extra black streak before the dorsal.

(*Para*, near; *alternus*, alternate, the related species.)

MYOCHARAX subgen. nov.

Type *Leporinus desmotes* sp. nov.

Differs from the subgenus *Anostomus* in the dentition, that of the mandible being composed of two long slender curved rodent-like incisors, and also two somewhat similar though much shorter ones externally and well back. Upper jaw with six tricuspid incisor-like teeth. Anterior nostrils in rather long cutaneous tubes.

One species, described below.

(*Μυς*, mouse; *χάραξ*, Charax; with reference to the rodent-like teeth.)

Leporinus desmotes sp. nov. Fig. 5.

Head 4; depth $4\frac{2}{3}$; D. III, 10, I; A. III, 8, I; P. I, 16; V. I, 9; scales 35 in lateral line to caudal base and 6 more on latter; 6 scales above l. l.; 5 scales below l. l. to ventral origin; 5 scales below l. l. to anal origin; 13 predorsal scales; head width 2 in its length; head depth at occiput $1\frac{1}{2}$; snout $2\frac{1}{3}$; eye 4; maxillary 4; interorbital $2\frac{1}{3}$; first branched dorsal ray 1; first branched anal ray $1\frac{2}{7}$; least depth of caudal peduncle $2\frac{3}{4}$; upper caudal lobe $1\frac{1}{8}$?; pectoral $1\frac{2}{5}$; ventral $1\frac{1}{4}$.

Body elongate, compressed, tapers somewhat posteriorly, deepest at dorsal origin, anterior upper profile rather evenly convex, and edges all convexly rounded. Caudal peduncle compressed, about long as deep.

Head rather small, compressed, somewhat conic, surfaces rather conic, and profiles similarly straight and inclined. Snout conic, broad, length $\frac{4}{5}$ its width, and as seen from above rather acuminate. Eye rounded, lateral, and centre falls trifle behind middle in head length. Adipose-eyelid narrow, best developed anteriorly. Mouth small, inferiorly terminal. Maxillary with thick integument, well inclined and reaches trifle over half way to eye or about opposite front edge of posterior nostril. Lips thick and fleshy. Upper lip broader, with two series of fleshy lamellæ, of which outer show much deeper clefts, are longer, though more vaguely defined externally. Lower lip peculiar, with deep-cleft narrow fleshy lobe each side leaving broad symphyseal surface, this crowned with seven or more series of lamellæ, each deeply cleft and therefore distinct, besides each lamella being broken up transversely into as many small apical papillæ. Teeth of upper jaw quite different from those in lower, 6 in number, though each rather indistinctly tricuspid median cusp much better defined, and outer tooth of each side a little smaller than subequal inner ones. Lower teeth developed as two long slender upward-curved pointed teeth, and basally though well back on each side another similar, much shorter and inconspicuous tooth, apparently less firm in its socket. Mouth with very broad upper buccal membrane, its surface finely papillose. Tongue not determined. Mandible short, rami not especially high. Anterior nostril lateral, in conspicuous and somewhat bell-shaped cutaneous tube equal to half of eye-diameter in length, and protruded beyond edge of upper lip. Posterior nostril lateral oblique slit, formed about last $\frac{2}{5}$ in snout length about opposite eye centre. Interorbital broadly convex. Suborbitals moderate in width. Hind edge of preopercle slopes forward. Opercle moderate, smooth.

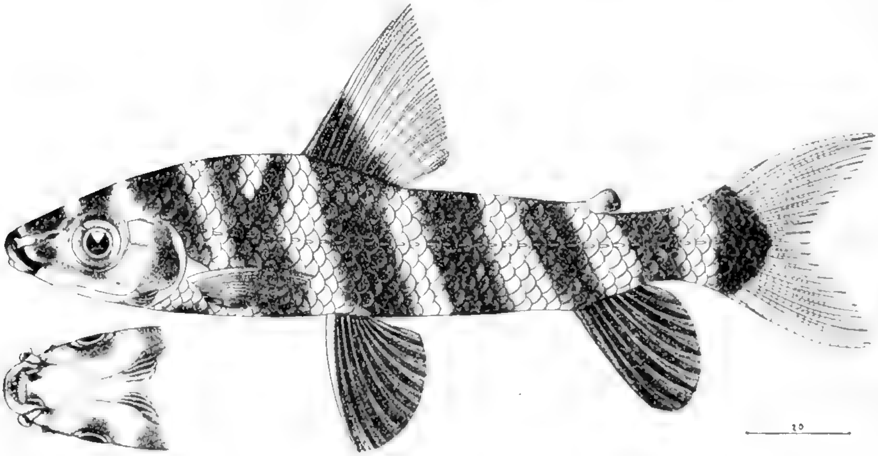

Fig. 5.—*Leporinus desmotes* Fowler. (Type.)

Gill-opening restricted, extends forward only about last sixth in head. Gill-rakers 8 + 11 rather short broad firm points, trifle over $\frac{1}{3}$ in gill-filaments and latter slightly exceeding half an eye-diameter. Isthmus rather broad and convex. Branchiostegals 4, rather broad, moderate, subequal.

Scales large, well exposed, slightly smaller on breast and predorsal region, though much more so on caudal base, otherwise uniform, and disposed in longitudinal series parallel with l. l. Scaly sheaths at dorsal and anal bases low, allowing movements of fins, though not extending on their surfaces. Ventral with free pointed axillary scaly flap, nearly 3 in length of fin. L. l. complete, nearly straight, and tubes simple, extending well over first half in scale exposures.

Dorsal origin midway between snout tip and hind basal edge of adipose fin, first branched ray longest or extends back well beyond tips of last, and fin reaches but trifle less than half way to caudal base. Adipose fin inserted little nearer depressed dorsal tip than caudal base, and length about equals eye. Anal inserted trifle before adipose fin, first branched ray longest, and fin reaches trifle beyond caudal base. Caudal large, well forked, broad pointed lobes about equal. Pectoral low, pointed, reaches about $\frac{7}{8}$ to ventral. Latter inserted behind first branched dorsal ray base, fin large, and reaches $1\frac{2}{3}$ to anal origin. Vent nearly at first third in space between depressed ventral and anal origin.

Color in alcohol generally pale brownish or whitish, marked by ten very conspicuous well-defined slaty-black transverse bars, those on trunk meeting their opposite sides and sloping slightly posteriorly. On head lower surface pale and dark bars reflected slightly across. Lips pale or whitish. Iris slaty. First dark bar includes upper edge of snout, extends down along maxillaries and then across lower surface of mandible posterior to symphyseal papillæ, and its width much less than any of the other bars. Second dark bar close behind, and of moderate width, bridges lores over upper surface of snout. Third dark bar extends over interorbitals and also reflected on infraorbital. Fourth dark bar extends from occiput, includes opercles and pectoral root. Fifth dark bar slightly forked above and below, midway in predorsal. Sixth dark bar includes dorsal base anteriorly and ventrals. Seventh dark bar postdorsal and postventral in position. Eighth dark bar wholly before adipose fin, extends to front half of anal. Ninth dark bar includes adipose fin and caudal peduncle. Tenth dark bar includes caudal base. Except for such intrusion as noted, all fins of whitish color generally.

Length 170 mm. (caudal tips damaged).

Type, No. 39,324, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Nos. 39,325 to 39,327, paratypes, same data. Head $3\frac{3}{7}$ to $3\frac{3}{4}$; depth $3\frac{3}{4}$ to 4; D. iii, 10, i; A. iii, 8, i; scales 33 to 35 in l. l. to caudal base and 3 or 4 more on latter; 6 scales above l. l.; 5 scales below l. l.; 12 or 13 predorsal scales; snout $2\frac{2}{7}$ to $2\frac{1}{2}$ in head; eye $3\frac{3}{4}$ to $4\frac{1}{3}$; maxillary $4\frac{1}{5}$ to 5; interorbital $2\frac{2}{5}$ to $2\frac{1}{2}$; length 105 to 149 mm. Only comparatively slight individual variation is noticed in these examples. One example also has an additional lesser external mandibular tooth on the right side, only very inconspicuous.

(Δεσμώτης, prisoner, with reference to the dark cross-bands suggestive of convict garb.)

Schizodon fasciatus Agassiz.

One example 170 mm.

TETRAGONOPTERINÆ.

Tetragonopterus argenteus Cuvier.

One example 78 mm.

Tetragonopterus chalceus Agassiz.

Two examples, one 80 mm. and the other 97 mm.

Astyanax rupununi sp. nov. Fig. 6.

Head 4; depth $2\frac{4}{5}$; D. III, 8, I; A. III, 28, I; P. I, 12; V. I, 7; scales 35 in lateral line to caudal base and 3 more on latter; 8 scales above l. l.; 6 scales below l. l. to ventral origin; 7 scales below l. l. to anal origin; 13 predorsal scales; head width $1\frac{9}{10}$ in its length; head depth 1; first branched dorsal ray 1; first branched anal ray $1\frac{2}{7}$; least depth of caudal peduncle $2\frac{1}{3}$; pectoral $1\frac{1}{6}$; ventral $1\frac{1}{2}$; snout 4 in head measured from upper jaw tip; eye $2\frac{4}{5}$; maxillary $2\frac{3}{7}$; interorbital $2\frac{2}{3}$.

Body elongately ovoid, well compressed, deepest at dorsal origin, and edges all rounded convexly except median predorsal ridge, which slightly trenchant. Caudal peduncle compressed, length about equals least depth.

Head small, compressed, lower profile little more inclined than upper, and flattened sides not converging above or below. Snout convex, length about $\frac{3}{5}$ its width. Eye rounded, placed about first $\frac{2}{5}$ in head. Mouth very slightly inclined, transverse, broad, terminal. Maxillary inclined vertically, free, extends back to front eye edge and greatest expansion $3\frac{1}{4}$ in eye. Lips firm, rather thin. Upper jaw teeth biserial, outer series smaller and tricuspid, and inner series of larger mostly quincuspid, in all cases median cusp much largest. Mandibular teeth quincuspid, large, powerful and uniserial. At least one of teeth extending from inner upper series on inner base of maxillary, though tooth quite small and obsolete. Mandible very slightly protrudes, strong, and rami scarcely elevated inside mouth. Tongue depressed, rounded, and free in front, rather broad. Inner buccal folds broad. Nostrils together, anterior simple pore with hind cutaneous rim exposing larger posterior aperture in crescent, and anterior falls about last third in snout length. Interorbital evenly convex. Infraorbital broad, covers cheek, with few radiating striæ, and its width $\frac{3}{4}$ of eye-diameter. Hind preopercle edge nearly vertical. Opercle narrow, with a few obsolete striæ, and its width trifle less than $\frac{1}{3}$ its length.

Gill-opening forward to front eye edge. Gill-rakers about 10 + 13, slender, tapering, pointed, and slightly shorter than gill-filaments, which latter about half of eye. Isthmus narrow, constricted, surface rounded though with median groove in front. Branchiostegals moderate, subequal.

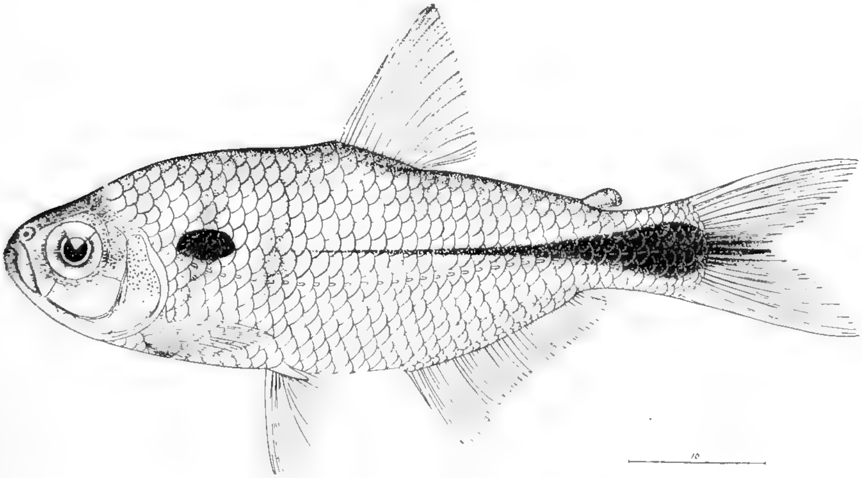

Fig. 6.—*Astyanax rupununi* Fowler. (Type.)

Scales disposed in even longitudinal series parallel with l. l., mostly uniform in size except those variably smaller along predorsal, breast, preventral, postventral, caudal base and along anal base. Ventral with free scaly pointed axillary flap about $\frac{2}{5}$ length of fin. L. l. complete, decurved slightly below median axis, and extending up a little low along side of caudal peduncle at first. Tubes simple, and better exposed in posterior course of l. l.

Dorsal origin midway between snout tip and caudal base, first branched ray longest, extends back well beyond tips of last, and depressed fin reaches half way to caudal base. Adipose fin inserted little nearer depressed dorsal tip than caudal base, and its length about $\frac{2}{3}$ of eye. Anal with long base, inserted below last branched dorsal ray base, first branched ray longest equals half length of base, and lower edge nearly straight. Caudal well forked, pointed lobes about equal. Pectoral low, pointed, reaches slightly beyond ventral origin, though not back till opposite dorsal origin. Ventral inserted midway between pectoral and anal origins, reaches back $\frac{3}{4}$ to anal. Vent at tip of depressed ventral.

Color in alcohol largely dull brownish on back and upper surface of head. Sides of head and trunk paler than back, and becoming still more so, or whitish, on ventral region. All scales of back and sides with darker brownish edges, made up of dark dots. Sides of head, opercle, postorbital and muzzle sprinkled with larger dusky dots. Iris slaty. Slightly above level of eye centre, just above l. l., and about opposite middle in length of pectoral, a blackish ellipsoid blotch, its length about equal to eye. From its upper front end and its entire hind end a pale area extends transversely as two ill-defined pale or whitish spots, posterior much greater in extent. Extending back along vertebral axis a dusky line begins behind pale area and continues back along caudal peduncle side, where it widens, to expand still more at caudal base into large dusky or blackish blotch, and also reflected out on median caudal rays to their tips. Fins all whitish, dorsals and caudal tinged grayish. Distal edge of anal its whole extent slightly tinged grayish.

Length 64 mm.

Type, No. 39,228, A. N. S. P. Rupununi River, British Guiana. 1912. J. Ogilvie.

No. 39,329, paratype, same data. Head $3\frac{4}{5}$; depth $2\frac{5}{6}$; D. III, 9; A. IV, 26, I; scales 36 in l. l. to caudal base and 3 ? more on latter; 7 scales above l. l.; 7 scales below l. l. to ventral origin; 8 scales below l. l. to anal origin; 14 predorsal scales; snout 4 in head; eye 3; maxillary $2\frac{1}{3}$; interorbital $2\frac{4}{5}$; length 62 mm.

This species appears to be related to *Astyanax wappi* (Valenciennes), as described from the type by Eigenmann.[11] It differs in the smaller head, deeper body, and larger eye. There are, however, no "traces of longitudinal streaks between the rows of scales."

(Named for the Rupununi River.)

Mœnkhausia chrysargyrea leucopomis subsp. nov. Fig. 7.

Head $3\frac{4}{5}$; depth $1\frac{9}{10}$; D. III, 9; A. IV, 26, I; P. I, 13; V. I, 7; scales 34 in lateral line to caudal base and 2 ? more on latter (squama-

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[11] *Mem. Carnegie Mus.*, V. 1912, p. 355, Pl. 52, fig. 1.

tion injured); 8 scales above l. l.; 7 scales below l. l. to ventral origin; 8 scales below l. l. to anal origin; 9 scales before dorsal to posterior end of occipital process; head width 2 in its length; head depth at occiput 1; snout $3\frac{5}{6}$; eye 3; maxillary $2\frac{2}{5}$; interorbital $2\frac{3}{5}$; first branched anal ray $1\frac{3}{5}$; least depth of caudal peduncle $2\frac{1}{4}$; pectoral $1\frac{1}{5}$; ventral $1\frac{1}{2}$.

Body deep, well compressed, rather ovoid, predorsal and postdorsal with slight median ridge, and other edges convex, except slight ridge each side along abdomen before ventral, most distinct just before latter. Greatest depth at dorsal origin. Caudal peduncle well compressed, and its length about $\frac{3}{4}$ its least depth.

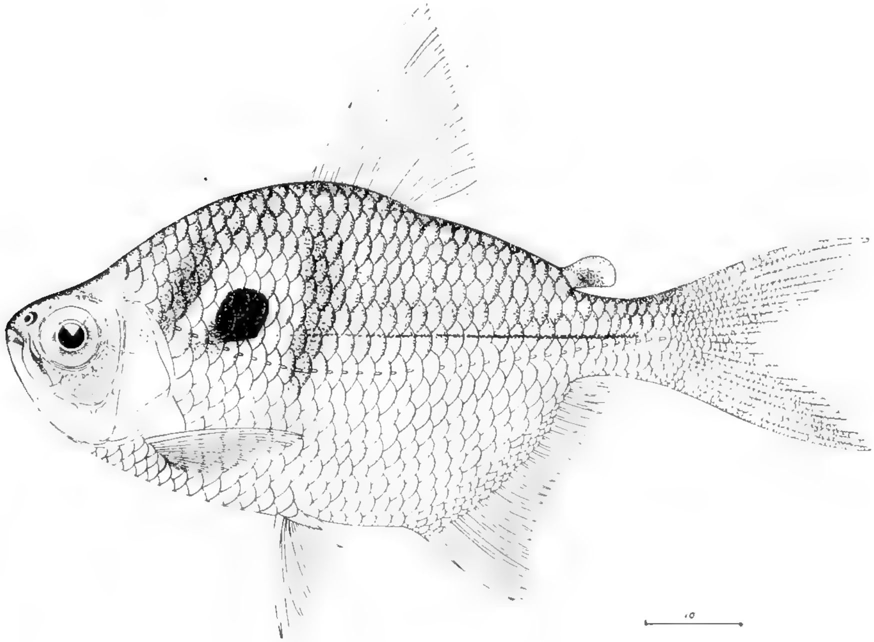

Fig. 7.—*Mœnkhausia chrysargyrea leucopomis* Fowler. (Type.)

Head deep, well compressed, lower profile more inclined than upper, which latter nearly straight from snout front to occiput. Flattened head sides very slightly converging below. Snout convex over surface and in profile, broadly convex as seen from above and length about half its width. Eye rounded, placed about first $\frac{2}{5}$ in head. Adipose-eyelids slightly developed in front and behind. Mouth broad, terminal, about level with upper rim of pupil. Lips thick, fleshy, firm. Jaws about even when closed, mandible scarcely projecting. Maxillary vertically inclined, extends back slightly beyond front eye edge, and its greatest expansion a little less than 3 in eye. Teeth in upper jaw biserial, quincuspid, though those in inner series larger and apparently continued on inner base of each maxillary as a small single tooth. Mandible with uniserial quincuspid teeth, median largest and lateral ones very small posteriorly. Tongue broad, depressed, rounded and free in front. Inner buccal folds broad. Mandible strong, convex over surface, and rami not elevated inside mouth. Nostrils together, anterior simple pore with cutaneous flap behind exposing posterior in crescent, and frenum would fall about last fourth in snout length. Interorbital evenly convex. Posterior infraorbital broad, covers all of cheek except lower narrow strip, rather obscurely striate, and its greatest width $\frac{2}{3}$ of eye. Postorbital narrow. Hind preopercle edge nearly vertical, sloping slightly forward below. Opercle deep and narrow, and surface nearly smooth. A long occipital fontanel begins opposite front pupil rim and extends up within occipital process well towards its tip.

Gill-opening forward opposite front edge of eye. Gill-rakers about 9 + 12, slender, lanceolate, about $\frac{2}{3}$ length of gill-filaments, and latter $1\frac{2}{3}$ in eye. Isthmus narrowly constricted, surface convex, and with slight groove in front. Branchiostegals moderate, subequal.

Scales mostly large and well exposed, disposed in longitudinal series parallel with l. l., and each one with a number of radiating striæ, about 8 usually exposed. Scales become a little smaller along anal base, and two or three series extend over latter, at least on anterior part of fin. Scales of small size over most of caudal, at least its greater basal portion. Free axillary pointed ventral scaly flap, its length $\frac{2}{5}$ of fin. L. l. complete, slightly decurved, running a little low along side of caudal peduncle at first, and simple tubes extend about first $\frac{2}{3}$ over exposures of scales.

Dorsal inserted about midway between hind edge of adipose fin and snout tip, first branched ray longest, and depressed fin extends $1\frac{3}{4}$ to caudal base. Adipose fin inserted much nearer depressed dorsal tip than caudal base, its length about equal to eye. Caudal well forked, pointed lobes about equal. Anal inserted opposite last dorsal ray base, with slight elevated lobe in front. Pectoral slender, pointed, low, reaches slightly beyond ventral origin. Ventral inserted slightly before dorsal insertion, and depressed fin about reaching to anal origin. Vent at last third in space between ventral and anal origins.

Color in alcohol largely pale brownish, upper or dorsal region very slightly darker, and lower surface paler. Head brownish above, paler below. Lips pale brown. Eye slaty. Level with upper part of eye, or on vertebral axis, a blackish humeral blotch, a little deeper than wide, and distant from head 5 scales. All about humeral blotch a pale area, best understood on examining figure. Several scales posterior a narrow dusky streak begins and runs along vertebral axis, and though gradually enlarging to caudal base, not forming spot on latter. Fins all pale or whitish, dorsal and caudal tinged with grayish.

Length 95 mm.

Type, No. 39,330, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

No. 39,331, paratype, same data. Head $3\frac{5}{6}$; depth 2; D. III, 9; A. IV, 23, I; scales 33 in l. l. to caudal base, and 2 more on latter 8 scales above l. l.; 6 scales below l. l. to ventral origin; 7 scales below l. l. to anal origin; 10 predorsal scales; snout 4 in head; eye $3\frac{1}{10}$; maxillary $2\frac{3}{5}$; interorbital $2\frac{3}{4}$; length 95 mm.

Apparently a form of *Mœnkhausia chrysargyrea* (Günther),[12] though it is incompletely described. No mention is made of the pale area surrounding the humeral blotch, and the dark posterior lateral vertebral streak. That this color pattern should have resulted from preservation originally in formaline may be likely in the first case, though less so in the last.

(*Λευκὸς*, white; *ἐπωμὶς*, shoulder.)

Gymnocorymbus nemopterus sp. nov. Fig. 8.

Head $3\frac{4}{5}$; depth $1\frac{2}{3}$; D. IV, 9, I; A. IV, 32, I; P. I, 11; V. I, 7; scales 33 in l. l. to caudal base and 2 more on latter; 10 scales above l. l.; 10 scales below l. l. to anal origin; 12 predorsal scales; head width $1\frac{7}{8}$ its length; head depth at occiput 1; snout 4 in head, measured from upper jaw tip; eye $2\frac{2}{5}$; maxillary $2\frac{7}{8}$; interorbital $2\frac{1}{2}$; least depth of caudal peduncle 2; first branched anal ray $1\frac{1}{3}$; pectoral 1; ventral $1\frac{1}{2}$.

Body deeply ovoid, compressed, upper anterior profile double concave, and lower profile much more bulging. Body edges constricted, though not trenchant, and greatest depth at dorsal origin. Caudal peduncle well compressed, its length about half its least depth.

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[12] *Tetragonopterus chrysargyreus* Günther, *Cat. Fish. Brit. Mus.*, VII, 1868, p. 328. Essequibo.

Head small, compressed, upper profile slightly concave from snout to occiput, lower profile a little more inclined, and flattened sides but very slightly constricted below. Snout convex over surface and in profile, broadly convex as viewed from above, and its length about half its width. Eye rounded, placed about first $\frac{2}{5}$ in head. Adipose-eyelid little developed, only extends on eye a little in front and behind. Mouth broad, shallowly cleft, and latter falling on level with upper edge of pupil. Maxillary nearly vertical, reaches opposite front of eye, slender, and greatest expansion about $\frac{1}{3}$ of eye.

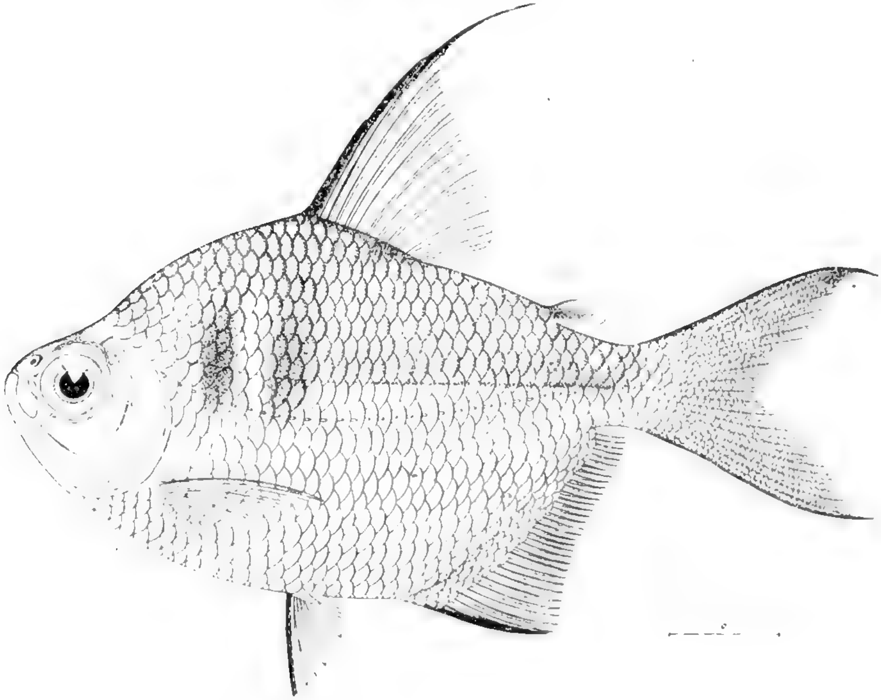

Fig. 8.—*Gymnocorymbus nemopterus* Fowler. (Type.)

Lips firm, moderate. Mandible, when closed, very slightly protruding, and moderate rami not elevated in mouth. Upper teeth biserial, quincuspid, and inner row larger. No maxillary teeth. Teeth in lower jaw uniserial, median largest, and similar to upper teeth. Tongue broad, depressed, free, and rounded in front. Nostrils together, anterior circular and its hind cutaneous rim exposes larger posterior in crescent with its frenum falling over front eye edge. Interorbital evenly convex. Posterior infraorbital broad, leaves but very narrow naked strip below, scarcely striate, and its width $\frac{3}{5}$ of eye. Hind preopercle edge vertically inclined or sloping slightly forward. Opercle narrow, deep, smooth, upper hind edge scarcely emarginate.

Gill-opening extends forward opposite front pupil edge. Gill-rakers about $10 + 15$, lanceolate, slender, sharp-pointed, about $\frac{2}{3}$ in gill-filaments, and latter 2 in eye. Isthmus narrowly constricted, surface convex. Branchiostegals rather small, broad, subequal.

Scales well exposed, large, and disposed in series parallel with l. l. Caudal base and good portion of lobes, also anal base, covered with smaller scales. Each exposure of scale shows about 8 to 10 radiating striæ. Ventral with short free pointed axillary scaly flap about $\frac{1}{3}$ in length of fin. L. l. complete, slightly decurved or bending down till about midway in greatest depth, and formed of simple tubes, each extending over about first $\frac{2}{3}$ of scale exposure. From occiput to origin of dorsal a narrow median naked strip, over which none of scales pass.

Dorsal origin a little nearer snout tip than caudal base, last simple ray longest and its tip prolonged into a filament extending back far as adipose fin. Latter inserted much nearer caudal base than last dorsal ray base, and fin length trifle less than eye. Caudal well forked, pointed lobes about equal. Anal inserted nearly opposite last branched dorsal ray base, first branched ray longest, though anterior rays not forming lobe. Pectoral broad, pointed, reaches back about opposite first third in depressed ventral. Ventral inserted about opposite dorsal origin and depressed fin extends $\frac{7}{8}$ to anal origin. Vent at last $\frac{2}{5}$ in space between ventral and anal origins.

Color in alcohol largely pale brownish, whitish on sides and below. Head dull brownish above, sides and below whitish. Iris slaty. A dull brownish vertical ill-defined humeral blotch, about third scale from head on vertebral axis and posterior 3 scales, also another less distinct one. Both these blotches with white intermediate area in front. From second dark blotch a narrow dusky vertebral line extends back towards caudal base, though ends abruptly before latter. Throughout its course it gradually expands and finally results in a spot on the side of caudal peduncle. Fins all pale and all more or less tinged with grayish. Front edges of dorsal, anal, and especially ventral, dusky. Adipose fin dusky. Median dark streak down back.

Length 80 mm.

Type, No. 39,332, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Also Nos. 39,333 to 39,336, paratypes, same data. Head $3\frac{1}{2}$ to 4; depth $1\frac{3}{4}$ to 2; D. III, 9, I; A. IV, 31, I or IV, 32, I; scales 34 in l. l. to caudal base and 2 more on latter; 9 scales above l. l.; 11 scales below l. l.; usually 13 predorsal scales, sometimes 14; snout $3\frac{3}{4}$ to 4 in head; eye $2\frac{2}{5}$ to $2\frac{3}{4}$; maxillary $2\frac{2}{3}$ to $2\frac{7}{8}$; interorbital $2\frac{1}{2}$ to $2\frac{4}{5}$; length 50 to 76 mm.

Related to *Gymnocorymbus thayeri* Eigenmann,[13] and agrees as far as the short account allows. The long produced anterior or first branched dorsal ray and dark ventral and anal edges would appear to be distinguishing characters.

(*Νῆμα*, thread; *πτερόν*, fin; with reference to the first branched dorsal ray.)

BRYCONINÆ.

Brycon falcatus Muller and Troschel.

Three examples, 118 to 137 mm.

Chalceus labrosus Schomburgk is imperfectly described, though likely identical. The figure is less satisfactory.

Chalceus macrolepidotus Cuvier.

Two examples, 150 to 157 mm. They differ slightly from *Pellegrinina heterolepis* Fowler.[14] The latter has shorter pectorals, a broader snout, dusky fins, nearly even jaws, pectoral reaches beyond ventral origin, and adipose eyelid absent, etc. The erroneous locality was doubtless due to the mixing of collections in the Academy from West Africa and Surinam or some other part of South America. I shall therefore admit the nominal *Pellegrinina* as identical, following Regan.

STETHAPRIONINÆ.

Ephippicharax orbicularis (Valenciennes).

Head $3\frac{4}{5}$ to 4; depth 2 to $2\frac{2}{5}$; D. III, 9, I; A. V, 31, I to V, 33, I; scales 32 to 35 in l. l. to caudal base and 2 more on latter; 10 scales above l. l.; 10 or 11 scales below l. l. to anal origin; 9 predorsal scales forward to hind end of occipital process; snout $3\frac{3}{4}$ to 4 in head, measured from upper jaw tip; eye $2\frac{1}{8}$ to $2\frac{1}{2}$; maxillary $2\frac{2}{5}$ to $2\frac{3}{5}$; interorbital $2\frac{1}{3}$ to $2\frac{1}{2}$; length of three examples 50 to 66 mm.

CHALCINÆ.

Chalcinus angulatus (Agassiz).

Head $3\frac{4}{5}$; depth $2\frac{3}{4}$; D. III, 8, I; A. III, 26, I; scales 32 in l. l. to caudal base, and 3 more on latter; 6 scales above l. l.; 2 scales

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[13] *Bull. Mus. Comp. Zool.*, 1908, p. 93. Amazons, from Tabatinga to Gurupa.

[14] *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 442, fig. 39.

below l. l. to ventral origin, and 3 to anal origin; predorsal scales 14, counted forward to hind end of occipital process; snout 4 in head, measured from upper jaw tip; eye $3\frac{2}{3}$; maxillary 3; interorbital 3; gill-rakers 16 + 34; length 143 mm. This example differs slightly from others in the collection I previously studied in the slightly curved dorsal profile. Compared with the type of *Triportheus flavus* Cope, it shows few scales above l. l., and shorter pectoral, this not reaching tip of ventral, or scarcely beyond dorsal origin.

SERRASALMINÆ.

Serrasalmus gymnogenys Günther.

One example 130 mm.

Serrasalmus rhombeus (Linnæus).

One example 148 mm.

Pygocentrus piraya (Cuvier).

One example 158 mm.

Pygocentrus scapularis (Günther).

One example 160 mm.

Pygopristis denticulatus (Cuvier).

Two examples, 85 and 112 mm. Each show about twelve darker vertical streaks on side of back, though last two which are on caudal peduncle anteriorly and on caudal base larger and darker. Upper sides also with a number of small dark brown spots, obscure and rather irregular. Both specimens infested with psorosperms, especially smaller.

MYLINÆ.

Catoprion mento (Cuvier).

Two examples, 90 to 135 mm.

Mylophus rubripinnis (Müller and Troschel).

Two examples, 105 to 175 mm.

CYNODONTINÆ.

Cynodon gibbus Spix.

One example 220 mm.

CHARACINÆ.

Exodon paradoxus Müller and Troschel.

Two examples, 98 and 118 mm.

XIPHOCHARAX gen. nov.

Type *Xiphocharax ogilviei* sp. nov.

Premaxillary with pair of small approximated or median canines, two smaller canines at distal end of each bone, and all smaller teeth entirely uniserial. Mandible with three canines on each ramus, and these graduated to external, which largest. Maxillary with single series of fine small teeth and without canines. Clavicle notched. Lower angle of preopercle ends in spine directed down posteriorly. Chéeks naked.

Related to *Acanthocharax* Eigenmann, and *Heterocharax* Eigenmann, but differs in the above characters. One species.

(*Ξιφος*, sword; *Χαραξ*, Charax; with reference to the long canines.)

Xiphocharax ogilviei sp. nov. Fig. 9.

Head 4; depth $3\frac{1}{5}$; D. III, 8, I; A. V, 38, I; P. I, 16; V. I, 7; scales 78 in l. l. to caudal base and 6 more on latter; 26 scales in vertical series between dorsal origin and l. l.; 18 scales between anal origin and l. l.; 53 scales between dorsal origin and hind end of occipital process; head width $1\frac{9}{10}$ in its length; head depth at occiput $1\frac{1}{5}$; mandible $1\frac{4}{5}$; first branched dorsal ray $1\frac{1}{5}$; least depth of caudal peduncle 3; ventral $1\frac{5}{6}$; first branched anal ray $2\frac{1}{4}$; snout $3\frac{4}{5}$ in head, measured from upper jaw tip; eye $3\frac{1}{8}$; maxillary $1\frac{9}{10}$; interorbital $3\frac{2}{3}$.

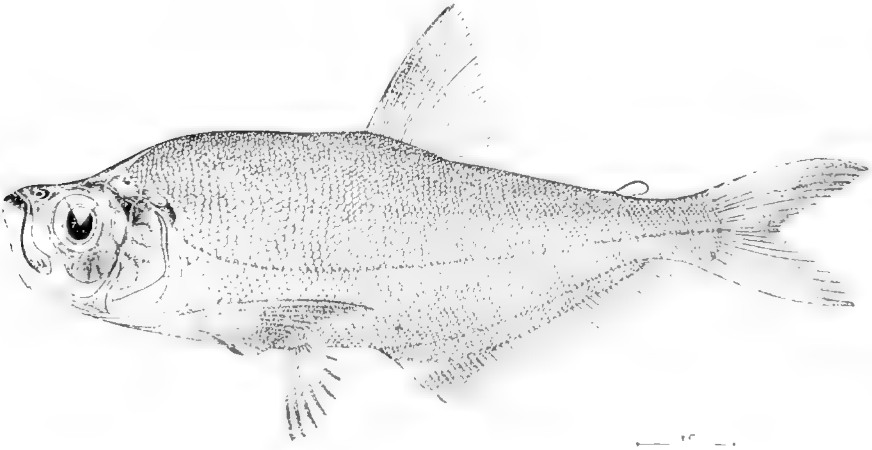

Fig. 9.—*Xiphocharax ogilviei* Fowler. (Type.)

Body elongate, greatly compressed, form elongately ovoid with greatest depth at ventral origin, edges all convexly rounded with breast broad and depressed and postventral well constricted. Caudal peduncle well compressed, its length about $\frac{3}{4}$ its least depth.

Head large, deep, well compressed, though flattened sides not constricted above or below, upper profile concave and lower bulges convexly into much greater inclination from mandibular articulation. Snout convex in profile and over surface, length about half its width, and broadly convex as viewed from above. Eye large, high, a trifle deeper than wide, and placed about first $\frac{2}{5}$ in head, measured from upper jaw tip. Pupil vertically ellipsoid, large. Adipose-eyelid slightly developed in front and behind. Mouth large, superior, broad. Maxillary vertical, extends down well below lower eye edge, only lower portion exposed, which shows many deep vertical striæ, and greatest expansion $2\frac{3}{4}$ in eye. Lips firm, rather thin. Upper jaw with a general series of small equal simple conic teeth, extending on maxillaries nearly to their hind or lower end. Upper jaw teeth interrupted in premaxillary region by 4 equally spaced enlarged simple conic canines, of which inner pair slightly larger and obsoletely barbed. Mandible with 6 large conic barbed canines, and each outer one largest. Innermost pair of mandibular teeth smallest, though separated slightly more than those medianly in upper jaw, also smaller than latter. On sides of mandibular rami a few equal small obscure conic teeth, these also continued irregularly in places, as behind symphysis in an inner series. Inner buccal folds broad. Tongue broad, depressed, rounded and well free in front. Mandible large, well protruded in front, powerful, and rami moderately elevated in mouth. Nostrils together, anterior simple pore with cutaneous hind edge exposing larger posterior in crescent, frenum formed about level with upper eye edge. Interorbital broadly convex. Preorbital narrow and long. Infraorbital a little shorter than preorbital elements, covers greater part of cheek, surface with radiating striæ, its width about half its length and latter about equals eye. Preopercle ridge and hind edge inclined well forward, and latter ends in broad strong pointed spine projecting obliquely down posteriorly. Opercle deep, upper hind edge scarcely emarginated, smooth, except deep transverse median groove. Bony exposure of shoulder-girdle with fine striæ, and deeply notched to receive base of pectoral fin. Suprascapula entire, small. Occipital and parietal fontanels long and distinct. Occipital process extends back opposite hind edge of exposed shoulder-girdle.

Gill-opening extends forward opposite front eye edge. Gill-rakers III 3 + 10 II, strong, lanceolate, and $2\frac{3}{4}$ in gill-filaments, which latter about 2 in eye. Isthmus broadly convex, constricted in front. Branchiostegals large, subequal, broad.

Scales small, narrowly imbricated, disposed in longitudinal series parallel with l. l., and in transverse series sloping obliquely forward.

Scales on back all reduced in size and crowded. Caudal base and anal base covered with small scales. No scaly axillary flaps. L. l. complete, extends as decurved a little below middle in greatest depth and sloping up low along side of caudal peduncle to caudal base medianly. Tubes of mostly simple structure, though ends in posteriorly downward directed prong.

Dorsal inserted a little nearer caudal base than snout tip, first branched ray longest, and depressed fin reaches $2\frac{1}{5}$ to caudal base. Adipose fin small, its length $1\frac{3}{4}$ in eye, and its origin nearer caudal base than depressed dorsal tip. Caudal (damaged) slightly emarginate and lobes apparently equal? Anal inserted slightly before middle of dorsal base, anterior rays slightly longer than others, and fin base not quite twice dorsal length. Pectoral broad, low, inserted slightly behind gill-opening, and reaches back apparently to anal (tip damaged). Ventral inserted a little nearer anal origin than pectoral origin, and fin about reaches latter. Vent about last fourth in space between ventral and anal origins.

Color in alcohol dull brownish on back, becoming paler below and on abdomen. Head brownish above, sides and below pale or whitish. Front of lips tinged brownish. Iris slaty. Fins all pale brownish, mostly with more or less dusky tints.

Length 210 mm. (caudal damaged).

Type, No. 39,337, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Only the above example known. In the figure, the ends of the fins are restored in some cases.

(Named for Mr. J. Ogilvie, who collected the type.)

ACESTRORHYNCHINÆ.

Acestrorhynchus falcirostris (Cuvier).

Two examples, 227 and 233 mm.

HYDROCYNINÆ.

Hydrocynus cuvieri (Agassiz).

One example 314 mm.

ERYTHRININÆ.

Hoplias malabaricus (Bloch).

Two examples, 150 and 155 mm.

Erythrinus unitæniatus Agassiz.

One example 160 mm.

GYMNOTIDÆ.

ELECTROPHORINÆ.

Electrophorus electricus (Linnæus).

One example 346 mm.

STERNOPYGINÆ.

Sternopygus macrurus (Schneider).

Five examples, 128 to 432 mm.

Eigenmannia virescens (Valenciennes).

Two examples, 305 and 338 mm.

Gymnorhamphichthys hypostomus Ellis.

Two examples, 100 and 138 mm.

STERNARCHINÆ.

Sternarchus albifrons (Linnæus).

Two examples, 141 and 173 mm. These agree largely with Cope's example, recorded as *Sternarchus albifrons* from the Peruvian Amazon.[15] It differs, however, in having the light predorsal streak continuous from the head to the origin of the dorsal fin. The Rupununi examples show it only for the first quarter or third of this region. They also show the following: Head $5\frac{2}{3}$ to $6\frac{1}{4}$; depth $5\frac{1}{3}$ to $5\frac{4}{5}$; A. 150? to 160?; scales about 72 to 90 in l. l. according to tubes and pores; 15 to 18 scales above l. l., opposite pectoral tip, counted to median line of back; 3 or 4 scales above l. l. to dorsal origin; about 116 to 120 predorsal scales; about 30 scales below l. l. at greatest body depth; snout $2\frac{2}{3}$ to $2\frac{7}{8}$ in head; interorbital $4\frac{1}{2}$; maxillary $1\frac{2}{5}$ to $1\frac{2}{3}$ in snout; eye $3\frac{1}{2}$ to $5\frac{1}{2}$; gill-rakers 2 + 5 or 6. These two examples also differ from one another in respect to color, the larger having a black and rather long slender caudal peduncle. The smaller has a very constricted caudal peduncle, marked by a dusky blotch, and the caudal dusky, while in the larger example the caudal is white.

ASPREDINIDÆ.

Bunocephalus amaurus Eigenmann.

One example, 40 mm. long. It differs from Eigenmann's account in the head width, which is $3\frac{2}{3}$ in total length. Barbels banded basally. Maxillary barbel not quite reaching pectoral. Eigenmann gives[16] as a distinction from *Bunocephalus gronovii* Bleeker, in his

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[15] *Proc. Amer. Philos. Soc.*, Phila., XVII, 1878, p. 628.

[16] *Mem. Carnegie Mus.*, V, 1912, p. 126, Pl. 2 (non 1), fig. 2.

key, "distance from snout to dorsal considerably more than 3 in length with caudal." My example would show it about $2\frac{3}{4}$, nearly in agreement with his figure.

SILURIDÆ.

PIMELODINÆ.

Megalonema rhabdostigma sp. nov. Fig. 10.

Head $3\frac{1}{4}$; depth $4\frac{1}{4}$; D. I, 6; A. IV, 9, I; P. I, 9; V. I, 5; head width $1\frac{3}{7}$ in its length; head depth at occiput $1\frac{7}{8}$; snout $2\frac{1}{10}$; eye $5\frac{3}{4}$; maxillary $2\frac{7}{8}$; mouth width $2\frac{1}{5}$; interorbital 4; antero-internasal $5\frac{1}{3}$; dorsal spine, and flexible tip, $1\frac{3}{4}$; length of adipose fin about $1\frac{2}{5}$; first branched anal ray 2; least depth of caudal peduncle $4\frac{1}{2}$; upper caudal lobe about $1\frac{1}{3}$; pectoral $1\frac{1}{2}$; ventral $1\frac{7}{5}$.

Fig. 10.—*Megalonema rhabdostigma* Fowler. (Type.)

Body moderately compressed, anteriorly slightly robust, deepest at dorsal origin, and edges all convex. Caudal peduncle moderately compressed, least depth about 2 in its length.

Head moderately robust, upper profile but very slightly undulate from snout tip to occiput and dorsal origin, and a little more inclined than lower profile, convex sides slightly converge convexly above and very broad below, with under surface but slightly convex. Snout broadly depressed, surface nearly level, its length about $1\frac{1}{4}$ its greatest width, or head width opposite front of eyes. Eye large, superior, ellipsoid, centre slightly behind middle in head length. Eyelids free, without adipose development. Mouth large, broadly transverse, commissure short and with folded groove at each corner reaching back opposite last $\frac{2}{5}$ in snout length. Broad band of villiform teeth in upper jaw, twice as broad as similar mandibular band, and exposed below in specimen as now preserved, as snout protrudes well before mandible. No vomerine teeth. Inner buccal folds broad. Tongue broad, fleshy, not free except along edges, and depressed. Maxillary extends back nearly to last third in snout, with long barbel originating superiorly, depressed basally somewhat, and extending back nearly opposite last anal ray base. Outer mental barbels longer than inner, extend back slightly beyond pectoral origin. Inner mental barbels reach about $\frac{2}{3}$ of space to pectoral origin. Internasal spaces subequal, posterior pair slightly more remote from one another, and space between front and hind nostril about $1\frac{1}{3}$ in antero-internasal space. Interorbital broad, slightly concave, with fontanel extending back not quite opposite hind edges of eyes, where greatest width obtains, and gradually narrowed forward till it ends about opposite last $\frac{2}{7}$ in snout length. Occipital and lateral contiguous bones, also predorsal plate, all with fine rugose striæ. Opercle with well-marked radiating striæ.

Gill-opening extends forward about opposite last fifth in snout length. Gill-rakers 4 + 14, short, firm, lanceolate, about $1\frac{2}{3}$ in filaments. Latter 2 in eye. Isthmus broad, level.

Body covered with smooth skin. Head rugosely striated, as mentioned, also occipital process and articulating predorsal bucker, besides exposure of shoulder-girdle over pectoral origin. L. l. a little high at first, soon becomes median, with more or less alternating short branches most of its course, which continuous out on caudal base.

Dorsal origin about first $\frac{2}{5}$ in space between snout tip and caudal base, spine moderate, smooth, slightly curved, with flexible tip and latter slightly less than tip of first dorsal ray. Adipose fin inserted slightly nearer dorsal origin than caudal base, with contour sloping up to high median apex. Anal inserted slightly behind insertion of adipose fin, first branched ray longest and reaches back well beyond tip of last ray or $\frac{2}{3}$ of distance to caudal base. Caudal well forked, slender pointed lobes about equal, and emargination of fin nearly $\frac{2}{3}$ its length. Pectoral low, pointed, spine slender, both edges with small antrorse serræ, with flexible tip which longest of rays, and fin extends $1\frac{1}{4}$ to ventral. Latter inserted slightly nearer dorsal origin than origin of adipose fin, and depressed fin reaches $\frac{3}{4}$ to anal. Vent and genital pore well separated. Genital pore about first sixth in space between inner ventral ray base and anal origin, and vent about first third of same area.

Color in alcohol dull brownish above or on back and upper surface of head, lower or under surfaces and lips paler or whitish. From dorsal origin down on back a pale streak, when below l. l. it follows latter below to caudal. Behind oblique lateral pale streak, another lengthwise streak begins posterior to its crossing l. l. and continues to caudal base, keeping parallel with l. l. its whole extent. On caudal both pale streaks are merged in the median color of that fin. Lower boundary of lower pale streak indicated by a pale grayish lengthwise streak, made of minute dusky dots, which become closer on caudal base and finally form a blackish streak across median portion of lower caudal lobe nearly to its tip. In similar fashion upper dark body color marks upper caudal lobe. Maxillary barbels brownish above, pale or whitish below like mental barbels. Dorsal fin whitish, with a large sharply contrasted superior median blackish blotch. Adipose fin brownish. Remaining tints of caudal, on regions not mentioned, whitish. Pectoral, ventral and anal whitish.

Length 270 mm.

Type, No. 39,338, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Known only from the above. It resembles *Megalonema platycephalum* Eigenmann, but that species is said to be pale or nearly uniform in color, with a pair of hidden spots at the caudal base and the lower caudal lobe dusky.

(*Ῥάβδος*, streak; *στίγμα*, spot; with reference to the lengthwise streaks and the dorsal blotch.)

Chasmocranus longior Eigenmann.

One example, 87 mm. long.

Rhamdia sebæ (Valenciennes).

One example, 127 mm. long.

Rhamdia holomelas rupununi subsp. nov. Fig. 11.

Head $3\frac{4}{5}$; depth $6\frac{2}{3}$; D. I, 6; A, IV, 8; P. I, 8; V. I, 5; head width $1\frac{1}{3}$ in its length; head depth at occiput $1\frac{9}{10}$; snout $2\frac{3}{5}$; eye 4; maxillary 4; mouth width $2\frac{7}{8}$; interorbital 5; antero-internasal $5\frac{1}{4}$; dorsal spine 2; first branched dorsal ray $1\frac{2}{5}$; second branched anal ray $2\frac{1}{4}$; upper caudal lobe $1\frac{1}{4}$; least depth caudal peduncle 3; pectoral spine $1\frac{1}{2}$; pectoral fin $1\frac{1}{4}$; ventral fin $1\frac{3}{5}$.

Body elongate, slender, moderately compressed, anteriorly slightly depressed, deepest about dorsal origin, and edges all convexly rounded. Caudal peduncle compressed, length about equals its least depth.

Head depressed, profiles similar, well convex bulging sides slightly constricted above, and under surface broadly convex. Snout broadly depressed or very slightly convex, its length about $\frac{2}{3}$ its width opposite front eye edges. Eye ellipsoid, superior, impinging on upper profile, and centre midway in head. Eyelids free, not adipose-like. Mouth moderate, transverse, commissure very short. Broad bands of villiform teeth in jaws, lower $\frac{3}{4}$ width of upper and latter with posteriorly directed angle at each end. No other teeth in mouth. Inner buccal folds moderately broad. Tongue broad, depressed, fleshy, rounded in front and free around edges. Maxillary reaches about opposite middle in snout length. Maxillary barbel slender, depressed basally, reaches opposite second dorsal ray base. Outer mental barbels slightly extended beyond pectoral origin.

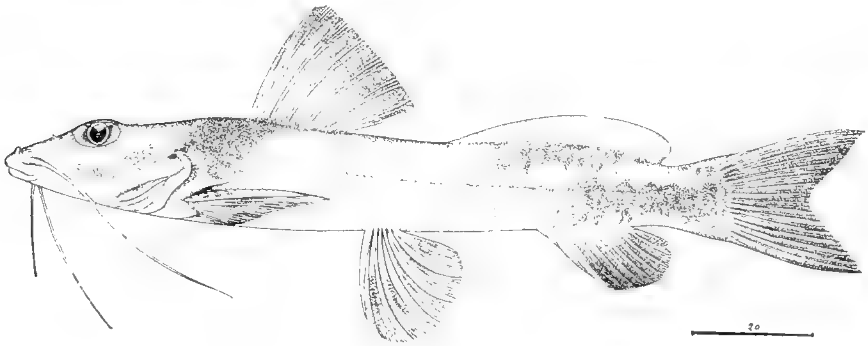

Fig. 11.—*Rhamdia holomelas rupununi* Fowler . (Type.)

Inner mental barbels shorter, reach $\frac{4}{7}$ to pectoral origin. Mandible shallow, with snout slightly protruded in front. Internasal spaces subequal, anterior nostril near front edge of snout and posterior at last third in its length. Interorbital narrow, osseous area restricted, and cutaneous supraorbital region elevated to produce concave appearance. Surface of head smooth, covered with skin. Opercle broad. Occipital process short, well separated from dorsal.

Gill-opening extends forward opposite front pupil edge. Gill-rakers 5 + 13, slender, curved, lanceolate, little longer than filaments, or $1\frac{3}{4}$ in eye. Isthmus broadly convex.

Body covered with smooth skin, without any rugose areas. L. l. superior at first, becomes median after ventrals, complete and continuous on caudal base, not branched.

Dorsal origin about first third in space midway between snout tip and caudal base, spine with front edge distally furnished with a series of antrorse serræ under skin, and tip ends in flexible ray-like end. First branched dorsal ray longest, depressed tip falls slightly short of tips of last. Origin of adipose fin slightly nearer gill-opening than caudal base, slopes up gradually at first until near middle when uniformly high, and its entire length about $3\frac{1}{5}$ in combined length of head and trunk. Caudal moderate, well forked, lobes about equal, sharply and similarly pointed, and rudimentary rays well developed. Anal inserted slightly nearer ventral origin than caudal base, and third branched ray about longest, edge of fin rounded. Pectoral low, with strong spine, both edges with antrorse serræ though inner distal edge smooth, and depressed fin reaches $1\frac{1}{3}$ to ventral. Ventral inserted just behind dorsal base, fin rounded, and extends about $\frac{2}{3}$ to anal origin. Vent anterior, falls about first $\frac{2}{5}$ in space between ventral and anal origins.

Color in alcohol dull or pale uniform brownish above, becoming somewhat mottled or variegated with darker brownish on caudal peduncle, posterior region of trunk and caudal base. Lower surface of body pale brownish to whitish. Iris slaty. Lips pale. Maxillary barbels brownish, and mental barbels pale or whitish like chin. Fins all grayish-brown, tinted a little deeper medianly.

Length 145 mm.

Type, No. 39,339, A. N. S. P. Rupununi River, British Guiana J. Ogilvie.

Related to *Rhamdia holomelas* (Günther),[17] and it may possibly prove to be identical. However, Günther gives the long adipose fin as 2 to $2\frac{1}{4}$ in total length without caudal, maxillary barbels reaching origin or middle of adipose fin, outer mental barbels reach middle of pectoral, depth 5 to $5\frac{2}{3}$, head 4, eye 2 in interorbital, caudal cleft to base and color uniform black with brownish shade, lighter on belly. His examples were a foot long, though he also had young. The inference would be that these characters would apply to young and adult as their latitude allows. For this reason, as my example will be seen to differ considerably, especially in the above-mentioned points, I allow it as distinct.

(Named for the Rupununi River.)

Rhamdella leptosoma sp. nov. Fig. 12.

Head $4\frac{7}{8}$; depth $8\frac{1}{4}$; D. I, 6; A. vi, 8; P. I, 9; V. i, 5; head width $1\frac{1}{3}$ in its length; head depth at occiput $1\frac{3}{4}$; snout $3\frac{1}{4}$; eye $3\frac{1}{4}$; max-

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[17] *Pimelodus holomelas* Günther, *Cat. Fish. Brit. Mus.*, V, 1864, p. 120. Essequibo.

illary 5; mouth width 3; interorbital 4; pungent dorsal spine 2; first branched dorsal ray $1\frac{1}{5}$; first branched anal ray $1\frac{7}{8}$; least depth of caudal peduncle behind adipose fin 3; pectoral spine $1\frac{1}{2}$; pectoral fin $1\frac{1}{4}$; ventral fin $1\frac{2}{5}$.

Body elongate, slender, compressed, deepest at dorsal origin and tapers back gradually and slightly, edges all convex. Caudal peduncle well compressed, least depth $1\frac{1}{2}$ its length, measured from hind edge of adipose fin.

Head small, depressed, profiles similarly and slightly convex, swollen sides below broadly converge above, lower surface convex. Snout broadly convex, length $\frac{2}{3}$ basal width at front of eyes. Eye ellipsoid, superior, centre slightly anterior in head length. Adipose-eyelid not developed, and eyelids free. Mouth moderately small, with upper jaw slightly protruding, commissure very short. Lips firm, fleshy. Maxillary extends about $\frac{3}{5}$ in snout length. Teeth in villiform bands in jaws, subequal in width, and each end of upper band ends in posteriorly directed angle. Inner buccal folds narrow, No other teeth in mouth. Tongue broad, fleshy, thick, depressed. edges not free. Maxillary barbel very long, slender, reaches back about half way in length of depressed last anal ray. Outer mental barbel reaches to last or distal sixth of depressed pectoral spine. Inner mental barbel reaches pectoral origin. Internasal spaces subequal, anterior nostril near front snout edge in slight tube and posterior nostril at last third in snout as simple pore. Interorbital moderate, level. Bones on upper surface of head covered with thin skin, surfaces smooth. A narrow lengthwise median fontanel, well defined most entire upper extent of cranium and ending pos-

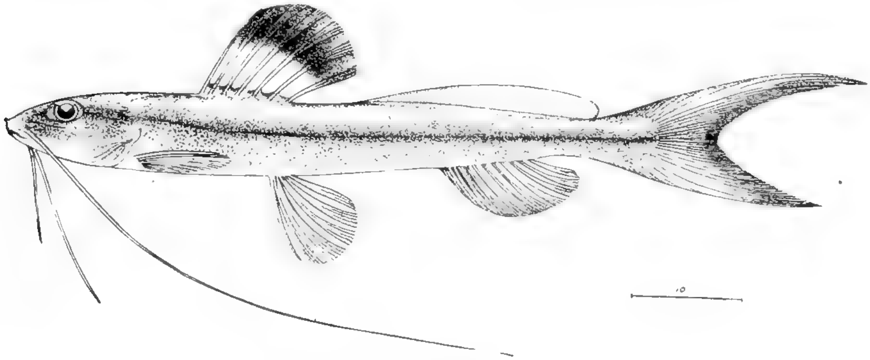

Fig. 12.—*Rhamdella leptosoma* Fowler. (Type.)

teriorly at base of occipital process. Opercle widely and unevenly triangular. Occipital process extends back toward dorsal as narrow slender prolongation $\frac{2}{3}$ of space.

Gill-opening extends forward nearly opposite front eye margin. Gill-rakers 4+6, slender, lanceolate, firm, about $\frac{2}{3}$ of filaments. Latter $2\frac{1}{3}$ in eye. Isthmus broadly convex.

Body covered with smooth skin, and no rugose bony surfaces. L. l. complete, midway along side, and extends to median caudal base.

Dorsal origin nearer adipose fin origin than snout tip, slender pungent spine smooth-edged and equals about half length of fin, ending in long slender flexible tip. Second dorsal ray longest and extends back as far as any of others. Adipose fin inserted nearly midway between front eye edge and caudal base, fin low, graduated up at first, and its length $2\frac{2}{3}$ in combined head and trunk length. Anal inserted nearly midway between ventral origin and hind basal edge of adipose fin, first to fourth branched rays subequally longest and fin rounded. Caudal very long, deeply forked, lobes slender, pointed, and upper longer. Pectoral low, spine pungent, outer distal edge and median posterior edge with small antrorse serræ, depressed fin extending $1\frac{1}{2}$ to ventral. Latter inserted about opposite fifth dorsal ray base, fin reaching $1\frac{2}{3}$ to anal. Vent close behind ventral bases, or about first fifth in space between ventral and anal origins.

Color in alcohol pale or very light brownish generally on upper surfaces, lower surface paler or translucent whitish. Upper surface of darker tint, due to minute dusky dots. A dark streak, made up of closely set dusky dots, extends from snout tip to caudal base, embracing l. l. Lips pale brownish. Maxillary barbel brownish, and other barbels whitish. Dorsal largely pale or translucent basally on membranes, upper or distal halves dusky. Adipose fin and caudal dusky-gray. Other fins pale or grayish. Iris slaty.

Length 80 mm.

Type, No. 39,340, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Also, paratype, No. 39,341, A. N. S. P., same data. Head $4\frac{4}{5}$; depth 7; D. I, 6; A. VI, 8, I; snout $2\frac{2}{3}$ in head; eye $3\frac{1}{4}$; maxillary $3\frac{2}{3}$; mouth width 3; interorbital 4; length 81 mm.

This species differs from *Rhamdella foina* (Müller and Troschel)[18]

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[18] *Pimelodus foina* Müller and Troschel, *Reis. Schomburgk*, III, 1848, p. 628. Takutu.

in its more slender body, more anal rays, longer maxillary barbels, and the coloration. *Rhamdella eriarcha* (Eigenmann and Eigenmann)[19] another related species agrees in the slender body and coloration, though differs in its short maxillary barbels and fewer gill-rakers. *Rhamdella ignobilis* Steindachner[20] has maxillary barbels reaching only to the dorsal end basally, larger head and deeper body, though its color is suggestive.

(Λεπτὸς, slender; σῶμα, body.)

Pimelodella cristata (Müller and Troschel).

One example 140 mm.

Pimelodella gracile (Valenciennes). Fig. 13.

One example 155 mm. Not previously recorded from British Guiana.

Fig. 13.—*Pimelodella gracile* (Valenciennes).

Pimelodus clarias (Bloch).

One example 220 mm. Maxillary barbels reach caudal base.

Hemisorubim platyrhynchos (Valenciennes).

One example 260 mm.

Sorubim lima (Schneider).

One example 270 mm. Also an addition to the fauna of British Guiana.

DORADINÆ.

Doras costatus (Linnæus).

Two examples 180 mm. and 270 mm.

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[19] *Rhamdia eriarcha* Eigenmann and Eigenmann, *Proc. Cal. Acad. Sci.*, (2) I, 1888, p. 129. Rio Grande do Sul.

[20] *Sitz. Ak. Wiss. Wien*, CXVI, I, 1907, p. 484. Rio Cubataõ, Brazil.

Doras hancocki Valenciennes.

One example 76 mm. long.

Leptodoras linnelli Eigenmann.

One example 165 mm.

Leptodoras trimaculatus sp. nov. Fig. 14.

Head $3\frac{2}{3}$; depth $4\frac{1}{4}$; D. I, 6; A. IV, 9; P. I, 7; V. I, 6; head width $1\frac{2}{3}$ in its length; head depth at occiput $1\frac{1}{3}$; snout $2\frac{2}{5}$; eye $2\frac{2}{3}$; interorbital $4\frac{1}{2}$; dorsal spine 1; ventral $1\frac{3}{4}$; first branched anal ray about $2\frac{1}{2}$; upper caudal lobe $1\frac{1}{4}$; least depth of caudal peduncle $4\frac{1}{3}$.

Body well compressed, moderately long, deepest at dorsal origin, edges all convex, though predorsal slopes up each side to median constricted edge. Caudal peduncle wider than deep, least depth about half its length.

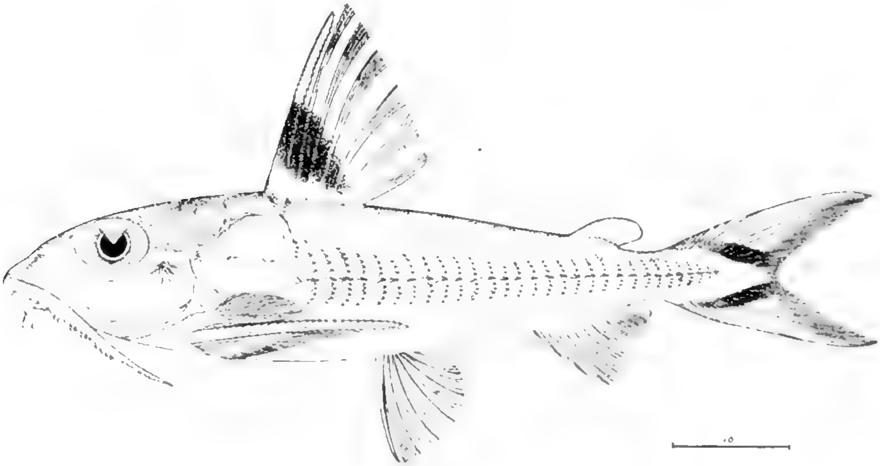

Fig. 14.—*Leptodoras trimaculatus* Fowler. (Type.)

Head large, well compressed, elevated, upper profile convex, curves down rather steeply in front. Snout conic, basal width about $\frac{1}{5}$ its length, upper profile concave-convex. Eye large, ellipsoid, high, and centre slightly posterior in head length. Eyelid not free, continuous with skin of head as adipose-eyelid. Mouth small, anteriorly inferior. No teeth. Lips rather thick, fleshy. Maxillary barbel reaches slightly beyond pectoral origin, fleshy, and its outer edge fringed with cirri. Mandible with cluster of four thick papillose fleshy barbels hanging down, length of each about $\frac{2}{5}$ of eye. Tongue fleshy, little distinct. Nostrils simple pores, anterior pair slightly closer to one another and about midway in snout length, posterior pair close in front of eye above. Interorbital nearly level. Opercle with a few radiating striæ covered with thin skin. Upper surface of head and predorsal buckler finely rugose-striate. Occipital fontanel begins on upper surface of interorbital opposite front eye edges and extends back half way to dorsal origin.

Gill-openings lateral, inferior, extend forward about opposite hind pupil edge. Gill-rakers 1+9, short, conic, blunt at tips, longest 4 in filaments and latter 2 in eye. Isthmus broad and flattened.

Body without scales and exposed skin smooth. L. l. with an armature of 30 large scutes, of equal width over most of extent, only becoming smaller on side of caudal peduncle, and hind edge of each strongly denticulated. Exposed bony shoulder-girdle, slightly swollen above pectoral base, with lengthwise striæ or grooves.

Dorsal origin a little nearer snout tip than origin of adipose fin, with long strong compressed spine, its front edge antrorsely serrate and hind edge also serrate, though there serræ turned forwards. Adipose fin inserted a little nearer caudal base than origin of ventral, fin small or about equals eye. Anal inserted before adipose fin, or slightly nearer ventral origin than caudal base, first branched ray longest and lower edge slightly emarginate. Caudal well forked, pointed lobes equal, and rudimentary rays well developed. Pectoral low, with large well-compressed spine, both edges strongly serrate, and when distended extends back nearly to first third in depressed ventral length. Ventral origin just behind dorsal base, and fin reaches $\frac{3}{4}$ to anal origin. Vent at first third in space between ventral and anal origins.

Color in alcohol largely slaty-gray above, becoming silvery or whitish below. Down middle of back from dorsal base, and just above each lateral series of scutes, a deep gray or nearly slaty lengthwise streak. Lateral scutes pale or whitish. Iris slaty. Sides of head silvery-white. Fins all with general tint pale grayish to whitish. Dorsal with subbasal blackish blotch anteriorly and extending down to bases of rays. Each caudal lobe with inner basal blotch of blackish.

Length 77 mm.

Type, No. 39,342, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Related to *Leptodoras linnelli* Eigenmann, but differs in the larger eye and coloration.

(*Tri*, three; *macula*, spot; with reference to the dorsal blotch and the two caudal blotches.)

AUCHENIPTERINÆ.

Trachycorystes galeatus (Linnæus).

One example 145 mm. long.

Auchenipterus demeraræ Eigenmann.

Three examples 125 to 135 mm.

Ageneiosus ogilviei sp. nov. Fig. 15.

Head $3\frac{1}{4}$; depth $6\frac{1}{3}$; D. I, 6; A. IX, 32, I; P. I, 14; V, I, 7; head width $1\frac{1}{2}$ in its length; head depth at occiput 2; snout 2; eye $6\frac{3}{4}$; maxillary 2; mouth width $1\frac{4}{5}$; interorbital $1\frac{1}{2}$; dorsal spine 2; first branched dorsal ray $1\frac{3}{4}$; length of adipose fin $3\frac{1}{6}$; first branched anal ray 3; least depth of caudal peduncle $5\frac{1}{8}$; upper caudal lobe $1\frac{3}{4}$; pectoral spine $1\frac{2}{3}$; pectoral fin $1\frac{3}{5}$; ventral $1\frac{9}{10}$.

Body elongate, trunk greatly compressed, and extremely broad anteriorly or at head, greatest depth at dorsal origin, edges all convexly rounded, and trunk slopes gradually back to rather deep caudal peduncle. Caudal peduncle well compressed, its least depth $2\frac{1}{4}$ in its length.

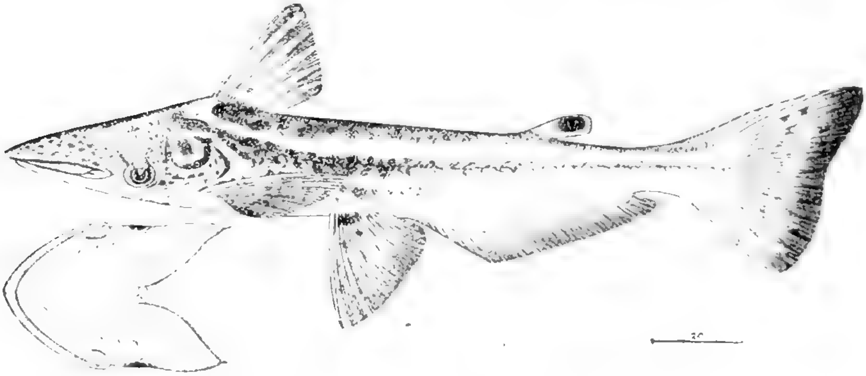

Fig. 15.—*Ageneiosus ogilviei* Fowler. (Type.)

Head large, greatly depressed, upper profile nearly straight from snout tip to dorsal origin, lower profile horizontally convex, upper surface convex and lower surface flattened. Snout very broad, broadly convex as viewed above, length $\frac{3}{4}$ its width, and protrudes slightly beyond edge of mandible in front. Eye moderate, without free eyelid, laterally inferior, and about midway in head length. Skin around eye forming somewhat adipose-like. Maxillary reaches back till close in front of eye. Jaws with about equally wide or broad bands of villiform teeth, rather firm and rough to touch. No other teeth in mouth. Inner buccal membranes very narrow, only slightly developed. Tongue large, broad, thick, depressed above, smooth, and free around edges. Lips not developed. Mandibular rami low and broad, and asperous edge of upper jaw includes it all around. Nostrils well separated, though posterior pair a little closer and placed about $\frac{4}{7}$ in snout length. Interorbital broadly convex. Opercle moderate, with few radiating striæ, though these covered with thin skin of head. Frontal fontanel moderately broad, extends from about midway between eyes till about midway in snout length, and bones each side with lengthwise striæ, though their surfaces covered with thin skin. Occipital process wide, strong, receives dorsal base in its posterior cleft.

Gill-opening extends forward about opposite middle of eye. Gill-rakers about 3+19, lanceolate, sharp-pointed, firm, $1\frac{3}{4}$ in gill-filaments, and latter about $1\frac{1}{4}$ in eye. No pseudobranchiæ. Isthmus broad. Branchiostegals 9, slender, outer longer.

Body covered with thin skin, at present rather soft and delicate. No ossifications exposed on head. L. l. complete, a little high at first, becoming midway along side of caudal peduncle, continuous on caudal base, and with moderately short branches all along its course, giving off both above and below.

Dorsal origin well anterior or well before first third in combined head and trunk length, with slender compressed smooth-edged spine but little less than first branched or longest dorsal ray, and depressed fin extends $2\frac{1}{4}$ to origin of adipose fin. Latter inserted little nearer ventral origin than caudal base, rather elongate and truncate behind. Anal long, inserted about midway between hind maxillary edge and caudal base, first branched ray longest and all other rays graduated down smaller, base of fin about $3\frac{1}{5}$ in combined head and trunk length. Caudal broad, rudimentary rays well developed, very slightly emarginate with upper lobe longer so as to produce oblique hind edge. Pectoral with compressed slender pungent smooth-edged spines ending in flexible tip, fin broad, low, reaches slightly beyond ventral, and its own insertion but slightly before dorsal. Ventral broad, low, insertion well behind dorsal base, and fin reaching back nearly to first branched anal ray base. Vent close in front of anal, its surrounding area greatly constricted.

Color in alcohol largely grayish or slaty-brown on back, sides and lower surface whitish. Head brownish above, obscurely mottled with dusky. Iris slaty. Lower surface of head, breast, and belly whitish. Opercle with dusky border below. Edge of gill-opening and postorbital region whitish, marked with several pale dusky spots. Following course of l. l. its entire extent dusky lengthwise streak, well defined and separated from color of back by whitish or pale parallel and similar streak. Also another parallel and similar pale streak below until over anal medianly, after which it merges in general pale lower tint. From pectoral axilla dusky streak extends back to anal, fading out behind. Now all dusky lengthwise streaks, and dark color of back variegated with irregular blotches of dusky, anterior to ventral fins. Fins all with grayish-white general color. Dorsal with a few small dusky spots, and pectorals and ventrals with similar variable spots on their upper surfaces, showing through below, and with their distal portions more or less dusky. Anal shows traces of few pale dusky spots on distal portions of longest rays. Caudal with broad posterior dusky to blackish edge, each lobe with few rounded dusky spots. Adipose fin with large dusky blotch above.

Length 195 mm.

Type, No. 39,343, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Related to *Ageneiosus brevifilis* Valenciennes, though differs apparently in the large pectorals and ventrals and black-edged caudal. Cope's Peruvian example, about 200 mm. ? long, in poor condition, shows the damaged pectorals apparently not reaching the ventrals.

(Named for Mr. J. Ogilvie.)

PYGIDIDÆ.

STEGOPHILINÆ.

COBITIGLANIS subgen. nov.

Type *Ochmacanthus taxistigma* sp. nov.

Differs from *Ochmacanthus* Eigenmann in the anal being entirely behind dorsal base and spines of preopercle and opercle in lesser number.

(*Κωβῖτις*, loach; *γλανίς*, catfish; with reference to the superficial resemblance these fishes bear to the loaches of the Old World.)

Ochmacanthus taxistigma sp. nov. Fig. 16.

Head $5\frac{1}{2}$; depth $6\frac{1}{2}$; D. III, 6, I; A. III, 4, I; P. I, 5, I; V. I, 4, I; head width $1\frac{1}{10}$ its length; head depth at occiput $1\frac{4}{5}$; snout $3\frac{1}{4}$; eye 3; mouth width $1\frac{1}{2}$; interorbital $3\frac{1}{5}$; length of dorsal $1\frac{1}{8}$; of anal $1\frac{2}{7}$; of pectoral $1\frac{2}{5}$; of ventral 2; of lower caudal lobe $1\frac{1}{6}$; least depth caudal peduncle $2\frac{1}{2}$.

Body elongate, slender, well compressed, belly bulging so that deepest about midway in space between pectoral and ventral bases, edges convex. Caudal peduncle well compressed, rather slender, least depth about $\frac{1}{3}$ its length.

Head well depressed, broad, upper profile a little more convex than lower, and lower sides bulge a little so that they slope slightly in above, lower surface nearly level. Snout broadly depressed, nearly evenly convex as seen from above, well protruded, and length about $\frac{2}{5}$ its greatest width about opposite front of eyes. Eyes without free eyelids, skin of head extending over, superior, elongate, and slightly ovoid, and placed about first $\frac{3}{7}$ in head length. Mouth broad and moderately crescentic as seen from below. Lips broad, fleshy, and with rather obsolete transverse plications, though on mandibular portion indistinctly broken or divided into papillæ. Maxillary ending in short, basally thick fleshy barbel, tip sharp or pointed, and measured along its upper free edge about equals eye in length. Inside and hidden, also a much smaller maxillary barbel, its length about $\frac{1}{5}$ that of outer, though similar in most respects. Upper jaw with 6 series of uniformly small teeth, rows arranged transversely and continuously at equal distances across anterior portion of mouth, all more or less pliable except last series, which firmly, entrenched. At least 7 distinct transverse series of similar teeth arranged along each mandibular ramus, and a few others not in very regular order scattered about symphysis. No other teeth in mouth. Inner buccal folds broad. Tongue far back, broad, fleshy, depressed, and evidently scarcely free. Each end of lower lip forms broad fold on side of head below maxillary. Mandible broad, depressed, flattened on lower surface, and symphysis would form opposite front edge of eye. Nostrils well separated, anterior much more widely apart and close in front of eye, and both pairs with

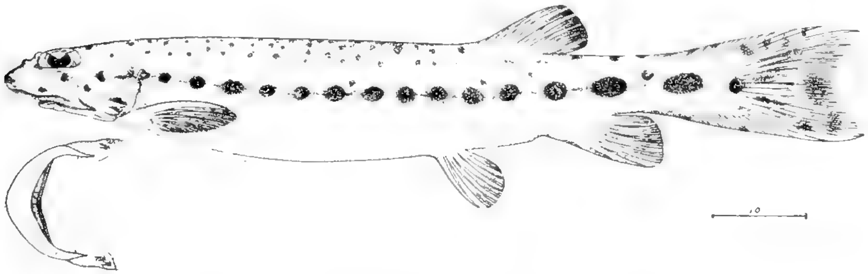

Fig. 16.—*Ochmacanthus taxistigma* Fowler. (Type.)

slightly elevated cutaneous rims, though posterior pair larger and placed opposite and within space between front edges of eyes. Interorbital level. Preopercle with a cluster of 5 more or less concealed large conic spines, partly erectile. Opercle with 2 similar, only smaller, spines.

Gill-opening small, lateral, just before pectoral base.

Body naked, covered with smooth skin. L. l. complete, simple or without branches, and median along side.

Dorsal origin a little nearer caudal base than pectoral origin, first branched ray longest, and depressed fin extends about $\frac{2}{5}$ to caudal base. Anal inserted just behind dorsal base, first branched ray longest or extends back beyond tip of last so that fin reaches $\frac{4}{7}$ to caudal base. Caudal slightly emarginate, elongate and with well-developed fulcra. Pectoral low, broad, extend about $\frac{1}{3}$ to ventral. Latter inserted well before dorsal origin or about midway between pectoral origin and caudal base, and extends back $\frac{2}{3}$ to anal origin. Vent midway between depressed pectoral tip and anal origin.

Color in alcohol pale or very light brownish, shading to whitish on lower or under surface. Predorsal region with about four series of dusky irregular spots. From behind dorsal only a few median dusky spots, though upper surface of head with spots of similar size to those of predorsal region. One of these blotches marks opercular spines and another preopercular spines. Also a dark spot above pectoral base. Following course of l. l. 16 dusky blotches, at first small, then gradually larger until maximum size obtains on side of caudal peduncle. Along upper extent of this series also several smaller dark scattered spots. Fins all pale or whitish, several obscure spots of dusky on dorsal, caudal, and pectoral base, others uniform. Iris slaty.

Length 93 mm.

Type, No. 39,344, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

This species resembles *Ochmacanthus flabelliferus* Eigenmann, but differs in its dentition, coloration, and position of its fins.

(*Τάξις*, row; *στίγμα*, spot; with reference to the series of large dark lateral blotches along the lateral line.)

CALLICHTHYIDÆ

Callichthys callichthys (Linnaeus).

One example 128 mm.

Hoplosternum thoracatum (Valenciennes).

One example 70 mm.

LORICARIIDÆ.

PLECOSTOMINÆ.

STONEIELLA gen. nov.

Type *Stoneiella leopardus* sp. nov.

Teeth fine, but little enlarged at ends, moderately small, not numerous. Interopercle with erectile spines, and these on movable plate. Body spinescent almost everywhere above, especially anteriorly. Lower surface of head, lower sides of abdomen and belly naked. Lateral edges, as well as upper surfaces of head, finely spinescent. Temporal plate imperforate. Tail short, compressed. Adipose fin present. Anal with five branched rays.

This genus differs from the related genera, or those of the present subfamily, in the naked or unarmed lower regions. In its dentition it approaches *Lithoxus* Eigenmann. One species.

(Named for Dr. Witmer Stone, in slight recognition of his contributions to natural history.)

Stoneiella leopardus sp. nov. Fig. 17.

Head 4; depth 5; D. I, 8; A. I, 5; P. I, 6; V. I, 5; spinescent armature of l. l. with about 24 bucklers, indistinctly defined; head width $1\frac{1}{10}$ in its length, with head measured from snout tip to hind end of occipital process; head depth at gill-opening about 2; snout $1\frac{4}{5}$; eye 5; width of buccal disk $2\frac{1}{8}$; interorbital $2\frac{7}{8}$; dorsal spine 1; anal spine $1\frac{3}{5}$; pectoral spine $1\frac{1}{8}$; ventral spine $1\frac{1}{8}$; least depth of caudal peduncle 3; upper caudal lobe about $1\frac{1}{8}$ (tip damaged).

Body moderately long, well depressed, convex above, flattened below, deepest at dorsal origin and widest at pectoral origins. Caudal peduncle stout, becomes more compressed behind, and length about $\frac{3}{4}$ its depth.

Head large, broad, convex above, flattened below, and upper profile a little inclined and nearly straight. Snout depressed, surface generally convex, as seen from above rather elongately triangular with length about $\frac{3}{4}$ greatest width at point opposite front of eyes. Eye superior, close on upper profile, a little ellipsoid, placed about last third in head length measured to hind occipital process, and edges without eyelid, free. Mouth inferiorly anterior, with broad rounded disk. Upper jaw retractile, with a series of 8 slender hooked compressed bifid teeth, each with tips of bifurcations worn in appearance as if somewhat truncate, and inner branch larger. Mandible with a series of 12 similar teeth. Teeth medianly in both jaws larger, and lateral ones smallest. Inner buccal folds broad. Lips very broad, forming large buccal disk, and their lower surfaces with many papillæ, most distinct and raised where they border jaws. Outer edge of disk formed of conic fleshy barbel extending from hind end of maxillary, and its length about equals eye length. Nostrils large, together, both with elevated coextensive cutaneous rims, fall about last fourth in snout length, closer together than interorbital width, and placed in smooth area nearly as large in extent as eye. Interorbital moderate, level. Occipital process nearly an equilateral triangle, extends about half way to dorsal origin.

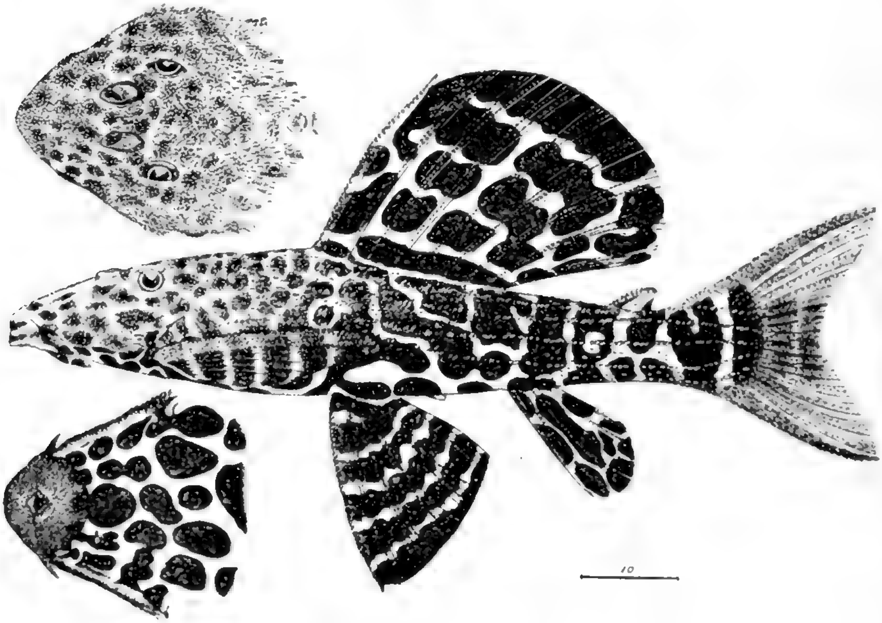

Fig. 17.—*Stoneiella leopardus* Fowler. (Type

Gill-opening small, oblique, before pectoral base above, and its extent opposite and equal to eye in length. Isthmus very broad level.

Body remarkable for its spinescent armature. Upper surface of head with small close-set sharp prickles or spines, including occipital process, opercle, and shoulder-girdle above pectoral base. Cluster of 12 depressible slender sharp-pointed spines on preopercle, last movable. Lower surface of head, breast, belly region around anal base, and along lower sides naked. Four lateral lengthwise series of posteriorly directed spines, and short fifth series on lower side of caudal peduncle and caudal base. Each of these spines in lengthwise series well separated, with one or more smaller or minute spines scattered around basally. Thus indications of lateral plates, ill-defined at first, though well-marked on caudal peduncle and caudal base, corresponding to squamation, are formed. Anteriorly lower series of lengthwise spines originates on bony plate over base of pectoral spine. Predorsal and postdorsal regions of back with minute spines, also lower surface of caudal peduncle and lower surface of trunk above anal base. All spines of fins and sides of larger rays spinescent, latter condition varying from quite large strong denticles on front of pectoral spine to those very minute on fin-rays. L. l. not evidently developed, median series of lateral spines in no way differing from others.

Dorsal origin about midway between that of adipose fin and snout tip, spine rather slender and with somewhat flexible tapering tip, fin quite large and all rays well developed. Adipose fin moderately large, spinescent, inserted little nearer last dorsal ray base than caudal base, fin about $\frac{1}{2}$ an eye-diameter in length. Anal inserted just after dorsal base, with slender and rather flexible spine, first branched ray longest and extends back about $\frac{3}{4}$ to caudal base. Caudal large, emarginate, both outer rays enlarged and spinescent. Pectoral low, with very strong spine, reaches $\frac{3}{5}$ to ventral origin. Latter inserted below first branched dorsal ray base, with strong spine rather flexible at tip, fin extends beyond anal base slightly, or about $\frac{3}{5}$ to caudal base. Vent with short tube, placed at last $\frac{2}{5}$ in space between ventral and anal origins.

Color in alcohol very dark or dusky generally, especially above. Everywhere more or less with large close-set blackish blotches, spots, or short vermiculations, on upper surface more or less obscured by bristles or spines, though below very conspicuous. General tint of lower surface much paler than back, thus adding to contrast. All fins with similar black blotches, the pale intervening areas often forming more or less into narrow transverse pale lines. Caudal with lobes distally somewhat chestnut-brown above and below, median portion of fin, however, with large blackish blotches like on trunk and narrow pale areas intervening. Iris slaty, also disk. Teeth worn brownish at tips, whitish basally.

Length 92 mm.

Type, No. 39,345, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Only the type known.

(Λεόπαρδος, leopard; with reference to the spots.)

Plecostomus plecostomus (Linnæus).

One example, 235 mm.

Pseudancistrus nigrescens Eigenmann.

Two examples, 112 and 175 mm. The smaller example agrees with Eigenmann's figure of the head, though the larger has the posterior edge of the occipital plate triangular. Both have numerous lateral bristles around front edge of head, except about snout tip, though in the larger example they are much longer, slender, and altogether better developed. Mandibular ramus $1\frac{1}{4}$ to $1\frac{3}{5}$ in interorbital. Dorsal spine equals or less than combined eye and snout length. Pectoral extends back about opposite first third in ventral. Color uniform dark brown above, belly pale. Trunk with brassy tinge in places.

Ancistrus hoplogenys (Günther).

Two examples, 120 and 178 mm. Both show body, especially below, and fins with minute white spots.

LORICARIINÆ.

Loricariichthys acutus (Valenciennes).

One example, 210 mm. long (caudal tip damaged). This species has been described by Eigenmann as *Loricaria microdon.* My example does not appear to differ from *L. acutus* as described by Regan.

Loricariichthys griseus (Eigenmann).

One example 167 mm.

Harttia platystoma (Günther).

One example 145 mm.

Sturisoma monopelte sp. nov. Fig. 18.

Head $5\frac{1}{8}$; depth $9\frac{1}{2}$; D. I, 7; A. I, 5; P. I, 6; V. I, 5; osseous plates 35 in lateral series; 24 postdorsal bony plates; head width $1\frac{4}{5}$ in its length, measured to hind edge of occipital process; head depth 3; snout $1\frac{3}{5}$; eye $6\frac{2}{3}$; mouth-width 4; interorbital $4\frac{1}{2}$; snout tip to front mouth edge $2\frac{1}{4}$; pectoral $1\frac{2}{5}$; ventral $1\frac{3}{5}$; anal $1\frac{1}{2}$; least width of caudal peduncle $6\frac{1}{2}$.

Body greatly elongate and depressed, slender in profile, dorsal and ventral surfaces generally convex. Very slight median predorsal depression, with slight ridge each side. From upper edge of eye obsolete keel extends back to join median lateral keel at fifteenth plate of latter, junction indicated by slight angle. Median lateral keel at first obsolete, though after dorsal very distinct and continued as lateral flange to caudal. Lower lateral keel extends from plate of shoulder-girdle back to twenty-second plate of median (then upper) keel, where it merges without an interruption. Before each ventral origin slight lengthwise keel. Caudal peduncle extremely long, depressed, broad, and tapering.

Head rather small, sides convexly approximated above, lower surface broadly convex. Snout greatly acuminate, narrowed tip produced, width at front of eyes $1\frac{2}{5}$ its length. Eye small, a little ellipsoid, high, slightly posterior to last third in head measured to hind edge of occipital plate. Edges of eyes free, without membrane covering over. Mouth width broad, forms rather large rounded disk, and transverse mouth cleft would form about last third in snout length. Lips very broad and greatly papillose, and papillæ bordering jaws much larger. About 66 small, simple, slender, clavated, and slightly crooked teeth in transverse series in upper jaw, and about same number of similar ones, more bent over at ends, in lower jaw. Ramus of mandible slightly less than eye. Upper jaw with 3 fleshy papilliferous flaps inside, median much larger. Inner buccal fold very broad and free. Externally each side of disk forms small pointed barbel. Nostrils in moderate-sized depression, together, formed just before front orbital edges, anterior with broad cutaneous flap mostly concealing posterior. Interorbital generally level, with lengthwise shallow depression each side of median line.

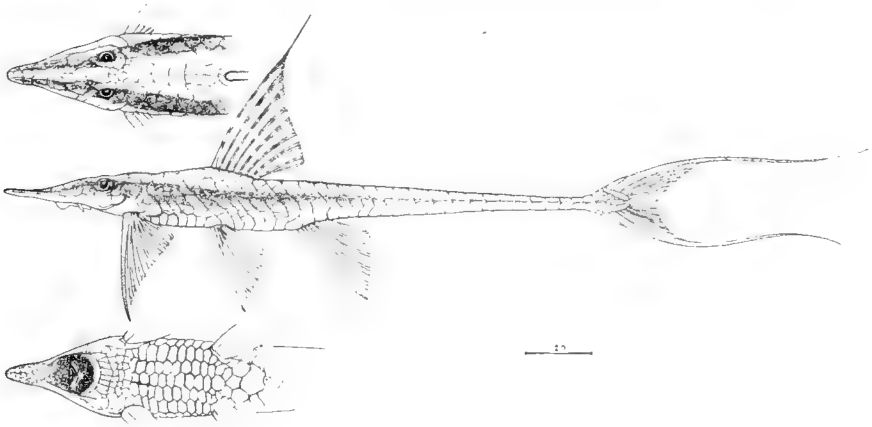

Fig. 18.—*Sturisoma monopelte* Fowler. (Type.)

Gill-opening small, restricted, lateral, extends forward about opposite first $\frac{2}{5}$ in eye and extends behind latter nearly half an eye-diameter.

Scales, or scutes, all minutely spinescent. Predorsal region with 4 scutes to occipital. Five series of scutes transversely across belly, each outer series of larger ones. A single scute interposes each side medianly between anal plate and preanal plate.

Dorsal origin about first third in space between snout tip and caudal base, spine ends in filament extending back slightly less than half way to caudal base. Anal inserted well behind dorsal base or about midway between snout tip and thirty-second lateral scute, flexible spine, reaches $3\frac{2}{5}$ to caudal base. Caudal small, upper and lower, or outer, rays produced in filaments, latter at least $\frac{2}{5}$ rest of body length, and fin deeply forked. Pectoral with flexible spine extends slightly beyond ventral origin. Ventral inserted opposite dorsal origin, spine flexible, extends back slightly beyond anal origin. Vent midway in space between ventral and anal origins.

Color in alcohol brownish above, with dark lateral streak or ill-defined band extending along each side of snout from tip, including eye, embracing region of obsolete upper and distinct median lateral keels and then continued externally along edge of caudal peduncle where, however, narrow. Lower surface of snout dusky. Entire lower surface of head and body otherwise pale brownish to whitish. Fins all pale, dorsal obscurely mottled or blotched with pale dusky. Caudal with edges above and below, and filaments pale, median rays whitish, and posterior inner portions of both lobes more or less mottled dusky, that of lower nearly blackish and mostly uniform. Iris slaty.

Length 265 mm.

Type, No. 39,346, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

This species is closely related to *Sturisoma rostrata* (Spix) and, as compared with the specimen Cope recorded from the Peruvian Amazon as *Loricaria rostrata*,[21] differs in the coloration. Cope's example also shows the fins less produced and two plates each side imposing between plate containing vent and preanal.

(*Μόνος*, one; *πέλτη*, shield; with reference to the single interposed shield between ventral and anal plate.)

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[21] *Proc. Amer. Philos. Soc.*, Phila., XVII, 1878, p. 681.

BELONIDÆ.

Potomarrhaphis guianensis (Schomburgk).

Two examples, 107 and 172 mm.

SCIÆNIDÆ.

Plagioscion squamosissimus Heckel.

One example, 295 mm.

Pachypops furcræus (Lacépède).

One example 148 mm.

CICHLIDÆ.

Acaropsis nasa (Heckel).

Two examples, 60 and 110 mm.

Æquidens tetranemus (Heckel).

One example 80 mm.

Cichlasoma severum (Heckel).

Two examples, 125 and 160 mm.

Mesonauta festivius (Heckel).

Two examples, 115 and 108 mm.

Geophagus surinamensis (Bloch).

Two examples, 170 and 112 mm.

Geophagus jurupari Heckel.

Two examples, 150 and 110 mm.

Apistogramma ortmanni rupununi subsp. nov. Fig. 19.

Head $2\frac{3}{4}$; depth $2\frac{3}{4}$; D. XV, 7; A. III, 6, I; P. I, 11; V. I, 5; scales 22 in median lateral series to caudal base and 6 more on latter; scales 12 in upper branch of l. l.; 4 scales posteriorly in lower branch of l. l.; 3 scales between spinous dorsal origin and l. l.; about 8 scales transversely between origins of rayed dorsal and anal; 9 predorsal scales; head width 2 in its length; head depth at occiput about $1\frac{1}{5}$; snout 3; eye $3\frac{1}{2}$; maxillary $3\frac{1}{8}$; interorbital 4; mandible $2\frac{1}{3}$; last dorsal spine 2; third dorsal ray $1\frac{2}{5}$; third anal spine $2\frac{1}{5}$; third anal ray $1\frac{1}{5}$; least depth of caudal peduncle $2\frac{1}{10}$; caudal 1; pectoral $1\frac{1}{4}$; ventral spine $2\frac{1}{8}$; ventral fin $1\frac{1}{8}$.

Body rather elongately ovoid, well compressed, profiles similar, and deepest midway in length of depressed pectoral, edges all convex. Caudal peduncle well compressed, length about $\frac{2}{3}$ its least depth.

Head large, compressed, both profiles convex, upper more inclined, and nearly flattened sides slightly converging above, so that lower surface more broadly convex. Snout moderate, convex over surface and in profile, basal width about $\frac{3}{4}$ its length. Eye large, rounded, superior, its centre falling slightly before middle in length of head, and eyelids or edge free. Pupil circular, rather large. Mouth rather wide, small, or with short slightly curved and nearly horizontal commissure. Muzzle moderate, not especially protruded, and jaws equal. Premaxillary protractile. Maxillary rather small, extends well back towards eye beyond posterior nostril, though not quite to eye, well inclined and curved down below lower lip. Lips rather fleshy, form rather broad, free fold along each jaw edge. Jaws with villiform and nearly uniform teeth, arranged in band in each. Apparently no other teeth. Buccal folds inside mouth moderately wide. Tongue depressed, slightly pointed, and free around front edge. Mandible rather shallow, rami a little elevated inside mouth posteriorly, and surface convex. Nostrils small, anterior larger, about last third in snout length, and posterior inconspicuous, superior, and slightly before eye front, also slightly nearer together than outer pair. Interorbital convex. Hind preopercle edge nearly straight, slightly inclined backward. Membrane along hind edge of gill-opening moderate.

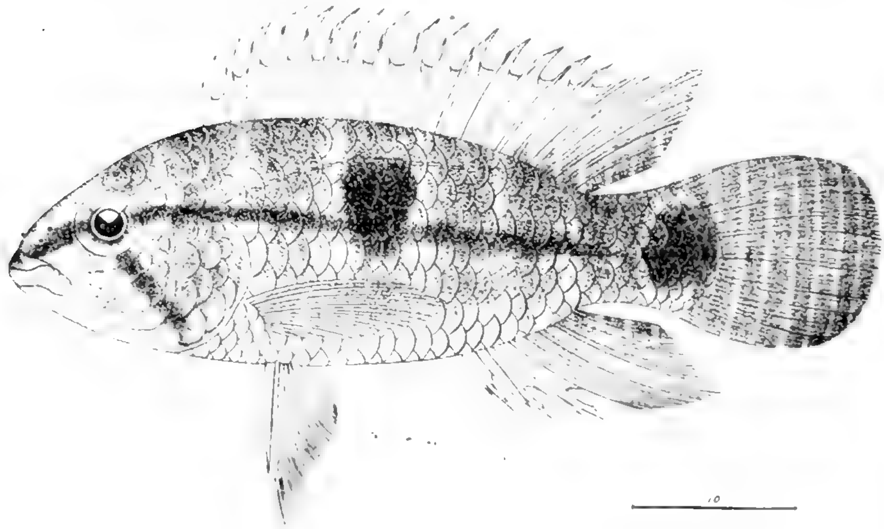

Fig. 19.—*Apistogramma ortmanni rupununi* Fowler. (Type.)

Gill-opening extends forward about last $\frac{2}{3}$ or nearly opposite hind eye edge. Rakers 1+4, short broad fleshy, or rather flexible, tubercles, about 4 in gill-filaments. Latter 2 in eye. Suprapharyngeal pad at epibranchial of first gill-arch well developed. No pseudobranchiæ. Isthmus convex, mostly concealed by broad branchiostegal membrane. Branchiostegals slender, outer much longer.

Scales large, well exposed, finely ctenoid, arranged in lengthwise series, and slightly smaller on breast than elsewhere on trunk. Fins scaleless, except caudal base, and latter covered with many small scales. Head largely scaly. Cheek with 3 rows of scales. Occipital scales extend forward to middle of interorbital. Opercles and subopercles scaly. Head otherwise naked. No axillary scaly flaps. Pores on preopercle, lower cheek, suborbitals, muzzle, and interorbital small and in moderate number. L. l. interrupted, or of two divisions, upper longer, at first 3 scales from spinous dorsal origin but soon separated from spinous dorsal base by one scale, and in posterior portion of its extent by only half a scale. Lower or posterior division of l. l. median along caudal peduncle, with tubes only over 4 scales, being preceded by 3 punctures on as many scales, and no tubes or punctures, continued posteriorly, or on caudal base. Tubes all simple, well exposed, or extend whole extent of each scale exposure.

Spinous dorsal inserted nearer snout tip in vertical than spinous anal origin, graduated up from first or shortest to fourth, after which more or less subequally long to posterior ones, which longest. Edge of spinous dorsal deeply notched, and edge of each membrane forms produced longer free point. Rayed dorsal with posterior median rays longest, form a produced point, begins about opposite of origin of lower l. l., and edge entire. Spinous anal begins about opposite end of upper branch of l. l., spines graduated to third or longest, edge of fin with cutaneous points similar to those of spinous dorsal. Rayed anal similar to rayed dorsal, its origin also about opposite. Caudal with hind margin nearly truncate or very slightly convex, fin elongate in contour. Pectoral broad, median upper rays longest and depressed fin extends back about opposite vent. Ventral inserted close after pectoral base, spine extends $\frac{1}{3}$ to anal origin, while tip of first ray reaches rayed anal origin. Vent close before anal.

Color in alcohol largely deep brownish on back, becoming paler only on lower or under surface of head and abdomen. General tint at present with more or less swarthy appearance. Along side of snout, from its tip, then continued behind eye in straight horizontal line, a black streak or line, and not continued behind to caudal peduncle, but terminating above first two tubes of lower branch of l. l. Slightly posterior from lower eye edge a dusky streak extends obliquely across cheek to subopercle. Suborbital chain also marked by broad-angled dusky streak, its point of divergence at beginning of oblique dark streak extending across cheek. Several irregular broken streaks or blotches of brownish on forehead. About eight broad obscure transverse bands, at present ill-defined and somewhat irregular as to boundaries. From pectoral base they appear still more obsolete as a lengthwise dusky shade, hardly a streak or band, extending horizontally back toward caudal base. Third obsolete transverse band, between upper l. l. and median lateral streak, set out as large blackish blotch. Caudal base with large blackish blotch, about equal to eye in size. Iris slaty. Fins all with dull dusky-gray ground-color, and only ventral slightly paler. Rayed dorsal with eight or nine vertical pale dusky streaks, of same general tint of spinous portion of fin, and extending mostly on basal and posterior portion of fin. Rayed anal with similar streaks, about six in number. Caudal with nine similar streaks, though first two interrupted by basal spot, and all streaks parallel and slightly inclined forward. Other fins unmarked.

Length 54 mm.

Type, No. 39,347, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Another example, No. 39,348; A. N. S. P., paratype, same data. Head $2\frac{3}{4}$; depth $2\frac{3}{4}$; D. XIV, 6; A. III, 6, I; scales 21 in median lateral series to caudal base, and 6 more on latter; 14 scales in upper branch of l. l.; 5 scales in lower branch of l. l.; 9 predorsal scales; snout $3\frac{1}{16}$ in head; eye $3\frac{1}{5}$; maxillary 3; interorbital $3\frac{3}{4}$; length 50 mm.

This species is closely related to *Apistogramma ortmanni* (Eigenmann), though differs in coloration, the black superiorly median lateral blotch not being present in that species according to the figure and description.[22]

(Named for the Rupununi River.)

Cichla ocellaris Schneider.

Two examples, 183 and 105 mm.

Crenicichla lugubris Heckel.

One example 285 mm.

Crenicichla alta Eigenmann.

One example 163 mm.

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[22] *Mem. Carnegie Mus.*, V, 1912, p. 506, Pl. 68, fig. 1.

Crenicichla pterogramma sp. nov. Fig. 20.

Head $2\frac{3}{4}$; depth $4\frac{2}{5}$; D. XVIII, iii, 11, i; A. III, 10, i; P. i, 15; V. i, 5; scales about 60 in median lateral series to caudal base, and about 6 distinct on latter; 23 scales in upper branch of l. l.; 11 scales in lower branch of l. l. before caudal base, and 2 more on latter; 8 scales between origin of spinous dorsal and l. l.; 4 scales between origin of rayed dorsal and upper l. l.; 12 scales in vertical series between origin of spinous anal and upper l l.; 19 predorsal scales; head width $2\frac{1}{4}$ in its length; head depth at occiput 2; mandible 2; last dorsal spine 3; seventh branched dorsal ray $1\frac{2}{5}$; third anal spine 4; seventh branched anal ray $1\frac{1}{8}$; least depth of caudal peduncle 3; caudal 1; pectoral $1\frac{4}{5}$; ventral 2; ventral spine $3\frac{2}{5}$; snout $3\frac{1}{5}$ in head, measured from upper jaw tip; eye 5; maxillary $2\frac{3}{5}$; interorbital 4.

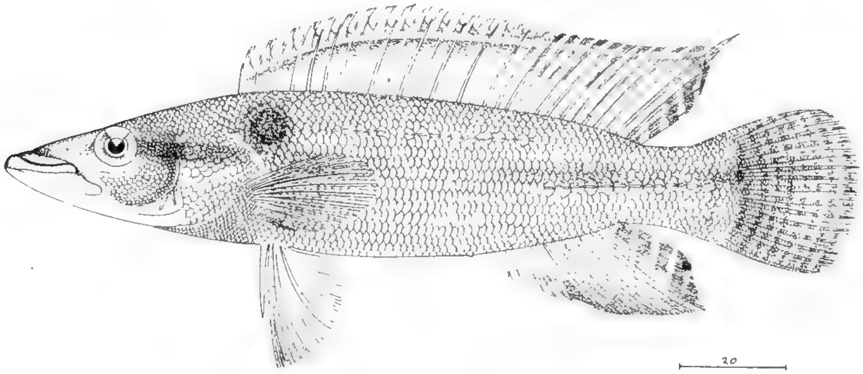

Fig. 20.—*Crenicichla pterogramma* Fowler. (Type.)

Body elongate, compressed, rather slender, deepest about midway in depressed ventral length, and edges all convex. Caudal peduncle well compressed, length about $\frac{4}{5}$ its least depth.

Head large, compressed, conic, upper profile straight from snout tip nearly to spinous dorsal origin, lower profile similar, convex sides not constricted above or below. Snout broad, rather depressed, surface convex, length about $\frac{7}{5}$ its basal width. Eye large, rounded, close to upper profile, its centre near first $\frac{2}{5}$ in head length as measured from snout tip. Eyelids free, not adipose-like. Pupil large, circular. Mouth large, wide, with horizontal commissure. Premaxillary protractile. Maxillary rather large, reaches back little inclined till slightly past front of eye, though not quite opposite front edge of pupil, received below preorbital. Lips fleshy, rather broadly folded above and narrow below. Jaws with broad bands of small or fine uniform conic teeth, largely depressible and directed inwards. No other teeth. Buccal folds inside mouth moderately broad. Tongue depressed, attenuate, and free in front. Mandible broad, shallow, well produced in front beyond snout tip, rami not elevated inside mouth, though outer lip forms broad fleshy pocket to receive upper at rictus. Nostrils simple, lateral or on side of snout about last third its length. Interorbital level. Preopercle with entire edge, slightly inclined forward above. Opercle ends in rather pointed cutaneous flap above.

Gill-opening extends forward about opposite last $\frac{2}{5}$ in eye. Rakers, 1+12 asperous short broad tubercles, about 3 in gill-filaments. Latter about 1$\frac{3}{4}$ in eye. Isthmus narrow, constricted, surface convex. Branchiostegals slender, outer longer, and membrane rather broad across isthmus.

Scales large, well exposed, smooth on head, predorsal region, and region embracing bases of dorsal fin, though this greatly narrowing posteriorly, also on breast and belly, other regions with finely ctenoid scales. Fins scaleless, except caudal base, and on latter scales smooth and quite small. Cheek with 9 series of scales. Occipital scales extend forward only to hind edge of interorbital. Opercles and subopercles scaly. Head otherwise naked, though with a number of mucous pores, especially above. L. l. interrupted, or in two divisions, upper much longer, scales larger than those surrounding. Upper division of l. l. concurrent with dorsal profile, replaced below by median lower division. Tubes simple, and all well developed or extending completely across exposure of scale.

Spinous dorsal inserted about midway between snout tip and seventeenth dorsal spine base, first spine shortest and all others graduated up to twelfth and then subequal, though last spine longest. Edge of spinous dorsal with membranes ending in cutaneous points, free and projecting above tips of spines. Rayed dorsal higher than spinous portion, rays graduated to fourth and fifth branched, which longest and produced in filamentous point, edge of fin entire. Spinous anal inserted slightly before second simple dorsal ray base, spines graduated up to third which longest, and edge of fin with cutaneous points like spinous dorsal. Rayed anal with seventh branched anal ray longest, preceding rays subequally shorter, and edge of fin entire. Caudal rounded, elongate. Pectoral broadly expanded, median rays longest, and fin depressed extends slightly less than half way to anal origin. Ventral inserted close behind anal base, spine pungent or about $\frac{3}{5}$ length of fin, and latter depressed half-way to anal. Vent falls about last $\frac{2}{5}$ in space between depressed ventral tip and anal origin.

Color in alcohol largely dull brownish, paler below. A dark or dusky lateral streak extends from hind eye edge back to median caudal base, though in position parallel and just above posterior or lower branch of l. l. At its termination on caudal base a black pale-edged ocellus not much larger than pupil, and another on fourth to sixth scales of l. l. about equal to eye in size. Vertical fins grayish, dorsal paler basally, and subterminally lengthwise pale or whitish streak its entire length and extending back to point of rayed fin. Last dorsal rays with about four transverse whitish streaks. Anals with lower edge dusky, and upper posterior half of fin with about six whitish transverse streaks. Caudal grayish, lower edge darker, and with about six transverse whitish streaks. Ventral and anal whitish. Iris slaty. Lower surface of head pale.

Length 162 mm.

Type, No. 39,349, A. N. S. P. Rupununi River, British Guiana. J. Ogilvie.

Only the type known. Apparently related to *Crenicichla saxatilis* (Linnæus) and *C. alta* Eigenmann, though differs at once in coloration.

(*Πτερον*, fin; *γραμμή*, line; with reference to the pale submarginal streak on the dorsal fins.)

TETRODONTIDÆ.

Colomesus psittacus (Schneider).

Three small examples.

SOLEIDÆ.

Achirus lineatus (Linnæus).

Two examples.

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CONTRIBUTION TO THE ANATOMY OF THE ILYSIIDÆ.

BY JOSEPH C. THOMPSON, SURGEON, U. S. N.

Three species of this family have recently been the subjects of an autopsy. A few additional secondary characters have been learned, but none were of the primary importance of those already known, and which have been employed by Mr. Boulenger to maintain the group as a family.

The salient character found to be common to the three species studied, was the comparatively large diameter of the segment of the posterior vena cava that is just caudad to the heart. A generic character of rather an unusual nature was found in *Cylindrophis*, consisting of a bridge of connective tissue in the floor of the mouth, that extends between the sheath of the tongue and the lip.

Ilysia scytale (Linnæus).

This species has been made the subject of several pages by Dr. Beddard.[1] The characters of an example just studied conform with those touched on in the article, with the exception of the position of the liver. By Dr. Beddard, this organ was found to commence "just at the heart as in Vipers." In the present example the anterior tip of the liver was 37 mm. posterior to the apex of the heart.

A comparison of the measurements brings out the point that the only difference between the two specimens is in the position of the liver.

Specimen.—	Collection of Dr. Beddard.		Brit. Museum Exchange Series.	
	Male.		Female.	
Sex.	mm.	Per cent.	mm.	Per cent.
Total length	495	100	480	100
Apex of heart	115	23.2	125	26
Liver, anterior tip	115	23.2	162	33.7
Liver, posterior end	293	59	295	61.5
Gall-bladder	356	71.8	345	72
Kidney, right:				
Length	23		20	
Distance from cloaca	21		30	
Kidney, left:				
Length	21		15	
Distance from cloaca	11		21	

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[1] *Proc. Zool. Soc. London*, 1906, vol. I, p. 31.

Specimen.—Brit. Mus. Ex. No. 19a. South America. Female: total length 480, tail 20 mm.

Squamation.—The number of scale rows, the sequence in which they are added, suppressed, and the gastrostege level at which these changes occur, are as follows:

19 rows, VI row added, right 55th, left 53d gastrostege, making:
21 rows, V row ends, right 206th, left 202d gastrostege, leaving:
19 rows, VI row ends, right 220th, left 221st gastrostege, leaving:
17 rows, which are continued to the vent.

Gastrosteges 236; anal divided; urosteges 12 and a terminal scute, the first and second paired, the remainder entire. Frontal barely touching the occipital; supraocular larger than the parietal; supralabials 5, the third and fourth touching the ocular shield; infralabials 5, the first pair the deepest and in contact behind the long mental; a single pair of large geneials which are not in contact; three azygos gular shields.

Anatomy.—The *tracheal cartilages* terminate at the level of the 61st gastrostege. The *tracheal membrane* is narrow and is not lined with pulmonary tissue. The *right lung* extends from the 57th to the 135th gastrostege; it is 152 mm. long, and lined throughout with pulmonary tissue. There is a small free apex, 2.5 mm. long, that extends to the 57th gastrostege; it is in relation with the right side of the trachea, and the lumen is continuous with that of the lung. The lung terminates in a blunt end which is 3.3 mm. in diameter. The *left lung*, 5.5 mm. long, extends from the 58th to the 61st gastrostege. It is in relation above with the end of the trachea and the right lung, to the right with the apex of the heart and the inferior vena cava, below with the ventral wall of the pleural cavity, and to the left with the stomach. It is lined with pulmonary tissue throughout. The *left bronchus* opens from the ventral side of the trachea opposite the 60th gastrostege. It enters the lung at the junction of the middle and the posterior one-third. The *liver* in this species and in *Cylindrophis rufus* is peculiar in that macroscopically it appears finely reticulate, with lines composed of minute black dots.

The anterior portion of the liver from the tip to the level of the 126th gastrostege is composed of the left lobe, along the right side of which courses the large inferior vena cava. At the 126th gastrostege this vessel begins to furrow the ventral and left side of the liver and divides the organ into right and left lobes. These lobes continue posteriorly; the right, which is 6 mm. the longer, terminating at the 147th, and the left at the 144th gastrostege.

The coiled portion of the *ileum* terminates at the 209th gastrostege; the remainder, 9 mm. in length, is straight.

The *ileo-cæcal valve* is at the 214th gastrostege.

The *cæcal pouch*, 8.5 mm. long, extends from the 214th to the 209th gastrostege; it lies between the right oviduct and the terminal straight portion of the ileum.

The junction of the ileum and cæcum, and the cæcal pouch are subject to a wide range of variation in different species, and are worthy of being recorded in detail.

The *posterior vena cava* is anomalous owing to its large diameter, which is 2.5 mm. Upon opening the cœlum, just caudad to the heart, this vessel appears as if it were the liver. The illusion is increased as just posterior to the apex of the heart this vein is sharply flexed towards the dorsal wall, and from below, this bend looks exactly like the blunt tip of a liver.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:

		Per cent.
Total number of gastrosteges	236	100
Apex of heart	59	25
Liver, anterior tip	78	33
Liver, posterior end	147	62.2
Gall-bladder, centre	171	72.5
Kidney, right, anterior tip	210	88.8
Kidney, right, posterior end	220	93
Kidney, left, anterior tip	216	91.5
Kidney, left, posterior end	226	95.8

The scale formula in this specimen is abnormal. It will be noted that the first row to be added was the VI, and the first to be suppressed was the V, and the next to be dropped was the VI. The normal condition would have been for the VI to be the first suppressed followed by the V.

Over five hundred specimens of various species have recently been investigated for this scale formula character. In the normal state, when a certain scale row is added anteriorly and further along the body begins to taper and a reduced count occurs, this reduced count is regularly brought about by the suppression posteriorly of the same scale row that was added. Where several rows are added and later these are suppressed, the sequence of suppression is regularly in an inverse order to that in which they appeared.

The scale formula of a different specimen having 226 gastrosteges was as follows:

19 rows, VI added, right 52d, left 52d gastrostege, making:
21 rows, VI ends, right 199th, left 194th gastrostege, leaving:
19 rows, which are continuous to the vent.

CYLINDROPHIS Wagler.

Since the publication of the *Catalogue of the Snakes in the British Museum,* there have been described two new[2] species belonging to the Ilysiidæ. Both of these new forms are in the genus *Cylindrophis,* the species of which may be distinguished as follows:

I—Diameter of the eye about half its distance from the nostril.
  Interocular width more than the length of the snout .... *rufus.*
  Interocular width equal to the length of the snout .... *isolepis.*
II—Diameter of the eye one-third to one-fourth its distance from the nostril.
  A—Ventrals not twice as large as the contiguous scales.
    Scales in 23 rows .... *opisthorhodus.*
    Scales in 21 to 19 rows .... *maculatus.*
  B—Ventrals nearly twice as large as the contiguous scales.
    Scales in 21 rows .... *lineatus.*

Cylindrophis rufus (Laurenti).

Specimen.—California Acad. Sci., No. 33,054. Sarawak, Borneo. Male; total length 454, tail 11 mm.

Squamation.—The number of scale-rows on the body, the sequence in which they become suppressed, and the gastrostege level at which they terminate are as follows:

Neck:
21 rows, IV row ends, right 8th, left 8th gastrostege, leaving:
Body:
19 rows, V row ends, right 195th, left 190th gastrostege, leaving:
17 rows, which are continued to the vent.

Gastrosteges 202; anal divided; urosteges 6, second and fourth divided, the remainder entire. Præfrontal enters the eye; frontal larger than the supraocular, larger than the parietal, longer than its distance from the rostral; a small postocular; supralabials 6, the third and fourth entering the eye; infralabials 6; a single pair of geneials; one pair and two azygos gular shields.

Anatomy.—The *tracheal membrane* is narrow and is not lined with pulmonary tissue. The *trachea* terminates just caudad to the left bronchus. The right *intrapulmonary bronchus* terminates at the 61st gastrostege. It appears as the narrowed continuation of the

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[2] *Cylindrophis isolepis* Boulenger, 1896, *Ann. Mag. Nat. Hist.*, (6), vol. XVIII, p. 62, Jampea, Id.
C. opisthorhodus Boulenger, 1897, *loc. cit.*, vol. XIX, p. 505, Lombok.

trachea. At first it is a gutter of bronchial tissue, from the edges of which the ends of the cartilages project into the lumen of the lung for a distance of .3 mm.

The right lung extends from the 54th to the 114th gastrostege. It is lined with pulmonary tissue to about the 100th gastrostege; the terminal portion ends as a blunt and stout-walled anangious air-sac. There is an *apex,* 2.5 mm. long, and adherent to the right side of the trachea. The wall between the apex and the trachea is formed of pulmonary tissue alone, there being no fibrous tissue dividing the two structures. The lumen of the apex opens into the lung by a simple tube that is pentagonal in shape and appears to be a single air-cell that is deeper than the rest.

The *left lung,* 6 mm. long, is lined with air-cells. The bronchus, at the level of the 58th gastrostege, is a minute opening from the ventral wall of the trachea.

The left lobe of the *liver* extends from the 73d to the 111th gastrostege. At this point the posterior vena cava begins to furrow the organ and to form the right lobe. Posteriorly the two lobes end nearly at the same level, the right being but 1.5 mm. the longer.

The *gall-bladder* is 6 mm. long. The *cystic duct* flows forward for 1.5 mm., and is composed of several tubes. The *hepatic duct* divides into several branches; these anastomose with the cystic duct to form a complex rete which is 7 mm. long and flows anteriorly to enter the pancreas. The usual condition in serpents is for the hepatic and cystic ducts to join posteriorly to the gall-bladder.

The *ileum* is lined with fine longitudinal folds. The last loop is at the 172d gastrostege; from this point it is nearly straight. At the 176th gastrostege there is a sacculated dilatation 3 mm. long and about one-half again the diameter of the gut. The walls are thin and pellucid and the lining is smooth.

The *cæcum* is lined with deep longitudinal plicæ and there are no transverse septal folds. The *ileo-cæcal* valve is at the 193d gastrostege. The cæcal pouch is small, being 2.5 mm. long and of about the same diameter; it lies dorsad to the ileum.

The *intercostal arteries* are regular, being one for each space. Each arises as a single artery that bifucates below the median line, one fork entering on either side.

The *teeth* are of moderate size; the *maxillary* bears 11, the palatine 6, the pterygoid 5, and the dentary bone 12 teeth.

The *floor of the mouth* presents unusual conditions. The mandible bends towards the median line, and the anterior tip of the dentary bone protrudes through the floor of the mouth for a distance of 1 mm. The tip is covered with pad of fibrous tissue and the mucous membrane. The opening of the sheath of the tongue is 3 mm. from the lip. A tough band of fibrous tissue, which is furrowed above for the tongue, extends between this opening and the lip. This band is attached anteriorly and posteriorly; beneath it is free and forms a bridge under which an instrument may be passed. Between the anterior attachment of this bridge and the tip of each dentary bone, is an opening into a pouch which lies on either side of the median line. Each pouch is covered above by the mucous membrane of the mouth, and extends posteriorly to the level of the opening of the sheath of the tongue. These pouches are in communication with each other beneath the bridge of connective tissue that extends from the opening of the sheath of the tongue to the lip.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:

		Per cent.
Total number of gastrosteges	202	100
Apex of heart	58	28.7
Liver, anterior tip	73	36.2
Liver, posterior end	128	63.5
Gall-bladder, centre	138	68.5
Testis, right, anterior tip	150	74.4
Testis, right, posterior end	155	77.1
Testis, left, anterior tip	162	80.2
Testis, left, posterior end	167	82.8
Kidney, right, anterior tip	172	85
Kidney, right, posterior end	186	92
Kidney, left, anterior tip	176	87
Kidney, left, posterior end	190	94

In this species it will be noted that the scale-row count of 21 terminates well forward on the neck, and that the count of 19 persists nearly to the vent.

A uniform scale-row count over the entire body is found in two types of serpents. It occurs in those with cylindrical bodies in which there is no reduction of the diameter posteriorly and also in those in which the body tapers posteriorly. The majority of those in the latter category are in widely separated genera belonging to the Colubridæ. These genera with tapering bodies have one character in common and that is the scale-row count is regularly a low one, being usually 17, 15, or 13 rows throughout. In these serpents the scales accommodate themselves to the narrowing of the body by becoming smaller.

In the majority of species the tapering of the body is associated with a reduced scale count posteriorly. In each species this reduced scale count is brought about by the loss of definite scale rows. The discovery of this phenomenon was made by Mr. Ruthven while studying the genus *Thamnophis*.[3]

Two additional characters bearing on this subject may be entered into. If a series of one species is critically recorded, it will be found that not only is there a definite sequence of suppression, but that a given scale row terminates at about the same relative position on the spinal column in each specimen. Also, that the suppression of a scale row is in fairly definite relation to the posterior end of an underlying organ.

It is to be understood that these two characters are stated in general terms. Barring individual variation, for which no allowance can be made, they will be found to hold with satisfactory constancy.

Bibliography.—The original description of this species is contained on page 71 of the *Synopsin Reptilium* by Laurenti, published in 1768. In this work the serpent was named *Anguis ruffa.* Throughout literature it has been referred to by the emended name of *rufa.* It is probably only a question of time before some philologist will insist that the current term be again emended and that the original incongruous spelling be perpetuated.

Cylindrophis maculatus (Linnæus).

Specimen.—California Acad. Sci., No. 16,890. Ceylon.

Female; total length 330, tail 6.5 mm.

Squamation.—The number of scale rows, the sequence in which they are added or suppressed, and the gastrostege level at which these changes occur may be thus presented:

Neck:
19 rows, V row ends, right 10th, left 8th gastrostege, leaving:

Body:
17 rows, IV row added, right 39th, left 49th gastrostege, making:
19 rows, IV row ends, right 182d, left 184th gastrostege, leaving:
17 rows, which are continued to the vent.

Gastrosteges 194, in the middle of the body 3 mm. wide, adjacent scale row 2.5 mm. wide; anal divided, urosteges 5, entire. Præfrontal the largest shield; one small postocular; supralabials 6, the third and the fourth entering the eye; infralabials 6; anterior genials large; one pair and two azygos gular shields.

Anatomy.—The *tracheal membrane* is narrow and is not lined with

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[3] 1908, *Bull. 61, U. S. National Museum.*

air-cells. The *right lung* extends from the 58th to the 98th gastrostege and is lined throughout with respiratory tissue. The *apex* is adherent at the trachea. The *left lung* is 5 mm. long and contains air-cells; anteriorly it is narrow and posteriorly broad and truncate. The left bronchus is at the 60th gastrostege and enters at the middle of the lung.

The *liver* begins at the 78th gastrostege. At the 91st gastrostege there is an S-shaped kink in the organ, the recurrent limb of which is 6 mm. long, and lies to the right and above the anterior portion. The liver reaches to the 113th gastrostege; at this point the end bends downward and forward for a distance of 3 mm. Whatever may have been the cause of the kink in the liver, it apparently in no way affected the right lung. The liver from the anterior tip to the first bend in the kink lies to the left and below the lung; the recurrent limb of the kink is ventrad to the lung; the liver posterior to the second bend in the kink lies to the right and below the lung. In other words, the lung is perfectly straight and lies at first to the right side, then above the kink, and finally to the left side of the liver. A similar flexure of the liver has been observed in a female *Tropidonotus vibakari* Boie, containing embryos that were nearly mature.

The *œsophagus* at the 96th gastrostege makes a Z-shaped bend; the recurrent limb of which is 4 m. long, and is directed forwards and to the left. This bend is in the horizontal plane and is just caudad to the S-shaped kink in the liver.

The *posterior vena cava* is of large calibre; it has two kinks, one just caudad to the left lung, and the other 8 mm. anterior to the tip of the liver.

Whether these kinks in the various organs are deformities or are part of the displacement of the viscera during the latter weeks of pregnancy is not certain.

The *ileo-cæcal* valve is at the 182d gastrostege. The *cæcal pouch* is 6 mm. long and the apex is at the 177th gastrostege. It is of the same diameter as the caecum and lies between the ileum and the right ovary.

The *teeth* are less in number than in *C. rufus*. The *maxillary* bears 8, the palatine 7, the pterygoid 4, and the dentary bone 11 teeth.

The *floor of the mouth* has the protruding tips of the maxillary bones and the two pouches on either side of the median line quite as described in *C. rufus*.

There are three *embryos;* these extend from the 118th to the 178th gastrostege. The growth of the anterior one has been aborted, evidently owing to pressure. The middle one has a yolk sac 25 mm. long, on the dorsal and anterior surface of which is coiled the embryo. The head is free, being beneath and anterior to the coils. The prevailing condition is for the head to be in the centre of the coils, where it is more protected. The total length of the embryo, when uncoiled, is about 45 mm. The tail measures 2 mm., which is longer proportionately than in the adult. Each rudimentary hind limb is free; it is held at right angles to the body and measures .5 mm. in length. The yolk sac of the posterior embryo measures 36 mm.

A well-nourished *fat-body* lies between the bend in the œsophagus and the first embryo.

The *external landmarks* of the principal viscera in terms of gastrosteges are as follows:

		Per cent.
Total number of gastrosteges	194	100
Apex of heart	60	30.9
Liver, anterior tip	78	40.2
Liver, posterior end	113	58.2
Gall-bladder, centre	116	59.8
Kidney, right, anterior tip	172	88.7
Kidney, right, posterior end	181	93.1
Kidney, left, anterior tip	178	90.8
Kidney, left, posterior end	185	95.2

In these three species a comparison of the position of the viscera in terms of percentage down the spinal column may be presented:

Species.—

	Ilysia scytale.	*Cylindrophis rufus.*	*Cylindrophis maculatus.*
Sex.	Female.	Male.	Female.
Spinal column	100	100	100
Apex of heart	25	29	31
Liver, anterior tip	33	36	40
Liver, posterior end	62	63	58
Gall-bladder	72	68	60
Kidney, right, tip	89	85	89
Kidney, right, end	93	92	93
Kidney, left, tip	91	87	91
Kidney, left, end	96	94	95

To obtain this data the number of the gastrostege underlying a given anatomical point, counting from the first shield in the neck, is noted. This number is then divided by the total number of gastrosteges in the specimen, thereby giving the position in terms of percentage.

THE OLFACTORY SENSE OF HYMENOPTERA.

BY N. E. McINDOO, PH.D.

CONTENTS.

INTRODUCTION AND METHODS.

In the investigation here recorded three objects have been kept in view: (1) To determine physiologically the relative sensitiveness of ants and hornets to different odors, so that it may be expressed numerically for comparison under different conditions; (2) to locate the olfactory organs; and (3) to determine morphologically the relative sensitiveness of different species of Hymenoptera to odors. The study of the behavior of normal ants and hornets under experimental conditions is used as a basis for correctly interpreting the observations on these insects made abnormal for the purpose of obtaining data which concern the first two objects in view.

Many entomologists have had something to say about the seat of the organs of smell in insects, but most of the views are purely speculative. A few have done extensive and thorough experimental work to determine the location of this sense. However, since they have failed to study sufficiently the behavior of the insects investigated, the responses observed have misled them in determining the seat of the olfactory organs. It is now generally believed that the antennæ bear the organs of smell, but as all the antennal organs are covered with a hard membrane the objection has been raised that such organs cannot receive olfactory stimuli. Hicks (1857) discovered some peculiar organs on the bases of the wings and on the legs of insects and suggested that they have an olfactory function. The writer (1914) made a comprehensive study of these organs in the honey bee. He experimentally proved that they have an olfactory function and for this reason called them olfactory pores. The present paper embodies the results of a comparative study on Hymenoptera in much the same manner as pursued on the honey bee.

To obtain material for the study of the disposition of the organs described by Hicks, adult specimens were used. The legs and wings were pulled off at their articulations, and the thoraces and abdomens were slit open. These parts were put into a cold saturated solution of caustic potash, where they remained one to three days, depending on the size of the material.. When removed from this solution the material was washed thoroughly in water and then was decolorized with chlorine gas in the following manner: A small quantity of potassium chlorate was put into a small wide-mouthed bottle. All the parts belonging to a specimen were loosely wrapped in a small piece of cheesecloth which was suspended in the neck of the bottle. Then a pipetteful of hydrochloric acid was dropped upon the potassium chlorate in the bottom of the bottle. At once chlorine gas was liberated which soon bleached the dark colored specimen.

To obtain material for the study of the internal anatomy of the organs herein discussed, pupal insects were mostly used. The appendages and bodies of the pupæ were cut into small pieces, which were immediately dropped into Carnoy's fluid (equal parts of absolute alcohol, chloroform, and glacial acetic acid, with corrosive sublimate to excess). For embedding, the double method of celloidin and paraffin was employed. Serial sections cut six and ten microns thick were stained with Ehrich's hämatoxylin and oesin. For further details in regard to technique the reader is referred to the writer's work on the honey bee.

The writer is indebted to the following persons: to Messrs. J. C. Crawford, H. L. Viereck and S. A. Rohwer of the U. S. National Museum and the Bureau of Entomology for all the dried specimens used; to Mr. Rohwer the writer is particularly grateful for the systematic arrangement and names of most of the specimens included in the table, pages 330 to 334; to Mr. Theo. Pergande for identifying the ants used; to Miss Mabel Colcord for assistance in obtaining references; and to Emma Pabst McIndoo, the writer's wife, for translating some of the foreign works.

A. THE OLFACTORY SENSE OF ANTS AND HORNETS.

In order to keep ants in the laboratory, several modified Fielde ant nests were constructed. Colonies of various species were confined in these nests. The behavior of the ants in the nests was carefully studied and this behavior was used as a standard for judging the behavior of all the ants used singly in the various experiments. Many females of *Camponotus*[1] were found in rotten stumps and logs in the woods. Some of them had no eggs, some had only a few eggs, while others had several eggs, a few larvæ, and a few pupæ. Each female with her own brood, if brood was found in her nest, was put into a honey-bee queen cage. This cage is 3½ inches long, 2½ inches wide and ¾ inch deep.

To study the behavior of one colony of *Formica obscuriventris* Forel in surroundings more natural than those afforded by using Fielde nests, a large glass cage with four compartments was constructed. The nest portion of the cage was 10 inches long, 10 inches wide and 16 inches tall. The entrance of the nest was 10 inches long, 10 inches wide and 8 inches tall. This compartment was raised 8 inches above the table so that one end of it connected with the upper half of one side of the nest. The run-way was 8 inches long, 4 inches wide and 1 inch deep. This was also supported 8 inches above the table. One end of it connected with the distal end of the nest entrance and the other end connected with the fourth compartment, the manger.

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[1] Here as elsewhere in this paper unless otherwise indicated is meant the large brownish variety of *Camponotus pennsylvanicus* Say.

The manger, or feeding compartment, was 10 inches long, 8 inches wide and 8 inches tall. It and the nest were not elevated above the top of the table. The tops and bottoms of all four compartments were glass, except the bottom of the run-way, which was perforated tin. To make the bottoms of the nest and manger watertight an additional bottom made of plaster of Paris was added to each of these compartments. The joints of the cage were so securely covered with adhesive cloth and the tops fitted so snugly that vapor collected on the tops and was transformed into large drops of water. A large colony of *Formica* was found in a rotten log. A half-bushel of the rotten wood and perhaps a quart of the ants with brood of all stages were placed into the nest of the cage.

A large flat piece of cotton wet with water was constantly kept in each Fielde nest. A small piece of cotton was kept in each queen cage, and a small amount of water was occasionally poured upon the wood in the nest and twice a week water was put into the manger. Honey, sugar syrup, queen-cage candy, live insects, and larvæ of various insects served as food.

I. Experiments on Normal Ants and Hornets.

To determine the relative sensitiveness of females, males, and workers to various odors, under conditions which permitted of their close observation, triangular experimental cases were used. These were made of three narrow wooden strips, two of which were 5 and the third 4 inches long, each strip being half an inch thick. Wire screen served as a bottom and glass as a top for the case. The apices and bases of these cases rested on two supports above a rigid table and the table legs rested on a concrete floor, near a window. Cheesecloth was spread across both supports, thus making a double bottom for the cases. No screen was used to prevent the ants from seeing the observer because they never showed any responses to the movements made by the observer.

The following sources of odor were used for determining the reactions of the ants in the observation cases: Chemically pure essential oils of peppermint, thyme, and wintergreen; food—honey and comb, parts of plant leaves, and bits of the stem of pennyroyal (*Hedoma pulegioides* ?); ant secretion—formic acid. All these substances except the last were kept in stoppered vials of the same shape and size. The leaves and bits of the stem of the pennyroyal were dried, but they still gave off a strong odor when the vial was uncorked. The formic acid was obtained by squeezing the abdomen of a large worker of *Formica* or of *Camponotus*. This caused the ant to discharge all of the formic acid stored up and some of it lodged on the tip end of the abdomen. The liquid on the abdomen gave off a penetrating odor which lasted four or five minutes.

An ant or hornet was carefully removed from its nest or cage and was placed into one of the experimental cases. When first put into the case the insect usually wandered about for several minutes, but finally became quiet. The insect was tested with each of the above odors only when it became perfectly quiet, without even the antennæ being moved in the least. The stopper of a vial was quickly removed and the vial was gently and slowly placed under the experimental case directly beneath and within one-half inch of the individual being tested. Occasionally the vial was placed a few inches in front of the specimen, to test its ability of smelling for a short distance. When using the odor from the formic acid, the ant whose abdomen carried some of this acid was held by a pair of forceps under the experimental case in the same position in which a vial was held. When all of these precautions were taken, a normal ant or hornet responds to anyone of these odors without failure. As a control, an empty and odorless vial was now and then placed under the insects in the same manner. If by chance an ant or hornet moved while the control test was being made, its behavior was quite different from that observed when odors were used. Only the first responses have been recorded and in all cases where there was the least doubt as to whether the insect moved for any reason other than the olfactory stimulus, such movements were never recorded. The reaction time was counted in seconds. With an ordinary watch the minimam time which can be definitely recorded is two seconds, although most of the individuals responded to some of the odors much more promptly. Owing to this source of error, the average recorded time is probably double what it should be in the cases when the response was prompt. An intermission of 10 minutes elapsed between any two tests in the same experimental case. A few individuals were tested twice with the same odor, but most of them were tested only once.

In the following paragraphs are given the responses of the three castes of ants and of worker hornets to the odors of the six different substances and the average reaction times in seconds. In recording the responses the term "vibrated" is used to describe the rapid movement of the antennæ up and down or from side to side. When this movement is slow they are described simply as having "moved." Quite often an ant or hornet lies flat on its thorax and abdomen, so the word "arose" is to be interpreted as meaning that the insect gets up and stands on its feet. In the averages of reaction times the probable error is presumably high. It has not been calculated since slight differences in reaction time are not considered as significant in the discussion of results. All anthropomorphic terms are put in quotation marks.

1. *Winged females of Formica.*

Oil of peppermint:

10 vibrated antennæ.
7 vibrated antennæ and moved away.
5 moved away quickly.
2 arose quickly.
1 jumped toward odor.

Reaction time 2 seconds, average 2.00 seconds.

Oil of thyme:

8 vibrated antennæ.
8 vibrated antennæ and moved away.
3 arose quickly.
3 moved away quickly.
2 turned around quickly over odor.
1 moved slightly.

Reaction time 2–3 seconds, average 2.04 seconds.

Oil of wintergreen:

12 vibrated antennæ.
6 vibrated antennæ and moved away.
5 arose quickly.
1 vibrated antennæ and arose quickly.
1 moved away quickly.

Reaction time 2–3 seconds, average 2.32 seconds.

Honey and comb:

12 vibrated antennæ.
5 vibrated antennæ and turned around over odor.
3 vibrated antennæ and tried to get through bottom.
2 vibrated antennæ and moved away.
1 vibrated antennæ and moved toward odor.
1 moved toward odor.
1 moved quickly and tried to get through bottom.

Reaction time 2–5 seconds, average 3.00 seconds.

Leaves and stems of pennyroyal:
- 18 vibrated antennæ.
- 3 vibrated antennæ and arose quickly.
- 2 vibrated antennæ and turned around over odor.
- 1 vibrated antennæ and moved away.
- 1 arose quickly.

Reaction time 2–3 seconds, average 2.52 seconds.

Formic acid:
- 12 vibrated antennæ.
- 5 vibrated antennæ and turned around over odor.
- 3 vibrated antennæ and tried to get through bottom.
- 2 vibrated antennæ and moved head on bottom.
- 2 vibrated antennæ and arose quickly.
- 1 moved away quickly.

Reaction time 2–4 seconds, average 2.80 seconds.

The average reaction time of all six odors for 25 females tested is 2.45 seconds. These females were very restless and much time was spent while waiting for them to become quiet. These females and 23 more normal ones, making 48 in all, were put into a small wooden box half full of rotten wood. An equal number of sister females with their funiculi cut off were also put into the box at the same time. They were given food and water. The normal ants lived from 1 to 23 days with an average of 14 days and 10 hours. The mutilated females lived from 4 to 22 hours, with only 19 hours as an average.

2. *Winged males of Formica.*

Oil of peppermint:
- 4 vibrated antennæ.
- 4 raised antennæ.
- 2 arose slowly.
- 2 arose quickly.
- 2 turned around over odor.
- 1 jumped backward.
- 1 moved away quickly.
- 1 vibrated antennæ and arose quickly.

Reaction time 2–3 seconds, average 2.23 seconds.

Oil of thyme:
- 10 vibrated antennæ.
- 2 moved away quickly.
- 2 moved antennæ.
- 1 arose slowly.
- 1 arose quickly.
- 1 vibrated antennæ and moved away.

Reaction time 2–3 seconds, average 2.29 seconds.

Oil of wintergreen:
6 vibrated antennæ.
4 vibrated antennæ and moved away.
3 arose quickly.
1 arose slowly.
1 moved away quickly.
1 moved antennæ.
1 jumped away quickly.
Reaction time 2–3 seconds, average 2.12 seconds.

Honey and comb:
13 vibrated antennæ, some of these quite vigorously.
2 moved antennæ.
1 vibrated antennæ and moved legs.
1 vibrated antennæ and arose.
Reaction time 2–5 seconds, average 3.41 seconds.

Leaves and stems of pennyroyal:
7 vibrated antennæ.
4 moved antennæ.
2 vibrated antennæ and moved legs.
2 arose quickly.
1 raised antennæ.
1 jumped quickly.
Reaction time 2–4 seconds, average 2.82 seconds.

Formic acid:
11 vibrated antennæ.
2 vibrated antennæ and turned around over odor.
2 vibrated antennæ and moved away.
1 arose quickly.
1 moved antennæ.
Reaction time 2–4 seconds, average 2.94 seconds.

The average reaction time of all six odors for the 17 males tested is 2.63 seconds. These males were very quiet and were tested without any difficulty. Their longevity as normal ants is unknown, for they were used in another set of experiments after the wings had been pulled off.

3. *Winged males of Camponotus.*

Oil of peppermint:
9 moved away quickly.
8 vibrated antennæ.
3 arose quickly.
2 raised antennæ and moved away.
1 arose slowly.
1 vibrated antennæ and moved away.
1 moved backward quickly.
Reaction time 2–3 seconds, average 2.12 seconds.

Oil of thyme:
14 vibrated antennæ.
5 moved away quickly.
2 vibrated antennæ and moved away.
1 moved backward quickly.
1 arose quickly.
1 vibrated antennæ and moved one leg.
1 arose slowly.
Reaction time 2–3 seconds, average 2.48 seconds.

Oil of wintergreen:
8 moved away quickly.
7 vibrated antennæ.
4 vibrated antennæ and moved away.
4 arose quickly.
2 arose slowly.
Reaction time 2–3 seconds, average 2.28 seconds.

Honey and comb:
16 vibrated antennæ.
5 moved antennæ.
1 moved antennæ and moved backward.
1 arose quickly.
1 arose and vibrated antennæ.
1 vibrated antennæ and moved front legs.
Reaction time 2–7 seconds, average 3.68 seconds.

Leaves and stems of pennyroyal:
17 vibrated antennæ.
3 moved antennæ.
3 arose slowly.
1 arose quickly.
1 moved away quickly.
Reaction time 2–3 seconds, average 2.48 seconds.

Formic acid:
13 vibrated antennæ.
5 moved away slowly.
2 vibrated antennæ and arose slowly.
2 arose quickly.
1 moved backward slowly.
1 moved away quickly.
1 vibrated antennæ and moved away.
Reaction time 2–5 seconds, average 3.40 seconds.

The average reaction time of all six odors for the 25 males tested is 2.74 seconds. These males were very active and agile, but quite restful, and they were easily tested. They lived from 4 to 133 days, with 23 days and 9 hours as an average.

4. *Major workers of Camponotus.*

Oil of peppermint:

6 vibrated antennæ.
6 vibrated antennæ and moved away.
3 vibrated antennæ and moved backward.
3 moved antennæ and moved away.
3 arose quickly.
2 arose and worked antennæ.
1 raised antennæ.
1 arose slowly.

Reaction time 2–3 seconds, average 2.12 seconds.

Oil of thyme:

10 vibrated antennæ.
6 arose quickly.
4 moved away quickly.
2 moved antennæ and moved away.
2 raised antennæ.
1 arose quickly and vibrated antennæ.

Reaction time 2–3 seconds, average 2.40 seconds.

Oil of wintergreen:

8 moved away quickly.
6 vibrated antennæ.
3 arose quickly.
2 moved antennæ.
2 jumped backward quickly.
2 arose slowly.
1 moved antennæ.
1 tried to get through bottom.

Reaction time 2–4 seconds, average 2.44 seconds.

Honey and comb:

11 moved antennæ.
10 vibrated antennæ.
3 moved away slowly.
1 tried to get through bottom.

Reaction time 3–10 seconds, average 5.56 seconds.

Leaves and stems of pennyroyal:

12 moved antennæ.
9 vibrated antennæ.
2 raised antennæ.
2 moved antennæ and moved away.

Reaction time 2–5 seconds, average 3.40 seconds.

Formic acid:

10 moved quickly and tried to get at odor.
6 vibrated antennæ.
3 vibrated antennæ and turned around over odor.
2 vibrated antennæ and tried to get at odor.
2 moved away and vibrated antennæ.
1 jumped toward source of odor.
1 moved away slowly.

Reaction time 2–6 seconds, average 3.40 seconds.

The average reaction time of all six odors for the 25 large workers tested is 3.22 seconds. These ants were kept in a Fielde nest with many more workers and males. Between May 24 and July 5, 19 workers of various sizes had died. These 19 lived from 47 to 72 days, with 26 days and 8 hours as an average.

5. *Minor Workers of Camponotus.*

To ascertain if the smallest workers of a colony of ants respond as quickly to odor stimuli as do the largest workers of the same colony, 25 small workers were tested. These were sisters to the large workers just described and were taken from the same colony. The responses of the small workers to the six odors were similar to those of the large workers. In two instances when the ant was tested with honey and comb, it tried to get at the source of the odor. In one instance when the ant was tested with formic acid, it turned around quickly and turned up the abdomen as if going to discharge its own formic acid.

The reaction times for the 25 small workers are: oil of peppermint, 2–3 seconds, average 2.12 seconds; oil of thyme, 2–3 seconds, average 2.08 seconds; oil of wintergreen, 2–4 seconds, average 2.60 seconds; honey and comb, 2–10 seconds, average 4.84 seconds; leaves and stems of pennyroyal, 2–5 seconds, average 3.16 seconds; formic acid, 2–8 seconds, average 3.72 seconds. The average reaction time of all six odors for the 25 small workers tested is 3.09 seconds.

Only 2 soldiers were tested. They were sisters to the workers just described. Their reaction times are similar to those of the other workers.

6. *Females of Vespula maculata.*

A large hornets' (*Vespula maculata*) nest, containing many adult hornets and all stages of young, was suspended inside a large wire-screen cage. Twenty-five of the adult worker hornets were removed from the cage, and they were then placed singly into the experimental cases. A piece of queen-cage candy and a piece of cotton wet with water were also placed into each case. The hornets were not "at home" at all in these cases. They were extremely restless, wandered about inside the case for some time, and with their powerful mandibles tore the large piece of candy into many bits, but ate very little of it. All of those that failed to become quiet after such a confinement for a few hours were discarded and others were used. When tested with the three essential oils, they responded promptly. Most of the responses were similar to those of normal ants, but one characteristic response not observed, when experimenting with ants, was that the hornets seemed to notice the odor; this means that the hornet turned its head toward the floor of the case as if watching from whence the odor was coming, and sometimes it grabbed a wire in the bottom just above the top of the vial. If the hornets saw the vial during these tests they were compelled to see through both the wire-screen bottom and the cheesecloth bottom. It was also necessary to place a cheesecloth screen between them and the observer to prevent them from noticing the observer's movements. They were confined singly in these cases until they died. They lived from 16 hours to 17 days and 21 hours, with an average of 9 days and 7 hours. The reaction times are: oil of peppermint, 2–3 seconds, average 2.12 seconds; oil of thyme, 2–4 seconds, average 2.56 seconds; oil of wintergreen, 2–4 seconds, average 2.60 seconds. These give a general average of 2.43 seconds.

II. EXPERIMENTS ON ANTS AND HORNETS WITH MUTILATED ANTENNÆ.

Since it is now generally believed that the olfactory organs of insects are located in the antennæ, and to determine whether the olfactory organs of ants and hornets are located in these appendages, the antennæ were mutilated, the behavior of the mutilated insects was then studied, and later these insects were tested with odors as usual.

1. *Funiculi of ants cut off.*

The funiculi of 12 workers of *Formica* were cut off with a small pair of sharp scissors and these mutilated ants with 12 unmutilated normal sisters were placed into a Fielde nest. When a funiculus was cut off, a small drop of yellowish blood exuded from the wound. The mutilated ants when put into the nest cleaned off the exuded blood. They were slightly hostile to each other and to their unmutilated sisters. When a bee and a fly were put into the nest, the mutilated ants did not offer to catch the strange insects, but the unmutilated sisters lost no time in catching them. Only one of the 12 mutilated ants ate food, the other 11 stood quietly by the food as if ready to attack an enemy. All of the 12 unmutilated ants greedily ate the food.

Fifty workers of *Formica* were removed one at a time from the large glass cage. The funiculi of each were cut off and then the insect was returned to the cage. A small drop of yellowish blood exuded from every wound. Each mutilated ant was quite irritable and invariably attacked one or more sisters, and as a result several ants were killed.

The funiculi of 2 soldiers, 10 large workers, and 7 small workers of *Camponotus* were cut off. These mutilated sister ants were then put into a Fielde nest. For three hours thereafter they were quite irritable and fought each other, then they became very inactive and when tested with oil of peppermint, they responded slowly by moving away. The next day they were still quite inactive and "paid no attention" to anything, except when they came in contact with each other, they still fought one another. When tested with odors they failed to respond. At no time did they eat or drink.

The funiculi of 30 winged virgin females of *Formica* were cut off. When each antenna was severed a small pencil brush wet with 95 per cent. alcohol was applied to the wound for several seconds. This seemed to check the flow of blood, but did not stop it entirely. A half-hour after the funiculi had been cut off these ants were placed singly into the experimental cases. They wandered about inside the cases considerably, and when they stopped wandering they stroked the stubs of the antennæ incessantly and as a rule were very inactive. When tested with the three essential oils—peppermint, thyme, and wintergreen—their responses were less pronounced than were those of unmutilated ants. As a whole, their responses were uncertain, but were of the same nature as those of unmutilated ants. Sometimes, instead of giving the usual response, they moved or vibrated one or more legs. Sometimes an ant grabbed a wire in the bottom of the case and held on to it tenaciously and did not react at all to odors. Five of them failed to respond to odors and scarcely moved when touched with a pencil. These ants were discarded from the experiments. The other 25 were tested with the three essential oils. Their reaction times are: oil of peppermint, 2 10 seconds, average 3.08 seconds; oil of thyme, 2 15 seconds, average 4.48 seconds; oil of wintergreen, 2 20 seconds, average

5.60 seconds. These give a general average of 4.38 seconds, while the same average for unmutilated sister females is 2.12 seconds. Confined in a Fielde nest, these mutilated ants lived from 4 to 22 hours, with only 19 hours as an average. Since these ants were abnormal, it is reasonable to attribute the difference of 2.26 seconds in reaction time to the inactiveness of the insects, and it is certain that the inactiveness was brought about by the operation.

2. *Funiculi of ants covered with glue.*

Thirty winged virgin females of *Formica* from the large glass cage were fastened to a pine board with pins. One pair of pins was placed x-wise over the petiole and another pair was stuck into the board in the same manner between the head and the thorax. With a small pencil brush the entire surfaces of both funiculi were covered with a thin coat of liquid glue. After an interval of 15 minutes the glue had become perfectly dry, the ant was unpinned and was put into an experimental case. When unpinned from the board the ants ran rapidly, but for a few moments thereafter when placed into the cases they moved about more or less "crazily" and then became so quiet that it was not necessary to wait on them to come to rest. Five failed to respond to odors and when touched lightly with a pencil they scarcely moved, but when touched harder they jumped up quickly and ran about "crazily." These five were discarded from the experiments with odors. All the ants with glued antennæ were quite abnormal, because they did not move when mechanically irritated unless really compelled to move. When tested with the three essential oils some responded promptly while others hesitated to respond. As a whole their responses were about as pronounced as, and were similar to, those of unmutilated sister females. Often instead of responding in the usual manner they moved or vibrated one or more legs. Their reaction times are: oil of peppermint, 2–15 seconds, average 6.08 seconds; oil of thyme, 3–15 seconds, average 6.40 seconds; oil of wintergreen, 2–10 seconds, average 4.88 seconds. These give a general average of 5.78 seconds. Since the behavior of these mutilated ants was abnormal and since they lived from 1 to 12 days, with only an average of 6 days, the injury caused by the glue must certainly have brought about the slow reaction time.

3. *Flagella of hornets cut off.*

The flagella of 25 *Vespula maculata* were cut off with a pair of sharp scissors. A small drop of blood exuded from each wound. When these mutilated hornets were placed into the experimental cases, they were at first extremely restless, then they became "sullen" and inactive.

Some of these mutilated hornets responded promptly when tested with the three essential oils; some responded slowly, and a few failed to respond at all. All of those which failed to respond to odors scarcely moved when touched with a pencil. These were discarded and the flagella of others were cut off. In behavior, hornets with the flagella cut off are abnormal, and these lived from 3 hours to 3 days and 20 hours with 1 day and 13 hours as an average. The reaction times are: oil of peppermint, 2–5 seconds, average 2.84 seconds; oil of thyme, 2–5 seconds, average 2.92 seconds; oil of wintergreen 2–5 seconds, average 3.52 seconds. These give a general average of 3.09 seconds which is 0.66 second greater than the same average for normal hornets. We can certainly attribute this small difference in reaction time to the inactiveness of the mutilated insects.

III. Summary.

The common response of all the normal ants tested to each of the six odors used is as follows: (1) if lying flat on the thorax and abdomen, they arose either slowly or quickly; (2) if standing on their feet, they moved away either slowly or quickly. The more common response is—they vibrated the antennæ and moved away either slowly or quickly. The most common response is—they vibrated the antennæ more or less vigorously. Many of the ants turned around over the odors. While testing with honey and formic acid, many of the ants tried to get through the bottoms of the cases to the sources of the odors. In one instance while testing with formic acid, the ant turned up its abdomen in the same position in which the abdomen is held when the ant attacks an enemy. The average reaction times of all six odors for all the normal ants tested in any one set of experiments are as follows: females of *Formica* 2.45 seconds, males of *Formica* 2.63 seconds, males of *Camponotus* 2.74 seconds, major workers of *Camponotus* 3.22 seconds, and minor workers of *Camponotus* 3.09 seconds. The average reaction time of the three essential oils for all the normal hornets tested is 2.43 seconds. From these figures, it is evident that the olfactory sense in the ants and hornets tested is quite acute. Judging from the reaction times of the females and males of *Formica*, the olfactory sense in both sexes is equally developed. The slightly slower reaction time of the males may be due, however, to the fact that these males were young and because they were not very active. The olfactory sense of the males of *Formica* and of *Camponotus* seems to be about equally developed in both. The olfactory sense in the males of *Camponotus* seems to be more highly developed than it is in the workers of the same genus. There seems to be practically no difference in the ability of the large and small workers of *Camponotus* to receive odor stimuli.

Ants with the funiculi either cut off or covered with glue are not normal and they do not live long. They soon become inactive and some of them can hardly be mechanically irritated. Those which almost fail to respond to mechanical stimuli never respond to odor stimuli. These were discarded from the experiments in which odors were used and all the others were tested with odors. The average reaction times of the mutilated ants are about double those of unmutilated sisters. The slowness in responding to odors is probably due to the inactiveness of the mutilated insects. If the slow reaction times indicate that some of the olfactory organs were prevented from receiving odor stimuli, then the olfactory organs that brought about the responses must be looked for elsewhere than on the antennæ.

Hornets with the antennæ cut off are not normal and never live long. The reaction time of hornets thus mutilated is only 0.66 second more than that of unmutilated hornets. Most of the olfactory organs, if not all, of hornets must be looked for elsewhere than on the antennæ.

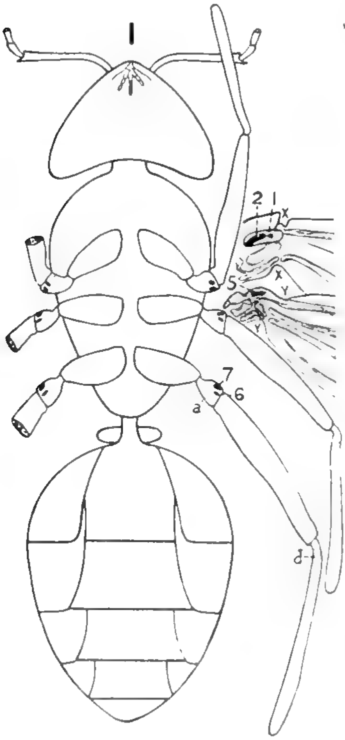
IV. Morphology of the Olfactory Pores.

Since the organs in the antennæ of ants and hornets fail to receive most, if not all, of the odor stimuli used in the preceding experiments, and because the writer proved experimentally that the pores first described by Hicks (1857) do receive odor stimuli in the honey bee, these pores in ants and hornets will now be discussed.

1. *Disposition.*

In making a study of the disposition of the olfactory pores of ants and hornets the following were used: five specimens each of winged females, winged males, and major workers of *Formica;* five specimens each of deälated females, winged males, major and minor workers of *Camponotus;* and one specimen of *Vespula maculata.* All the wings and legs of all 36 specimens were examined carefully for pores. Since the winged female of *Formica* is typical, its olfactory pores will be described in detail and then the variations found in the other above-enumerated individuals will be stated.

(*a*) *Winged Female of Formica.*—The wings have dorsal and ventral surfaces, and the legs may be divided for description into four surfaces. The inner surface faces the ant's body and the outer surface is directed from the body. The anterior surface faces the head, while the posterior surface is directed backward. There are always three groups of pores on the front wing, two on the hind wing, three on the trochanter, and one on the femur of each leg. There are also two groups of isolated pores on each trochanter and on each tibia. The groups are located as follows: Nos. 1 to 5 inclusive lie on the bases of the wings, Nos. 1 and 2 (text fig. 1) being on the



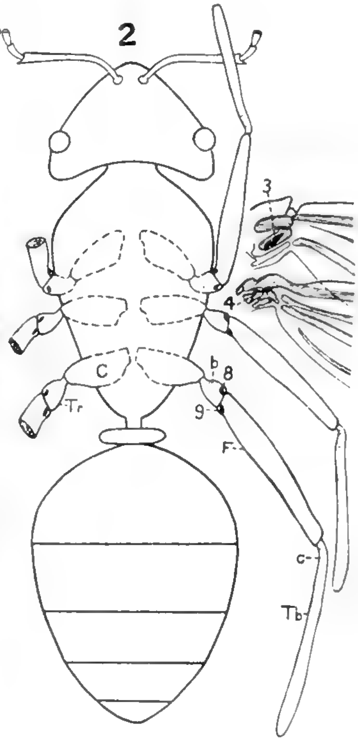


Fig. 1.—Diagram of ventral surface of female of *Formica*, showing location of groups of pores. × 7.

Fig. 2.—Diagram of dorsal surface of female of *Formica*, showing location of groups of pores. × 7. In figures 1 and 2 the wings are disarticulated and are inserted at the right. × 15.

ventral surface of the front wing and No. 3 (text fig. 2) on the dorsal surface of the same wing; No. 4 (text fig. 2) lies on the dorsal surface of the hind wing, and No. 5 (text fig. 1) lies on the ventral surface of the same wing; Nos. 6 to 8 inclusive, always lie on the trochanter at the distal end, Nos. 6 and 7 (text fig. 1) being on the anterior surface, while No. 8 (text fig. 2) lies on the inner surface. No. 9 (text fig. 2) always lies at the proximal end of the femur on the posterior surface. Groups *a* and *b* of the isolated pores lie on the trochanter, while groups *c* and *d* lie on the tibia. The groups of isolated pores are not always constant in position, but are usually located as follows: Group *a* (text fig. 1) lies on the outer surface near the distal end of the trochanter and group *b* (text fig. 2) is found near the proximal end of the same segment on the inner surface. Groups *c* and *d* (text figs. 1 and 2) combined form a horseshoe-shaped row of pores with the toe of the horseshoe lying on the posterior surface at the proximal end of the segment, and the sides of the horseshoe pass around the tibia in opposite directions and end with the two heels lying on the anterior surface. In the female of *Formica*, as well as in most ants, all the groups are quite constant in number on all the legs and wings and the positions of those on the legs vary only slightly by them rotating around the segments. Those on the wings never vary in position. In fact, the number of groups and their respective positions are almost identical to those of the worker honey bee.

For all five females of *Formica* examined, the groups of pores on the wings and third pair of legs vary in regard to the number of pores as follows: No. 1, 11 to 18, average 13; No. 2, 70 to 86, average 78; No. 3, 60 to 74, average 69; No. 4, 9 to 13, average 12; No. 5, 35 to 39, average 37; No. 6, 4 to 8, average 5; No. 7, 17 to 19, average 18; No. 8, 6 to 9, average 8; No. 9, 9 to 11, average 9; group *a*, 3 to 6, average 5; group *b*, 3 to 5, average 4; group *c*, 1 to 6, average 3; group *d*, 4 to 5, average 5. The numbers of pores in the groups on the first and second pairs of legs vary slightly more than those on the third pair of legs. On the first pair of legs there is a total average number of 112 pores; on the second pair 116 pores; and on the third pair 114 pores, making a total of 342 pores as an average for all six legs of a female of *Formica*. The front pair of wings has 320 pores, while the hind pair has only 98 pores, making 418 pores for all four wings. It is thus evident that an average female of *Formica* has only 760 pores, while by referring to the table page 333 it is seen that a worker honey bee has 2,204 pores.

(*b*) *Other Ants and Hornets Examined.*—The groups of pores in the other specimens of *Formica* and *Camponotus* examined are tolerably constant in number and position. They are so similar to those of the females of *Formica*, that only the total number of pores will be given. Counting the pores for all five individuals in each set, the total average number of pores is as follows: males of *Formica*—legs 356, legs and wings 892; major workers of *Formica*—legs 332; deälated females of *Camponotus*—legs 317; males of *Camponotus*—legs 322, legs and wings 1,090; major workers of *Camponotus*—legs 331; minor workers of *Camponotus*—legs 314. In regard to the total number of pores on the legs, it is thus seen that there is practically no difference between the number on the legs of workers and queens and only a few more on the legs of males, but the wings of males have many more than do the wings of females. (For more details see table, page 331.)

The groups of pores in the worker hornet (*Vespula maculata*) are also quite constant in number and position and resemble those of the worker honey bee more than those of an ant. The group on the femur is always double, consisting of two rows of pores widely divided, and for this reason each row is regarded as a separate group. Groups Nos. 7 and 9 on the leg of an ant also each consist of two rows of pores, but since the two rows lie side by side they may be regarded as only one group. Group No. 6 of an ant is a straight row, while the pores of the same group of a hornet are bunched. The other groups of the hornet are quite similar to those of the honey bee. The total number of pores for the hornet examined is 1,957. (See table, page 333, for details.)

The pores of an ant vary more in size than do those of the hornet or honey bee. Group No. 8 (Plate XI, fig. 3)[2] on the trochanters well illustrates this. Here the largest pore is at least five times the size of the smallest one. Those on the tibiae (fig. 4) also vary much. Those on the wings (fig. 5) vary only slightly in size. In proportion to the sizes of an ant and of a worker honey bee, the pores of the ant are much larger. The pores of a hornet are proportionately as large as those of the honey bee.

2. *Structure.*

(*a*) *External Structure.*—When examined under a low-power lens, the olfactory pores may be easily mistaken for hair sockets from

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[2] All figures, except text figures 1, 2, and 3, are numbered consecutively on Plates XI and XII.

which the hairs have been removed. When more carefully observed under a high-power lens, a striking difference in external form is seen. The pores appear as small bright spots when a strong transmitted light is used. Each bright spot has a dark boundary or pore wall (fig. 3, *PorW*). Near the centre of this boundary is a transparent spot, the pore aperture, which may be round, oblong, or slit-like. On the wings the pore apertures are always round or oblong (fig. 5, *PorAp*) and never slit-like as on the legs (fig. 3, *PorAp*). At the lowest focusing level any pore aperture, however, is perfectly round. The boundary (fig. 3, *PorB*) of the pore is usually bordered by a band of darker chitin.

(*b*) *Internal Structure.*—All the olfactory pores studied are inverted flask-shaped structures in which the bottoms of the flasks are chitinous layers (fig. 6, *ChL*). These layers of chitin contain the pore apertures and they form external coverings for the pores. In a typical pore as found in the tibia of *Formica*, the neck (*NkFl*) of the flask is wide and the mouth (*Mo*) is flaring. About two-thirds of the space at the bottom of the flask is occupied by a chitinous cone (*Con*). The cone generally stains less deeply than the surrounding chitin (*Ch*), but is not separated from it. The apex of the cone is hollow and extends to the neck of the flask. The sense cell (*SC*) lies beneath the mouth of the flask. It is bipolar, long, and slender, and comparatively large. The sense fiber (*SF*) of this cell is enlarged at the apex of the cone. Its peripheral end runs into the hollow of the cone, pierces the bottom of the cone, and enters the lowest portion of the pore aperture. The nerve fiber (fig. 13, *NF*) of the sense cell joins a nerve cord. The nucleus (*SCNuc*) with its nucleoli (*SCNucl*) is always conspicuous.

Now since the anatomy of a pore is understood, the external appearance of a pore may be explained. The dark border of chitin (fig. 3, *PorB*) around the boundary of the pore is due to the thick chitin (fig. 13, *aa*) at the mouth of the flask. The boundary (fig. 3, *PorW*) is the same as the greatest width of the flask. The bright area inside the boundary is caused by the light having to pass through only the chitinous cone (fig. 13, *Con*) and the chitinous layer (fig. 13, *ChL*). The aperture appears transparent because the sense fiber (fig. 13, *SF*) and all the other tissues have been removed by the caustic potash treatment.

Sections through the tibiæ of pupal muddobbers throw some light on the origin of the anatomy of a pore. Quite often very large cells (Plate XII, fig. 38, *SC*) may be seen among the small hypodermal cells

(*HypS*). This indicates that the sense cells are modified hypodermal cells. It appears that the cone (*Con*) is formed after the surrounding chitin is almost completed. In figure 38 the hypodermis (*Hyp*) has shrunk a short distance from the chitin (*Ch*) drawing the hypodermal strand (*HypSt*) an equal distance from the base of the cone (*Con*). This strand probably served as a passage-way for conveying a hypodermal secretion which formed the cone. With Ehrlich's hämatoxylin and oesin the outer margin (*a*) of the cone stains a faint purple. The inner margin (*b*) is pink, having the same color as that of the lowest strata (*c*) of the surrounding chitin. The chitin at *d* is light yellow; at *e*, dark yellow, and at *f*, it is semi-transparent. At these last three places it failed to stain.

Judging from what can be gleaned from all the sections studied, including those of the honey bee, the origin of these organs is probably about as follows. In the early pupal stage, the hypodermis is thick, no chitin is yet formed, and all the hypodermal cells have about the same size. In the 16-day-old worker pupæ of the honey bee neither pores nor sense cells are found, but many large hypodermal cells occur where the sense cells later appear. At this age the chitin and hairs are being rapidly formed. A day later pores and sense cells are found. The sense cells and flasks including the pore apertures are then simultaneously formed, while the cone and sense fiber are later formations. Both poles of the sense cell are formed as growing processes. The peripheral pole unites with the pore aperture and the inner one joins the nerve branch while the cone is being formed by the hypodermal strand.

The flasks vary much in diameter and length. The length always depends on the thickness of the chitin. Figures 6 and 7 represent the largest and smallest pores in the tibiæ of the pupal females of *Formica*. Figures 8 to 11 represent the flasks as found in the wings of the same insect. Figure 8 is from group No. 2, and figure 9 is from group No. 3 on the front wing. Figure 10 is from group No. 4, and figure 11 is from group No. 5 on the hind wing. Figure 12 from group No. 2 on the front wing shows the slight variations in size of the flasks and also the bunch of sense cells (*SC*). Here none of the pore apertures were discernible. Figures 13 and 14 show how the pores, sense cells (*SC*), and hypodermis (*Hyp*) actually appear in sections through the trochanters of the same insect. Figure 13 is from group No. 7 and figure 14 is from group No. 8. Quite often the sense cells (fig. 14, *SC*) lie among the hypodermal cells (*HypS*), and hypodermal strands (*HypSt*) may be seen running toward and into the cones, again indicating that the sense cells are modified hypodermal cells and that the hypodermis forms the cones about the time when the other chitin is completed. Hair-mother cells (*HrMS*) forming the hairs are also common. Figure 15 is a pore from group No. 6 and figure 16 is an isolated pore from group *b* on the trochanter.

Sections through the trochanters of adult deälated females of *C. pennsylvanicus* and through the front wings of adult females and males of *C. mela* were made. The pores (figs. 17 to 22) found in these sections are like those already described for the females of *Formica*.

To ascertain if the nerves running to the wings and the sense cells in the stubs of the wings of old deälated female ants are present, the thorax of a deälated female of *Camponotus* was cut transversely into sections 25 microns thick. This female had been kept in captivity eight months and had reared a small family. On account of the broken conditions of the sections, nerves cannot be traced into the stubs of the wings, but the thoracic ganglia give off branches, and some of these run toward the bases of the wings. Pores and sense cells are easily found in the stubs of the wings. The sense cells appear to be normal in all respects. Figure 23, *SC*, represents a few of them taken from one wing. It thus seems that the nerves and sense cells do not degenerate, as do most of the muscles in the thorax of a deälated female ant, but the organs in the bases of the wings appear to function throughout the life of the ant.

Text fig. 3 is a diagram representing a transverse-longitudinal view of a small portion of the femur (*F*) and about two-thirds of the trochanter (*Tr*) from the third leg of a female of *Formica*. Groups Nos. 7, 8, 9, and *b* are shown as marked by these characters. The anatomy of the leg and the innervation of these groups are also shown. At this articulation the nerve (*N*) runs near the centre of the leg and nerve branches (*NB*) are given off which run to the groups of sense cells (*SC*). The sense cells are so located that the muscles (*M*) are not near them, and a trachea runs near each group of sense cells.

Plate XI, fig. 25, and Plate XII, fig. 26, are semidiagrams representing the innervation of the groups of pores (marked 2, 3, 4, and 5) as found in the wings of *Formica*. Each wing arises from a niche (*Nic*) in the thorax. The hard chitin of the wing is represented by solid black, the soft articular chitin of the wing by dots, and the hard chitin of the thorax by broken lines.

Sections through the wings and legs of pupæ of the hornet (*Vespula maculata*) and the muddobber (*Sceliphron cementarius*) were also made. The pores of the hornet (figs. 27 to 32) are the largest ones studied, and this insect is also the largest one examined. The pore apertures are actually visible in only four of the pores drawn (figs. 29 and 31). The pores of the muddobber (figs. 33 to 41) are the second largest ones studied. Four pores (fig. 41) were found on the thorax at the base of the niche of the front wing.

All the pores of the ant, hornet, and muddobber described in the preceding pages may be compared with a typical pore (fig. 42) from the tibia of a worker honey bee. All drawings of these pores are enlarged the same number of times.

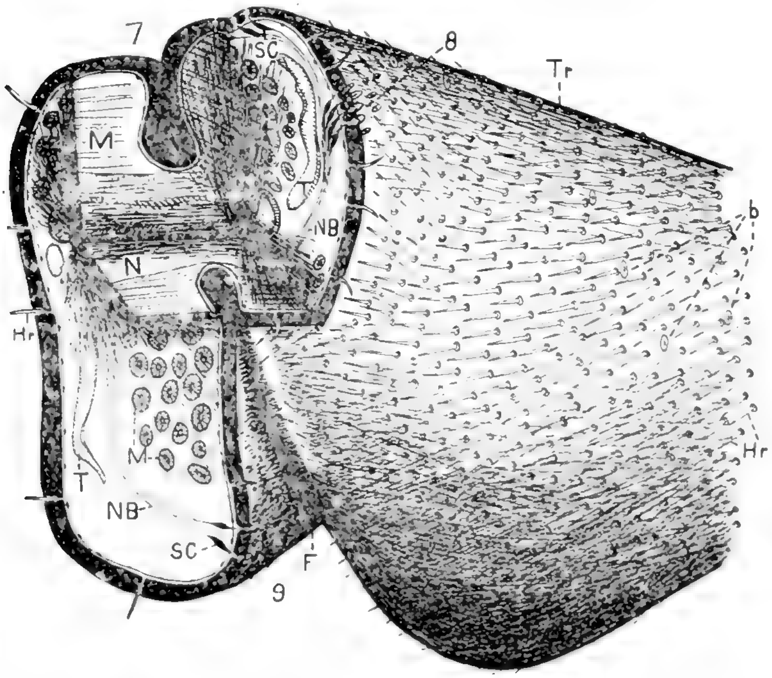

Fig. 3.—Diagram of a transverse-longitudinal view of a small portion of femur (F) and about two-thirds of trochanter (Tr) from hind leg of female of *Formica*, showing the internal anatomy of the leg and innervation of groups of pores, Nos. 7, 8 and 9.

V. Physiology of the Olfactory Pores.

To ascertain whether the pores, which have been studied, are actually the organs in ants and hornets that receive odor stimuli, the wings and legs of many individuals were mutilated. The behavior of these mutilated insects was carefully studied and they were tested with the various odors in the same manner as described on pages 297 to 305.

1. *Deälated females of Formica.*

May 31, four deälated females and several workers were removed from a small colony of *Formica*. They were placed into a Fielde nest. Later the four females were put singly into experimental cases and were tested with the six odors. Their reaction times are: oil of peppermint 2–3 seconds, average 2.50 seconds; oil of thyme 2–3 seconds, average 2.25 seconds; oil of wintergreen 2–3 seconds, average 2.75 seconds; honey and comb 2–5 seconds, average 3.25 seconds; leaves and stems of pennyroyal 2–4 seconds, average 3.00 seconds; formic acid 3–4 seconds, average 3.50 seconds. These give a general average of 2.89 seconds, while the same average for winged females of the same species is 2.45 seconds. The wing niches of the four deälated females were examined. In seven of the eight niches, pores were seen. One of these females lived 38 days. The other three and all the workers died November 25th. They had been neglected and had not been given water for more than a week.

2. *Wings of females of Formica pulled off.*

All 4 wings of each of 25 virgin females of *Formica* were pulled off. This is accomplished by pinning the ant to the board as described on page 307. Seize a wing with the thumb and index-finger and pull gently with the wing standing at right angles to the thorax. A half-hour after the wings had been pulled off, these wingless females were tested with the six odors. In behavior they appeared normal in every respect except they responded to odors slightly more slowly. Confined in a Fielde nest alone, they lived from 4 to 16 days with 10 days as an average, whereas their winged sisters lived 14 days and 10 hours as an average. Their reaction times are: oil of peppermint 2–4 seconds, average 2.20 seconds; oil of thyme 2–3 seconds, average 2.44 seconds; oil of wintergreen 2–4 seconds, average 2.32 seconds; honey and comb 3–6 seconds, average 3.84 seconds; leaves and stems of pennyroyal 2–5 seconds, average 3.16 seconds; formic acid 2–5 seconds, average 3.16 seconds. These give a general average of 2.85 seconds, while the same average for sister females with wings is 2.45. All the wings of these 25 females were examined microscopically after they had been pulled off. Of the front wings 14 carried pores and 36 were devoid of pores. Of the hind wings 24 carried pores and 26 were devoid of pores. Thus when tested with odors these ants carried pores on only 62 per cent. of the bases of their wings. Might not the difference of 0.40 second in reaction time between the reaction time of these wingless ants and that of the winged sisters be due to the fact that the pores on 38 per cent. of the wings were prevented from functioning?

To ascertain if a greater percentage of wings including the pores could be pulled off artificially, the wings of 37 more winged females were pulled off. This time greater care in pulling off the wings was taken. These wings were also examined microscopically. Counting all the wings from both lots of ants, 62 ants in all, 50 per cent. of the wings pulled off bore pores. Of the front wings pulled off 52 bore pores and 72 were devoid of pores. Of the hind wings pulled off 72 bore pores and 52 were devoid of pores.

To ascertain the percentage of wings including the pores actually lost by the natural method, many detached wings from the virgin females were removed from the large glass cage. These wings were certainly shed in the same manner in which the wings of female ants are shed in nature. The worker ants had carried great numbers of these detached wings out of the nest and had laid them on the refuse pile. Of the 786 detached wings of females examined microscopically only 18 per cent. of them bore pores. Of the front wings 120 bore pores and 365 did not bear pores. Of the hind wings 21 bore pores and 280 did not carry pores. Thus one-third of the front wings bore pores, while only one-thirteenth of the hind wings bore them. As stated on page 311, the average number of pores for both front wings of one of these females is 320, and the average number of pores for both hind wings of the same female is 98. With these females it is, therefore, evident that when the wings are shed only 21 per cent. of the pores as an average are lost, while 79 per cent. are not prevented from functioning, because the wings devoid of pores always break off at a weak place (text fig. 1 and Plate XI, fig. 25, *xx*, *yy*) in the chitin just distal to the groups of pores. The wound made by the wing breaking off at this place cannot affect the sense cells in the least because a thick layer of chitin separates these cells from the outside air.

One of the virgin females which had recently shed her wings was examined. All four of the bases of the wings of this female were left intact.

3. *Wings of males of Formica pulled off.*

The wings of 7 males of *Formica* were pulled off and the mutilated males were tested with odors as usual. They appeared normal in every respect except they responded more slowly to odors than they did before the wings were pulled off. Confined in a Fielde nest with several sister workers, they lived from 3 to 9 days, with an average of 5 days. Their reaction times are: oil of peppermint 2–5 seconds, average 3.14 seconds; oil of thyme 2–5 seconds, average 3.00 seconds; oil of wintergreen 2–4 seconds, average 2.86 seconds; honey and comb 3–10 seconds, average 4.86 seconds; leaves and stems of pennyroyal, 2–5 seconds, average 3.71 seconds; formic acid 3–5 seconds, average 3.43 seconds. These give a general average of 3.50 seconds, whereas the same average for the same ants before the wings were pulled off is 2.63 seconds. The detached wings of these 7 males and those from other brother ants were examined microscopically. Of the 56 detached wings examined, 87½ per cent. bore pores. Of the front wings 29 bore pores and one had no pores. Of the hind wings 20 bore pores and 6 had no pores. On page 331 it is stated that the average number of pores for both front wings of one of these males is 402, and for both hind wings of the same male the average number of pores is 134. From these figures it is plain that 92 per cent. of the pores as an average were lost when the wings were pulled off. The difference of 0.87 second in reaction time between the reaction time of the same males before the wings were pulled off and the reaction time after the wings were pulled off may possibly be attributed to the loss of the 92 per cent. of the pores on the wings.

4. *Bases of wings glued and legs of females of Formica covered with vaseline.*

With a small pencil brush the bases of all 4 wings of each of 25 winged females of *Formica* were covered with liquid glue. When the glue was dry another small pencil brush was employed in covering the surface of each leg with a vaseline-beeswax mixture. Since yellow commercial vaseline spreads too much when used alone, a mixture was made by using three parts of vaseline and one part of beeswax. All parts of the leg except the tarsus were covered with this mixture.

As soon as this double operation was completed, the ant was put into an experimental case. When unpinned from the board the ant was as active as usual and when placed inside the experimental case it was slightly more restless than ordinarily. Confined singly they cannot remove the glue from the wings, but they begin at once to clean off the vaseline-beeswax mixture. They pulled the front legs between the mandibles and licked them with the mouth parts. Then they rubbed the front legs on the other two pairs and again put the front legs to the mouth parts. Sometimes they also stand still and stroke the antennæ with the front legs. As a result of all these cleaning processes, they smear the vaseline-beeswax mixture over the greater part of the body and some of it covers the spiracles. Except for the slight restlessness caused by the double operation and for the slowness in responding to odors, they appeared normal in all other respects. They lived from 1 to 5 days, with 3 days as an average. Their deaths were probably due to the vaseline-beeswax mixture being spread over the spiracles. Their responses to odors were similar to those of intact ants, but more often than with unmutilated ants they vibrated one or more legs. The reaction times are: oil of peppermint 3–12 seconds, average 5.16 seconds; oil of thyme 3–10 seconds, average 4.48 seconds; oil of wintergreen 3–10 seconds, average 4.56 seconds; honey and comb 4–25 seconds, average 6.32 seconds; leaves and stems of pennyroyal 3–10 seconds, average 4.92 seconds; formic acid 3–15 seconds, average 5.80 seconds. These give a general average of 5.21 seconds, which is slightly more than twice the same average for unmutilated sister females. May not this slow reaction time be attributed to the fact that many of the pores were prevented from functioning?

5. *Deälated females of Camponotus.*

During May and June, 1913, 26 deälated females of *Camponotus* were caught in the woods, either with colonies or just beginning to found colonies. When brought to the laboratory they were put into Fielde nests and queen cages as already described on page 296. Twenty-five of these females were placed singly into the experimental cases. Each one soon became quiet. and then it was tested with the six odors. Their responses were similar to those already described for unmutilated workers of the same species. The reaction times are: oil of peppermint 2–3 seconds, average 2.24 seconds; oil of thyme 2–4 seconds, average 2.28 seconds; oil of wintergreen 2–3 seconds, average 2.44 seconds; honey and comb 3–20 seconds, average 6.00 seconds; leaves and stems of pennyroyal 2–4 seconds, average 3.00 seconds; formic acid 2–12 seconds, average 3.52 seconds. These give a general average of 3.25 seconds. The longevity of these females cannot be given. Only 4 of those confined in queen cages have died up to the time of this writing, May 20, 1914. These 4 lived from 3 to 56 days. Not a single one kept in the Fielde nests has yet died.

6. *Glue in wing niches and legs of deälated females of Camponotus covered with vaseline.*

During October the 22 remaining live deälated females of *Camponotus* were tested with the six odors after the niches from which their wings arise had been filled with liquid glue and the legs had been covered with the vaseline-beeswax mixture. When put into the experimental cases they were as quiet as before they were thus mutilated and seemingly removed but little of the vaseline. They appeared normal in all respects except that they responded to odors more slowly than they did before the glue and vaseline were used. The reaction times are: oil of peppermint 3–15 seconds, average 5.64 seconds; oil of thyme 3–15 seconds, average 6.32 seconds; oil of wintergreen 3–10 seconds, average 5.14 seconds; honey and comb 3–60 seconds, average 19.00 seconds; five times they failed to respond to the honey odor when the vial was held under them for 60 seconds; leaves and stems of pennyroyal 4–15 seconds, average 6.32 seconds; formic acid 3–10 seconds, average 5.23 seconds. These give a general average of 7.94 seconds, which is more than twice the reaction time obtained by using the same ants before glue was put into the wing niches and vaseline was put on the legs. At the present writing (May 20, 1914) the longevity of these mutilated females cannot be given, for as yet only 5 of them have died. These 5 lived from 7 to 44 days. After being tested, each female was returned to her own nest or cage. Those put back into Fielde nests were at first accepted hostilely by their offspring. This hostility was probably due to the presence of the glue and vaseline. All of those that had workers were sooner or later cleaned, and thus they became normal again. Four of the five that died had no workers and the vaseline spread over the greater portion of the ant's body. Cannot the slow reaction time obtained by using the mutilated females be attributed to the fact that many of the pores were prevented from receiving odor stimuli on account of these pores being covered with glue and vaseline?

7. *Wings of males of Camponotus pulled off.*

The wings of 25 males of *Camponotus* were pulled off. Usually a small drop of blood exuded from the wound when a wing was pulled off. They were quite restful and were easily tested. They appeared normal in all respects except that they responded to odors more slowly than did their brothers with intact wings. The reaction times are: oil of peppermint 2–5 seconds, average 2.72 seconds; oil of thyme 2–4 seconds, average 2.88 seconds; oil of wintergreen 2–5 seconds, average 3.12 seconds; honey and comb 3–10 seconds, average 4.56 seconds; leaves and stems of pennyroyal 2–6 seconds, average 3.64 seconds; formic acid 3–7 seconds, average 4.00 seconds. These give a general average of 3.49 seconds, which is one and a fourth times the reaction time of unmutilated males. These mutilated males lived from 1 to 24 days, with 7 days and 2 hours as an average.

The detached wings of these males were examined microscopically. Of the front wings pulled off 45 bore pores and 5 were devoid of pores. Of the hind wings pulled off 4 had pores and 9 were devoid of pores. As stated, the average number of pores for the front wings of the males of this species is 595 and for the hind wings the average number of pores is 173. It is, therefore, evident that 88 per cent. of the pores belonging to the wings were prevented from functioning. May not this fact be used to explain the slow reaction time of these wingless males?

8. *Wings of Vespula maculata pulled off.*

The wings of 21 workers of *Vespula maculata* were pulled off. Only occasionally did a small drop of blood exude from the wounds. When placed into the experimental cases, they were as restless as were their sister winged hornets and they appeared normal in all respects except that they responded more slowly to odors than did the ones with wings. They lived in these cases from 2 days to 6 days and 12 hours, with 4 days, and 8 hours as an average. The reaction times are: oil of peppermint 3–20 seconds, average 6.57 seconds; oil of thyme 3–15 seconds, average 6.19 seconds; oil of wintergreen 3–15 seconds, average 6.29 seconds. These give a general average of 6.35 seconds, which is almost three times the same average for sister hornets with the wings intact.

The detached wings of these mutilated hornets were examined microscopically. Of the front wings pulled off 29 bore pores and 13 were devoid of pores. Of the hind wings pulled off 41 bore pores and 1 was devoid of pores. As stated, the average number of pores for the front wings of these hornets is 1,036 and the average number of pores for the hind wings is 448. It is, therefore, evident that 78 per cent. of the pores belonging to the wings were prevented from functioning. May not this fact again be used to explain the slow reaction time of these wingless hornets?

9. *Summary.*

From the preceding pages it is seen that probably not more than 21 per cent. of the pores on the wings of female ants are lost at the time the wings are shed and that the remaining 79 per cent. of the pores are not prevented from functioning because the wings break off at a weak place (text fig. 1 and Plate XI, fig. 25, *xx, yy*) in the chitin just distal to the groups of pores. The wound caused by the wings breaking off cannot affect the sense cells connected with the pores, because a heavy layer of chitin separates them from the external air. Sections through the thorax of an old deälated female ant show that most of the muscles in the thorax have degenerated, but the nerves running to the wings are still present and the pores in the stubs of the wings are still connected with sense cells. This indicates that the sense organs in the stubs of the wings function throughout the life of the ant.

All of the results obtained in the experiments on normal and mutilated insects are summarized in the following table. To make the table complete for Hymenoptera and for comparison, the data from the writer's former paper concerning the worker honey bee are appended. The "three odors" used are those from oil of peppermint, oil of thyme, and oil of wintergreen. The "six odors" used are those from oil of peppermint, oil of thyme, oil of wintergreen, honey and comb, leaves and stems of pennyroyal, and formic acid. It will be noted that when the antennæ of any of the insects listed in the table are mutilated, the insects are abnormal in behavior; but when the pores on the legs and wings are covered, the insects are normal in behavior. The reaction times obtained by using insects with mutilated antennæ are slower than those obtained when unmutilated individuals are used, but it is quite possible that the slower reaction times are caused by the abnormal behavior of the insects and are not due to the theory that some of the olfactory organs are prevented from functioning. When the wings are pulled off artificially, about three-fourths of the pores on these appendages are lost and the reaction times are slightly slower. When the pores on the legs and wings are covered, the reaction times are more than doubled, while in the honey bee the reaction time is increased twelve times. It was impossible to prevent the ants from removing most of the vaseline from the legs.

Table I.—Olfactory Experiments on Ants, Hornets, and Bees.

Species.	Experiment.	Average reaction time		No. of individuals tested.	Average length of life in captivity.	
		for three odors.	for six odors.			
		Sec.	Sec.		Days.	Hours.
♀ Formica	Unmutilated. Winged, normal in behavior.	2.12	2.45	25	14	10
♀ “	Funiculi cut off. Abnormal in behavior.	4.38	......	25	0	19
♀ “	Funiculi glued. Abnormal in behavior.	5.78	......	25	6	0
♀ “	Deälated. Normal in behavior.	2.50	2.89	4	142	0
♀ “	Wings pulled off. Normal in behavior.	2.32	2.85	25	10	0
♀ “	Bases of wings glued and legs covered with vaseline. Normal in behavior.	4.73	5.21	25	3	0
♂ “	Unmutilated. Winged, normal in behavior.	2.21	2.63	17	Used	below
♂ “	Wings pulled off. Normal in behavior.	3.00	3.50	7	5	0
♀ Camponotus	Deälated. Normal in behavior.	2.32	3.25	25	Several	mo.
♀ “	Glue in wing niches and legs covered with vaseline. Normal in behavior.	5.70	7.94	22	Several	mo.
♂ “	Winged. Normal in behavior.	2.29	2.74	25	23	9
♂ “	Wings pulled off. Normal in behavior.	2.91	3.49	25	7	2
☿ Major “	Unmutilated. Normal in behavior.	2.32	3.22	25	26	8
☿ Minor “	Unmutilated. Normal in behavior.	2.27	3.09	25	26	8
☿ Vespula	Unmutilated. Winged, normal in behavior.	2.43	......	25	9	7
☿ “	Flagella cut off. Abnormal in behavior.	3.09	......	25	1	13
☿ “	Wings pulled off. Normal in behavior.	6.35	......	21	4	8
☿ Apis	Unmutilated. Winged, normal in behavior.	2.64	3.40	37	9	3
☿ “	Glue on thorax as control. Normal in behavior.	2.76	......	19	9	3
☿ “	Vaseline on abdomen as control. Normal in behavior.	2.73	......	18	9	3
☿ “	Flagella burnt off. Abnormal in behavior.	4.00	......	7	0	17
☿ “	Flagella glued. Abnormal in behavior.	2.90	......	21	1	0
☿ “	Wings pulled off. Normal in behavior.	22.20	27.10	28	9	20
☿ “	Bases of wings glued. Normal in behavior.	18.50	28.20	20	9	3
☿ “	Pores on legs covered with vaseline. Normal in behavior.	5.20	8.00	20	9	3
☿ “	Wings pulled off and pores on legs covered with vaseline. Normal in behavior.	36.90	40.00	20	9	5

B. DISPOSITION OF THE OLFACTORY PORES OF OTHER HYMENOPTERA.

In making a comparative study of the olfactory pores of Hymenoptera, 29 species representing 22 families have been used (those of ants and hornets already described included). Since the pores of only one specimen for each species were counted, the total number of pores recorded certainly cannot be a fair average. Besides this error, there is also a probable error of not less than 10 per cent. on an average for all the specimens. In the smaller individuals, particularly ants, the probable error is perhaps not more than 2 or 3 per cent., but in the larger specimens, especially the hairy ones, this error is perhaps more than 10 per cent. The pores on only the wings and legs have been included in the total numbers. On all the stings examined, pores have been found. The mouth parts of a few of the specimens were hurriedly examined; all of them bear pores. A few antennæ were also hurriedly examined. None of the pores first described by Hicks were found on these appendages, but this can be definitely decided only after a critical study of the antennæ has been completed. No pores were found on the petiole or other parts of the ant not already named.

I. Distribution.

Since all the variations relative to distribution are slight, only the most important ones will be mentioned. In all the species having two segments in the trochanter, the groups of pores ordinarily found on the femur occur on the second segment of the trochanter. Sometimes groups Nos. 1 and 2 on the front wing are united. At other times group No. 2 is almost divided into two separate groups. The groups of pores are usually located in areas devoid of hairs, but occasionally the groups are closely bordered by hairs. Sometimes a group is surrounded by clear chitin caused by the group lying in an area of thin chitin. In short, the distribution of pores of those species placed below the ants in the scheme of classification is similar to the distribution of the pores in ants; the distribution of those species placed above the ants in the scheme of classification is more like to the distribution of pores in the honey bee.

II. Number.

In regard to the number of groups and the total number of pores found in the different species, the variations are great. *Cimbex,* regarded as the lowest hymenopteron, has the least number of groups of all the species examined, but it stands fourth in regard to the number of isolated pores. Its total number of pores is larger than those of many of the higher forms. Among ants the variations are also great. For the legs of ants the number of pores varies from 211 to 356 and for the winged ants the total number varies from 463 to 1,090. The smallest specimen among the ants and the second smallest one of all the Hymenoptera examined is a female with 463 pores as the lowest number. The drone honey bee with 2,608 pores has the highest number. The smallest specimen examined is a wasp with 688 pores. (For further details see table, p. 332.)

III. Relative Sensitiveness of Species Examined to Odors.

It was impossible to obtain a sufficient number of live insects of each species examined so that their relative sensitiveness to odors could be experimentally determined. If such had been possible, the reaction times obtained would probably not represent the true relative sensitiveness better than the method described below, because the reaction times depend not only upon the ability to receive odors, but also upon the agility and sluggishness of the insects used. Using only the grand total number of pores of each species examined (see table, pp. 330 to 334) as a basis, it is also impossible to ascertain the relative sensitiveness because the numbers are too variable. Moreover, it may be generally said that the smaller the species the fewer and proportionately larger are the pores.

The method adopted for determining the relative sensitiveness to odors is: (1) determine the relative sizes of the prepared insects; (2) divide the total area of cytoplasm exposed to the air in all the pores of a given insect by the total area of cytoplasm exposed to the air in all the pores of *Microgaster*, used as a standard; (3) divide the quotient obtained in (2) by the relative size of the given insect. The number resulting by this division is called the relative sensitiveness of the given insect.

Since it seems reasonable that as a general rule the sizes of two hymenopterous insects are proportional to the respective diameters of their femurs at the extreme proximal ends, the femur of the hind leg of each prepared specimen was measured with the aid of a camera lucida. These measurements may be called the relative sizes of the insects and the diameter of the extreme proximal end of the femur belonging to *Microgaster* may be called 1.00, as a standard by which to calculate the diameters of the other femurs. It was thus ascertained that the relative sizes of a few of the specimens were less than 1.00, while most of them were greater than 1.00.

A study of the anatomy of the pores shows that the diameters of the peripheral sense fibers are proportional to the diameters of the flasks. Of course, the greater the diameters of the peripheral sense fibers, the more cytoplasm is exposed to the external air. The diameters of the ends of the sense fibers cannot be measured, but the diameters of the flasks can be accurately measured. To facilitate matters, the largest pore on the femur of the leg measured and the largest one on the front wing of each individual insect were drawn with the aid of a camera lucida. Figures 43 to 79 represent these pores. The larger pore in each case is from the femur and the smaller one is from the front wing. For our purpose each pore may be regarded as a circle having for its diameter the shorter diameter of the pore as shown in the drawings. To obtain the relative sensitiveness of all the pores on the legs of a given insect, the diameter of the largest pore on the femur, the total number of pores on the legs and the relative size of the given insect were used. To obtain the relative sensitiveness of all the pores on the legs and wings combined, the diameters of both pores, the grand total number of pores, and the relative size of the given insect were used.

By this system of calculating it was determined that *Cimbex* with its 1,216 pores smells 0.87 times as well as *Microgaster* which has only 622 pores, and only 0.85 times as well as the smallest ant with 463 pores. In speaking of the relative sensitiveness obtained by this system of calculating, a large probable error must always be allowed and the figures only approximately represent the truth. Allowing for the probable error, all the winged individuals, except three, placed between *Cimbex* and *Ceropales* in the table seem to have the olfactory sense about equally developed. The three exceptions are the ichneumon-fly (*Megarhyssa*), the female ant of *Aphænogaster*, and the male ant of *Camponotus*, all three of which seem to smell slightly better than the others. The males of *Camponotus* probably smell slightly better than the females of the same genus and considerably better than the winged forms of *Formica*. The small workers of *Camponotus* seem to smell slightly better than their large sisters and considerably better than the large workers of *Formica* and of *C. mela*. According to the reaction times obtained in determining the relative sensitiveness to odors of ants, the males of *Camponotus* receive odor stimuli considerably better than the workers and females of the same genus, but about as well as do the winged forms of *Formica*. The quicker reaction time of *Formica* is probably due to the fact that *Formica* is more agile than *Camponotus*. Based on reaction times, the small workers of *Camponotus* smell slightly better than their large sisters. Judging from the total number of pores, the winged forms of any species of ants smell considerably better than the workers of the same species.

Among the wasps the relative sensitiveness is tolerably well graduated from the lowest to the highest species as listed in the table. Instead of the two social wasps, *Polistes* and *Vespula*, having the highest relative sensitiveness, they seem to take second place, while the first place is held by the guest wasp, *Pseudomasaris*, and the solitary wasp, *Monobia*.

Among the bees the relative sensitiveness is also tolerably well graduated from *Andrena*, the lowest examined, to *Apis*, the highest. This system of calculating shows that the worker honey bee smells considerably better than the queen and equally as well as the drone. Reaction times show that drones smell slightly better than workers and considerably better than queens. It is thus seen that the honey bee has the most highly developed olfactory sense of the Hymenoptera, while that of ants is considerably inferior.

Based upon reaction times, the relative sensitiveness to odors of insects depends not only upon their ability to receive odor stimuli, but also upon their agility and sluggishness in responding when the olfactory organs are stimulated. To illustrate this point, the workers of *Camponotus* are more agile than the workers of *Apis*, and for this reason probably alone they respond more quickly to odors. Judging from only their reaction times, the former smell better than the latter, but in all probability the reverse is the truth. The ability to receive odor stimuli depends upon the development of the entire nervous system, including the olfactory apparatus, and upon the physiological state of the insect being tested. At the mating time the winged females of ants certainly smell as well and probably much better than the workers of the same species. As long as the recently fertilized females perform all duties necessary in bringing their first brood to maturity, they certainly retain almost the same degree of acuteness in smelling as before; but when they become a mere egg-laying machine and perform none of the nest duties, their ability to receive odor stimuli is probably less acute. It is thus seen that the physiological state is an important factor when the relative sensitiveness is considered, and we have little means of knowing just what physiological condition a given insect is in when it is being tested. To decide definitely about the relative sensitiveness to odors of insects, it is, therefore, necessary to consider (1) the degree of agility or sluggishness in responding when stimulated; (2) the degree of development of the entire nervous system, including the olfactory apparatus; and (3) the physiological state or condition in which the insects are in when being tested.

Table II.—The Number of Olfactory Pores and the Relative Sensitiveness of Various Species of Hymenoptera.

The letters "F," "M," "H," and "G" stand for front, middle, hind, and grand, in the order named. The "Total" means all the pores found on all six legs, and the "G. total" means all the pores found on all six legs and all four wings combined. "1 R. Sen." means the relative sensitiveness to odors of an insect based on the morphology of the olfactory pores found on the legs; "2 R. Sen." means the same based on the grand total number of pores.

	CIMBICIDÆ.			TENTHREDINIDÆ.			ICHNEUMONIDÆ.			BRACONIDÆ.		
	Cimbex americana Leach.			*Macrophyla flavicoxa* Nort.			*Megarhyssa lunator* Fabr.			*Microgaster mamestræ* ? Vier.		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs	2	17	112	6	63	33	8	66	36	6	42	21
M. legs	2	12	92	5	64	51	6	62	25	6	30	39
H. legs	3	24	118	6	68	47	6	48	38	6	43	36
Total			375			326			275			211
F. wings	6	468		6	303		6	344		6	319	
H. wings	4	373		4	157		4	198		4	92	
G. total	17		1216	27		786	30		817	28		622
1 R. Sen.			0.70			1.17			1.12			1.00
2 R. Sen.			0.87			1.05			1.25			1.00

	EVANIIDÆ.			CHRYSIDIDÆ.			FORMICIDÆ. MYRMICINÆ.					
	Evania appendigaster Linn.			*Chrysis tridens* Lep.			Not identified. ♀			*Aphænogaster aquia* Buckley. ♀		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs	6	38	50	6	64	39	8	41	31	8	40	31
M. legs	4	26	52	6	62	48	8	38	34	8	39	32
H. legs	2	10	46	6	42	29	8	41	40	8	39	30
Total			222			284			225			211
F. wings	6	418		6	644		6	158		6	231	
H. wings	4	140		4	272		4	80		4	100	
G. total	22		780	28		1200	34		463	34		542
1 R. Sen.			0.71			0.85			1.14			1.56
2 R. Sen.			1.03			1.10			1.04			1.23

FORMICIDÆ.

CAMPONOTINÆ.

	Lasius aliena Förster. ♀			*Formica obscuriventris* Forel.									*Camponotus.*																	
				Major. ☿			Winged. ♀			Winged. ♂			*mela* Say. Major. ☿			*pennsylvanicus* Say. Black var. ♀			*pennsylvanicus* Say. Large brownish variety.											
																			Minor. ☿			Major. ☿			Deälated. ♀			Winged. ♂		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs	8	81	26	8	71	40	8	80	32	8	79	41	8	79	28	8	80	30	8	72	31	8	80	32	8	73	33	8	71	39
M. legs	8	74	32	8	76	32	8	83	33	8	79	37	8	78	26	8	78	29	8	71	34	8	78	31	8	73	32	8	71	35
H. legs	8	78	28	8	77	36	8	83	31	8	82	38	8	79	29	8	80	28	8	72	31	8	78	32	8	74	32	8	71	35
Total			319			332			342			356			319			325			314			331			317			322
F. wings	6	348					6	320		6	402					6	366											6	595	
H. wings	4	138					4	98		4	134					4	150											4	173	
G. total	34		805				34		760	34		892				34		841										34		1090
1 R. Sen			1.10			1.11			1.58			1.41			1.04			1.02			1.59			1.35			1.47			1.58
2 R. Sen			1.11						1.02			1.11						1.07												1.58

	PSAMMOCHARIDÆ.			SPHECIDÆ.			LARRIDÆ.		
	Ceropales fraterna Say.			*Sceliphron cementarius*			*Larropsis distincta* Sm.		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs	8	90	61	3	31	56	9	76	69
M. legs	7	58	70	6	52	77	7	60	62
H. legs	6	52	64	6	53	65	8	72	50
Total			395			334			389
F. wings	6	454		6	484		6	514	
H. wings	4	170		4	154		4	166	
G. total	31		1019	25		972	34		1069
1 R. Sen.			1.97			2.50			1.42
2 R. Sen			1.56			1.92			1.30

	PHILANTHIDÆ.			MIMESIDÆ.			PEMPHREDONIDÆ.		
	Philanthus punctata Say.			*Mimesa Kohli* Fox.			*Stigmus universitatus* Rohwer.		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs	8	74	76	6	53	84	6	36	51
M. legs	6	69	94	6	44	79	6	34	64
H. legs	7	86	72	5	41	76	6	30	38
Total			471			377			253
F. wings	6	610		6	586		6	330	
H. wings	4	300		4	190		4	105	
G. total	31		1381	27		1153	28		688
1 R. Sen.			1.50			1.17			1.60
2 R. Sen			1.55			1.60			1.66

	PISONIDÆ.			CRABRONIDÆ.			MASARIDÆ.		
	Trypoxylon frigidum Sm.			*Solenius interruptus* Lep.			*Pseudomasaris vespoides* Cress.		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs	6	48	78	6	39	64	6	75	79
M. legs	6	56	87	8	66	50	8	95	80
H. legs	6	61	73	8	78	63	8	85	66
Total			403			360			480
F. wings	6	926		6	945		6	909	
H. wings	4	490		4	400		4	384	
G. total	28		1819	32		1705	32		1773
1 R. Sen.			1.13			1 37			2.29
2 R. Sen			2.27			1.98			2.75

	EUMENIDÆ.			VESPIDÆ.						ANDRENIDÆ.			MEGACHILIDÆ.			BOMBIDÆ.						APIDÆ.								
	Monobia quadridens Linn.			*Polistes nestor* Fabr.			*Vespula maculata* Linn.			*Andrena vicina* Sm.			*Megachile brevis* Say.			*Psithyrus* Sp.			*Bombus* Sp.			*Apis mellifica* Linn.								
																						☿			♀			♂		
	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.	No. of groups	No. of pores in groups.	No. of isolated pores.	No. of groups.	No. of pores in groups.	No. of isolated pores.
F. legs....	4	41	182	5	43	82	6	67	90	6	54	65	6	39	42	6	62	35	8	95	132	8	96	128	6	57	96	6	77	119
M. legs....	6	71	173	5	45	85	6	70	102	4	39	77	4	37	56	6	66	55	8	88	72	8	86	146	6	60	99	5	75	111
H. legs....	4	38	150	6	61	76	6	64	80	5	46	47	6	54	63	6	66	63	8	83	53	8	101	137	6	51	89	7	88	140
Total			655			392			473			328			291			317			523			694			452			610
F. wings .	6	806		6	844		6	1036		6	750		6	790		6	838		6	701		6	970		6	840		6	1232	
H. wings	4	554		4	416		4	448		4	338		4	288		4	393		4	400		4	540		4	470		4	766	
G. total ..	24		2015	26		1652	28		1957	25		1416	26		1369	28		1578	34		1627	34		2204	28		1762	28		2608
1 R. Sen..			2.33			1.85			1.19			0.80			1.23			1.39			1.66			2.59			1.30			1.66
2 R. Sen..			2.76			2.37			1.59			1.33			1.86			1.80			1.67			3.16			2.09			3.00

VARIATION.

	No. of groups.	Average No. of pores in groups.	No. of isolated pores.
F. legs	2–8	5–12	21–182
M. legs	2–8	5–15	25–173
H. legs	2–8	5–13	27–150
Total			211–694
F. wings	6–6	158–1232	
H. wings	4–4	80–766	
G. total			463–2608
1 R. Sen			0.70–2.59
2 R. Sen			0.87–3.16

DISCUSSION.

In regard to the location of the olfactory organs in insects several views have been held. Lehmann (1799) tries to analogize the spiracles of insects with the noses of vertebrates. Comparetti (1800) places the seat of smell in different parts for different families as follows: The club of the antennæ in lamellicorn beetles, the proboscis in Lepidoptera and certain frontal cells in Orthoptera. Ramdohr (1811) mistakes the salivary glands in the head for the olfactory apparatus. Rosenthal (1811) regards a folded skin beneath the antennæ as the seat of the olfactory organs. Huber (1814) considers the mouth cavity of the honey bee as the seat of olfaction. Treviranus (1816) thinks that the œsophagus is the seat of the olfactory apparatus. Kirby and Spence (1826) regard the rhinarium or nostril-piece as the seat of the organs of smell. Burmeister (1836) considers that insects smell with what he calls the "internal superior surface." Paasch (1873) claims that a plate between the eyes and beneath the antennæ is the seat of the olfactory organs. Wolff (1875) calls the hairlike organs on the epipharynx of the honey bee the olfactory apparatus. Joseph (1877) claims to have found an olfactory region near the spiracles which communicates with the tracheæ.

After having cut off the antennæ of two male moths, Dugés (1838) says that the insects were unable to find a female that they had previously been able to locate while their antennæ were intact.

Blow-flies with the antennæ cut off fail to find putrid meat as before.

Lefebvre (1838) experimented with bees and wasps with mutilated antennæ. He thinks that the olfactory organs are located at the extremities of the antennæ.

Perris (1850) says: (1) In amputating the extremity of the antennæ the olfactory sense is not destroyed, but it is weakened, and by cutting them off at the base the sense of smell is totally or partially destroyed; (2) covering the antennæ with a layer of india rubber renders these organs insensible; (3) sometimes a little sensibility is shown when the palpi are amputated.

Cornalia (1856) experimented with mutilated male moths. He thinks that the seat of olfaction lies in both the antennæ and palpi.

Garnier (1860) denies that the antennæ of *Necrophagus* are the seat of the olfactory organs, because these beetles returned immediately to the body of a mole from which they had been removed.

Balbiani (1866) says that male butterflies with the antennæ cut off fail to respond, as do unmutilated males, to females in any manner.

Grimm (1869) after many experiments concludes that the antennæ of beetles do not function as olfactory organs.

Forel (1874, 1885) says that ants when deprived of their antennæ cannot guide themselves and are not able to distinguish companions from enemies or to discover food placed at their sides. When deprived of the anterior part of the head and of the entire abdomen they preserve all their faculties. The same author (1878) found that a wasp with the anterior part of the head cut off responded to a needle dipped in honey, while a wasp with both antennæ cut off failed to respond. Forel (1908) says that carrion-feeding beetles with the antennæ cut off cannot find putrid meat as before the antennæ are mutilated.

Hauser (1880) studied the behavior of various insects before and after the removal of the antennæ. When the antennæ were cut off, many individuals soon became sick and died, although some of them lived thereafter for many days. In insects with their antennæ dipped into melted paraffin, the behavior was similar to that of those with the antennæ amputated. After performing many experiments with *Philonthus æneus*, he concludes that these insects lose the olfactory sense by the removal of the antennæ. Experiments with species of several other genera gave the same results, but those with beetles of the genera *Carabus*, *Melolontha*, and *Silpha* were less satisfactory. These never completely failed to respond to strong-smelling substances. Experiments with *Hemiptera* gave a still less favorable result. After the loss of the antennæ, these insects reacted almost as well as they did with their antennæ intact.

Porter (1883) thinks that the antennæ of butterflies and some other insects have nothing to do with olfaction. Some insects are affected little, if at all, by the extirpation of the antennæ, while others become very sick after the loss of these appendages.

Graber (1885) contends that ants (*Formica rufa*) and flies (*Lucilia cæsar*) and beetles (*Silpha thoracica*) without their antennæ still possess the sense of smell. He is inclined to the view that insects do not have any special olfactory organ, and that when the odoriferous emanations are intense they may be perceived by the surfaces of the body which are covered with thin chitin and which are provided with terminal excitable nerves.

Plateau (1886) says that in *Blatta* the antennæ are the olfactory organs. Graber (1887) repeated Plateau's experiments by using many cockroaches, and declares that in these insects the antennæ actually function as olfactory organs, but this is not true for all insects.

Fielde (1901, 1903, 1907) claims that the eleventh or distal segment of the antennæ of ants perceives the nest odor; the tenth segment, the colony odor; the ninth segment, the individual track; the eighth and seventh, the inert young; and the sixth and fifth, the odor of enemies. Miss Fielde clipped the antennæ with sharp scissors, and 15 days after the operation about 40 per cent. of the ants recovered from the effect of the shock. "Before their recovery the ants were listless and abnormally irritable; and they attacked with self-destructive violence any moving thing that touched them." She also found that queen ants deprived of their antennæ did not behave normally.

Barrows (1907) says that gum on the antennæ of *Drosophila ampelophila* does not keep out odors, nor could the antennæ be burnt off without considerable injury to the flies. He etherized some flies and cut off the terminal segment bearing sense cones with fine scissors, and he declares that the ether did not affect the results of the experiments with odors. He says: "It therefore seems certain that the sense of smell is absent, or at least greatly reduced in flies that have lost the terminal joints of the antennæ."

Kellogg (1907) informs us that male silkworm moths with extirpated antennæ are unable to find the females unless by accident.

From the foregoing it is seen that about one-fourth of all the writers who have experimented on insects with mutilated antennæ assert that these appendages do not carry the olfactory organs. Most of the observers have failed to state whether or not the insects used were normal. The inactivity of most of their insects indicates abnormality. With Miss Fielde's ants, only 40 per cent. recovered from the effect of the shock, and in all probability all of these were more or less abnormal. The writer has found that when the antennæ of ants, wasps, and bees are mutilated in the slightest degree the insects are always more or less abnormal in behavior.

Hicks (1857, 1859, 1860) first discovered the organs called the olfactory pores in this paper on the halteres and on the bases of the wings of all *Diptera* examined; on the bases of all four wings of the four-winged tribes; on the trochanter and femur of all insects, and occasionally on the tibia. He examined many species representing various insect orders and found these pores even on the lower insects, such as the earwig. In such wingless insects as the worker and soldier ants, he infers that these pores are much more abundant on the legs than they are on these appendages in the winged insects. Hicks suggested an olfactory function for all of these pores, whether on the legs or wings, but he performed no experiments of any kind. His drawings represent only the superficial appearance of the pores.

Janet (1904, 1907) found porelike sense organs in large numbers in all the ants that he examined. They occur on the mouth parts, legs, and he saw a few on the thorax at the base of the wing of a queen ant. His drawings of the superficial aspects of all these pores are very similar to those seen by the writer, but he has failed to understand the internal anatomy. He calls the chitinous cone an umbel, which is always separated from the surrounding chitin by a chamber. The chamber communicates with the exterior by means of a pore. The sense fiber, or his manubrium, runs into the umbel, and he thinks that it spreads out over the inner surface of the umbel and does not open into the chamber. Thus the umbel forms a thin layer of chitin which separates the end of the sense fiber from the external air.

In conclusion, it seems that the organs called the olfactory pores in this paper are the true olfactory apparatus in Hymenoptera and that the antennæ play no part in receiving odor stimuli.

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Explanation of Plates XI, XII.

All figures, except those in the text, are from camera lucida drawings made at the base of the microscope. All drawings, except the text figures and Plate XI, fig. 25, and Plate XII, fig. 26, are enlarged 875 diameters. These were made with V and S4 oc. and $\frac{1}{12}$ oil imm.

Abbreviations.

C	coxa.
Ch	chitin.
ChL	chitinous layer.
Con	chitinous cone.
F	femur.
Hr	hair.
HrMS	hair-mother cell.
Hyp	hypodermis.
HypS	hypodermal cell.
HypSt	hypodermal strand.
M	muscle.
Mo	mouth.
N	nerve.
NB	nerve branch.
NF	nerve fiber.
Nic	niche in which wing arises.
NkFl	neck of flask.
PorAp	pore aperture.
PorB	pore border.
PorW	pore wall.
SC	sense cell.
SF	sense fiber.
SCNuc	sense cell nucleus.
SCNucl	sense cell nucleolus.
T	trachea.
Tb	tibia.
Tr	trochanter.
a	outer margin of cone.
aa	thick chitin around flask.
a to d	groups of isolated pores.
b	inner margin of cone.
c	lowest strata of chitin.
d	outermost strata of chitin.
e	strata forming "chitinous layer."
f	middle strata of chitin.
xx	weak place in chitin of front wing where wing breaks off.
yy	weak place in chitin of hind wing where wing breaks off.
1 to 9	groups of pores.

Plate XI.—Fig. 3.—Group No. 8 from trochanter of female of *Formica*, showing superficial appearance of pores.

Fig. 4.—Two pores and three hairs from tibia of female of *Formica*, showing superficial appearance.

Fig. 5.—Group No. 1 on front wing of female of *Formica*, showing superficial appearance.

Fig. 6.—Cross-section of one of largest pores and sense cell from tibia of female of *Formica*, showing internal anatomy.

Fig. 7.—One of smallest pores from tibia of female of *Formica*.

Fig. 8.—Two pores from group No. 2 on front wing of female of *Formica*.

Fig. 9.—Two pores from group No. 3 on front wing of female of *Formica*.

Fig. 10.—Two pores from group No. 4 on hind wing of female of *Formica*.

Fig. 11.—Two pores from group No. 5 on hind wing of female of *Formica*.

Fig. 12.—Six pores and a bunch of sense cells as actually seen in group No. 2 on front wing of female of *Formica*.

Fig. 13.—Three pores, one sense cell, and hypodermis as actually seen in group No. 7 on trochanter of female of *Formica*.

Fig. 14.—Two pores with sense cells and hypodermis as actually seen in group No. 8 on trochanter of female of *Formica*.

Fig. 15.—Pore from group No. 6 on trochanter of female of *Formica*.

Fig. 16.—Isolated pore from group *b* on trochanter of female of *Formica*.

Fig. 17.—Two pores from a group on trochanter of deälated female of *C. pennsylvanicus*.

Fig. 18.—One of largest isolated pores from trochanter of deälated female of *C. pennsylvanicus*.

Fig. 19.—One of smallest isolated pores from same trochanter as in fig. 18.

Fig. 20.—Three pores from group No. 2 on front wing of old winged female of *C. mela*.

Fig. 21.—Three pores from group No. 3 on same wing as in fig. 20.

Fig. 22.—Three pores from group No. 2 on front wing of old winged male of *C. mela*.

Fig. 23.—Four pores and bunch of sense cells from stub of wing of old deälated female of *C. pennsylvanicus*. This female had been kept in captivity eight months before killed.

Fig. 25.—Semidiagram of cross-section of front wing of female of *Formica*, showing innervation of groups Nos. 2 and 3. × 280. As in fig. 26, hard chitin of wing is represented by solid black; soft articular chitin of wing by dots, and hard chitin of thorax by broken lines. Owing to the broken condition of the chitin, the nerves (N) could not be traced into these wings, but they were traced into the wings of the honey bee and muddobber.

Plate XII.—Fig. 26.—Semidiagram of cross-section of hind wing of female of *Formica*, showing innervation of groups Nos. 4 and 5. × 280.

Figs. 27 to 32, inclusive, are cross-sections through pores of hornet (*Vespula maculata*). Fig. 27: One of largest pores, and fig. 28 is one of smallest pores from tibia. Neither pore aperture was seen in section. Fig. 29: Three pores on trochanter cut obliquely, showing pore apertures. Fig. 30: One of smallest pores from a group on trochanter, showing sense cell. Pore aperture was not visible. Fig. 31: Pore from femur. Fig. 32: Three pores from front wing.

Figs. 33 to 41, inclusive, are cross-sections through pores of muddobber (*Sceliphron cementarius*). Figs. 33 and 34: Two pores from two different groups on trochanter. Figs. 35 and 36: One of largest and one of smallest isolated pores from trochanter. Fig. 37: Pore from group on femur. Fig. 38: Shows origin of internal anatomy of a large pore and sense cell from tibia. Fig. 39: One of smallest pores from tibia. Fig. 40: Three pores from group No. 2 on front wing. Fig. 41: Pore from thorax at base of niche near articulation of front wing.

Fig. 42.—Pore and sense cell from tibia of a worker honey bee.

Figs. 43–79 show the relative sizes of the superficial appearances of pores of various hymenopterous insects. In each figure, the larger pore is from the femur and the smaller one is from the front wing. These pores are the largest ones seen on these appendages. Below in the order named are given (1) the figure number, (2) the name of insect, and (3) the relative size of the insect. The relative sizes of the various insects were found as explained on page 326.

Fig. 43.—*Cimbex americana*	6.00
Fig. 44.—*Macrophyla flavicoxæ*	1.75
Fig. 45.—*Megarhyssa lunator*	3.33

Fig. 46.—*Microgaster mamestræ*	1.00
Fig. 47.—*Evania appendigaster*	2.40
Fig. 48.—*Chrysis tridens*	2.41
Fig. 49.—♀ Ant (not identified)	0.56
Fig. 50.—♀ *Aphænogaster aquia*	0.74
Fig. 51.—♀ *Lasius aliena*	1.37
Fig. 52.—☿ Major *Formica obscuriventris*	1.41
Fig. 53.—♀ *Formica obscuriventris*	2.00
Fig. 54.—♂ *Formica obscuriventris*	1.77
Fig. 55.—☿ Major *Camponotus mela*	2.50
Fig. 56.—♀ *C. pennsylvanicus*, black var	2.00
Fig. 57.—☿ Minor *C. pennsylvanicus*, brown var	2.22
Fig. 58.—☿ Major *C. pennsylvanicus*, brown var	2.59
Fig. 59.—♀ Deälated *C. pennsylvanicus*, brown var	3.00
Fig. 60.—♂ Winged *C. pennsylvanicus*, brown var	1.85
Fig. 61.—*Ceropales fraterna*	2.25
Fig. 62.—*Sceliphron cementarius*	3.35
Fig. 63.—*Larropsis distincta*	2.22
Fig. 64.—*Philanthus punctata*	2.00
Fig. 65.—*Mimesa Kohli*	0.90
Fig. 66.—*Stigmus universitatus*	0.53
Fig. 67.—*Trypoxylon frigidum*	4.00
Fig. 68.—*Solenius interruptus*	2.40
Fig. 69.—*Pseudomasaris vespoides*	3.10
Fig. 70.—*Monobia quadridens*	3.15
Fig. 71.—*Polistes nestor*	3.14
Fig. 72.—*Vespula maculata*	4.44
Fig. 73.—*Andrena vicina*	3.00
Fig. 74.—*Megachile brevis*	2.15
Fig. 75.—*Psithyrus sp*	3.70
Fig. 76.—*Bombus sp*	3.52
Fig. 77.—☿ *Apis mellifica*	3.00
Fig. 78.—♀ *Apis mellifica*	3.90
Fig. 79.—♂ *Apis mellifica*	3.71

DESCRIPTION OF A NEW BLENNY FROM NEW JERSEY, WITH NOTES ON OTHER FISHES FROM THE MIDDLE ATLANTIC STATES.

BY HENRY W. FOWLER.

During 1912 and the past year, a number of local collections have been acquired by the Academy. Many afford new or interesting localities, which are grouped according to the several States. Though multitudes of the commoner species were examined at the fisheries, usually small collections and small specimens were obtained where possible.

NEW JERSEY.

Dasyatis say (Le Sueur).

Examined a large one on the beach at Corson's Inlet, June 20, 1913. At this locality on June 19 saw *Fundulus heteroclitus macrolepidotus*, *Poronotus triacanthus*, *Cynoscion regalis*, *Chilomycterus schœpfi*, and *Lophius piscatorius*. On June 20 and 21, saw *Anguilla chrisypa*, *Fundulus heteroclitus macrolepidotus*, *Fistularia tabacaria*, *Hippocampus hudsonius*, *Cynoscion regalis*, *Bairdiella chrysura*, *Sciænops ocellatus*, *Menticirrhus saxatilis*, *Pogonias cromis*, *Monacanthus hispidus*, and *Paralichthys dentatus*. The *Fistularia* was preserved, having been taken in the summer of 1912, and was about 15 inches long.

Several selachians have been reported to me on apparently trustworthy authority. They are:

Alopias vulpes.

One 16 feet long, taken in the pounds at Sea Isle City in May, 1900. T. Küpfer.

Scoliodon terræ-novæ.

One about 3 feet long, examined by Mr. W. J. Fox, was parasitized with numerous female copepods (*Pandarus sinuatus*), which were preserved. This shark was secured May 31, 1913, and the fishermen reported several more shortly afterward.

Squatina squatina.

One reported at Ocean City on December 31, 1912, and another in the same month at Stone Harbor, credited with being four feet long.

Dorosoma cepedianum (Le Sueur).

Dr. R. J. Phillips secured an adult at Corson's Inlet, October 16, 1913, taken in a mullet-net.

Synodus fœtens (Linnæus).

One received from Dr. Phillips, taken in the summer of 1912, at Corson's Inlet, with *Atopichthys*, *Gasterosteus aculeatus*, and *Lagodon rhomboides*. Mr. D. McCadden secured an example at Ocean City on September 17, 1912.

Felichthys marinus (Mitchill).

An adult from Corson's Inlet, secured on August 19, 1912, by Mr. Fox.

Tylosurus marinus (Walbaum).

Many examples, about ten inches long, obtained by Mr. McCadden, on August 11, 1912, at Ocean City. August 30, 1913, at the same locality, he obtained a young *Prionotus evolans strigatus*, and found *Seriola zonata* abundant.

Tylosurus raphidoma (Ranzani).

Dr. Phillips secured a large example on August 15, 1913, taken in the pounds at Sea Isle City. Several other examples were also taken. The species appears to be frequent off our coast in the summer.

Sphyræna borealis De Kay.

A small one was secured in the bay at Corson's Inlet, on August 2, 1913, by Dr. Phillips.

Trichiurus lepturus Linnæus.

Mr. Fox reported one at Sea Isle City on July 5, 1912, and another on July 16, which last contained numerous small whitish eggs. A third example was taken in Great Egg Harbor Bay at Ocean City, July 30, 1913, and notice sent to me by Mr. W. B. Davis.

Caranx hippos (Linnæus).

A small example was obtained at Corson's Inlet on September 7, 1913, and another a little larger on September 8, by Dr. Phillips.

Rachycentron canadus (Linnæus).

Mr. Fox secured an example, 30 inches long, at Sea Isle City, on August 12, 1912.

Orthopristis chrysopterus (Linnæus).

Five small ones were caught at Corson's Inlet on September 20, 1913, and forwarded by Dr. Phillips. When caught, they grunted.

Sciænops ocellatus (Linnæus).

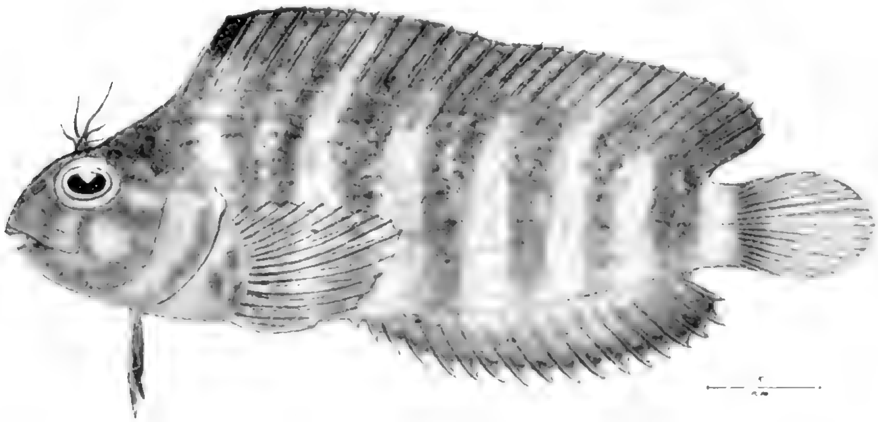
Dr. Phillips secured a small one at Corson's Inlet on September 8, 1913, and about the same time Mr. McCadden got a large one at Ocean City. Both these specimens were infested with lerneans.

Blennius foxi sp. nov.

Head $3\frac{1}{3}$; depth $3\frac{1}{2}$; D. XI, 15; A. 18; P. 14; V. I, 3; head width $1\frac{3}{5}$ in its length; head depth at ventral origin $1\frac{1}{5}$; snout $3\frac{1}{5}$; eye $3\frac{2}{5}$; maxillary $2\frac{3}{5}$; interorbital space 2 in eye; first dorsal spine about $1\frac{7}{8}$ in head; tenth dorsal ray about $1\frac{4}{5}$; tenth anal ray about $2\frac{1}{4}$; least depth of caudal peduncle $2\frac{3}{4}$; caudal fin $1\frac{3}{5}$; tenth pectoral ray $1\frac{1}{2}$; ventral 2.

Body elongate, well compressed, contour elongately ellipsoid, with greatest depth at pectoral base. Caudal peduncle well compressed, short.

Head large, compressed, rather pointed, anterior upper profile moderately oblique, moderately convex sides slightly more wide below than above. Snout short, profile oblique, surface convex, slightly shorter than broad. Eye large, high, rounded, and anterior in head, centre falling slightly behind first third in length of head. Pupil horizontally ellipsoid. Supraorbital cirrus large, its length about equals postorbital portion of head, and with two smaller filaments each side basally. Mouth moderate, terminal, and jaws about even, gape below upper basal edge of pectoral. Lips broad, fleshy. Maxillary large, slightly inclined, and nearly extending back opposite centre of eye. Teeth simple, close-set, and about 17 in each jaw. Also each jaw with a posterior canine on each side posteriorly (thus 4 in all), and the upper a little anterior to middle in length of maxillary as viewed laterally. Mandible strong, convex over surface, and rami not much elevated inside mouth. Tongue thick, fleshy, little free, and far back. Nostrils separated, though rather close, and near middle in length of snout. Interorbital narrowly concave.



Gill-openings entirely lateral, large, each about equal in length to combined snout and eye, and extend forward last third in length of head. Interior not examined.

Body scaleless, with smooth skin. Mucous system well developed on head, especially along preopercle ridge. L. l. system at first somewhat distinct, high, or close to back, and towards end of pectoral sloping down till midway along side, when obscure to caudal base.

Dorsals little differentiated, spines similar to simple rays, slightly more pungent, both rays and spines more or less uniform and covered with membrane, edge of fin entire. Dorsal origin little before hind edge of preopercle. Rayed dorsal well separated behind from caudal peduncle, and anal fin similar. Anal with edge notched, rays graduated down to shortest anteriorly, and fin inserted a little nearer snout tip than caudal base. Caudal moderately long, hind edge rounded. Pectoral large, graduated to ninth ray, which longest, and lower rays less graduated and thickened. Ventral inserted slightly before spinous dorsal origin, extends back slightly more than half way to anal. Vent close before anal.

Color when fresh largely various shades of neutral tint, with dorsal and anal slightly darker. Head marked with dark blotches of neutral tint, which somewhat obscurely defined, and radiate from eye. Trunks with seven vertical broad dark bands, wider or equal to the interspaces, and each with several whitish spots or blotches variously distributed within their boundaries. These dark vertical bands also reflected more or less on bases of dorsals. Iris brownish. Cirrus dusky. Dorsals deep neutral tint, without pale edge, and membrane between first two spines blackish. Anal with free tips of rays whitish and a submarginal deep neutral tint whole length of fin, base being paler. Caudal pale grayish. Pectoral livid gray, with several dark blotches before its base. Ventral pale along front edge, terminal portion behind dusky.

Length 38 mm.

Type, No. 39,440, A. N. S. P. Sea Isle City, Cape May County, New Jersey. September 5, 1913. Edward Nolan Fox.

Only the type known. It was secured in a little slough formed about the pilings of the pier, and left by the tides. The specimen was alive when found, swimming actively about, though it died shortly after its capture, when confined in a small vessel.

The species falls within the subgenus *Blennius* Linnæus. It is related to *Blennius fucorum* Valenciennes, though that species has a smaller and obtuse head, its orbital cirrus bifid at tip and fringed at its base, more teeth (24 in each jaw), and a different coloration. It is said to be olivaceous, spotted with brown, and the spinous dorsal edged with paler. De Kay figures an example secured between New York and Constantinople, and it is therefore uncertain if he really obtained it in our limits.

Blennius stearnsi Jordan and Gilbert also differs in the coloration, more slender body, longer maxillary, and more numerous teeth (24 to 26).

(Named for Master Edward Nolan Fox, who secured the type.)

Urophycis regius (Walbaum).

Mr. McCadden secured one in Great Egg Harbor Bay, at Ocean City, on July 6, 1913, with *Bairdiella chrysura*, and a large prawn (*Peneus setiferus*). The Bairdiella was infested with a lernean parasite. On July 20, he found several more examples of *Urophycis*.

Urophycis tenuis (Mitchill).

A small example in the Academy was obtained many years ago at Cape May. This is the first I have seen.

On May 26, 1912, I visited the Dutch Neck Fishery, between Florence and Burlington, on the Delaware River shores, and found *Abramis crysoleucas, Ameiurus nebulosus, Fundulus heteroclitus macrolepidotus, F. diaphanus,* and *Eupomotis gibbosus* abundant. On June 1, 1913, I found *Pomolobus pseudoharengus, Anguilla chrisypa, Catostomus commersonnii, Abramis, Schilbeodes gyrinus, F. heteroclitus macrolepidotus, F. diaphanus, Apeltes quadracus, Eupomotis*, and *Boleosoma nigrum olmstedi*.

Mr. J. T. Nichols informs me he found an example of *Lobotes surinamensis* on September 20, 1913 at Galilee (Seabright), N. J. *Scomber colias, Pelamys alleterata*, and *Chætodipterus faber* were also noted at the same time. Another *Lobotes*, with a large example of *Fistularia tabacaria*, was also forwarded from Anglesea, N. J., October 21, 1913, through Mr. W. J. Fox.

PENNSYLVANIA.

Two large collections were received from Erie, one in April and the other in May, 1912. The specimens were collected in Lake Erie, at or near Erie, and forwarded at the direction of Mr. N. R. Buller, Fish Commissioner of Pennsylvania.

During the spring of 1912, and again in 1913, a great number of fishes were studied at Lovett's Fishery, situated at the mouth of Tullytown Creek on the Delaware River. A small spring-fed stream, also flowing into the river close below this point, was thoroughly explored and yielded interesting material. Though unnamed, it is here referred to as "Tullytown Brook."

In June, 1912, I visited Mr. F. J. Meyers at Bethlehem, in Northampton County, and made a number of collections from the streams flowing into the Lehigh River in that vicinity. Mr. Meyers again invited me to join him in this region in late May of 1913, when we also made a few more collections. We then continued this excursion to Pocono Summit and explored various streams in Monroe County.

Mr. R. W. Wehrle sent several collections from Indiana and Huntingdon Counties.

In late July I spent a week in the lower Susquehanna region, around Peach Bottom, in York County, and with the assistance of Mr. H. L. Mather, Jr., secured several interesting collections.

Various other collections of lesser interest, though some quite extensive, have also been received during the past two years.

Petromyzon marinus Linnæus.

A young bluish example, taken in the shad-net at Tullytown.

Lampetra æpytera (Abbott).

Mr. Wehrle sent three small ones, though mature, from Hoffman's Run in Indiana County. He writes: "There were a lot of them sticking to stones in the riffles, and I think they were spawning. When scared down stream they remained quiet a while, but soon returned to stick to the same stones." Two others were also received from him, taken in Brick Pond. All taken in April, 1913.

Acipenser sturio Linnæus.

Two at the Tullytown Fishery. One, four feet long, taken early in May, and the other taken May 28, a small example.

Lepisosteus osseus huronensis (Richardson).

Erie.

Amiatus calvus (Linnæus).

Five from Erie, one a female and others males. Stomachs nearly empty, one containing small *Perca flavescens.*

Pomolobus pseudoharengus (Wilson).

Several hundred examined at Tullytown, from which about a dozen copepods (*Naobranchia pomolobi*) were taken. The parasites were all within the gill-openings. One adult female had a lernean, *Lerneoceropsis septemramosus*, attached to its side below dorsal fin.

Pomolobus æstivalis (Mitchill).

Many taken at Tullytown, and in several hauls almost all the fish were this species. A few copepods (*Naobranchia*) were also found in the gill-openings of some.

Alosa sapidissima (Wilson).

Over a hundred examined at Tullytown, though no crustacean parasites found on them.

Leucichthys artedi (Le Sueur.)

Erie.

Salmo fario Linnæus.

One from the Schuylkill River below Fairmount Dam, received from the Philadelphia Aquarium. Possibly it was washed out of the Wissahickon Creek, as suggested by Mr. W. E. Meehan.

Salvelinus fontinalis (Mitchill.)

Two from McMichæl's Creek in Monroe County. Abundant in the Monocacy Creek above Bethlehem, and below in the Saucon Creek, also at Hellertown. In Monroe County at Tannersville, Pocono Creek, Tunkhanna Creek, Pocono Lake, and Snyderville. Mr. Wehrle sent an example from Laurel Run, in Huntingdon County, containing a cestode.

Anguilla chrisypa Rafinesque.

Tullytown Creek, Scott's Creek, Lovett's Fishery, Cash Ledge Bar, and Tullytown Brook, Bucks County. Also common in Muddy Creek, York County.

Campostoma anomalum (Rafinesque).

North Branch of Altman Creek, Yellow Creek, and Brick Pond, in Indiana County.

Pimephales notatus (Rafinesque).

Yellow Creek, North Branch of Altman Creek, Lucus Pond, and Brush Creek, in Indiana County. Abundant in the Susquehanna River at Peach Bottom, York County.

Semotilus bullaris (Rafinesque).

Tullytown Brook, Fallsington, and White's Island, Bucks County; Peach Bottom, York County.

Semotilus atromaculatus (Mitchill).

Hellertown, Northampton County; Tunkhanna Creek, Tobyhanna Creek, Pocono Lake, Snyderville, Monroe County; Laurel Run, Huntingdon County; North Branch of Altman Creek, Yellow Creek, Brick Pond, Lucus Pond, Brush Creek, Indiana County.

Leuciscus elongatus (Kirtland).

North Branch of Altman Creek, Brick Pond, Lucus Pond, Brush Creek, Indiana County.

Abramis crysoleucas (Mitchill).

Scott's Creek, Cash Ledge Bar, Tullytown Creek, Tullytown Brook, Fallsington, Queen Anne Creek, Bucks County; Darby Creek near Moore's, and Media, Delaware County. A good series of adults from Erie do not differ from our common eastern examples.

In a collection of fish-bones from a kingfisher's nest, taken May 20, 1913, at Bustleton, sent to me by Mr. R. F. Miller, I did not find the remains of this fish, as in a previous nest I reported. It contained only remains of *Notropis cornutus*, *Catostomus commersonnii*, and *Cambarus bartonii*. Of the first-named about 40 pharyngeal bones were examined.

Notropis bifrenatus (Cope).

Queen Anne Creek near Emilie, Tullytown Brook, Cash Ledge Bar, Fallsington, Bucks County; Hellertown, Lime Kiln Run, Saucon and Monocacy Creeks, Northampton County.

Notropis procne (Cope).

Susquehanna River at Peach Bottom, York County.

Notropis hudsonius amarus (Girard).

Queen Anne Creek near Emilie, White's Island, Bucks County; Schuylkill River below Fairmount Dam, Philadelphia County; Muddy Creek, York County.

Notropis whipplii analostanus (Girard).

Scott's Creek, Tullytown, Cash Ledge Bar, White's Island, Bucks County; Muddy Creek, and Peach Bottom, York County.

Notropis cornutus (Mitchill).

Robertson's Brook and Media, Delaware County; Monocacy and Saucon Creeks, Lime Kiln Run, Hellertown, Northampton County; Tunkhanna Creek, Tobyhanna Creek, Monroe County.

Muddy Creek, Sowego Creek, Peach Bottom, York County.

North Branch of Altman Creek, Yellow Creek, Lucus Pond, Brush Creek, Indiana County.

Notropis chalybæus (Cope).

Delaware River at Cash Ledge Bar, Bucks County.

Notropis photogenis amœnus (Abbott).

Schuylkill River below Fairmount Dam, Philadelphia County; Susquehanna River at Peach Bottom, York County.

Ericymba buccata Cope.

Yellow Creek, Indiana County.

Rhinichthys atronasus (Mitchill).

Media and Robertson's Brook, Delaware County; White's Island, Bucks County; Lime Kiln Run, Hellertown and Saucon Creek, Northampton County; Pocono Creek, Tunkhanna Creek, Tobyhanna Creek, Pocono Lake, Snyderville, Monroe County.

Sowego Creek, York County; Laurel Run, Huntingdon County.

North Branch of Altman Creek, Lucus Pond, Brick Pond, and Brush Creek, Indiana County. Many from the last locality are greatly infested with protozoan parasites.

Hybopsis kentuckiensis (Rafinesque).

Sowego Creek and Susquehanna River at Peach Bottom. Muddy Creek, York County.

Exoglossum maxillingua (Le Sueur).

Muddy Creek and Sowego Creek, York County.

Cyprinus carpio Linnæus.

Tullytown; Erie; Lucus Pond, Indiana County.

Carpiodes thompsoni Agassiz.

Erie.

Catostomus commersonnii Lacépède.

Robertson's Brook, Delaware County; Tullytown Creek, Fallsington, Bucks County; Lime Kiln Run, Saucon and Monocacy Creeks, Northampton County; Peach Bottom, York County; North Branch of Altman Creek, Lucus Pond, and Brush Creek, Indiana County.

About a dozen examples were received from Erie, some of which are nearly two feet long. One of these was immediately noticed to be pale or whitish, besides being silvery tinted. When opened it contained a large cestode measuring 530 mm. in length. The parasite was submitted to Dr. J. P. Moore, who kindly informs me that it is the larval stage of *Dibothrium ligula* Donnadieu. He says it also occurs, in the larval form, in many birds, and in the mature stage, in fish-eating birds. The parasite was wound in several coils loosely through the liver and about the abdominal cavity. No distension of the abdomen, such as being swollen out, was noticed. No parasites were found in the other fishes.

Catostomus nigricans Le Sueur.

Peach Bottom, York County, North Branch of Altman Creek, Indiana County.

Erimyzon sucetta oblongus (Mitchill).

Tullytown Brook and Fallsington, Bucks County. Erie.

Moxostoma breviceps (Cope).

Erie.

Moxostoma macrolepidotum (Le Sueur).

Peach Bottom, York County.

Ameiurus natalis (Le Sueur).

Erie.

Ameiurus nebulosus (Le Sueur).

Media, Delaware County; Schuylkill River below Fairmount Dam, Philadelphia County; Tullytown, Scott's Creek, Cash Ledge Bar, and Tullytown Brook, Bucks County; Dry Land Pond, Northampton County; Brick Pond, and Lucus Pond, Indiana County.

Ameiurus melas Rafinesque.

Erie.

Schilbeodes gyrinus (Mitchill).

An interesting example about eight inches long was taken in a fyke-net, at Torresdale, in the Delaware River. It was very pale, or a case of albinism, the general tint being dilute saffron. Mr. J. R. Berkhouse secured it and sent it to the Philadelphia Aquarium, where I saw it alive.

One adult from Lime Kiln Run, Lehigh County.

Esox americanus (Gmelin).

Media, Delaware County; Schuylkill River below Fairmount Dam, Philadelphia County; Scott's Creek, Tullytown Brook, Fallsington, and one from Tullytown Creek at Tullytown on May 26, 1913, with large round worm in viscera, Bucks County; Saucon and Monocacy Creeks, Northampton County; Tobyhanna Creek, and Pocono Lake, Monroe County.

Esox reticulatus Le Sueur.

Erie.

Umbra pygmæa (De Kay).

Tullytown Brook, Bucks County.

Fundulus heteroclitus macrolepidotus (Walbaum).

Darby Creek near Moore's, Delaware County; Scott's Creek, Tullytown Brook, Cash Ledge Bar, Bucks County.

Fundulus diaphanus Le Sueur.

Media, Darby Creek near Moore's, Delaware County; Tullytown Creek, Tullytown Brook, Scott's Creek, Cash Ledge Bar, White's

Island, Bucks County; Monocacy and Saucon Creeks, Northampton County.

Tylosurus marinus (Walbaum).

Susquehanna River at Peach Bottom, York County.

Apeltes quadracus (Mitchill).

Monocacy and Saucon Creeks, Northampton County.

Pomoxis annularis Rafinesque.

Schuylkill River below Fairmount Dam, Philadelphia.

Pomoxis sparoides (Lacépède).

Erie; Delaware River at Tullytown, Bucks County.

Ambloplites rupestris (Rafinesque).

Lucus Pond, Indiana County. Also examples from Erie.

Enneacanthus gloriosus (Holbrook).

Tullytown Brook, Bucks County.

Lepomis auritus (Linnæus).

Media, Delaware County; Tullytown Brook, Cash Ledge Bar, and White's Island, Bucks County; Muddy Creek, York County.

Lepomis incisor (Valenciennes).

Erie.

Eupomotis gibbosus (Linnæus).

Media, Delaware County; Tullytown, Tullytown Brook, Queen Anne Creek near Emilie, Fallsington, Cash Ledge Bar, Bucks County; Monocacy Creek, Northampton County; Saylor's Lake, Monroe County. Muddy Creek and Peach Bottom, York County. Erie.

Several small specimens from a mine-pond, near Bethlehem, taken in September, 1913, and received from Mr. F. Bureaw, were greatly parasitized with protozoa.

Micropterus dolomieu Lacépède.

Tullytown, Bucks County; Addingham, Delaware County; Yellow Creek, Indiana County.

Micropterus salmoides (Lacépède).

Erie.

Stizostedion vitreum (Mitchill).

Erie.

Perca flavescens (Mitchill).

Tullytown and Cash Ledge Bar, Bucks County. Erie.

Boleosoma nigrum (Rafinesque).

North Branch of Altman Creek, Yellow Creek, and Brick Pond, Indiana County.

Boleosoma nigrum olmstedi (Storer).

Tullytown Brook, Scott's Creek, and White's Island, Bucks County; Hellertown, Monocacy and Saucon Creeks, Northampton County; Snyderville, Tobyhanna Creek, Pocono Lake, Monroe County.

Peach Bottom, York County; Laurel Run, Huntingdon County.

Etheostoma flabellare Rafinesque.

North Branch of Altman Creek and Brick Pond, Indiana County.

Roccus lineatus (Bloch).

Tullytown.

Roccus chrysops (Rafinesque).

Erie.

Morone americana (Gmelin).

Tullytown and Cash Ledge Bar, Bucks County.

Aplodinotus grunniens Rafinesque.

Erie.

Cottus ictalops (Rafinesque).

Yellow Creek and Brick Pond, Indiana County.

Cottus gracilis Heckel.

Monocacy and Saucon Creeks, and Lime Kiln Run, Northampton County.

DELAWARE.

The following list pertains largely to a visit I made, with Mr. C. J. Pennock, to Mr. A. D. Poole, at Rehoboth, in late April, 1913. Mr. Poole assisted me in every way to make my stay profitable as possible. On my return to Philadelphia several days were also spent at Lewes. At Rehoboth I visited the off-shore pounds, and thus had opportunity of seeing many interesting species. Several species are new additions to the State fauna.

Mustelus canis (Mitchill).

Rehoboth and Lewes beaches. Common.

Raja erinacea Mitchill.

Lewes beach. Few.

Raja ocellata Mitchill.

Rehoboth and Lewes beaches. Common.

Raja eglanteria Lacépède.

Rehoboth and Lewes beaches. The most abundant species.

Raja lævis Mitchill.

Few large ones in the off-shore pound at Rehoboth.

Acipenser sturio Linnæus.

Two large ones in the Rehoboth pound. The larger measured $104\frac{1}{2}$ inches in length, and yielded about 50 pounds of caviare.

Lepisosteus osseus (Linnæus).

May 8, 1913, Mr. Poole informs me "large ones were very abundant in the dam at Greens Mills, which is near Bridgeville. The stream is the northwest fork of the Nanticoke."

Pomolobus mediocris (Mitchill).

Small ones at Rehoboth and Lewes.

Pomolobus pseudoharengus (Wilson).

Very abundant at Rehoboth and Lewes.

Alosa sapidissima (Wilson).

Saw a few, possibly a dozen each day, at Rehoboth. Few at Lewes.

Brevoortia tyrannus (Latrobe).

Very common at Rehoboth. Among the multitudes examined but one had *Olencira prægustator* in its mouth, besides being parasitized by *Lernæenicus radiatus*. The latter was common on almost every fish. Few at Lewes.

Anchovia mitchilli (Valenciennes).

Large schools seen in the pound at Rehoboth. Very common along the bay-shore at Lewes.

Anguilla chrisypa Rafinesque.

Young in multitudes, in Lewes Creek and the canal at Rehoboth. Common at Lewes.

Abramis crysoleucas (Mitchill).

A few in Lewes Creek at Rehoboth.

Ameiurus nebulosus (Le Sueur).

Common in Lewes Creek and many young in the ponds, lake, and canal at Rehoboth. Few at Lewes.

Esox reticulatus Le Sueur.

Several small ones in Lewes Creek at Rehoboth and Lewes.

Umbra pygmæa (De Kay).

Abundant in Lewes Creek, at Rehoboth and Lewes.

Fundulus majalis (Walbaum).

Common on the bay-shore at Lewes and about Cape Henlopen.

Fundulus heteroclitus macrolepidotus (Walbaum).

Common with the last. At Rehoboth it was common in the canal, though less so in the lake, and very abundant in Lewes Creek.

Fundulus diaphanus (Le Sueur).

About Rehoboth common in the fresh-water glades, and some half-grown males in full breeding-dress. At Lewes a few were found in the tidal reaches of Lewes Creek, though it was more common in the glades, where I found few or none of the preceding species.

Lucania parva (Baird).

Several in the canal at Rehoboth.

Menidia beryllina cerea Kendall.

Few in the canal at Rehoboth, with the last.

Menidia menidia notata (Mitchill).

Shoals seen in the pound at Rehoboth. Also common on the bay-shore at Lewes.

Hippocampus hudsonius De Kay.

Rehoboth beach.

Gasterosteus aculeatus Linnæus.

One taken in the lake, which virtually is head of Lewes Creek, at Rehoboth.

Poronotus triacanthus (Peck).

Common at Rehoboth and Lewes beaches.

Enneacanthus gloriosus (Holbrook).

Common in the glades of Lewes Creek at Rehoboth and Lewes.

Eupomotis gibbosus (Linnæus).

In the lake at Rehoboth.

Orthopristis chrysopterus (Linnæus).

Several in Rehoboth pound.

Stenotomus chrysops (Linnæus).

Few large ones in Rehoboth pound.

Cynoscion regalis (Schneider).

Very abundant at Rehoboth and Lewes.

Micropogon undulatus (Linnæus).

Common at Lewes and Rehoboth. With the last, the most abundant food-fish.

Menticirrhus saxatilis (Schneider).

Few at Lewes and Rehoboth.

Pogonias cromis (Linnæus).

Several large ones in the Rehoboth pound.

Tautoga onitis (Linnæus).

Lewes.

Spheroides maculatus (Schneider).

Common in the Rehoboth pound.

Prionotus evolans strigatus (Cuvier).

Abundant at Rehoboth and Lewes.

Lophopsetta maculata (Mitchill).

Few at Rehoboth.

Paralichthys dentatus (Linnæus).

Common, some large, at Rehoboth and Lewes.

Urophycis regius (Walbaum).

Adult and several small ones at Rehoboth.

Lophius piscatorius Linnæus.

Rehoboth and Lewes.

MARYLAND.

In late April of 1912, I made several collections in the Choptank and its tributaries about Denton, in Caroline County. A small collection was made in the Pocomoke River near Willards, in Wicomico County, in May of the same year. Rather extensive series of fresh-water fishes were also secured in the streams of Harford County, mostly from Deer Creek, at and near the Rocks, and in the Gunpowder River, in August, 1912.

Lepisosteus osseus (Linnæus).

I examined one of nine examples, from the Passerdyke Creek, at Eden, Wicomico River basin in Somerset County, May 2, 1913.

Pomolobus pseudoharengus (Wilson).

Choptank River and Gary's Branch, near Denton.

Alosa sapidissima (Wilson).

Choptank River at Cedar Island and Denton.

Anguilla chrisypa Rafinesque.

Deer Creek near Sharon, and common at the Rocks.

Semotilus atromaculatus (Mitchill).

Sharon and the Rocks.

Leuciscus vandoisulus Valenciennes.

The Rocks, and Laurel Brook, a tributary of the Gunpowder River.

Abramis crysoleucas (Mitchill).

Gary's Branch and Choptank River near Denton. Aydelotte Branch and Pocomoke River near Willards.

Notropis hudsonius amarus (Girard).[7]

Gary's Branch and Choptank River near Denton.

Notropis whipplii analostanus (Girard).

The Rocks.

Notropis cornutus (Mitchill).

Sharon, the Rocks, and Clermont Mills.

Notropis chalybæus (Cope).

Abundant in the Pocomoke River and Aydelotte Branch near Willards, associated with *Abramis* and *Palæmonetes vulgaris.*

Rhinichthys atronasus (Mitchill).

The Rocks, Clermont Mills, and Laurel Brook.

Hybopsis kentuckiensis (Rafinesque).

The Rocks, Sharon, Clermont Mills, and Laurel Brook.

Exoglossum maxillingua (Le Sueur).

Same as last species.

Catostomus commersonnii (Lacépède).

The Rocks, and Sharon.

Catostomus nigricans Le Sueur.

Clermont Mills.

Ameiurus catus (Linnæus).

Choptank River near Denton.

Ameiurus nebulosus (Le Sueur).

Gary's Branch, and Choptank River near Denton. Pocomoke River at Willards.

Schilbeodes insignis (Richardson).

The Rocks.

Esox americanus (Gmelin).

Aydelotte Branch near Willards.

Esox reticulatus Le Sueur.

Gary's Branch, and Choptank River near Denton. Pocomoke River, and Aydelotte Branch near Willards.

Umbra pygmæa (De Kay).

Aydelotte Branch near Willards.

Fundulus diaphanus (Le Sueur).

Choptank River, and Cedar Island near Denton.

Lepomis auritus (Linnæus).

The Rocks, Sharon, and Clermont Mills.

Eupomotis gibbosus (Linnæus).

Gary's Branch, and Choptank River near Denton. Pocomoke River near Willards.

Perca flavescens (Mitchill).

Gary's Branch, and Choptank River near Denton.

Boleosoma nigrum olmstedi (Storer).

Choptank River at Cedar Island and near Denton.

Morone americana (Gmelin).

Gary's Branch, Choptank River, and Cedar Island near Denton.

FISHES COLLECTED BY THE PEARY RELIEF EXPEDITION OF 1899.

BY HENRY W. FOWLER.

Mr. C. F. Silvester kindly placed this collection of fishes in my hands for determination. In some cases the specimens represent localities not given by previous writers. Two species are apparently new. The collection is small, though fairly representative of the meagre fish-fauna of such high latitudes in Greenland. At present it is contained in the Museum of Princeton University, with the exception of a series of duplicates presented to the Academy. The writer is indebted to Princeton University and to Mr. Silvester, for assistance and favors in framing the report.

COTTIDÆ.

Icelus bicornis (Reinhardt).

One example, 63 mm. long, from Foulke Fjord, in 35 fathoms, on August 4.

Three examples, 31 to 63 mm. long, from Ulriks Bay, in 7 to 25 fathoms, August 11.

Two examples, 31 to 67 mm. long, from Grandville Bay, in 10 to 22 fathoms, on August 18.

Four examples, 68 to 90 mm. long, from Cape Chalon, in 27 fathoms, on August 19.

One example, 39 mm. long, from Bardin Bay, on August 20.

One example, 38 mm. long, from Ulriks Bay, on August 24.

Four examples, 52 to 74 mm. long, from Karna, in 30 to 40 fathoms, on August 24.

Triglops pingeli Reinhardt.

One example, 69 mm. long, from Bardin Bay, on August 22.

Myoxocephalus grœnlandicus (Valenciennes).[1]

Two examples, 220 to 230 mm. long, dredged in 10 to 15 fathoms at Saunder's Island, on August 3.

One example, 175 mm. long, dredged in 7 to 25 fathoms in Ulriks Bay, on August 11.

The smallest example differs in lacking the warty prominences

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[1] The Academy has a large example obtained by the Peary Relief Expedition of 1892, at North Water, in northwest Greenland.

on the parietal region, which are well developed in the largest. All have a pore or slight slit after the last gill-arch, and the interorbital space nearly as wide as the eye is long. Scabrous tubercles on back and sides fewer in the smallest example.

Gymnocanthus tricuspis (Reinhardt).

One example, 188 mm. long, from Godhavn.

One example, 52 mm. long, from Upernavik, in 10 to 15 fathoms, in August.

One example, 66 mm. long, from Grandville Bay, in 20 to 40 fathoms, August 18.

Two examples, 62 to 79 mm. long, from Bardin Bay, on August 20.

One example, 78 mm. long, from Karna, in 30 to 40 fathoms, on August 24.

Nine examples, 53 to 123 mm. long, from Robertson Bay, in 5 to 40 fathoms, on August 24.

Two examples from Saunder's Island, in 10 to 15 fathoms, on August 3.

CYCLOPTERIDÆ.

Eumicrotremus spinosus (Müller).

One example, 25 mm. long, from Etah, in 5 fathoms, in August.

Two examples, 40 to 72 mm. long, without data.

Two examples, 38 to 70 mm. long, from Grandville Bay, in 20 to 40 fathoms, on August 18.

Also two examples, 36 to 42 mm. long, from Grandville Bay, on August 18.

Two examples, 33 to 35 mm. long, from Karna, in 20 to 40 fathoms, on August 24.

Four examples, 25 to 42 mm. long, from Robertson's Bay, in 5 to 40 fathoms, on August 24.

Lethotremus mcalpini sp. nov. Fig. 1.

Head $2\frac{3}{4}$; depth about $1\frac{7}{8}$; D. VII, 9; A. 10; P. about 22; head width about $2\frac{1}{8}$ in head and trunk; snout (in profile) 4 in head; eye (in profile) about 3; mouth width about $1\frac{1}{2}$; interorbital about 2; height of first dorsal $2\frac{2}{3}$; height of second dorsal 2; height of anal $2\frac{1}{3}$; least depth of caudal peduncle $3\frac{1}{3}$; caudal $1\frac{1}{2}$; upper longest pectoral ray $2\frac{1}{4}$; length of disk $1\frac{2}{5}$.

Body very robust, greatly swollen anteriorly, so that greatest width about equal to greatest depth, or nearly half length without caudal. Greatest width falls midway in region between base of uppermost pectoral ray and anal origin. Contour of body in lateral profile generally ovoid. Caudal peduncle compressed, its length $\frac{3}{4}$ its least depth.

Head large, broad, upper profile convex, more inclined than lower. Snout short, broad, convex over surface, its length about half its width. Eye large, circular, elevated, without free edges, and slightly anterior. Mouth broad, terminal, rather low, and broad fleshy lips similar. Jaws equal. Maxillary extends but slightly beyond front edge of eye. Dentition as a trenchant firm cutting-edge in each jaw, similar throughout most its extent, and edge only feebly notched or with but slight dentate appearance. Apparently no other teeth, though upper surface of mouth and tongue covered with small tubercles. Tongue large, broad, thick,

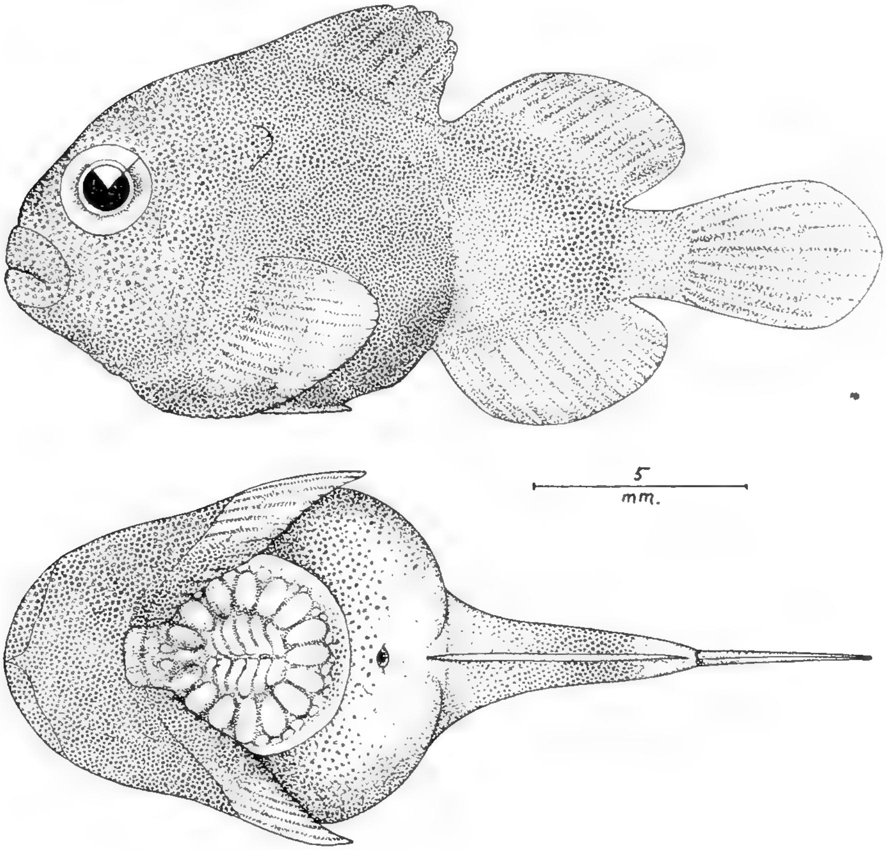

Fig. 1.—*Lethotremus mcalpini* Fowler. (Type.)

fleshy, front edge free. Upper and lower buccal membranes well developed. Nostrils near together, anterior in slight cutaneous tube, and posterior simple pore with simple cutaneous rim. In position anterior nostril about opposite middle of eye and posterior about opposite upper rim of eye. Interorbital broad and slightly convex.

Gill-opening high, mostly above upper level of eye, and small, its aperture not more than half of eye. Downwards and below to disk skin forms slight fold.

Skin perfectly smooth and without any conspicuous or evident pores, also without spines.

Dorsals separated by a deep notch, though their fleshy bases at least continuous. First dorsal smaller and more rounded than second, edge also slightly notched and of quite fleshy texture. Its insertion about over front of gill-opening. Second dorsal with rays more free or defined, though simple, and more uniform. Anal like second dorsal. Caudal moderate, rounded. Pectoral moderate, with long and moderately inclined base and composed of simple rays. Pectoral extends as far posteriorly as disk. Latter quite large, circular, and not ensheathed anteriorly by lower pectoral rays. Edge of disk entire. Vent close behind disk.

Color in alcohol largely pale brownish, fins paler or more or less whitish. Under a lens, head and trunk almost everywhere finely dotted with minute specks of darker shade. They also completely cover first dorsal, together with upper and lower regions of pectoral. On posterior ventral region darker dots quite sparse or inconspicuous. Iris pale slaty.

Length 21 mm.

Type, No. 2,950, Museum of Princeton University. Though the precise locality in Greenland is lost, Mr. Silvester thinks the specimen was probably taken in Ulriks Bay.

Only the type known. It is very similar to *Lethotremus muticus* Gilbert, from the Aleutian Islands, differing in the narrow notch between the dorsal fins, fewer dorsal rays, larger vertical fins, larger ventral disk, uniformly dotted coloration, etc. It agrees, however, in the smooth skin and dorsal spines. Gilbert gives the eye as very large, $2\frac{1}{3}$ to $2\frac{1}{2}$ in head, though his figure indicates that at the very least it is 4. His largest example was 30 mm. long.[2]

(Named for Mr. Charles W. McAlpin, to whom the University is indebted for assistance in securing the present collection.)

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[2] *Rep. U. S. F. Com.*, XIX, 1893 (1895), p. 449, Pl. 31. Unimak Pass, Alaska.

Lethotremus armouri sp. nov. Fig. 2.

Head $2\frac{1}{2}$; depth about $1\frac{7}{8}$; D. v, 11; A. 11; P. about 18; head width about $2\frac{1}{5}$ in head and trunk; snout (in profile) $3\frac{2}{5}$ in head; eye (in profile) $2\frac{1}{2}$; mouth width $1\frac{3}{5}$; interorbital about 2; height of first dorsal $1\frac{4}{5}$; height of second dorsal about 2; height of anal $1\frac{7}{8}$; least depth of caudal peduncle $2\frac{2}{3}$; caudal $1\frac{1}{4}$; upper longest pectoral ray $1\frac{4}{5}$; length of disk $1\frac{1}{4}$.

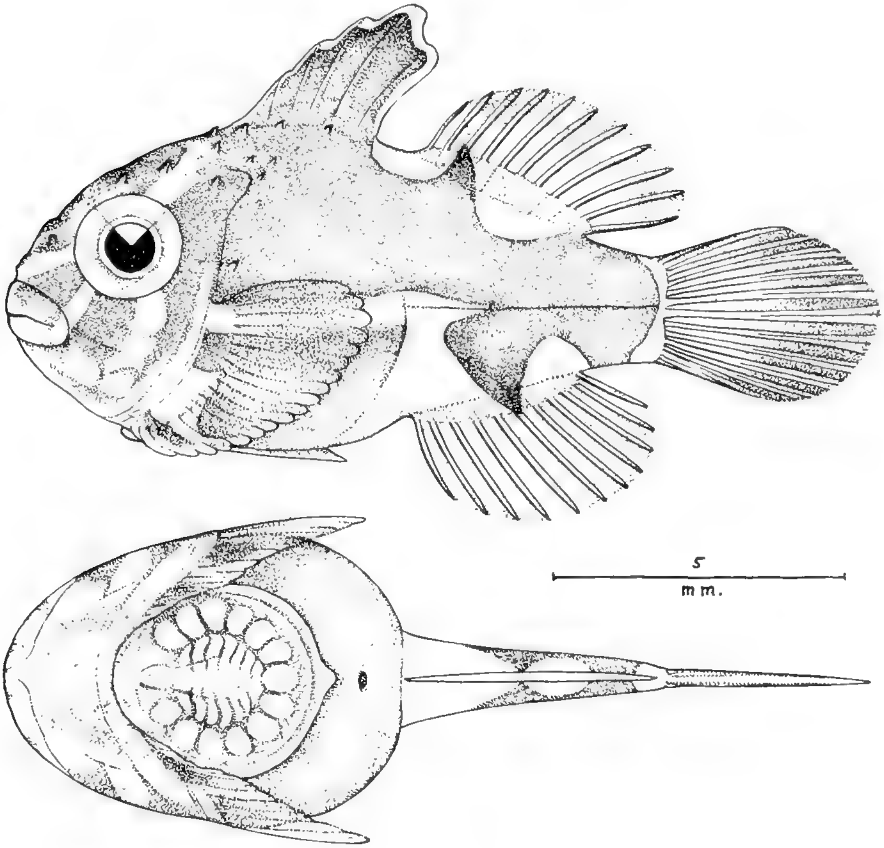

Fig. 2.—*Lethotremus armouri* Fowler. (Type.)

Body robust, swollen or rounded anteriorly, though greatest width not quite equal to greatest depth, or $2\frac{1}{3}$ in head and trunk without caudal. Greatest width falls at base of uppermost pectoral ray. Contour of body in lateral profile generally ovoid. Caudal peduncle compressed, its length about $\frac{3}{4}$ its least depth.

Head large, wide, upper profile generally convex, more inclined than lower. Snout short, wide, convex over surface, its length about $\frac{2}{3}$ its width. Eye large, circular, slightly anterior. Mouth broad, terminal, rather low, and broad fleshy lips similar. Jaws equal. Maxillary extending very slightly beyond front edge of eye. Each jaw with trenchant firm cutting-edge, feebly notched or with slight dentate appearance. Inside mouth skin apparently smooth. Tongue thick, fleshy, front edge free. Upper and lower buccal membranes slight. Nostrils near together, lower in slight tube about opposite middle of eye, and posterior simple pore about opposite upper rim of eye. Interorbital broad and slightly convex.

Gill-opening high, mostly above upper level of eye, and small aperture about half of eye. Downwards and below, skin forms slight fold.

Skin almost everywhere, except upper surface of head and front of back, which furnished with a number of bony tubercles, smooth and without any pores.

Dorsals entirely separated, space between about half of eye. First dorsal much shorter, though higher, than second, and its edge slightly notched. Spinous dorsal inserted over front of gill-opening. Second dorsal and anal similar, rays simple, well defined, and more or less uniform. Caudal moderate, rounded. Pectoral moderate, with long and moderately inclined base, and formed with simple rays. Pectoral reaches far posteriorly as disk. Latter quite large, circular, and not ensheathed in front by pectoral rays, edge entire. Vent close behind disk.

Color in alcohol largely brownish, contrasted with whitish markings. Color-pattern may best be understood by an examination of the accompanying figure. On head whitish is left radiating as several streaks from eye. First dorsal largely dusky-brown, with a white edge. Vertical fins otherwise pale or whitish. Disk pale. Iris pale slaty.

Length 15 mm.

Type, No. 2,951 Museum of Princeton University. Upernivik, in 8 to 10 fathoms, Greenland. August 1, 1899.

Paratypes, Nos. 2,952 to 2,954, Museum of Princeton University. Elah, in 5 fathoms, Greenland. August, 1899.

Related to *Lethotremus vinolentus* Jordan and Starks,[3] differing in the fewer spines, more numerous dorsal and anal rays, variegated

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[3] *Proc. Cal. Acad. Sci.*, 1895, p. 827, Pl. 94. Puget Sound, near Seattle, Wash.

color-pattern, etc. My examples are all similar and the paratypes but slightly smaller.

(Named for Mr. George A. Armour.)

LIPARIDIDÆ.

Liparis tunicatus Reinhardt.[4]

One example, 18 mm. long, from Etah, in 5 fathoms, in August.

One example, 82 mm. long, from Foulke Fjord, in 35 fathoms.

Three examples, 15 to 20 mm. long, from Upernavik, in 8 to 10 fathoms, on August 1.

Two examples, 76 to 85 mm. long, from Foulke Fjord, in 35 fathoms, on August 4.

One example, 62 mm. long, from Ulriks Bay, in 7 to 25 fathoms, on August 11.

One example, 48 mm. long, from Bardin Bay, on August 20.

One example, 104 mm. long, from Robertson's Bay, in 5 to 40 fathoms, on August 24.

ZOARCIDÆ.

Lycodalepis polaris (Sabine).

One example, 414 mm. long, from Saunder's Island, in 10 to 15 fathoms, on August 3.

Faunal Works.

BAY, E. 1896. Den östgrönlandske Expedition, udfört i Aarene 1891–92 under Ledelse af C. Ryder. < *Meddel. Grönland*, XIX, 1896, pp. 52–58. [List of 15 species from Scoresby Sound and Angmagsalik, in east Greenland.]

COLLETT, ROBERT. 1886. *Aphanopus minor*, en ny Dybvandsfisk af Trichuridernes Familie fra Grönland. < *Christ. Vidensk. Selsk. Forhandl.*, 1886, No. 19, pp. 1–7.

DRESEL, H. G. 1885. Notes on some Greenland Fishes. < *Proc. U. S. Nat. Mus.*, VII, 1884, pp. 244–258. [List of sixteen species with full notes.]

FABRICUS, OTHO. 1780. Fauna Grœnlandica, etc. Hafniæ et Lipsiæ, 1780. pp. 1–452. (Fishes, pp. 125–183, 344.) [Contains descriptions of 45 species, some of which described as new: *Salmo rivalis, S. stagnalis, Pleuronectes platessoides, Cottus scorpioides, Blennius punctatus, Gadus brosme, Ophidium viride*.]

GRAAH, W. A. 1832. Undersögelserejse til Ostkysten af Grönland. Kjöbenhavn, 1832, p. 194. [Eight species mentioned from the southern part of the east coast of Greenland.]

[GÜNTHER, A. 1877. Account of the Fishes collected by Capt. Feilden between 78° and 83° N. Lat., during the Arctic Expedition 1875–6. < *Proc. Zool. Soc.* London, 1877, pp. 293–295, Pl. 32. (Six species listed and *Salmo arcturus* described as new; also 4 species from Godhavn Harbor.)]

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[4] I may also note three examples in the collection of the Academy from Godhaab, and one from McCormick Bay, by Dr. B. Sharp in 1892.

Four wholly unarmed examples of *Gasterosteus aculeatus* Linnæus from Godhavn, having 3 to 5 dorsal spines, were received from Dr. I. Hayes.

An example of *Pholis fasciatus* (Schneider), 265 mm. long, was obtained at Godhavn.

—— Report on a Collection of Fishes made by Mr. C. Hart during the late Arctic Expedition. < *L.c.*, pp. 475–477, Pl. 50. (Six species from Franklin Pierce Bay and two species from lakes in Discovery Bay.)]

Holm, G. 1888. Den östgrönlandske Expedition, udfört i Aarene 1883–85 under Ledelse af G. Holm. < *Meddel. Grönland*, X, 1888, pp. 54, 81–82. [Seven species listed from Angmagsalik in southern part of east Greenland; notes on Esquimaux food fishes.]

Holmqvist, Otto. 1899. List of Fishes collected during the Peary Auxiliary Expedition, 1894. < *Ann. Mag. Nat. Hist.* London, (7) III, 1899, pp. 214–223.

Jensen, A. S. 1902. Ichthyologiske Studier. < *Vid. Med. Fören.* Kjöbenhavn, 1901 (1902), pp. 191–215. (*Lycodes eudipleurostictus* from West Greenland and *L. ingolfianus* from Davis Straits, described as new, also ten other new fishes from the Arctic Seas.)

—— 1904. The North-European and Greenland Lycodinæ. < *Dan. Ingolf. Exped.*, II, pt. 4, 1904, pp. 1–99, Pls. 1–10. [Four new forms from the Arctic Seas; *Lycodes reticulatus* var. *macrocephalus* and *Lycenchelys kolthoffi* new species from east and northeast Greenland, respectively.]

—— The Fishes of East Greenland. < *Meddel. Grönland*, XXIX, 1904, No. 7, pp. 211–276, Pls. 11–13. [A detailed list of 36 species given, and *Lycodes reticulatus* var. *macrocephalus* and *Lycenchelys kolthoffi* again described as new.]

Johansen, Frits. 1912. The Fishes of the Danmark Expedition, collected and described by Fritz Johansen. < *Meddel. Grönland*, XLIV, 1912, pp. 46–675, Pls. 44–46. [A list of 13 species given.]

Koefoed, M. Einar. 1907. Poissons. < Duc d'Orléans, Croisière Océanographique accomplie a bord de la Belgica dans la Mer du Grönland 1905. Bruxelles, 1907, pp. 485–500, Pl. 78. [List of six species from east Greenland.]

Lönnberg, E. 1900. The fishes of the Swedish zoological polar expedition of 1900. < *Rev. Internat. Pêche Piscic.*, II, No. 4, St. Pétersbourg, 1900. [A list of 12 species obtained by the Kolthoff Expedition of 1900, in northeast Greenland.] (Not seen.)

Lütken, Chr. 1875. A Revised Catalogue of the Fishes of Greenland. < Manual of the Nat. Hist. Geol. Phys. Greenland, etc., 1875, pp. 115–122. [This contains a list of 78 species.]

—— 1898. The Ichthyological Results. < Danish Ingolf Exped., II, pt. I, 1898, pp. 1–39, Pls. 1–4. [*Raja ingolfiana*, *Cyclothone megalops* and *Macrurus ingolfi* new species.]

Peters, W. 1874. Fische. < Die Zweite Deutsche Nordpolarfahrt in den Jahren 1869 und 1870. Leipzig, 1870, pp. 169–174, Pl. 1, fig. 3. [Six species from east Greenland, with *Gadus glacialis* and *Salmo hoodii* described as new.]

Reinhardt, Johan. 1857. Naturhistoriske Tillæg til en geograpisk og statistisk Beskrivelse af Grönland. Tillæg Nr. 1. Fiske, pp. 20–27. < Grönland geographisk og statistisk beskrevet af H. Rink. Kjöbenhavn, 1857. [A list of 69 species.]

Scoresby, Jr., William. 1823. Journal of a voyage to Northern Whalefishery. Edinburgh, 1823, Appendix No. 3, p. 423. [Four species mentioned from the east coast of Greenland in N. Lat. 70°–75°.]

Smitt, F. A. 1901. On the genus Lycodes. < *Bihang K. Svensk. Vet. Ak. Handl.*, Stockholm, XXVII, Afd. IV, No. 4, 1901, pp. 1–46, one plate.

MONTANA SHELLS.

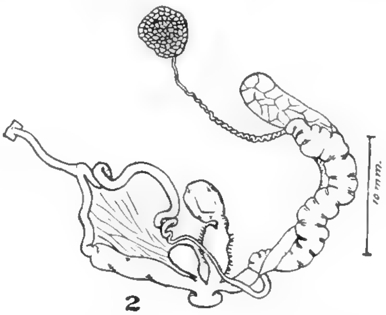
BY E. G. VANATTA.

Mr. L. E. Daniels collected the following species of shells in the Bitter Root Mountains, Montana:

Hemphillia danielsi n. sp. Figs. 1, 2.

Animal sluglike, with the shell partly exposed, and the mantle elevated into a visceral hump, as usual in this genus. The color in formaline is yellowish-gray with bluish-black markings, but in alcohol it is white with black maculations. The shell pore is about $\frac{1}{3}$ the length of the mantle. The posterior part of the foot is narrow, with a dorsal median groove and a tail pore. The ovo-testis, fig. 2, has a grayish color with black pigment where the ends of the follicles are in contact; albumen gland is yellow; the vas deferens is narrow, enlarged near the uterus; epiphallus long, narrow, and coiled where it joins the vas deferens, and at the insertion of the penis retractor which is as usual attached to the retensor muscle; penis long, conical, tapering towards the atrium, where there is a broad gland; penis papilla short and conical; spermatheca globular on a broad duct which is attached to the body wall in its lower part. Length 34 mm.

1



2

Types in the collection of the Academy of Natural Sciences 110,052, from Camas Creek in the Bitter Root Mountains, Montana, collected by Mr. L. E. Daniels, in whose honor I take pleasure in naming the species. Another specimen used to figure the external form is from Medicine Hot Springs, Mont.

This species differs from *H. camelus* P. and V. by having a caudal mucous pore, a narrow tail, and the penis is narrower, with a gland at the base. The mantle is papillose like *H. glandulosa* B. and B., but it does not have the "horn" on the tail.

Oreohelix cooperi Binn.

This species was collected near Lake Como; north side of Camas Creek Canyon at an elevation of 8,000 feet; south side of Camas Creek Canyon at an elevation of 7,000 feet; north fork of Lost Horse Canyon; Lost Horse Canyon; Medicine Hot Springs; Warm Spring Canyon near hotel; Warm Spring Canyon above Medicine Hot Springs, Mont.

Polygyra ptychophora Br.

This shell was found at Bitter Root Valley; Lost Horse Creek near Charles; White's Spring, west of Ward; bluff north side of Bitter Root River north of Ward; north end of Ward Mountain; west side of the Rocky Mountains near Ward; Camas Creek Canyon; north fork Lost Horse Canyon, 8,500 feet; Lost Horse Canyon; east side of the Rocky Mountains at Darby; Warm Spring Canyon near and below the hotel, west side of the Rocky Mountains; Warm Spring Canyon one mile above Medicine Hot Springs, on the west side of the Rocky Mountains; also one-quarter of a mile below the hotel.

Polygyra ptychophora Br. form **castanea** Hemp.

This color form was taken at Bitter Root Valley; White's Spring, west of Ward; bluff north side of Bitter Root River north of Ward; north end of Ward Mountain; west side of the Rocky Mountains near Ward; near Lake Como; Camas Creek Canyon; north fork Lost Horse Canyon; at an elevation of 8,500 feet in Lost Horse Canyon; east side of the Rocky Mountains at Darby; Warm Spring Canyon below the hotel, west side of the Rocky Mountains.

Polygyra devia oregonensis Hmp.

Was collected at Bitter Root Valley; bluffs near Bitter Root River, north of Ward; Lost Horse Creek near Charlos; south side of Saw Tooth Mountain; west side of the Rocky Mountains, near Ward.

Polygyra devia blandi Hmp.

This variety was collected near Lake Como, Bitter Root Mountains, Mont.

Thysanophora ingersolli Bld.

Camas Creek Canyon; Lost Horse Canyon at 8,500 feet elevation and Medicine Hot Springs, Mont.

Polita hammonis Ström.

Was collected at Hamilton; west side of Bitter Root River near Ward; White's Spring, west of Ward; west side of Bitter Root River, north of Ward; Lost Horse Creek near Charlos; east side of Bitter Root River, near Charlos; Ward; near Lake Como at 10,000 feet elevation; Grantsdale; Darby, Mont.

Zonitoides arborea Say.

This shell was found at White's Spring, west of Ward; west side of Bitter Root River, north of Ward; Lost Horse Creek, near Charlos; Gold Creek at the foot of Ward Mountain; Saw Tooth Mountain; north end of Ward Mountain, near Ward, 4,825 feet elevation; east side of Bitter Root River near Charlos; Grantsdale; Camas Creek Canyon; Darby; Medicine Hot Springs, Mont. Some specimens were very large.

Zonitoides nitidus Müll.

Was collected at White's Spring, west of Ward; Darby, Mont.

Vitrina alaskana Dall.

From Hamilton, White's Spring, west of Ward, Gold Creek, at the foot of Ward Mountain, and north end of Ward Mountain, 4,825 feet elevation, near Ward; Medicine Hot Springs, Mont.

Euconulus fulvus Drap.

This shell was collected at White's Spring, near Ward; Lost Horse Creek, near Charlos; Gold Creek, foot of Ward Mountain; Saw Tooth Mountain; north end of Ward Mountain, at an elevation of 4,825 feet; east side of Bitter Root River, near Charlos; Camas Creek Canyon; Darby, Mont.

Euconulus fulvus alaskensis Pils.

This variety was collected at Hamilton; west side of the Bitter Root River, near Ward; White's Spring West of Ward; west side of Bitter Root River, north of Ward; Gold Creek, at the foot of Ward Mountain; east side of Bitter Root River, near Charlos; at 10,000 feet elevation, near Lake Como; Grantsdale, Mont.

Cochlicopa lubrica Müll.

From west side of Bitter Root River, near Ward; White's Spring, Ward Mountain; Ward, Mont.

Hemphillia danielsi n. sp.

Most of the specimens of this slug were not mature; it was found at Bluffs near Bitter Root River, north of Ward; north end of Ward Mountain; Camas Creek Canyon; Medicine Hot Springs, Mont.

Agriolimax campestris Binn var. **montanus** Ing.

This variety was collected at White's Spring, west of Ward; Grantsdale; Darby; Medicine Hot Springs, Mont.

Columella edentula Drap.

From west side of Bitter Root River, near Ward, Mont.; White's Spring, west of Ward; Ward, Mont.

Columella alticola Ing.

Was found under a quaking asp, near Ward, Mont.

Bifidaria pentodon Say.

Was found at White's Spring, west of Ward, Mont.; Ward; near Lake Como, Bitter Root Mountains, at 6,500 feet elevation, Mont.

Vertigo ovata Say.

Was collected at Gold Creek, at the foot of Ward Mountain, Ward; Darby; Medicine Hot Springs, Mont.

Vertigo ventricosa elatior Sterki.

Taken at White's Spring, west of Ward; Darby.

Vertigo modesta parietalis Ancey.

Collected at Grantsdale, Mont.

Vertigo coloradensis basidens P. and V.

Was found at Ward, Mont.

Pyramidula occidentalis v. Marts.

This species was found at Lost Horse Canyon and north fork of Lost Horse Canyon, Mont.

Pyramidula cronkhitei Newc.

This shell was collected at Hamilton; west side of Bitter Root River, near Ward; White's Spring, west of Ward; west side of Bitter Root River, north of Ward; Gold Creek, at the foot of Ward Mountain; Saw Tooth Mountain; north end of Ward Mountain, elevation 4,825 feet, near Ward; east side of Bitter Root River, near Charlos; near Lake Como, at 10,000 feet elevation; Grantsdale; Darby, Mont.

Punctum conspectum Bld.

From White's Spring, west of Ward; Gold Creek Canyon, at the foot of Ward Mountain, at Ward; east side of Bitter Root River, near Charlos; Darby, Mont.

Succinea oregonensis Lea.

Taken at White's Spring, west of Ward; east side of Bitter Root River, near Charlos; Ward; near Lake Como, at an elevation of 6,500 feet; Darby, Mont.

Succinea nuttalliana Lea.

Was collected at Gold Creek, foot of Ward Mountain, at Ward; Grantsdale; Darby, Mont.

Planorbis parvus Say.

This shell was taken at east side of Bitter Root River, near Charlos; Grantsdale, Mont.

Planorbis umbilicatellus Ckll.

Collected at west side of Bitter Root River, near Ward, and at Ward, Mont.

MAY 19.

MR. CHARLES MORRIS in the Chair.

Nine persons present.

The Publication Committee reported the receipt of contributions to the PROCEEDINGS under the following titles:

"The scent-producing organs of the honey-bee," by N. E. McIndoo (April 24, 1914).

"The evolution of Sarcocystes muris in the intestinal cells of the mouse. (Preliminary note)," by Howard Crawley (April 27, 1914).

"Notice of a rare ziphioid whale, Mesoplodon densirostris, on the New Jersey coast," by Roy Chapman Andrews (May 4, 1914).

"Certain features of Solenogastre development," by Harold Heath (May 18, 1914).

Thomas L. Fansler was elected a member.

The following were ordered to be printed:

ON THE ORTHOPTERA FOUND ON THE FLORIDA KEYS AND IN EXTREME SOUTHERN FLORIDA. II.

BY JAMES A. G. REHN AND MORGAN HEBARD.

During the month of July, 1912, the authors undertook a careful field examination of the Florida Keys and the adjacent mainland in order to complete their studies in the Orthoptera of the subtropical area of southern Florida. Material procured by field work undertaken by the junior author in January and February, 1903 and 1904, and in March, 1910, as well as small collections made at Miami during the summer of 1903 and at that locality and Key West in November, 1911, have already been studied.[1] The supplementary results obtained from the present collection, when compared with the material of the two previous papers noted above, afford a very complete knowledge of all but the scarcest species of the Orthoptera of this region. A number of species of tropical origin are there so scarce and so difficult to find that our knowledge of them is based on the single or very few specimens taken; such species can only be fully studied by a resident or through definite search for these forms alone. We feel satisfied, however, that the present paper gives the final results of a very careful general examination of the region under consideration.

The recent summer work indicates several important facts. The families Mantidæ, Acrididæ, and Tettigoniidæ are shown to be severely affected in winter by the cold, the Acrididæ the least of the three families. Almost all of the fairly plentiful or abundant species are to be found in greatly increased numbers in the summer, but the scarce or very rare species are in the great majority of cases quite as difficult to find in the summer as during the winter. Certain species, particularly some of those belonging to the Acrididæ and Tettigoniidæ, which are numerous or very abundant during the summer, are wholly absent in the winter. The following table[2] will indicate the comparative abundance of forms as found in midsummer.

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[1] Proc. Acad. Nat. Sci. Phila., 1905, pp. 29–55; *Ibid.*, 1912, pp. 235–276.

[2] This table should be compared with that already given (Proc. Acad. Nat. Sci. Phila., 1912, p. 235) which shows the comparative abundance of forms as found just before the appearance of the spring forms.

Family.	Number of species.	Found on mainland only.	Found on keys only.	Very abundant.
Forficulidæ	6	2	3	1
Blattidæ	16	2	8	2
Mantidæ	4	...	2	.
Phasmidæ	4	2	1	...
Acrididæ	29	9	5	3
Tettigoniidæ	16	9	2	1
Gryllidæ	14	8	2	3

	Abundant.	Small numbers.	Rare.	Very rare.	Nymphs only.
Forficulidæ	3	1	...	1	..
Blattidæ	5	5	1	3	...
Mantidæ		2	1	1	..
Phasmidæ	1	2	1		..
Acrididæ	15	6	4	1	...
Tettigoniidæ	6	4	1	4	...
Gryllidæ	2	5	2	1	1

The number of specimens taken on the trip of July, 1912, is seventeen hundred and seventy-five (there are seventeen hundred and eighty specimens recorded in this paper) and eighty-nine species are represented. Of these species three are new, while one circumtropical species is recorded from the United States for the first time and the definite establishment of five tropical species within the United States is first demonstrated.

Besides the eighty-nine species discussed in the present paper, we have already recorded from this region the following species:

Labia curvicauda (Motsch.).
Ceratinoptera diaphana (Fabr.).
Chorisoneura plocea Rehn.
Neotettix variabilis Hancock.
Macneillia obscura (Sc.).
Scirtetica marmorata picta (Sc.).
Psinidia fenestralis (Serv.).
Stenacris vitreipennis (Marschall).
Melanoplus keeleri (Thomas).
Stilpnochlora marginella (Serv.).
Scudderia texensis S. & P.
Scudderia cuneata Morse.
Pyrgocorypha uncinata (Harris).
Atlanticus glaber R. & H.
Scapteriscus abbreviatus Sc.
Ellipes minuta (Sc.).
Anaxipha pulicaria (Burm.).
Orocharis saulcyi (Guerin).

In addition, *Blatta orientalis* Linn., has been recorded from Miami,[3] bringing the total number of species recorded from subtropical Florida to one hundred and eight, of which sixty-four have been taken on the keys.

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[3] Caudell, *Entom. News*, XXVI, p. 216 (1905).

Principal Localities and Dates of Examinations.

Miami, Dade Dounty, Florida.—January–February, 1903, (H.); January–February, 1904, (H.); March, 1905, (Caudell); March, 1910, (H.); November, 1911, (Englehardt).
Homestead, Dade County, Florida.—March, 1910, (H.); July, 1912, (R. & H.).
Detroit, Dade County, Florida.—July, 1912, (R. & H.).
Jewfish, Monroe County, Florida.—July, 1912, (R. & H.).
Key Largo, Monroe County, Florida.—March, 1910, (H.); July, 1912, (R. & H.).
Long Key, Monroe County, Florida.—March, 1910, (H.); July, 1912, (R. & H.).
Key Vaca, Monroe County, Florida.—March, 1910, (H.); July, 1912, (R. & H.).
Boot Key, Monroe County, Florida.—March, 1910, (H.).
Big Pine Key, Monroe County, Florida.—July, 1912, (R. & H.).
Key West, Monroe County, Florida.—January, 1904, (H.); March, 1905, (Caudell); March, 1910. (H.); November, 1911, (Englehardt); July, 1912, (R. & H.).
Garden Key, Dry Tortugas, Monroe County, Florida.—July, 1912, (R. & H.).
Bird Key, Dry Tortugas, Monroe County, Florida.—July, 1912, (R. & H.).
Loggerhead Key, Dry Tortugas, Monroe County, Florida.—July, 1912, (R. & H.).

Relative Value of Tropical Element.

In this region the truly tropical element is shown by the following species:

Prolabia arachidis (Yersin).
Ischnoptera rufescens (Beauv.).
Neoblattella detersa (Walk.).
Supella supellectilium (Serv.).
**Ceratinoptera diaphana* (Fabr.).
Leurolestes pallida (Brunn.).
Blaberus atropos (Stoll).
Holocompsa nitidula (Fabr.).
**Plectoptera poeyi* (Sauss.).
**Mantoida maya* S. & Z.
**Aplopus mayeri* Caudell.
**Stilpnochlora marginella* (Serv.).
**Oligacanthopus prograptus* R. & H.
Gryllodes sigillatus (Walk.).
**Cyrtoxipha gundlachi* Sauss.
**Orocharis saulcyi* (Guerin).
**Tafalisca lurida* Walk.

The species preceded by an asterisk appear to be the only forms which have not been accidentally introduced by man. Three of these nine species are known only from the keys, five from the keys and the jungle-like "hammock" land of the subtropical region of Florida, and one from the latter only. This evidence shows that half of the tropical species which have become permanently fixed in this region were, in all probability, accidentally introduced by man, and that outside of these species the tropical element is very weak, equalling but 11.3% of the non-introduced species, and only found in the scrub of the keys and the limited areas of jungle-like "hammock" land on the southernmost portion of the Florida peninsula, distinguished particularly by the presence of the gumbo limbo (*Bursera simarubra*). Of these species the genus *Mantoida* is tropical American, while *Oligacanthopus* is known only from a single specimen from Miami, Fla. All of the other species are West Indian, *Plectoptera poeyi*, *Stilpnochlora marginella*, and *Cyrtoxipha gundlachi* being found elsewhere in tropical America as well. One species, *Paratettix toltecus* (Sauss.), taken at Homestead, Fla., only, alone represents a purely Sonoran and Mexican form.

The following species are tropical intruders in the Lower Austral zone of the southeastern United States which are found in the region under discussion:

Anisolabis annulipes (H. Lucas).
Periplaneta australasiæ (Fabr.).
Periplaneta brunnea (Burm.).
Pycnoscelus surinamensis (Linn.).
**Scapteriscus abbreviatus* Sc.
**Cryptoptilum antillarum* (Redt.).

The species preceded by an asterisk again appear to be the only forms in this list which have not been accidentally introduced by man. The species *Pycnoscelus surinamensis* shows, however, very long residence in this region by its widespread abundance.

Pine trees are found only on Big Pine and the adjacent keys, and in the undergrowth of these forests three species, *Radinotatum brevipenne peninsulare*, *Schistocerca damnifica calidior*, and *Aptenopedes aptera*, were found, which species were not present elsewhere on the keys. In this situation the resemblance of specimens of a number of species to mainland individuals of the same was closer than to those taken in the keys scrub, the latter series as a rule differing in paler coloration.

FORFICULIDÆ.

Anisolabis annulipes (H. Lucas).

Homestead, Fla., July 10, 1912; 1 ♀.

Key West, Fla., July 5, 7, 1912; 3 ♂, 2 ♀.

The femoral annuli are prominent in all of these specimens, one female from Key West having these markings particularly heavy.

The specimen from Homestead was taken from under a board in a yard. The series from Key West was taken chiefly from under coquina boulders about the East Martello tower, while one specimen was captured between boards in the wood shed where *Blaberus atropos* was found numerous.

Anisolabis maritima (Gené).

Key West, Fla., July 5, 1912; 4 ♂, 5 ♀, 1 n.

This species was found, as in the winter, swarming under coquina boulders and drift on the beach. Individuals have almost always been found in the proximity of salt water.

Labidura bidens (Olivier).

Key West, Fla., July 7, 1912; 1 ♂, 1 ♀.

One of these specimens was taken moving actively across a coquina road after dark. At that hour, with the aid of a flash-lamp, this species was seen in numbers near piles of coquina and about dwellings near the beach. This insect is frequently found with the preceding species.

Labia minor (Linn.).[4]

Key West, Fla., July 7, 1912; 1 ♀.

This specimen, the first record of this cosmopolitan species from Florida, was found between boards in the wood shed where the series of *Blaberus atropos* was taken.

Prolabia unidentata (Beauv.).

Homestead, Fla., July 10, 1912; 1 ♂, 1 ♀.

These two individuals, both lacking wings, were taken under the bark of a dead pine log in the pine woods, where in like situations the species is occasionally found throughout the year in this region, though seldom in large numbers.

Prolabia arachidis (Yersin).

1876. *Labia brunnea* Scudder, Proc. Bost. Soc. Nat. Hist., XVIII, p. 264.

Homestead, Fla., July 10–12, 1912; 7 ♂, 13 ♀, 3 n.

This cosmopolitan species was found rather numerous in the greasy kitchen of the boarding house at Homestead. After dark the insects would appear in numbers accompanied by swarms of *Periplaneta americana*, but the series was secured with difficulty, as the insects were very active and invariably scuttled away into cracks in the walls and tables at the first approach of a light. Individuals were greasy and unclean.

Caudell[5] has recently placed Scudder's *Labia brunnea* correctly in the synonymy under the present species.

Though this species has been found introduced in the United

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[4] The species, *Labia curvicauda*, which was found so plentiful in March, 1910, on Long Key, was not seen in the summer of 1912. Peculiar conditions following the hurricane of 1909 afforded the opportunity to take the series on the earlier date, and had dying tops of cocoanut palms been present in the summer of 1912 there is little doubt but that the species would have been then found abundant.

[5] *Proc. U. S. Nat. Mus.*, XLIV, p. 598 (1913).

States at several localities, it is probably permanently and thoroughly established only in southern Florida.

BLATTIDÆ.

Ischnoptera deropeltiformis (Brunner).

Homestead, Fla., July 10, 1912; 1 ♂, 2 ♀, 2 n. (Nymphs numerous.)

Detroit, Fla., July 12, 1912; 1 ♀.

Key West, Fla., July 7, 1912; 1 ♂, 1 ♀.

At Homestead the species was found under boards lying on very wet ground in the prairie-like everglades, while at Detroit and Key West the specimens were taken in debris and leaf mold in heavy jungle-like areas of trees, bushes, and vines. The species had not been previously taken on the keys.

Ischnoptera uhleriana fulvescens S. and Z.

Homestead, Fla., July 10–12, 1912; 2 ♂, 1 ♀.

The remains of the above recorded males and an additional specimen of the same sex were found entangled in the webs of spiders at the railroad station, where they had probably been attracted by the lights.

Ischnoptera rufescens (Beauv.).

(*Ischnoptera blattoides* of authors.)

Key West, Fla., July 4, 1912; 1 ♂.

This individual, the first United States record of this circumtropical species, was taken in a very greasy cupboard in the Hotel Jefferson in company with swarms of *Blattella germanica* and a few specimens of *Supella supellectilium*. The much paler coloration made this specimen, the only one of the species seen, very conspicuous among the many other darker roaches disclosed by the light of a flash-lamp.

We follow Saussure in placing this species in the genus *Ischnoptera*. It is the only species of that genus found within the United States which has the ventro-cephalic margin of the cephalic femora armed with a complete row of spines, the more distal shorter than the more proximal. All of the other North American species of *Ischnoptera* have this margin armed with 3 to 5 strong spines succeeded distad by a close-set row of minute piliform spinulations.

Blattella[6] **germanica** (Linn.).

Big Pine Key, Fla., July 6, 1913; 1 ♂.

Key West, Fla., July 4, 1912; 4 ♀.

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[6] *Vide* Shelford, *Entom. Monthly Mag.*, (2), Vol. XXII, p. 154, 155 (1911).

Loggerhead Key, Dry Tortugas, Fla., July 8, 1912. Few seen in house.

The present species infests larders and kitchens throughout this region.

Neoblattella[7] **detersa**[8] (Walk.).

Homestead, Fla., July 11, 1912; 1 ♀.

A single specimen of this tropical species was found in spider webs at the railroad station, where it had probably flown attracted by the lights.

Supella[9] **supellectilium** (Serv.).

Key West, Fla., July 4–7, 1912; 8 ♂, 4 ♀, 1 n.

One specimen of this circumtropical species was taken in a fruit store, while the others of the series were captured at night in the Hotel Jefferson in the rooms and kitchen cupboards. The males occasionally appeared in lighted rooms running about with extreme rapidity and often taking flight. The females were all taken in cupboards where *Blattella germanica* was found in swarms.

The only previous record of the present species from the United States is that of Rehn,[10] as Saussure's synonymous *Phyllodromia cubensis*, from Miami, Fla.

Ceratinoptera lutea (S. and Z.).

Homestead, Fla., July 10, 1912; 1 ♀.

Key West, Fla., July 7, 1912; 1 ♀, 2 n.

The adult from Homestead was taken from under a board on very wet ground on the prairie-like everglades, while nymphs were found frequently under bark on decaying pine logs in the pine woods. At Key West nymphs were occasional in the leaf mold in the heavier jungle-like scrub.

Leurolestes pallidus[11] (Brunner).

Phœtalia lævigata of authors (not *Blatta lævigata*, Beauv., 1805).

Key West, Fla., July 4–7, 1912; 16 ♂, 25 ♀, 9 n.

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[7] *Ibid.*

[8] Records of *Blattella* (*Neoblattella*) *adspersicollis* (*Stål*) from the United States all apply to this species. Material recently received from Brazil shows *N. adspersicollis* to be a very different insect.

[9] Vide Shelford, *Entom. Monthly Mag.*, (2), Vol. XXII, pp. 154, 155 (1911).

[10] *Entom. News*, XIV, p. 125 (1903).

[11] *Λευρος, flat, ληστης, plunderer.* The authors propose this name to replace *Wattenwyliella* which was recently erected by them to replace "*Phœtalia*" of authors (*Entom. News*, XXV, pp. 216, 217, May, 1914). The name *Wattenwyliella*, however, was proposed in the month of April, 1914, by Carl (*Revue Suisse de Zoologie*, XXII, p. 174) for a member of the Pseudophyllinæ from Madagascar, in consequence of which preoccupation, we here propose *Leurolestes*.

The series was taken in a fruit store where the species was common in a pile of old burlap bags and in cracks under the stands which it shared with one fairly large colony of *Blattella germanica*, occasional specimens of *Holocompsa nitidula*, a few specimens of *Periplaneta americana*, and one specimen of *Supella supellectilium*. The present species was previously known from the United States from a single female taken on Key Largo, Fla.

A single female was captured which had just moulted into the adult condition, this specimen was uniform pale straw color. Nymphs of this species are above bay in coloration, below more tawny, especially on the limbs, while that portion of the head from the interantennal space to the clypeal suture is very dark; the entire dorsal surface of these nymphs is rough, much as are the distal abdominal segments in nymphs of *Pycnoscelus surinamensis*.

Eurycotis floridana (Walker).

Homestead, Fla., July 10–12, 1912; 1 ♂, 1 ♀, 1 n.
Detroit, Fla., July 12, 1912; 1 n.
Key West, Fla., July 3–7, 1912; 2 n.

The single specimen from Detroit was found concealed in an epiphyte (*Tillandsia fasciculata*), growing on the limb of an oak in "hammock" land. Two specimens were taken revealed by a flash-lamp at night; an adult climbing on the trunk of a pine at Homestead and a nymph climbing about in a clump of weeds over a foot from the ground at Key West. It appears that this species moves about at night, hiding under bark of logs and in other recesses during the day. Where pines were present individuals of this species have almost invariably been found hiding under the bark of dead logs and stumps of this tree.

Periplaneta americana (Linn.).

Homestead, Fla., July 10–12, 1912.
Big Pine Key, Fla., July 6, 1912; 1 ♂.
Key West, Fla., July 4, 1912; 1 ♀.

One specimen was found in a spider web at Homestead Station where the species swarmed at the boarding house. The species was very abundant in a quarter-boat at Pine Channel and a few adults but many nymphs were present in refuse under the stands in a fruit store at Key West.

Periplaneta australasiæ (Fabr.).

Homestead, Fla., July 10–12, 1912; 1 ♂, 1 ♀.
Big Pine Key, Fla., July 6, 1912; 1 ♀.
Key West, Fla., July 4, 1912; 1 ♂, 2 ♀, 2 n.

Loggerhead Key, Dry Tortugas, Fla., July 8, 1912. Few seen in houses.

In company with *Periplaneta americana* this species was found abundant at Pine Channel in a quarter-boat, while it was numerous everywhere in the Hotel Jefferson at Key West.

Periplaneta brunnea (Burm.).

Jew Fish, Fla., July 11, 1912; 1 ♀.

Pycnoscelus surinamensis (Linn.).

Homestead, Fla., July 10, 1912; 1 ♀.
Jew Fish, Fla., July 11, 1912; 1 ♀.
Key West, Fla., July 3–7, 1912; 4 ♀, 4 n.

Blaberus atropos (Stoll).

Key West, Fla., July 7, 1912; 15 ♂, 28 ♀, 10 n.

Adults of this species were found common, nymphs few, between old boards in a wood shed; many nymphs but few adults were also found under boards on the ground near by. This great insect is widely distributed and well known to the natives about Key West, where it is found in wood piles, under boards and other refuse about the town. The insects, when exposed, either remained motionless or scuttled toward another place of concealment with no great speed. The nymphs were usually found half buried in loose damp earth under boards, where they remained motionless, looking much like lumps of earth (with which they were usually much dusted) until disturbed. Two very small nymphs were observed which had recently moulted, these individuals were pure white and very soft.

Holocompsa nitidula (Fabr.).

1838. *C[orydia] (Holocompsa) cyanea* Burmeister, Handb. Ent., II, p. 492.
1838. *C[orydia] (Holocompsa) collaris* Burmeister, Handb. Ent., II, p. 492.

Key West, Fla., July 4–7, 1912; 16 ♂, 10 ♀.

These diminutive roaches were found in the folds of burlap bags under the counter of a fruit store where other interesting roaches were taken, and also with *Blaberus atropos* between old boards in a wood shed, where nymphs were more numerous than adults. The insects when disturbed ran about with great speed, but did not go far to hide, often stopping in the first bits of refuse to which they came. This is the first time that *Holocompsa nitidula* has been found established within the United States; the only previous record of the species being found in this country is that of Caudell,[12] of a single specimen found on cotton batting from the store room of the

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[12] *Proc. Entom. Soc. Wash.*, VIII, p. 133 (1907).

National Museum at Washington, D. C., which specimen was unquestionably accidentally introduced.

The present series enables us to synonymize Burmeister's *Holocompsa cyanea*, which was based upon males of the species, while his *Holocampsa collaris* was described from individuals of the opposite sex. The latter species was first recognized as a synonym of *Holocompsa nitidula* by Kirby in 1904.[13] Previous authors have failed to recognize *cyanea* and *collaris* as sexes of the same species owing, apparently, to their lack of sufficient material. The males are rather slender and almost uniformly shining blackish (the antennæ have three pale yellowish joints in the distal portion and the limbs are very dark brown), while the females are much more robust, the pronotum is strikingly cinnamon-rufous and the tegmina are a very dark metallic blue in the colored portion; in the latter sex somewhat more than the distal half of the antennæ is pale yellowish. Such striking differences between the sexes explains their being described as different species in the same paper.

Plectoptera poeyi (Sauss.).

Big Pine Key, Fla., July 6, 1912; 4 ♀.

Key West, Fla., July 7, 1912; 8 ♂, 12 ♀, 3 n.

On Big Pine Key the species was beaten from a fringe of tall bushes growing on the edge of a mangrove swamp, where individuals were scarce. The insects were found fairly common on Key West in rather scattered bushes, particularly *Ilex cassine*. One nymph was also taken at night at the latter locality, running about on the leaves of a buttonwood bush (*Conocarpus erecta*).

MANTIDÆ.

Mantoida maya S. and Z.

Key West, Fla., July 7, 1912; 1 ♀.

This is the second United States record of this peculiar mantis, which was described from Temax, northern Yucatan. The first record from within the United States was given with certainty from Florida and probably from Kissimmee.[14] The present specimen fully agrees with the original description and was taken while swiftly running about on the ground under high jungle brush.

Stagmomantis carolina (Johannson).

Homestead, Fla., July 10–12, 1912; 3 n.

Detroit, Fla., July 12, 1912; 1 n.

[13] *Synon. Catal. Orth.*, p. 169.

[14] Caudell, *Canad. Entom.*, XLIII, p. 156 (1911).

Long Key, Fla., July 13, 1912; 1 n.
Big Pine Key, Fla., July 6, 1912; 2 n.
Key West, Fla., July 3–7, 1912; 4 n., 1 oötheca.

The individuals from Homestead and Detroit are in the instar preceding maturity, while the others represent three less developed stages.

Gonatista grisea (Fabr.).

Key West, Fla., July 3–7, 1912; 3 ♂, 4 ♀, 9 n.

The nymphal individuals are in four stages of development, the most immature specimen having the body 8.25 millimeters in length, the same measurement in the largest nymph being 39 mm. The males show but little variation in size, all, however, equalling or exceeding the maximum measurements given by Caudell for this form.[15] The females show some size variation, the length of the pronotum in all being slightly longer than Caudell's measurements, although the tegminal length is under his maximum in all four individuals. The coloration of both sexes shows no decided variations. Specimens from more northern localities in the range of the species apparently average smaller than individuals from the keys, judging from a male from Tarpon Springs, Fla., and two females from Fort George, Fla., and Thomasville, Ga.

The present specimens were taken chiefly from gumbo-limbo trees in the heavy key scrub jungle, but the species also occurred on sea grape. The insects were always on the trunks or branches and generally about six feet from the ground, infrequently higher and very rarely lower. They were perfectly protected when in their resting position, being then closely pressed against the bark of the tree. When disturbed they would make off with a rapid scuttling run.

Thesprotia graminis (Scudder).

Homestead, Fla., July 10–12, 1912; 1 ♂, 2 ♀.
Big Pine Key, Fla., July 6, 1912; 1 ♂, 2 n.
Key West, Fla., July 3–7, 1912; 2 ♀, 4 n.

The nymphs are in three stages of development, the least mature being from Big Pine Key, taken the same day as an adult female. From this it would appear that the species matures over a considerable part of the year.

At Homestead the females of this species were taken in the undergrowth of pine woods, while the male was found dead in a spider's

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[15] *Psyche*, XIX, p. 161 (1912).

web; on Big Pine Key the nymphs were taken in the pine woods and the adult in grass, while at Key West individuals frequented low ground vegetation in the more open scrub.

PHASMIDÆ.

Manomera tenuescens (Scudder).

Homestead, Fla., July 10-12, 1912; 3 ♂, 1 ♀, 1 n.

Detroit, Fla., July 12, 1912; 1 ♂, 4 n.

On careful examination of our Florida series of twenty adults of this genus, two species were found to be present, distinguishable by very good characters in the male and female genitalia and also in the distal abdominal segments. The original description and figure of *tenuescens* show conclusively that the form with the elongate subcylindrical anal segment in the male is that species.

The two species of *Manomera* were taken together in the same situations; on prairie, in undergrowth of pine woods, and at night on the extremities of the leaves of the saw palmetto (*Serenoa*) at Homestead and in pine woods undergrowth on the edge of a hammock at Detroit.

Manomera brachypyga n. sp.

1907. *Manomera tenuescens* R. and H. (not *Bacunculus tenuescens* Scudder, 1900), Proc. Acad. Nat. Sci. Phila., 1907, p. 283. (In part.) (San Pablo, Florida.)

1912. *Manomera tenuescens* R. and H., (not *Bacunculus tenuescens* Scudder, 1900), Proc. Acad. Nat. Sci. Phila., 1912, p. 242. (Miami, Florida.)

Closely allied to *M. tenuescens* (Scudder), agreeing in general form, structure of the limbs, and coloration, but differing in the much more abbreviate seventh, eighth, and ninth abdominal segments and the form of the apex of the male abdomen. In the male the seventh, eighth, and ninth dorsal abdominal segments together are hardly or not at all longer than the sixth dorsal segment, while in *tenuescens* they are half again as long; the eighth dorsal segment in *brachypyga* is transverse instead of longitudinal; the ninth segment fornicate and subinflated instead of decidedly longitudinal and cylindrical as in *tenuescens;* while the cerci of *tenuescens* have a delicate spine at the internal base, which is represented in *brachypyga* by a much more robust tooth. The two forms can be very readily separated when the apex of the male abdomen is viewed from either the dorsal or lateral aspect. In the female the sixth dorsal abdominal segment is considerably longer than the seventh and eighth segments, while in *tenuescens* it is less than the seventh and eighth segments in length; the ninth segment is equal in length to the prothorax, which segment is longer than the prothorax in *tenuescens*, and the subgenital plate has the caudal margin less produced and more subtruncate than in that species.

TYPE: ♂; Homestead, Dade County, Fla. July 10–12, 1912. (Rehn and Hebard.) [Hebard Collection.]

Size, form, general structure and proportions, and coloration as in *tenuescens*, differing in the following characters: Abdomen with the first to sixth segments slightly more longitudinal, the apex of the caudal femora not quite reaching the distal margin of the fourth segment; seventh, eighth and ninth dorsal segments together no longer than the sixth segment; seventh segment longitudinal, lateral margins subparallel, not expanding caudad; eighth segment slightly transverse, but slightly more than half the length of the seventh segment, not compressed; ninth dorsal segment shorter than the seventh segment, the greatest width (caudal) but slightly greater than the length, fornicate, lateral margins converging proximad, distal margin arcuato-emarginate, exposing the strongly arcuate extremity of the supra-anal plate; cerci of the bent-arcuate type found in *tenuescens*, but with the proximo-internal base with a very blunt, subincrassate obliquely directed tooth; subgenital opercule small, shallower, and less pendulate than in *tenuescens*.

Fig. 1.

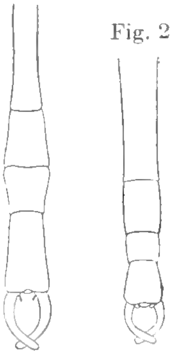

Fig. 2.

Figs. 1 and 2.—Dorsal outline of apex of abdomen of *Manomera tenuescens* (1; Homestead, Fla.) and of *M. brachypyga* (2; type). (× 3.)

Allotype: ♀; Miami, Dade County, Florida. March 28, 1910. (Hebard.) [Hebard Collection.]

Size, form, general structure and proportions, and coloration as in *tenuescens*, differing in the following characters: abdomen with the sixth dorsal segment considerably longer than the seventh and eighth dorsal segments; ninth dorsal segment equal in length to prothorax; subgenital plate with caudal margin very little produced, rotundato-subtruncate.

Fig. 3.

Fig. 4.

Figs. 3 and 4.—Lateral outline of apex of abdomen of *Manomera tenuescens* (3; Homestead, Fla.) and of *M. brachypyga* (4; type). (× 3.)

Measurements (in millimeters).

	Homestead, Fla. ♂ TYPE.	 ♂ Paratype.	 ♂ Paratype.
Length of body	87.5	87.4	88.5
Length of head	4.5	4.3	4.2
Length of prothorax	3.	3.2	3.
Length of mesothorax	20.5	20.6	21.4
Length of metathorax (including median segment)	18.5	18.3	18.7
Length of abdomen	41.	41.	41.2
Length of cephalic femur	22.3	24.	23.8
Length of median femur	18.2	19.4	19.5
Length of caudal femur	23.3	25.	25.3

	Miami, Fla. ♀ Allotype.	Detroit, Fla. ♂ Paratype.	San Pablo, Fla. ♂
Length of body	92.6	86.6	69.6
Length of head	5.1	4.5	3.5
Length of prothorax	3.2	3.	2.7
Length of mesothorax	21.	20.5	15.8
Length of metathorax (including median segment)	17.2	18.6	13.3
Length of abdomen	46.1	40.	34.3
Length of cephalic femur	23.8	22.	18.5
Length of median femur	18.4	19.1	15.3
Length of caudal femur	23.8	24.7	20.

The present authors have recorded a male of this species, taken at San Pablo, Fla., August 13, 1905, as *M. tenuescens*, at that writing not recognizing it as distinct from individuals of that species in the same series. A series of one adult female and eleven nymphs taken at Miami, Fla., March 28, 1910, have also been recorded as that species. The above-measured five males and one female constitute the known series of adult specimens of *brachypyga*, the San Pablo specimen showing that there is considerable variation in size, regarding which our series is too small for us to say whether it is geographical or individual in character. We consider the two additional Homestead specimens and the single Detroit individual, paratypes. The differential characters show almost no variation, there being but a slight amount of proportional difference in the length of the eighth dorsal segment. The distal margin of the ninth dorsal abdominal segment varies from arcuato-emarginate to obtuse-angulate emarginate. In coloration the Homestead and Detroit individuals are uniform, while the San Pablo specimen is of similar pattern but with the tones paler.

The new form was found on July 10–12, 1912, under exactly the same conditions at Homestead and Detroit as was *tenuescens*, the San Pablo specimen having been taken in the undergrowth of pine woods.

Aplopus mayeri Caudell.

Long Key, Fla., July 13, 1912; 1 n.

Key West, Fla., July 3–7, 1912; 1 n.

Loggerhead Key, Dry Tortugas, Fla., July 8, 1912; 16 ♂, 6 ♀, 19 n.

Bird Key, Dry Tortugas, Fla. Observed by Dr. Mayer.

Garden Key, Dry Torgugas, Fla. Observed by Dr. Mayer.

A special trip to secure specimens of this striking species was made to Loggerhead Key, where, with the kind assistance of Dr. Alfred G. Mayer, the Director of the Carnegie Marine Biological Laboratory, we were able to secure the above interesting series. All were taken from bushes of the bay cedar (*Suriana maritima*), to which, as shown by Stockard in his paper on the habits of this species,[16] the species is there restricted. The adult females show the marked color variations spoken of by Stockard, while the males vary only in the extent to which the greenish of the limbs tinges the thoracic segments.

Our series shows the following extremes in the length of the body, ♂ 83.–93. mm., ♀ (exclusive of the oviscapt) 114.–127.5. The oviscapt varies considerably in length individually, the extremes, which are in specimens of approximately the same general bulk, being 25.–29.5 mm. The Loggerhead Key nymphs represent three stages of development.

According to Dr. Mayer, the species occurs on Bird Key and Garden Key, the other islands of the Tortugas group. On Long Key the single very immature individual was beaten from heavy key scrub. The nearly half-grown male from Key West was found in the afternoon, climbing up the trunk of a bush in a heavy tangle.

Anisomorpha buprestoides (Stoll).

Homestead, Fla., July 10–12, 1912; 8 ♂, 3 ♀, 2 n.

Key West, Fla., July 3–7, 1912; 1 ♂, 3 n.

At Homestead this species was taken from under boards in the

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[16] Habits, Reactions and Mating Instincts of the "Walking Stick," Aplopus mayeri. Papers from the Tortugas Laboratory, Carnegie Institution, Washington, Publ. 103, II, No. 2, (1908).

day time in pine woods, and at night from the leaves of saw palmetto (*Serenoa*) in pine woods.

ACRIDIDÆ.

Paratettix rugosus (Sc.).

(*Apotettix rugosus* of authors.)

Homestead, Fla., July 10, 12, 1912; 2 ♂.

Jewfish, Fla., July 11, 1912; 26 ♂, 23 ♀, 6 n.

The larger series was taken in bare spots on semi-baked marsh soil at Jewfish, where more than an hour was spent in collecting the material, for the species was frequent but not abundant. All of these specimens are decidedly rugose, the specimens from Homestead recorded above as well as a few of those taken in 1910 in this region are considerably less rugose. All of the specimens from southern Florida before us are very uniform and dark in coloration, with the exception of two of the Jewfish series which individuals have the pronotum a lighter brown except on each side for a short distance caudad of the humeral angles. The extremes of pronotal length in the above series are: ♂♂ 11.7 to 13.3 mm.; ♀♀ 13.8 to 15.6 mm.

We are unable to consider *Apotettix* of Hancock a valid genus. Comparison of the type of the genus *Apotettix*, *A. convexus* (Morse), with specimens of the type species of the genus *Paratettix*, *P. meridionalis* (Ramb.), and study of the literature gives convincing proof that no valid characters have been given nor do any exist to have warranted the erection or retention of the genus *Apotettix*.

Paratettix toltecus (Sauss.).

Homestead, Fla., July 12, 1912; 1 ♂, 2 ♀.

These specimens agree in all respects with topotypical Mexican material ("Mexico calida," Jalapa taken as representative). The species is here recorded from Florida for the first time, New Mexican records being hitherto the most eastern for the United States.

Neotettix coarctatus Hanc.

Homestead, Fla., July 10–12, 1912; 59 ♂, 27 ♀, 1 n. 15 ♂, 6 ♀, elongate type.

Detroit, Fla., July 12, 1912; 2 ♂, 5 ♀. 1 ♂, elongate type.

Long Key, Fla., July 13, 1912; 1 ♂. 1 ♂, elongate type.

Big Pine Key, Fla., July 6, 1912; 8 ♂, 1 ♀, 1 n.

Key West, Fla., July 3–7, 1912; 6 ♂, 1 n.

The majority of the specimens from Big Pine Key and Key West are the smallest in size of the entire series and are of the extreme abbreviate type.

At Homestead the species was common on the prairie-like everglades and also in the "pot holes" in the pine woods, but not as numerous as in March, 1910. The specimen from Long Key was beaten from tall grasses in an open depressed area where *Mermiria intertexta* was taken.

Paxilla obesa (Sc.).

Homestead, Fla., July 10, 12, 1912; 1 ♂, 2 ♀, 2 n.

Detroit, Fla., July 12, 1912; 1 ♂.

These specimens were all taken in the low undergrowth of the pine woods in not the usual very wet situations.

Tettigidea lateralis (Say).

Homestead, Fla., July 10–12, 1912; 6 ♂, 11 ♀, 1 n.

Tettigidea spicata Morse.

Jewfish, Fla., July 11, 1912; 4 ♂, 5 ♀, 2 n.

This is the first record for a species of the present genus from the Florida Keys. The series was taken in company with *Paratettix rugosus*, in bare spots on sun-baked marsh soil, where it was found to be very scarce.

Radinotatum brevipenne peninsulare R. and H.

Homestead, Fla., July 10–12, 1912; 49 ♂, 22 ♀, 3 ♀ n.

Detroit, Fla., July 12, 1912; 14 ♂, 4 ♀, 1 ♀ n.

Big Pine Key, Fla., July 6, 1912; 30 ♂, 6 ♀, 5 ♂ n., 11 ♀ n.

The extensive Homestead and Detroit series of this race are perfectly typical in character, the Big Pine Key representation also having all the distinguishing features of *peninsulare*, although of slightly smaller size. There is considerable individual variation in size in all three lots, the extremes in length of body of each being as follows: Homestead, ♂ 32.2–35.7, ♀ 42.3–46.7; Detroit, ♂ 33.3–35.2, ♀ 45.2–48; Big Pine Key, ♂ 28.3–33, ♀ 37.3–40.8 mm. It will be seen that the Big Pine Key maximum measurements no more than touch the minimum of the other lots in the male sex and do not reach the same in the female. The average of the Big Pine Key series is very appreciably less than the maximum dimensions given for the same lot.

The Homestead series has the brown phase predominating, while the Detroit and Big Pine Key lots have the green phase outnumbering the brown in the male sex.

At all three localities the form was found common in the low undergrowth in the pine woods. The record from Big Pine Key is the first for the genus on the keys. It is doubtless found on all the islands possessing stands of pine, and not elsewhere, as the distribution of the forms of this genus is limited by this controlling factor.

Mermiria intertexta Scudder.

Homestead, Fla., July 10–12, 1912; 5 ♂, 1 ♀.
Big Pine Key, Fla., July 6, 1912; 18 ♂, 1 ♀, 7 ♀ n.
Long Key, Fla., July 13, 1912; 7 ♂, 3 ♀.

The present series has been compared with a male from Georgia, which is one of Scudder's types. In size the present representation shows no noteworthy difference except that the Long Key females are slightly smaller than the other two of that sex. In color the Homestead and Big Pine Key series are very similar, with the pale base color showing no greenish except in the Big Pine Key female. The Long Key series, on the other hand, has the pale base color greenish-yellow in the males, subochraceous in the females. The three individuals of the latter sex from Long Key have the discoidal area of the tegmina more or less distinctly maculate, superficially somewhat suggesting Bruner's *M. maculipennis.* In all of the Big Pine Key males the dark medio-longitudinal line is present on the head and pronotum, indicated but incomplete in the accompanying female, indicated more or less distinctly in all of the Homestead males and entirely absent in the female, indicated on the head and pronotum in four Long Key males, on the head and as a lining on the pronotal carina in two males and all three females, and present on the head and entirely absent from the pronotum in one male from the same locality. In two of the seven Big Pine Key nymphs there is no indication of this line and in the others it is only faintly marked.

At Homestead the species was infrequent in high grasses near the edge of the prairie-like everglade, on Long Key it was not uncommon in places where high grasses grew in an open depressed area, while on Big Pine Key it was taken from low plants on the edge of a mangrove swamp, where the males were not infrequent, the females mostly immature and but two adults of that sex seen.

Amblytropidia occidentalis (Saussure).

Homestead, Fla., July 10–12, 1912; 2 ♂, 5 ♀, 1 ♀ n.
Detroit, Fla., July 12, 1912; 1 ♂ n.
Big Pine Key, Fla., July 6, 1912; 8 ♂, 3 ♀, 2 ♂ n., 2 ♀ n.
Key West, Fla., July 3–7, 1912; 1 ♀.

The present series shows that the measurements previously given by us of specimens from Miami, Homestead, Long Key, Key Vaca, and Boot Key[17] are probably individual in the main and not geographic. As there stated, however, south Florida material is always larger than Thomasville, Ga., specimens, although occasionally but slightly so. The Big Pine Key series is quite similar in general size to the individuals previously measured from Boot Key and Key Vaca, although a single female is distinctly larger and subequal to the smallest of the Long Key females, while one Homestead male is subequal in proportions to the maximum Long Key males. Extremes of the present Homestead and Big Pine Key series, as well as the Key West female, show the following measurements in millimeters:

	♂			
	Homestead.		Big Pine Key.	
Length of body	22.	22.8	22.	22.2
Length of pronotum	4.4	4.5	4.2	4.4
Length of tegmen	16.2	20.	17.	18.2
Length of caudal femur	13.6	15.3	13.4	14.5

			♀		
	Homestead.		Big Pine Key.		Key West.
Length of body	29.	33.	31.2	33.8	31.3
Length of pronotum	5.2	6.	5.8	6.	6.
Length of tegmen	20.8	21.8	22.	22.8	23.7
Length of caudal femur	16.8	18.8	18.8	19.4	19.

The material from the keys which have scrub cover (Key Biscayne, Long Key, Key Vaca, Boot Key, and Key West) is all either uniformly colored or of the strongly bicolored phase (*i.e.*, dorsum solidly paler than the lateral aspects), while that portion of the material from pine woods (Miami, Homestead, Detroit, and Big Pine Key) contains thirteen specimens distinctly lined with black on each side of the median carina of the pronotum, in a number also distinctly punctulate with dark brownish on the tegmina. The single nymph from Detroit and one of the four from Homestead have the blackish lineations on the pronotum, showing that this coloration is fixed before the adult condition is reached.

At Homestead the species was uncommon in the pine woods, nymphs, however, being abundant, while the single nymph from Detroit was in similar surroundings. In the pine woods on Big Pine Key the species occurred in fair numbers, while the Key West female, all seen at that locality, was taken in the scrub.

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[17] Proc. Acad. Nat. Sci. Phila., 1912, p. 252.

Orphulella pelidna (Burmeister).

Homestead, Fla., July 10-12, 1912; 2 ♀.
Long Key, Fla., July 13, 1912; 2 ♂.
Big Pine Key, Fla., July 6, 1912; 3 ♂, 5 ♀, 1 ♀ n.
Key West, Fla., July 3-7, 1912; 3 ♂, 7 ♀.
Garden Key, Dry Tortugas, Fla., July 8, 1912; 1 ♀.

None of the Big Pine Key series are in the green phase, although five of the seven Key West females and both of the same sex from Homestead are in that phase. The Garden Key specimen is pale rufescent, but in structure normal for the species.

At Homestead and on Big Pine Key the species occurred in the undergrowth of pine woods, on Garden Key it was very common in short grass growing in the enclosure of Fort Jefferson, on Long Key it was secured in the depressed grassy area where *Mermiria intertexta* was also taken, and on Key West it was scarce among green herbage and grasses in scattered gumbo-limbo forest. At the latter locality nymphs were numerous.

Clinocephalus elegans pulcher R. and H.

Homestead, Fla., July 10-12, 1912; 30 ♂, 17 ♀, 1 ♂ n., 1 ♀ n.
Detroit, Fla., July 12, 1912; 2 ♂, 2 ♀.
Big Pine Key, Fla., July 6, 1912; 5 ♂, 3 ♀.
Key West, Fla., July 3-7, 1912; 6 ♂, 9 ♀, 1 ♀ n.

The range of this beautiful form is extended by the present records from the vicinity of Miami to Key West. In size the Homestead and Detroit series average rather large, but display a considerable amount of individual variation among themselves, the Big Pine Key series averages smaller and is much more uniform in size, while the Key West series is quite large but individually variable. The following measurements in millimeters are of the extremes of the Homestead and Key West series and of an average pair from Big Pine Key.

			♂		
	Homestead.		Key West.		Big Pine Key.
Length of body	17.	21.2	18.5	19.5	16.8
Length of pronotum	3.5	4.4	4.	4.2	3.5
Caudal width of dorsum of pronotum	2.	2.2	2.2	2.3	2.
Length of tegmen	10.8	12.	7.5	9.	7.5
Length of caudal femur	10.8	12.2	11.8	12.8	10.7

	♀				
	Homestead.		Key West.		Big Pine Key.
Length of body	26.3	30.2	27.5	29.	24.
Length of pronotum	5.	5.8	5.	5.8	5.
Caudal width of dorsum of pronotum	3.	3.3	3.3	3.2	2.8
Length of tegmen	15.8	12.2	10.	11.3	10.
Length of caudal femur	14.	17.	15.7	17.8	14.6

The Key West and Big Pine Key series are uniformly short-winged, while the Homestead and Detroit representations have a far greater proportion long-winged, abbreviate tegmina being present in five females and the same condition approximated in two males. It is probable that environment is the governing factor in regard to tegminal and wing length in this form.

All of the color phases known for this race are present in the series in hand, the only lot very uniformly colored being the male series from Key West, which are greenish with the usual postocular bars. The females from Key West, however, show three different color phases.

At Key West this form was common in green herbage or grasses in or near a gumbo limbo forest in company with *Orphulella pelidna*, while on Big Pine Key it was taken in pine woods undergrowth.

Arphia granulata Sauss.

Homestead, Fla., July 10–12, 1912; 4 ♂.
Detroit, Fla., July 12, 1912; 1 ♀.
Big Pine Key, Fla., July 6, 1912; 1 ♂, 1 ♀.
Key West, Fla., July 3–7, 1912; 3 ♂, 9 ♀.

Cruciform markings on the dorsum of the pronotum are more or less noticeable in five specimens of the present series. The differences in coloration previously noted[18] are found in the series before us.

Examination of the material shows that Caudell's record of *Arphia sulphurea* from Key West is incorrect, the specimens belonging unquestionably to the present species.

At the first three localities given above the species was scarce in the low undergrowth of the pine woods, but at Key West it was well distributed through the scrub and also in the open gumbo-limbo forest.

Chortophaga australior R. and H.

Homestead, Fla., July 10–12, 1912; 1 ♂, 2 ♀, 1 ♂ n.
Detroit, Fla., July 12, 1912; 1 ♂.

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[18] Proc. Acad. Nat. Sci. Phila., 1912, p. 253.

Jewfish, Fla., July 11, 1912; 1 ♂, 2 ♀.

Key West, Fla., July 3–7, 1912; 7 ♂, 9 ♀.

Loggerhead Key, Dry Tortugas, Fla., July 8, 1912; 7 ♂, 7 ♀.

The color phases of this species are well illustrated by the above series. No approach whatever is shown to *Chortophaga cubensis* (Sc.).

Spharagemon crepitans (Sauss.).

Key West, Fla., July 7, 1912; 2 ♂, 4 ♀.

The specimens of this splendid insect from the above locality are the most attenuate of a series of 37 individuals of the species before us. Length of body, ♂♂ 26.7–27.3 mm., ♀♀ 34.–37.; length of tegmen, ♂♂ 30.2–32.2, ♀♀ 34.–35.8. The caudal tibiæ lack the bright red coloration of *Spharagemon bolli* as is true of the entire series of this species before us.

The only situation in which this species was found was on the ground under bushes in high jungle growth of the keys, where a few scattered individuals and one small colony was encountered. The species was very difficult to capture as the brush was too heavy to use a net and the insects flew up hurriedly. Their flight was observed to be usually low and for short distances.

Trimerotropis citrina Sc.

Key West, Fla., July 4–5, 1912; 5 ♂, 4 ♀.

This species was very scarce on bare roads and occasional on the sand of the southern beach.

Romalea microptera (Beauv.).

Homestead, Fla., July 10–12, 1912; 25 ♂, 13 ♀.

Detroit, Fla., July 12, 1912; 5 ♂, 5 ♀.

This series shows a considerable amount of individual variation in size, the extremes measuring as follows: Length of body, ♂♂ 48.–54. mm., ♀♀ 60.–71.; length of pronotum, ♂♂ 13.4–18.8, ♀♀ 18.2–21.7; length of tegmen, ♂♂ 22.3–27.5, ♀♀ 23.8–32; length of caudal femur, ♂♂ 23.7–31.; ♀♀ 30.7–36.5. All of the specimens are of the typical phase of coloration.

These insects were widely distributed in moderate numbers through the undergrowth of the pine woods at both the above localities.

Leptysma marginicollis (Serv.).

Homestead, Fla., July 10–12, 1912; 9 ♂, 8 ♀, 1 ♂ n., 1 ♀ n.

Detroit, Fla., July 12, 1912; 2 ♂.

Two males and seven females are of the greenish phase of coloration, while the postocular bars are strongly indicated in all of the adults.

At Homestead the species was common in the tall saw-grass of the everglades and occasional over the prairie-like expanse, while at Detroit it was taken in grasses on the edge of the "hammock" in the pine woods.

Schistocerca alutacea (Harris).

Detroit, Fla., July 12, 1912; 1 ♂.
Long Key, Fla., July 13, 1912; 1 ♂.
Big Pine Key, Fla., July 6, 1912; 4 ♂, 2 ♀.
Key West, Fla., July 3–7, 1912; 15 ♂, 1 ♀.

All of these specimens are of the rusty-brown phase of coloration. Several specimens have two darker markings weakly indicated on the dorsal surfaces of the caudal femora.

The species was found occasional at Big Pine Key on the edge of a fringe of mangroves in tall bushes and low plants and not scarce locally in the scrub on Key West. It was taken in the same situation as *Schistocerca obscura* at both Detroit and Long Key, at which places the latter species was the more numerous.

Schistocerca obscura (Fabr.).

Detroit, Fla., July 12, 1912; 3 ♂.
Key Largo, Fla., July 11, 1912; 2 ♂.
Long Key, Fla., July 13, 1912; 3 ♀.

The males are of the brilliant yellow striped phase of coloration, while the females are rusty brown without a medio-longitudinal stripe but somewhat mottled and, as in nearly all other specimens of the species before us, the dorsal surfaces of the caudal femora have two decidedly darker markings.

The present species was found in the heavy "hammock" at Detroit, occasional in weeds beside the railroad on Key Largo and in the prevailing scrub on Long Key.

Schistocerca americana Sc.

Homestead, Fla., July 10, 1912; 1 ♂.
Detroit, Fla., July 12, 1912; 1 ♂, 1 ♀.
Jewfish, Fla., July 11, 1912; 1 ♂.
Key Largo, Fla., July 11, 1912; 1 ♀.
Long Key, Fla., July 13, 1912; 1 ♂.
Big Pine Key, Fla., July 6, 1912; 1 ♀.
Key West, Fla., July 3–7, 1912; 7 ♂, 7 ♀.
Bird Key, Dry Tortugas, Fla., July 9, 1912; 1 ♂.
Garden Key, Dry Tortugas, Fla., July 8, 1912; 1 ♀.
Loggerhead Key, Dry Tortugas, Fla., July 8, 1912; 7 ♂, 5 ♀.

This series bears out still more clearly the fact that the size and wing length in the present species is much less in southern Florida individuals than in more northern specimens and that this is particularly emphasized in individuals from the keys. A series of fifteen male specimens from the outermost keys, Key West and the Tortugas, give the following averages: Length of pronotum, 7.7 mm. (7.1–8.4); length of tegmen, 34.9 (32.3–38.).[19] The females bear out these facts in like manner.

In the series from Loggerhead Key, there are three males remarkable for the fact that the tegmina wholly lack maculations of any kind, which gives the insects a very distinctive appearance. No intermediates between this and the normal color phase were seen, but no characters exist to separate the specimens from typical *americana*, the difference being simply due to a loss of a portion of the color pattern through recession.

Though only occasional at the majority of localities, this species was very common through the scrub on Key West and quite numerous on Loggerhead Key in open spots where the sandy soil was covered with beach plants, grasses, and prickly pear.

Schistocerca damnifica calidior R. and H.

Homestead, Fla., July 10–12, 1912; 3 ♂, 1 ♀.

Big Pine Key, Fla., July 6, 1912; 2 ♂, 1 ♀.

At both of the above localities individuals were very scarce in the low undergrowth of the pine woods. One male, taken at Homestead, was very soft when captured, having but recently moulted into the mature condition.

Eotettix signatus Sc.

Homestead, Fla., July 10–12, 1912; 39 ♂, 42 ♀, 1 ♀ n.

Detroit, Fla., July 12, 1912; 2 ♂, 4 ♀.

The large series before us shows that not only is there great variation in size and tegminal length in specimens from the same locality, but also that specimens from the more southern localities in the species distribution average much smaller than those found further north.

Measurements (in millimeters) of extremes.

	Pablo Beach, Fla.	
	5 ♂♂	3 ♀♀
Length of body	19.4–20.5	26. –26.5
Length of pronotum	4.7– 4.9	6.2– 6.3
Length of tegmen	5. – 6.1	7.6– 8.5
Length of caudal femur	12. –12.6	15.5–16.6

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[19] For further notes on this variation see Rehn and Hebard, PROC. ACAD. NAT. SCI. PHILA., 1912, p. 257.

	Homestead and Detroit, Fla.	
	41 ♂♂	46 ♀♀
Length of body	14.2–17.6	19.5–24.8
Length of pronotum	3.4– 4.	4.3– 5.7
Length of tegmen	4.3– 5.6	5.1– 7.6
Length of caudal femur	10. –11.4	12. –15.1

The present species, in spite of the great variability in tegminal length, always has these organs longer than the pronotum and broad lanceolate with acute apex, which readily distinguishes the species from *Eotettix palustris* which has the tegmina not as long as the pronotum and broadly oval with rounded apex.

Like *Eotettix pusillus* and *E. sylvestris*, this form has in life a striking metallic lustre which has almost wholly disappeared in all of the dried specimens.

The species was found very common on the prairie-like everglades and in much fewer numbers about pot-holes in the pine woods, it has never been definitely recorded previously except from Pablo Beach in northeastern Florida.

Melanoplus puer Sc.

Homestead, Fla., July 10–12, 1912; 2 ♂, 2 ♀, 2 ♀ n.
Detroit, Fla., July 12, 1912; 1 ♂, 1 ♀, 1 ♀ n.

The species was very scarce at the above localities in the undergrowth of the pine woods.

Paroxya atlantica Sc.

Homestead, Fla., July 10–12, 1912; 10 ♂, 2 ♀.
Detroit, Fla., July 12, 1912; 1 ♂, 2 ♀.

The Detroit specimens show a slight tendency toward the keys race, *P. atlantica paroxyoides*.

Paroxya atlantica paroxyoides (Sc.).

Jewfish, Fla., July 11, 1912; 3 ♂, 3 ♀, 1 ♀ n.
Ley Largo, Fla., July 11, 1912; 1 ♂, 1 ♀ n.
Long Key, Fla., July 13, 1912; 3 ♂.
Big Pine Key, Fla., July 6, 1912; 6 ♂, 1 ♀ n.
Key West, Fla., July 3–7, 1912; 13 ♂, 10 ♀.

On Big Pine Key this geographic race was found in the undergrowth of the pine woods and along the edge of the key in few numbers. At Key West it was not scarce in the scrub and common in the vegetation back of the beach, while in the heavy jungle-like tangle it was the only species of grasshopper that was not scarce.

Paroxya floridana (Thomas).

Detroit, Fla., July 12, 1912; 5 ♂, 3 ♀.

The species was common in the typical saw-grass growing in knee-high water in the everglades.

Aptenopedes clara Rehn.

Homestead, Fla., July 10, 12, 1912; 3 ♂, 3 ♀, 1 ♀ n.
Detroit, Fla., July 12, 1912; 3 ♂, 1 ♂ n., 2 ♀ n.
Long Key, Fla., July 13, 1912; 2 ♂, 2 ♀, 1 ♂ n.
Big Pine Key, Fla., July 6, 1912; 4 ♂, 3 ♀ n.
Key West, Fla., July 3–7, 1912; 10 ♂, 12 ♀.

This species was found in the undergrowth of the pine woods and keys scrub, usually in damper situations than *Aptenopedes aptera*.

Aptenopedes aptera Sc.

Homestead, Fla., July 10–12, 1912; 1 ♂, 3 ♂ n., 4 ♀ n.
Detroit, Fla., July 12, 1912; 1 ♂ n., 2 ♀ n.
Big Pine Key, Fla., July 6, 1912; 1 ♂ n., 3 ♀ n.

The majority of the series are somewhat less than half grown. As this is an apterous species, none of the nymphs have any trace of tegmina, this together with their greater rugosity makes them easily separable from nymphs of *Aptenopedes clara*, which show tegminal sheaths from the earliest instars.

This species has not been recorded previously south of Miami, Fla.

TETTIGONIIDÆ.

Arethæa phalangium (Scudder).

Homestead, Fla., July 10, 1912; 1 ♂, 2 ♀.

These specimens were found dead in spider-webs on the railroad station building.[20]

Amblycorypha floridana R. and H.

Homestead, Fla., July 10–12, 1912; 8 ♂, 6 ♀, 1 ♀ n.
Detroit, Fla., July 12, 1912; 2 ♂, 2 ♀, 1 ♂ n.
Big Pine Key, Fla., July 6, 1912; 1 ♂.

The character of the tympanum of the male tegmina is typical in all of the individuals of that sex, while the ovipositor varies somewhat in depth and appreciably in length, the extremes of the latter in the Homestead females being ten and a half and eleven and eight-tenths millimeters. The blackish markings on the tympanum of the males vary considerably in intensity, in one extreme covering practically all of that field except the sutural half of the area proximad

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[20] *Vide*, Rehn and Hebard, *Trans. Amer. Entom. Soc.*, XL, pp. 147, 148 (1914).

of the stridulating vein, while in the other this coloration is decided only in spots, one proximad, one distad, and one immediately distad of the stridulating vein. One male from Homestead is quite brownish, two females from the same locality are dull straw colored or washed with brownish, while two Detroit females are much tinged on the pronotum and proximad on the tegmina with pale reddish-brown. A half-grown nymph from Miami, Fla., taken March 28, 1910, gives us an idea of the condition of individuals of the species at that time of year.

At Homestead this species occurred locally on the prairie-like everglades, where they were scarce in the daytime, but plentiful at night, perched on the grasses, stridulating fearlessly. Their note is an indescribable buzz and click. The Detroit specimens were taken in pine woods on the edge of a hammock, and on Big Pine Key the species was beaten from green bushes in the pine woods. Two specimens were found dead in spider-webs at the railroad station at Homestead on July 10.

Amblycorypha uhleri Stål.

Homestead, Fla., July 10–12, 1912; 5 ♂, 6 ♀.

When compared with Texan material of this species, the present series is seen to be identical, although the size is much greater than in individuals from New Jersey, which, however, show no specific differences from Texan topotypes. When careful examination of all the available material has been made, it will probably be found that the size regularly decreases northward. All of the males and several of the females have much of the pronotum, pleura, and proximal portion of the tegmina more or less ochraceous. Four of the males have the blackish tympanal maculation decided. The species was fairly common at Homestead, more numerous at night than in the daytime, always in the pine woods and in or near large-leaved small bushes of several species. When search was made for them at night with the aid of a flash-lamp, they proved to be quite shy, flying frequently before their exact location could be ascertained. Two specimens were taken from spider-webs on the station building at Homestead, July 10.

Microcentrum rhombifolium (Saussure).

Key West, Fla., July 3, 1912; 1 ♂.

The present specimen was taken from high bushes about twelve feet from the ground, several others being heard in the same vicinity. This is the first record of this widespread species from the keys.

Microcentrum rostratum R. and H.

Key West, Fla., July 3–7, 1912; 10 ♂, 1 ♂ n.

Long Key, Fla., July 13, 1912; 1 ♂ n., 1 ♀ n.

This striking and peculiar species was taken in but one location on Key West, and there it was found at night locally numerous but hard to secure. Individuals were taken only on buttonwood (*Conocarpus erecta*) on the two occasions on which the spot was visited. All the specimens were stalked with flash-lamp by the aid of their song, in consequence none but males being captured. Their note is quite different from that of any of the other species of the family found on the keys, being low and rasping, much like zrrrp-zrrrp, zrrrp. On Long Key the nymphs were taken from buttonwood (*Conocarpus erecta*), which there grows on the edge of mangrove swamps.

As the species was previously known only from the unique type, a female, we have made some notes on the differences of that sex from the original description.[21]

Allotype: ♂; Key West, Florida. July 3–7, 1912. (Rehn and Hebard.) [Hebard Collection.]

Fastigium slightly more compressed than in the female, but otherwise similar. Tympanum of tegmina half again as long as the disk of the pronotum, stridulating vein broad, depressed, arcuate, slightly oblique. Disto-dorsal abdominal segment arcuato-truncate mesad, with a medio-longitudinal depression; supra-anal plate trigonal, with a deep median sulcation; cerci tapering, nearly straight, considerably surpassing the distal margin of the subgenital plate, the apex blunted and slightly hooked dorsad, furnished dorsad with a pair of teeth placed side by side and with a single tooth placed ventrad of the same; subgenital plate ample, narrowing distad, lateral margins slightly arcuate but subregularly converging, distal extremity narrow, arcuato-emarginate, styles articulate, slightly tapering, their length not greater than the width of the distal extremity of the plate.

Measurements (in millimeters).

	Allotype, ♂.
Length of body	20.8
Length of pronotum	5.3
Caudal width of the disk of the pronotum	4.1
Length of tegmen	28.8
Greatest width of tegmen	7.5
Length of caudal femur	15.6
Length of caudal tibia	16.8

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[21] By an unfortunate transposition, the original description states that the lateral angles of the pronotal disk are "more apparent cephalad than caudad," when the reverse is true of the type and the present material. Proc. Acad. Nat. Sci. Phila., 1905, p. 43.)

In size the present series shows but little variation. The two Long Key nymphs are in quite different stages, the male being in the instar preceding maturity, while the female is not a third the size of the male. The Key West nymph is in the second instar preceding maturity.

Belocephalus sabalis Davis.

Homestead, Fla., July 10, 1912; 28 ♂.

Marathon, Kay Vaca, Fla., July 9, 1912; 1 ♂.

A comparison of this interesting series, the largest known of any single species of the genus, with a paratypic male from Punta Gorda, kindly presented to us by Mr. Davis, shows that while fully in accord in all the important specific characters the Homestead series uniformly differs in having the fastigium shorter, though of similar form, while the black marking of the clypeal suture is pronounced only in the brown phase and not always present in that condition. One single green male shows indications of this sutural marking, but in the others the face is unicolorous. The Marathon male has the fastigium more as in the paratype than is true of the Homestead specimens, but the apex is even there less elongate than in the Punta Gorda specimens, while the clypeal suture has no black. These differences are probably environmental or geographic but hardly specific in character.

In size there is considerable individual variation, the extremes of the Homestead series presenting the measurements in millimeters given below, with which are placed those of the Marathon male, which appreciably surpasses in build any from the mainland, and of the Punta Gorda paratype.

	Homestead.		Marathon, Key Vaca.	Punta Gorda (paratype).
Length of body	34.	41.	45.	38.6
Length of fastigium from eyes	3.1	3.5	4.2	4.5
Length of pronotum	8.6	8.6	10.4	9.2
Length of tegmen	5.2	6.7	7.9	7.1
Length of caudal femur	15.9	16.2	19.7	18.

Seven of the Homestead males are in the brown phase, all of the remainder in the green phase of coloration. The brown specimens have the broad dorsal darker bar mentioned by Davis.

At Homestead the species was very common on scrub palmetto (*Serenoa serrulata*) in the pine woods, rarely on other plants (two on sugar cane, one on a pine tree, and one on a low bush) and only found at night, when their stridulations permitted stalking with a flash-lamp. The song was faint and ceased on an approach of even as much as twenty feet. However, they were easy to capture when located, as they almost invariably made no attempt to escape, but instead merely slipped down the palmetto leaf a few inches or around to the other side and there flattened themselves out with caudal limbs extended backward and cephalic limbs forward. When picked up they would violently attempt to bite their captor, and if successful could inflict a painful bite on a tender portion of the hand. Their jaws are capable of cutting the tough palmetto leaves and in consequence are very powerful. Their note is very low and consists of a succession of sounds like zip-zip-zip-zip-zip-zip-zip-zip.

Neoconocephalus mexicanus (Saussure).

> *Conocephalus fusco-striatus* Redtenbacher, Verh. K.-k. Zool.-botan. Gesell. Wien, XLI, p. 399 (1891).

Homestead, Fla., July 10–12, 1912; 6 ♂, 1 ♀.
Jewfish, Fla., July 11, 1912; 1 ♂.
Key West, Fla., July 3–7, 1912; 5 ♂, 1 ♀ n.

At Homestead two perfectly typical males of *fusco-striatus* were taken in company with typical specimens of *mexicanus*, of which we are thoroughly convinced the former is merely the brown-color phase, absolutely no structural differences being found on careful examination. The song of individuals in the different phases was noted as being the same, a krzzzzz-krzzzzz-krzzzzz, each preceded, when one is near enough to detect it, by a sharp buzz. Individuals were only occasional in the pine woods at Homestead at night and exceedingly shy, although permitting a near approach until they ceased singing, when, however, they would dart wildly away. At Jewfish many were heard singing in high grasses, from which one was taken. All the specimens from Key West were secured in the scrub jungle, both in the daytime and at night, many nymphs being seen.

As remarked above, two individuals from Homestead are in the brown phase, all the others being in the green phase. The specimens in the latter condition show considerable variation in the blackish fastigial marking, this varying from the faintest possible median indication to quite a broad solid band crossing the entire fastigium.

Neoconocephalus velox n. sp.

This peculiar species has been carefully compared with all the available material of the genus from the United States, Central America, and the West Indies, as well as with all the literature bearing on the subject, and is found to show nearest relationship to N.

palustris. From this species it differs in the more slender, compressed form, which is unusually pronounced for the male sex of this genus, with the tympanum in consequence much narrowed, while the pronotum is exceptionally attenuate.

Type: ♂; Homestead, Dade County, Florida. July 12, 1912. (Hebard.) [Hebard Collection.]

Size moderately large; form compressed, slender, elongate. Head with the dorsal length considerably less than that of the pronotum; fastigium with its length beyond the eyes slightly greater than the space between the latter, subattenuate, tapering very gently distad, the apex very bluntly rounded, ventral tooth distinct, blunt, well separated from the facial fastigium; face strongly retreating; eyes ovato-trigonal, their depth slightly less than their length, compressed and but little prominent when seen from the dorsal aspect; antennæ moderately elongate, in an incomplete condition four-fifths as long as the tegmina. Pronotum with the surface impresso-punctate, elongate, narrow, the greatest (caudal) width of the dorsum but slightly more than half the length of the same, the cephalic width about two-thirds the caudal width, cephalic margin of disk truncate, caudal margin of same arcuate, obtuse-angulate, the dorsal length of the prozona contained three and one-half times in that of the metazona, lateral angles distinct, rotundato-subrectangulate caudad, well rounded cephalad, regularly but not decidedly diverging caudad; lateral lobes elongate, the greatest depth contained slightly more than one and one-half times in the greatest dorsal length, cephalic margin strongly oblique, faintly arcuate, ventro-cephalic angle broad arcuate, ventral margin more oblique than usual, straight, ventro-caudal angle arcuato-obtuse, caudal margin with a deep rotundato-subrectangulate humeral sinus, the ventral portion of the same margin oblique arcuate. Tegmina elongate, the greatest width contained about six and

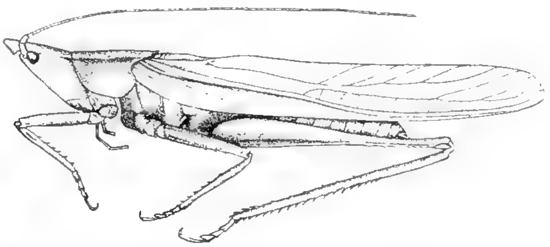

Fig. 5.—Side view of type of *Neoconocephalus velox* n. sp. (× 1¼.)

one-half times in the length; costal margin gently arcuate distad to the rather narrow suboblique rotundato-truncate apex; tympanum slightly longer than the disk of the pronotum, its greatest width subequal to the caudal width of the latter, stridulating vein short, slightly oblique, greatly thickened. Prosternum long bispinose; lobes of the mesosternum and metasternum slightly acute-angulate. Disto-dorsal abdominal segment with the distal margin arcuato-emarginate, subacute and faintly tuberculate laterad, strongly arcuato-emarginate at the base of each cercus; supra-anal plate trigonal, slightly elongate, lateral margins moderately concave, apex narrowly rounded, medio-longitudinal sulcus pronounced; cerci with the shaft robust, the surface of same subpustulate, ventral extremity bent mesad and slightly proximad, sinuate, acuminate, with a strong terminal spine, dorsal extremity with a shorter process, which is, however, similarly developed and with a slightly longer spine; subgenital plate moderately broad, tricarinate ventrad, the lateral carinæ heavier and more rounded than the median, being the trunks bearing the styles, which latter are brief, rather blunt, and faintly tapering, distal margin of plate obtuse-angulate emarginate. Cephalic femora about four-fifths as long as the dorsum of the pronotum, ventro-cephalic margin distad with two to three spines, ventro-caudal margin unarmed; cephalic tibiæ unarmed dorsad. Median femora a fourth longer than the cephalic femora, margin similar. Caudal femora about three-fifths as long as the tegmina, slender, armed on the distal half of each of the ventral margins with six spines.

Fig. 6,—Dorsal outline of head, pronotum and tympanum of type of *Neoconocephalus velox* n. sp. (× 1¼.)

General color tawny-olive. Head with the dorsum of the fastigium, occiput, and postocular region multilineate with weak bister lines, lateral margins and apex of fastigium bordered with cream-buff, ventral surface of fastigium with a faint purplish tinge, but no black; eyes seal-brown; antennæ of the general color. Pronotum with the dorsum very weakly and the lateral lobes, particularly dorsad, more strongly washed with warm sepia, the position of the lateral angles indicated by chamois lines. Tegmina with the discoidal field sprinkled with small points varying from blackish to seal-brown in tone. Limbs unicolorous, spines narrowly tipped with blackish brown.

Measurements (in millimeters).

	♂
Length of body	40.5
Length of fastigium (from eyes)	2.7
Length of pronotum	9.
Greatest caudal width of pronotum	5.2
Length of tegmen	42.
Length of caudal femur	25.2

This species was very shy and scarce in the pine woods at Homestead. It was only encountered at night, and while some few were heard, but one other than the type was seen. The song of this insect consists of a loud and sustained buzzing note.

Homorocoryphus malivolans (Scudder).

Conocephalus hoplomachus Rehn and Hebard, Proc. Acad. Nat. Sci. Phila., 1905, p. 46. (Chokoloskee, Monroe Co., Fla.)

Detroit, Fla., July 12, 1912; 1 ♂.

After a careful examination of the present specimen, the types of *Conocephalus hoplomachus* and of *Conocephalus malivolans* Scudder, we are convinced that *hoplomachus* represents the female of *malivolans*. The latter was based on a single male from Cedar Keys, Fla., which remained unique until the very different female was described by us as *C. hoplomachus*. At that time we examined the description of *malivolans*, but the sexual differences are so great that we could not recognize the female then in hand as the other sex of Scudder's species. The present specimen enables us to establish the above synonymy, agreeing as the individual does exactly with the original description and clearly being the male sex of the apparently very different *hoplomachus*.

The present specimen was taken during the daytime from saw grass growing in knee-high water on the edge of the everglades.

Odontoxiphidium apterum Morse.

Homestead, Fla., July 10–12, 1912; 8 ♂, 9 ♀, 2 ♀ n.
Detroit, Fla., July 12, 1912; 7 ♂, 5 ♀, 1 ♀ n.
Key Largo, Fla., July 11, 1912; 1 ♀.
Long Key, Fla., July 13, 1912; 1 ♀.
Big Pine Key, Fla., July 6, 1912; 4 ♂, 1 ♀, 3 ♀ n.
Key West, Fla., July 3–7, 1912; 18 ♂, 6 ♀, 6 ♀ n.

These specimens average considerably larger than individuals from southern Georgia and northern Florida, although each of the present lots shows in itself considerable individual variation in size. The maximum-sized individuals are from the keys, particularly in the female sex, the greater majority of the males being no larger than

Homestead specimens, all, however, larger than northern Florida representatives. The minimum and maximum measurements in millimeters of each sex in the present series are as follows:

♂

	Homestead.		Detroit.	
Length of body	12.5	14.2	12.8	13.
Length of pronotum	4.2	4.8	4.	4.5
Length of tegmen	3.	3.2	3.3	3.2
Length of caudal femur	12.5	14.5	12.2	13.2

♂

	Big Pine Key.		Key West.	
Length of body	11.7	12.8	12.7	15.3
Length of pronotum	4.	4.	3.9	4.6
Length of tegmen	2.8	2.8	3.5	4.2
Length of caudal femur	12.2	12.5	12.1	15.

♀

	Homestead.		Detroit.		Key Largo.
Length of body (exclusive of ovipositor)	11.6	17.	15.	14.	20.3
Length of pronotum	4.7	5.	4.9	5.3	6.
Length of caudal femur	13.8	16.	14.	16.7	17.4
Length of ovipositor	13.	13.	13.9	13.5	18.8

♀

	Long Key.	Big Pine Key.	Key West.	
Length of body (exclusive of ovipositor)	17.1	14.2	12.5	17.
Length of pronotum	5.2	4.9	5.3	5.5
Length of caudal femur	17.4	13.5	16.5	16.
Length of ovipositor	17.	13.	16.2	18.5

The range of the species is considerably extended to the southward by the present records, as it was not previously known from south of Sanford, Fla.

At Homestead the species was not scarce in rank grasses in potholes in the pine woods, at Detroit it was found in pine woods, on Key West a few adults and many nymphs were encountered in weedy tangles and grassy spots in jungle brush, while on Big Pine Key it was occasional in green herbage in the pine woods.

Orchelimum nitidum Redtenbacher.

Detroit, Fla., July 12, 1912; 4 ♂, 3 ♀.

The present record is the most southern known for the species, which has a considerable range to the northward.

At Detroit the species was not scarce in saw grass growing in the knee-high water of the everglades.

Orchelimum militare R. and H.

Detroit, Fla., July 12, 1912; 1 ♂, 1 ♀.

These specimens are inseparable from typical material of the species, the range of which is here extended to the southward of its former southern limit, Gainesville, Alachua County, Fla.

This pair was taken in the same situation as the series of *O. pulchellum.*

Orchelimum concinnum Scudder.

Homestead, Fla., July 10–12, 1912; 5 ♂, 9 ♀.

The present record slightly extends the range of this species to the southward, the most southern previous record being from Chokoloskee, Fla. Three males have the facial maculation indistinct, this certainly being due to desiccation in one specimen, but in the remaining eleven it is decided and moderately variable in width.

Individuals of this species were not uncommon in the prairie-like everglades.

Conocephalus fasciatus (DeGeer).

Miami, Fla., July 17–20, September 12, 1904 (Hebard); 2 ♂, 2 ♀.

Detroit, Fla., July 12, 1912; 2 ♀.

The range of the species is extended to the end of the Florida peninsula by the present records.

Conocephalus gracillimus (Morse).

Homestead, Fla., July 10–12, 1912; 10 ♂, 7 ♀.

Detroit, Fla., July 12, 1912; 1 ♂.

Jewfish, Fla., July 11, 1912; 12 ♂, 6 ♀.

Big Pine Key, Fla., July 6, 1912; 5 ♂, 1 ♀.

Key West, Fla., July 3–7, 1912; 2 ♂, 5 ♀, 1 ♀ n.

Loggerhead Key, Dry Tortugas, Fla., July 8, 1912; 2 ♂, 3 ♀, 1 ♂ n., 1 ♀ n.

These specimens show that considerable color variation is present in the species, and while in a certain measure geographic, it is chiefly individual. The Homestead series is in general uniformly quite dark, two males, however, being rather pale. The single Detroit individual is pale, as are most of the Jewfish specimens, none of which are as dark as the average Homestead representative. Big Pine Key specimens vary greatly, several having an average degree of marking, while three have the general color pale yellowish. Key West representatives are of the usual pattern in the female sex, but the males are much paler with a weak pattern. The Loggerhead Key series varies greatly in color, three adults and both of the nymphs having the pattern more or less distinctly indicated on a pale base color, while the other two adults are uniformly ochraceous without markings.

The specimens from the keys average slightly larger than the individuals from the mainland, the Key West females having this most apparent.

At Homestead the species occurred in potholes and in the prairie-like everglades, at Jewfish it was common in grasses on the edge of the everglades, on Key West it was not scarce in grassy tangles scattered through the jungle scrub, while on Loggerhead Key it frequented grasses growing on open areas among the bay-cedar thickets.

Ceuthophilus peninsularis n. sp.

Apparently nearest to *C. spinosus* Brunner from Georgia, but differing in the absence of pronounced spines on the external margin of the caudal femora, in the non-arcuate caudal tibiæ, in the smaller size, and in the rather different coloration. It also shows some relationship to *C. nigricans* Scudder in the longer caudal femora and tibiæ, in the long distal spine on the ventro-cephalic margin of the cephalic femora, in the same margin of the median femora having four spines, in the caudal femora being longer instead of shorter than the body, slenderer and three times as long as broad, in the ventro-internal margin of the caudal femora being more strongly serrato-dentate than the external, inner middle spur of the caudal tibiæ not markedly longer than the external middle one and but little shorter than the metatarsus.

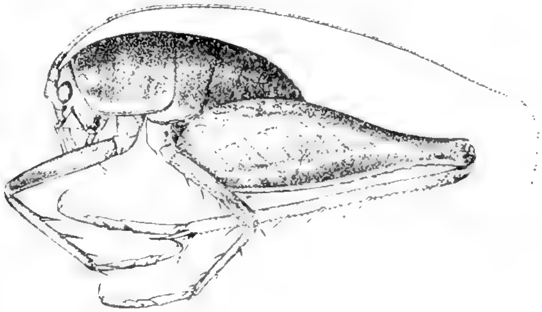

Fig. 7.—Side view of type of *Ceuthophilus peninsularis* n. sp. (× 3.)

TYPE: ♂; Homestead, Dade County, Fla. July 12, 1912. (Hebard.) [Hebard Collection.]

Size rather small; body subfusiform, glabrous. Fastigium strongly declivent, low; eyes not at all prominent; antennæ in an imperfect condition reaching to the apices of the caudal femora, rather heavy. Pronotum with the cephalic and caudal margins truncate, ventral margin of the lateral lobes flattened arcuate. Mesonotum and metanotum with their caudal margins subarcuate. Abdomen with the segments glabrous; cerci shorter than the pronotum, robust at the base and decidedly tapering to the acute apex. Cephalic femora about a tenth longer than the pronotum, armed on the ventro-cephalic margin with three spines placed on the distal half, the distal spine quite long and equalling the cephalic tibial spines in length, the others diminishing in length, ventro-caudal margin unarmed. Median femora subequal to the cephalic femora in length, slightly less robust, armed on the ventro-cephalic margin with four spines proportioned as on the cephalic femora, ventro-caudal margin armed with three subequal spines, caudal genicular lobe bearing a long spine. Caudal femora longer than the body, moderately robust, the greatest width contained three times in the length, dorsal surface with the dark areas of the pattern bearing numerous depressed points, a group of more decided spiniform points present dorsad on the internal face, ventro-external margin of the caudal femora with weak recumbent serrulato-spinulations, ventro-internal margin distad with seven distinct but recumbent serrato-spinulations; caudal tibiæ less than a twelfth longer than the caudal femora, straight, spurs subopposite distad, subalternating proximad, about one and one-half times as long as the tibial depth, slightly hooked at the tips, inner middle spur appreciably longer than the outer middle spur and subequal to the metatarsus in length, dorsal spurs of both faces slightly longer than the ventral ones, ventral surface of tibiæ distad with a single spine in addition to the apical pair; caudal tarsi with the third joint about half the length of the second, together very slightly shorter than the fourth.

Dorsal surface solidly brownish-black, passing into cinnamon-buff on the ventral surface, the pale coloration on the femora antique brown (Ridgway, Plate III), the head, pronotum, and dorsum of abdomen with a distinct continuous medio-longitudinal line of ferruginous. Face and palpi of the ventral color, the facial fastigium, a spot under each eye and a touch on the genæ of the dorsal color, the third palpal joint lightly and the fourth heavily marked with the same; eyes black; antennæ cream-buff, proximad passing into bister. Ventral section of the lateral lobes of the pronotum and corresponding portions of the mesonotum and metanotum stippled with the ventral color. Abdomen dorsad bearing on each side two complete and several incomplete longitudinal series of circular ferruginous spots; cerci of the ventral color, becoming bister distad. Cephalic and median femora with their distal halves and greater portion of corresponding tibiæ brownish-black. Caudal femora with a decided scalariform pattern of blackish-brown, the latter color nearly solid distad and along the ventro-lateral margin; caudal tibiæ honey-yellow, proximal extremity and dorsal surface brownish-black. All tarsi uniformly cream color.

Measurements (in millimeters).	Type. ♂.
Length of body	10.8
Length of pronotum	4.9
Length of cephalic femur	5.2
Length of caudal femur	12.6
Length of caudal tibia	13.5

The type of this species was found under a coquina boulder in the everglades near the edge of the pine woods. A very immature specimen of what is apparently this species was also taken at Homestead, March 17–19, 1910, by Hebard.

GRYLLIDÆ

Cryptoptilum antillarum (Redt.).

Homestead, Fla., July 10–12, 1912; 5 ♂, 4 ♀, 1 ♂ n.
Detroit, Fla., July 12, 1912; 2 ♀.
Big Pine Key, Fla., July 6, 1912; 4 ♂, 3 ♀.
Long Key, Fla., July 13, 1912; 2 ♂, 3 ♀.
Key West, Fla., July 3–7, 1912; 15 ♂, 22 ♀, 1 ♂ n., 1 ♀ n.
Loggerhead Key, Dry Tortugas, Fla., July 8, 1912; 1 ♀.

This species is widely distributed through the keys scrub and in "hammock" shrubbery on the mainland, as well as in weedy spots and vine tangles. One specimen was taken from an epiphyte (*Epidendron tampense*) growing on an oak in the "hammock" at Detroit. The species was found scarce in the bay-cedar bushes (*Suriana maritima*) on Loggerhead Key.

Cryptoptilum trigonipalpum R. and H.

Homestead, Fla., July 10–12, 1912; 1 ♂ n.
Detroit, Fla., July 12, 1912; 1 ♀ n.

The specimen from Detroit was taken from an oak in the "hammock."

Cycloptilum zebra R. and H.

Key West, Fla., July 7, 1912; 1 ♂.

A number of specimens were heard after dark stridulating in short grass growing in the street railway track. The song is a faint krik-krik-krik-krik, suggesting that of a species of *Nemobius*, but much fainter.

Nemobius fasciatus socius Sc.[22]

Homestead, Fla., July 10–12, 1912; 1 ♂.

Nemobius ambitiosus Sc.[22]

Homestead, Fla., July 10–12, 1912; 1 ♂.

Nomobius cubensis Sauss.[22]

Homestead, Fla., July 10–12, 1912; 3 ♂, 3 ♀.

Nemobius carolinus Sc.[22]

Homestead, Fla., July 10–12, 1912; 1 ♂, 1 ♀.

Miogryllus saussurei (Sc.).

Homestead, Fla., July 10–12, 1912; 2 ♀, 1 ♀ n.

Found in the undergrowth of the pine woods.

Gryllus firmus Sc.

Homestead, Fla., July 10–12, 1912; 1 ♂. Macropterous.

Detroit, Fla., July 12, 1912; 1 ♀.

Jewfish, Fla., July 11, 1912; 2 ♂, 1 ♀. 1 ♂, macropterous.

Key West, Fla., July 3–7, 1912; 2 ♂.

Great variation in size is found in this small series, the males measuring in length 20.5–29. mm., the females 25.–25.7. The song is a loud, sharp, vigorous chirruping.

Gryllus rubens Sc.

Homestead, Fla., July 12, 1912; 1 ♂. Macropterous.

This specimen was taken on the railroad track, "making a slower stridulation noticeably different from the hearty chirp of *Gryllus firmus*."

Gryllodes sigillatus (Walk.).

Jewfish, Fla., July 11, 1912; 2 ♀.

Key West, Fla., July 3, 7, 1912; 4 ♂, 1 ♀.

A few individuals of this species were found under boards in the station yard at Jewfish, while the species was everywhere common at Key West about the town. After dark at the latter locality the

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[22] These specimens have recently been fully studied by the junior author. Proc. Acad. Nat. Sci. Phila., 1913, pp. 394–491.

high, hurried, shrilling song of the species was to be heard on all sides, and with the aid of a flash-lamp individuals were easily taken when carefully approached and suddenly seized; this was apparently due to the fact that the specimens were blinded by the light, for the species is certainly the most active gryllid found within the United States.

Cyrtoxipha gundlachi Sauss.

Homestead, Fla., July 10–12, 1912. Numerous in fig trees near house.

Detroit, Fla., July 12, 1912; 1 ♀.
Key Largo, Fla., July 11, 1912; 1 ♂.
Long Key, Fla., July 13, 1912; 1 ♂, 2 ♀.
Big Pine Key, Fla., July 6, 1912; 4 ♂, 3 ♀.
Key West, Fla., July 3–7, 1912; 9 ♂, 12 ♀, 1 gynandromorph.

This series of specimens is very uniform in size, the male from Key Largo only being slightly larger than the other specimens. One specimen from Key West is a gynandromorph, the left tegmen is typical of the male sex while the right is that of the female, the left valves of a much distorted and shrivelled ovipositor are present, while the right half of the genitalia are masculine.

This species was found occasional everywhere through the Keys scrub, but in numbers only in bushes and low trees with broad leaves. The pleasant, clear, tinkling song of this insect is a familiar night sound almost everywhere in this region.

Hapithus quadratus Sc.

Homestead, Fla., July 10–12, 1912; 2 ♂ n.
Detroit, Fla., July 12, 1912; 1 ♂, 2 ♂ n.
Long Key, Fla., July 13, 1912; 1 ♂, 8 ♀.
Big Pine Key, Fla., July 6, 1912; 1 ♀.
Key West, Fla., July 3–7, 1912; 4 ♂, 9 ♀, 1 ♂ n., 1 ♀ n.

The present species is occasional throughout this region in low shrubbery and tangles of bushes and vines; it was found once in moderate numbers, in the keys scrub on Long Key.

Tafalisca lurida Walk.

Detroit, Fla., July 12, 1912; 1 ♀, 1 ♀ n.

The adult was taken from an epiphyte (*Tillandsia fasciculata*) growing on the limb of an oak in the heavy "hammock," while the nymph was later beaten from a low bush there.

THE VASCULAR SYSTEM OF THE FLORIDA ALLIGATOR.

BY ALBERT M. REESE.

The account given by Bronn in his *Thierreich* is apparently the only published description of the circulatory organs in the Crocodilia. This account, even when translated, is not very satisfactory, especially because it contains no diagrams of the circulation. It was, therefore, deemed worth while to work out the circulation in the Florida alligator in order that we might have not only a written description, but also a series of more or less accurate diagrams of the veins and arteries.

A number of departures from the description of Bronn were found, some of which are noted below.

Most of the work was done upon animals of about 30 inches length, which were obtained alive from the Arkansas Alligator Farm at Hot Springs, Ark.

The arteries were injected with a colored starch mass by inserting a two-way cannula into the dorsal aorta. With the blood thus forced into them from the arteries, the veins could, in most cases, be traced without difficulty.

In the diagrams the outlines of the more important organs are accurately shown by dotted lines, and the relative diameters of the blood-vessels are shown as accurately as possible by the solid black lines.

THE HEART.

In the Crocodilia, as is well known, the heart is four-chambered and has about the same general shape as in the higher vertebrates.

The venous blood is emptied into a thin-walled sinus venosus on the dorsal side of the heart by three large vessels and one small one. The largest of these, the postcava, empties into the posterior side of the sinus venosus and brings blood from the posterior regions of the body; it is quite wide, but is exposed for a very short distance between the liver and the heart. Two large hepatic veins empty into the postcava so near the sinus venosus that they practically have openings into the sinus, as is shown in a somewhat exaggerated way in Plate XIII, fig. 1. Near the postcaval and hepatic openings is the distinct coronary vein, lying in a slight depression between the right and left ventricles.

From the anterior regions of the body the blood is brought back through two fairly wide but very thin-walled precaval veins which pass across the dorsal surface of the heart to enter the sinus venosus.

The arterial blood is brought from the lungs by two wide, thin-walled pulmonary veins, Plate XIII, fig. 4, v.p.d., v.p.s. They leave the lungs somewhat caudad to their middle region, near the point of entrance of the bronchii and the pulmonary arteries, pass mediad in a direction almost at right angles to the long axis of the body, and enter the left auricle at the same point.

Blood leaves the heart through five large vessels: (1) the pulmonary artery, (2) the two aortic arches, (3) the right subclavian, (4) the primary carotid.

The pulmonary leaves the small right ventricle as a single stem, which soon branches into two arteries that pass cephalad and laterad to the lungs, along with and close to the main bronchi. The other arteries that carry blood into the systemic circulation are fused at their base to form a sort of conus arteriosus which may be distended in injected specimen until it is larger than the two ventricles together. When opened this conus is found to contain two chambers that lead into the left ventricle; the larger chamber gives origin to the right systemic arch, the right subclavian, and the primary carotid; the smaller chamber is the basal part of the left systemic arch.

The two systemic vessels, fig. 4, Ao.s, Ao.d, pass, in the usual manner, as two arches to the dorsal region, just posterior to the ventricles, where they form the dorsal aorta in the manner to be described in connection with the arterial system.

The further course of the primary carotid and of the right subclavian will also be described in connection with the arterial system.

The auricles are very large in proportion to the ventricles, though their relative sizes will, of course, vary with the amount of contained blood.

The Venous System.

The Posterior Vena Cava and its Branches.

The *postcava*, fig. 1, pc, as noted above, is a wide, thin-walled vessel seen extending across the short space between the anterior face of the right lobe of the liver and the sinus venosus. As was also noted above, the hepatic veins, vh—at any rate that from the left lobe of the liver—enter the postcava so close to the heart that they may be considered to have one or more distinct openings into the sinus venosus. Followed caudad, the postcava may be traced through the large right lobe of the liver, from which it receives several branches. Emerging from the posterior border of the liver, it is seen to extend caudad, in the median line, as a rather inconspicuous vessel that receives blood from the reproductive organs and the kidneys that lie close on either side of it.

The *hepatic portal* vein, h, has the usual distribution for that vessel. Entering the liver in the neighborhood of the bile duct, it receives first (*i.e.*, nearest the liver) a small branch from the pancreas, pv; near the pancreatic are one or two branches from the stomach, g, and a branch from the spleen, sp. A short distance caudad to these vessels are two or three mesenteric veins, m, leading from the mesentery and small intestine. Caudad to the mesenterics, the portal system may be seen as a vein of diminished caliber, i, leading from the posterior part of the small intestine and from the large intestine.

The connection, mentioned by Bronn, between the rectal ranch of the portal vein and the caudal vein could not be demonstrated. After entering the liver, the portal, of course, breaks up into capillaries, and the blood thus distributed is recollected by the capillaries of the hepatic veins above mentioned.

The *internal epigastric* veins, ep, are, perhaps, the most conspicuous vessels of the postcaval system. When the ventral abdominal wall of the animal is removed, they may be seen extending forward from the pelvic region, on each side of the body, to enter the posterior edge of the liver. The epigastric of the right side enters the large or right lobe of the liver, where it breaks up into capillaries; the left epigastric sends its main branch into the left lobe of the liver, but also sends a branch over to enter the right lobe.

Following the epigastrics caudad, they are seen to receive vessels from nearly all parts of the posterior region of the body. The left epigastric, which extends across the ventral side of the stomach, receives from that organ four or five branches, g^1; while the farther removed right epigastric receives only one or two branches from the stomach. Posterior to these gastric veins the epigastrics receive one or more veins, b, from the body wall and skin. Posterior, again, to the last-named, veins each epigastric receives, in the pelvic region, a large vein, the *iliac*, il, which receives, in turn, a vein from the pelvis, pl, and continues down the thigh and lower leg to the foot as the *femoral*, f, the chief vein of the posterior appendage.

After receiving small branches from the muscles of the thigh, the femoral receives near the knee a small branch from the posterior surface of the lower leg, fb, and a larger one, t, that leads from the anterior surface of the lower leg and foot.

The veins of the pes were so small, in the comparatively small animals it was necessary to use, that their distribution could not be determined with certainty, though they seemed to parallel very closely their corresponding arteries to be described below.

A short distance caudad to the iliac veins, each epigastric receives one or two fairly large branches from the pelvic region, called by Bronn the *ischiadic* veins, is. Caudad to the ischiadics and dorsal to the cloaca, each epigastric is united with a short but wide *renal portal* or renal advehente vein, rp, leading to the posterior border of its respective kidney and receiving, on the way, a short branch from the pelvic region, shown just cephalad to the references lines rt and rp.

Very close to its junction with the renal portals each epigastric gives off a small branch which unites with its fellow of the opposite side to form a median vein, rt, the *rectal* leading from the posterior part of the large intestine. A very short distance caudal to these last veins, in the region just dorsal to the anal opening, the epigastrics are formed by the division of the *caudal* vein, cv, which, of course, brings blood from the tail and is, on account of the large size of that organ, of considerable caliber.

The Anterior Venæ Cavæ and their Branches.

The entrance of the precaval veins into the heart was mentioned above; their branches, in order from the heart cephalad, will now be described. Since the two precavæ are alike, it will be necessary to describe the branches of only one side of the body. After leaving the heart, the precava may be traced forward, for a short distance, at the side of the trachea and œsophagus, as a wide, thin-walled trunk, fig. 2, vca. The first tributaries that it receives are the internal mammary and vertebral veins, which join it at the base of the neck at almost the same place.

The *internal mammary*, fig. 2, im, is a rather small vein, bringing blood from the ventral wall of the thorax. It may be followed along the inner surface of the ribs, near the sternum, in company with its corresponding artery.

The *vertebral vein*, fig. 2, v, is also of small diameter and extends to the dorsal body wall near the spinal column, from which region it returns blood to the anterior vena cava; it is drawn too large in the figure.

Just cephalad to the vertebral and internal mammary, the *internal jugular*, j, enters the precava. The internal jugular may be followed directly forward, close to the side of the trachea and œsophagus, from which it receives numerous branches. Near its point of entrance to, or rather exit from, the skull, it anastomoses, by two or three short branches, with the external jugular, ej, to be described later. Its distribution in the cranial cavity could not be determined in the available material. At the point of entry of the internal jugular the precava passes laterad for a short distance and then divides into two more or less equal branches, the above-mentioned external jugular, ej, and the subclavian, s, of which the latter will first be described.

The *subclavian*, s, of course, returns blood from the regions of the shoulder and arm. On reaching the body wall, where it might be called the *axillary*, ax, it receives, on its posterior side, a large *thoracic* vein, t, which returns blood from the thorax, shoulder, and skin. The thoracic receives a branch from the posterior surface of the arm, which might be called the *postbrachial*, pb; this postbrachial may be traced, as a rather small vessel, to the hand; at the elbow it is connected, by one or more small branches, with the brachial.

Just distal to the thoracic the axillary vein receives two fairly large vessels, the *subscapulars*, sc, that return blood from the shoulder and upper arm. After receiving the subscapulars, the axillary may be followed into the upper arm as the *brachial*, br. As has been said, the brachial and postbrachial anastomose near the elbow, and in this region the former receives a small vessel that extends parallel to it from the manus.

In the forearm the brachial may be called the *radial*, fig. 2, A, ra; on the back of the manus the radial receives branches from the various digits and from a rather complex plexus of vessels in the carpal region.

The *external jugular*, fig. 2, ej, after separating from the subclavian, may be traced cephalad, close beneath the skin, to the base of the skull, where it is connected with the internal jugular by short branches, as has already been noted. It receives several small branches from the skin and muscles of the neck and shoulder regions. At the region of its anastomosis with the internal jugular it receives a large branch, the *muscular*, ms, from the massive muscle at the angle of the jaw and from the skin of that region.

A short distance cephalad to the muscular the external jugular receives, on its mesial side, two or three branches from the trachea, larynx, and œsophagus, tr. Anterior to these vessels the external jugular is formed by the union of two chief veins, the *lingual*, l, from the ventro-lateral surface of the tongue, and the *inferior dental*, id, from the mesial surface of the lower jaw. The connection of the *superior dental* (extending along the bases of the maxillary teeth) with the jugular could not be determined with certainty, hence that vessel is not shown in the figure. The same is true of the small veins in the region of the cranium.

The Arterial System.

The Abdominal Aorta and its Branches.

The right and left aortic arches, fig. 3, Ao.d, Ao.s, arising from the heart in the manner already described, form a rather long loop and approach each other in the middorsal line. Here they are united by a short, wide connective in such a way that the left arch seems continued into the cœliac artery and the right into the dorsal aorta proper. Each arch, anterior to the connective, gives off two fairly large branches, oe, to the posterior region of the œsophagus.

The *cœliac* artery, fig. 3, c, is the largest branch of the abdominal aortic system. After giving off a couple of small branches, oe, to the posterior region of the œsophagus, it gives off a large *spleno-intestinal* artery, si, to the spleen and small intestine.

The cœliac then breaks up into three arteries of about the same size: the *gastro-hepatico-intestinal*, ghi, carrying blood to the stomach, liver, and small intestine; the *pancreo-intestinal*, pi, leading to the pancreas and small intestine; and the *gastric*, ga, to the greater part of the stomach.

From the *dorsal aorta* proper, da, which, as has been said, seems to be the direct continuation of the right aortic arch, several arteries are given off; these will be described as they occur in an anterio-posterior direction.

At about the point of union of the two aortic arches arises the most anterior of seven or eight pairs of *lumbar* arteries, lu 1–7; this first lumbar artery is continued cephalad for some distance as a longitudinal trunk that gives off several lateral branches to the walls of the thoracic region. The other six or seven lumbars are distributed to the dorsal body wall, and arise, at more or less regular intervals, as far caudad as the sacrum, or even back of that point.

The first large branch of the aorta is the unpaired *mesenteric* artery, m[1], which is given off in about the region of the fourth pair of lumbars; it carries blood through the mesentery to the greater part of the small intestine and also sends a small branch to the large intestine.

Posterior to the mesenteric, the aorta gives off four or five pairs of short arteries, the *urogenitals*, u 1–4, that lead to the nearby reproductive organs and kidneys.

About the middle region of the kidneys, a short distance anterior to the sacrum, is given off a pair of rather large arteries, called by Bronn the *ischiadicæ*, is[1]; each ischiadica, after giving off a couple of small branches to the back, passes laterad and divides into three main branches: (1[1]) to the ventral body wall, (3[1]) to the anterior border and deeper region of the thigh, and (2[1]) to the pelvis.

In the region of the sacrum is given off a pair of *iliac* arteries, il[1]. Each iliac is of about the same diameter as the ischiadica and gives off, soon after leaving the aorta, an artery, ab, that apparently leads chiefly to the abdominal muscles. Distal to the origin of the abdominal, the iliac gives off a small *pelvic* artery, pa, which leads, as the name would indicate, to the pelvis. The iliac then passes into the thigh, where it gives off several large branches and may be called the *sciatic*, sc. At the knee the sciatic gives off two rather small branches, one, the *fibular* artery, f[1], extends down along the posterior side of the lower leg; the other is parallel to the first and may be called the *tibial* artery, tb, since it extends along the anterior or tibial side of the shank. These two arteries give off numerous branches to the muscles of the lower leg. After giving off the fibular and tibial arteries, the sciatic passes, as a large vessel, through the lower leg, to which it gives but few branches, and may here be called the *crural* artery, cr. At the tarsus it divides rather suddenly and, perhaps, variably, into four chief branches, leading to the toes.

A short distance caudad to the origin of the iliacs the dorsal aorta gives off a pair of small *pelvic* arteries, pa[1], going to the muscles of that region. Caudal to these pelvis arteries is given off the unpaired *first hæmorrhoidal* artery, he[1], which divides into a *rectal*, rt[1], and a *cloacal*, cl, branch.

Caudal to the first hæmorrhoidal arises the *second hæmorrhoidal*, he[2]; also unpaired, leading to the cloaca.

Posterior to the second hæmorrhoidal, the aorta continues into the tail as the large *caudal* artery, ca.

The Anterior Arteries.

The origin of the great arterial trunks—the pulmonary, aortic arches, primary carotid, and right subclavian—has already been given and the distribution of the pulmonary arteries and aortic arches has been described, so that it now remains to describe the distribution of the right subclavian, fig. 4, Sc.d, and the primary carotid, capr.

The *right subclavian*, Sc.d., since it has an independent origin from the heart, instead of arising as a branch of the primary carotid, will be described first. After leaving the heart it passes cephalad and laterad and gives off the following branches in order, beginning at the heart: an *œsophageal* artery, oe, a small, caudally directed vessel carrying blood to the posterior region of the œsophagus. Close to the œsophageal arises another small, caudally directed vessel, the *pleural* artery, plu, extending to the pleura and possibly to the pericardium. From the same region as the preceding two arteries, but extending cephalad along the trachea and œsophagus, arises the much larger branch of the right subclavian, the right *collateralis colli*, cc, whose course and distribution will be described later.

Close to the distal side of the collateralis colli arises the very small *thyroid* artery, th, leading to the oval thyroid gland that lies against the ventral surface of the trachea a short distance anterior to the heart.

A short distance distal to the thyroid artery the subclavian gives off a fairly large artery, the *internal mammary*, im^1 (shown too large in the figure), that passes to the inner surface of the ribs near the sternum and lies parallel to the vein of the same name, described above.

A short distance distal to the internal mammary arises an artery of about the same diameter, the vertebral, v^1; it passes dorsad and caudad to the region of the thoracic vertebræ.

After giving off the five vessels just described, the subclavian artery passes into the shoulder where it divides into three main branches: (a) the *subscapular*, sc^1, going to the skin and muscles of the shoulder; (b) the *thoracic*, t^1, carrying blood to the posterior muscles of the shoulder and to the posterior region of the upper arm; (c) the *brachial*, br^1, which is really the continuation of the subclavian and is the chief artery of the anterior appendage.

After sending several branches to the upper arm the brachial divides, in the region of the elbow, into two main vessels, the *radial*, ra^1, and *ulnar*, ul^1, arteries, fig. 4, A. The radial artery, in the carpal region, divides in a complicated way into five main vessels that extend into the digits. The ulnar artery gives off several branches to the forearm, but apparently does not connect directly with the branches to the digits.

The *primary carotid*, capr. After leaving the heart, this very large vessel passes cephalad and laterad for some distance on the left side of the body and then gives off, from its anterior side, the large left subclavian artery, sc.s., to be described later. After giving off the subclavian artery, it makes a short loop, still further to the left, and then turns sharply mediad to pass to the head in the median plane directly dorsal to the œsophagus. Its distribution in the cervical and cephalic region will be described later. The mate to the œsophageal branch, oe (near heart), of the right subclavian which was mentioned above is apparently sometimes given off from the primary carotid near its base (as shown in fig. 4) and sometimes as a branch of the left pleural artery.

The *left subclavian* artery, sc.s., although it has a different origin, has the same branches as described in connection with the right subclavian. The exact order in which the first of these (the thyroid, th; the internal mammary, im^1; the collateralis colli, cc; the pleural, plu, and the vertebral, v^1) are given off is, as might be expected, subject to some variation.

The *collateralis colli*, cc (following Bronn's nomenclature), whose origin was noted above, will now be discussed; since the two are alike only one need be described. After leaving the subclavian, it passes cephalad, at the side of the trachea and œsophagus, in company with the internal jugular vein, so that in this part of its course it would seem to be the internal carotid artery. It gives numerous small twigs to the trachea and œsophagus, oe. In the region of the posterior part of the huge jaw muscle it is connected directly, x, with the adjacent branch, cm, (called by Bronn the common carotid) of the primary carotid, and indirectly, x^1, with a complicated group of branches from the common carotid. Cephalad to the connective x^1, which extends dorsad and is hence foreshortened in the figure, the collateralis colli gives off a small vessel, y (too large in fig 4), to the shoulder and skin; it then sends a fairly large branch, jm, into the large jaw muscle, close to which it now lies. Next a small branch, lg, is sent to the larynx. Continuing cephalad and laterad (in figure 4 it is drawn further to the side than it actually lies) for a short distance further, it divides into three branches: (1) a short twig, mg, that goes to the musk gland on the side of the mandible and to the skin of that region; (2) a large branch, the *mandibular*, md, that enters the large foramen on the mesial side of the mandible and extends in the cavity of that bone throughout its entire length; (3) the *lingual* artery, l¹, which, in turn, divides, some distance cephalad, into two branches, one extending along the lateral region, the other nearer the mid-ventral surface of the tongue. It is seen, then, that the collateralis colli arteries supply directly the lower side of the head—tongue, mandible etc.—though they may also send blood through the above-mentioned connectives to the brain and dorsal regions of the skull.

The *primary carotid*, capr, as was noted above, makes a curve to the left after leaving the heart and then passes back to the median plane, where it may be seen lying against the ventral side of the neck muscles and dorsal to the œsophagus; in this place it gives off a series of unpaired *cervical* arteries, fig. 4, ce, each of which almost immediately divides into an anterior and a posterior branch that carry blood to the cervical vertebræ. At the base of the skull, in the region where it is united by the first connective, x, with the collateralis colli, as described above, the primary carotid divides into two similar branches, called by Bronn the *common carotids*, cm. The distribution of these two vessels is symmetrical, so that only one need be described. While the collateralis colli, as has been said, carry blood chiefly to the tongue and lower jaw, the common carotids supply the cranium and upper jaw.

Soon after its formation by the division of the primary carotid, the common carotid is joined, as noted above, with the collateralis colli of that side by the connective x; since the common carotid and its branches all lie dorsal to the collateralis colli and its branches, the connectives x and x¹ extend in a more or less dorso-ventral direction. The two common carotids, almost completely surrounded by bone, in passing cephalad sweep first laterad then mediad, so that they together form almost a complete ellipse, as seen in figure 4; there is, however, no apparent connection between them at the anterior region where they lie so close together.

A short distance cephalad to the connective x the common carotid is connected laterally, z, with a rather complicated plexus of vessels lying at the base of the skull; it is through this plexus that the common carotid is connected with the collateralis colli by the second connective, x¹.

The short branch z quickly divides into three parts: (1) a small anteriorly directed vessel which may be called the *internal carotid*, ic, since it enters the skull through the most ventral of the three foramina in the exoccipital, and probably supplies the brain, though its further course could not be followed; (2) a somewhat larger posteriorly directed artery, oc, going to the muscles at the occipital region of the skull; (3) a short laterally directed stem, z^1. The last-named branch, z^1, in turn, leads in three directions: (a) to the collateralis colli artery through the connective x^1; (b) a short anteriorly directed vessel, e, that passes into the skull, possibly to the ear, through the large foramen that lies between the exoccipital and quadrate bones; it gives off a small twig, q, to the muscles in the region of the jaw articulation (quadrate); (c) the main stem of the branch z continues laterad and cephalad as one of the chief arteries, z^2, to the anterior region of the skull, giving off a fairly wide branch, jm^1, to the large jaw muscle, and then two branches, o^1 and o^2, to the lateral surface of the eyeball and socket; it then anastomoses, just cephalad and laterad to the eye, with the forward continuation, cm^1, of the corresponding main stem, cm, of the common carotid, already mentioned. The vessel cm^1, after almost meeting its fellow in the middle line, passes cephalad and laterad across the ventral surface of the eye to the union, above mentioned, with the lateral branch, z^2; at the posterior-mesial border of the eye it gives off a branch that divides into two twigs, one, o^3, for the posterior eye muscles, and one, e^1, to the region of the ear and the top of the skull.

At the point of union of the branches cm^1 and z^2 a sort of simple plexus may be formed from which two vessels, n, pass to the posterior nasal region, and two vessels pass forward along the side of the upper jaw. Of the latter two vessels one, which may be called the *inferior dental* of the maxilla, dm, is very small and extends along the maxilla to its very tip, at the base of the teeth and ventral to the palatine bone; the other, which is larger and may be called the *superior dental* of the maxilla, dm^1, extends cephalad along the mesial side of the maxilla, dorsal to the palatine bone; it sends numerous twigs into the maxillary bone among the roots of the teeth. After passing nearly to the end of the snout, the superior dental, dm^1, suddenly forms a loop towards the median line and passes as a straight branch, n^1, directly caudad, near and parallel to the median plane. The branch n^1 extends along the floor of the nasal cavity and, after giving off twigs to this chamber, ends in a network of vessels, o^4, on the anterior surface of the eyeball and socket.

A pair of very small arteries, n^2, may be seen in the nasal chamber between and parallel to the branches, n^1; they lie close to each side of the nasal septum and supply the anterior nasal region. They apparently arise, as shown by the broken lines, from the loop of the superior dental artery, dm^1, though this could not be definitely determined.

LETTERING.

Ao.s., Ao.d., left and right aortic arches.
ab, abdominal artery.
ax, axillary vein.

b, veins from body wall.
br, brachial vein.
br^1, brachial artery.

c, cœliac artery.
ca, caudal artery.
capr, primary carotid.
cc, collateralis colli artery.
ce, cervical artery.
cl, cloacal artery.
cm, cm^1, common carotid artery.
cr, crural artery.
cv, caudal vein.

da, dorsal aorta.
dm, inferior dental artery of maxilla.
dm^1, superior dental artery of maxilla.

e, e^1, artery into skull, perhaps to ear.
ej, external jugular vein.
ep, internal epigastric vein.
f, femoral vein. f^1, fibular artery.
fb, fibular vein.

g, gastric vein of portal.
g^1, gastric vein of epigastric.
ga, gastric artery.
ghi, gastro-hepatico-intestinal artery.

h, hepatic portal vein.
he^1, he^2, hæmorrhoidal arteries.

i, intestinal vein.
ic, internal carotid artery.
id, inferior dental vein.
il, iliac vein.
il^1, iliac artery.
im, internal mammary vein.
im^1, internal mammary artery.
is, ischiadic vein.
is^1, ischiadic artery.

j, internal jugular vein.
jm, jm^1, artery to jaw muscle.

l, lingual vein.
l^1, lingual artery.
lg, laryngeal artery.
lu, 1–7, lumbar arteries (numbers on left side of figure).

m, mesenteric vein.
m^1, mesenteric artery.
md, mandibular artery.
mg, artery to musk gland.
ms, muscular vein.

n, artery to posterior nasal region.
n^1, artery to anterior and mid-nasal region.
n^2, artery to anterior nasal region.

o^1–o^4, arteries to eye.
oc, artery to muscles at base of skull.
oe, œsophageal arteries.

pa, pelvic artery.
pa^1, second pelvic artery.
pb, post brachial vein.
pc, post cava.
pd, right pulmonary artery.
pi, pancreo-intestinal artery.
pl, pl^1, pelvic vein.
plu, pleural artery.
ps, left pulmonary artery.

q, artery to muscle at angle of jaw.

ra, radial vein.
ra^1, radial artery.
re, reproductive vein or artery.
rp, renal portal vein.
rt, rectal vein.
rt^1, rectal artery.
rv, renal vein.

sc, sciatic artery (fig. 3).
s, subclavian vein.
sc, subscapular vein (fig. 2).
sc^1, subscapular artery.
sc.d., sc.s., right and left subclavian arteries.
si, spleno-intestinal artery.
sp, splenic vein.
s.v., sinus venosus.

t, thoracic vein.
t^1, thoracic artery.
tb, tibial artery.
th, thyroid artery.
tr, tracheal vein.

u, 1–4, urogenital arteries (numbers on right side of figure).
ul^1, ulnar artery.

v, vertebral vein.
v^1, vertebral artery.

vca, anterior vena cava.
vh, hepatic vein.
vpd, vps, right and left pulmonary veins.

x, x^1, connectives between collateralis colli and carotid.

y, artery to shoulder and skin.

z, z^1, z^2, branches of common carotid.
1^1, 2^1, 3^1, branches of ischiadiac artery.

EXPLANATION OF PLATE XIII.

For lettering to all figures see above.

Fig. 1.—The veins of the posterior region of the Florida alligator. The postcaval system and its associated veins are shown in the main figure; the hepatic portal system is shown in the smaller figure to the left.
Fig. 2.—The veins of the anterior region of the Florida alligator. The veins of the left foreleg are shown at A.
Fig. 3.—The arteries of the posterior region of the Florida alligator.
Fig. 4.—The arteries of the anterior region of the Florida alligator. The arteries of the left foreleg shown at A.

THE METHOD OF PROGRESSION IN TRUNCATELLA.

BY HENRY A. PILSBRY AND AMOS P. BROWN.

Early in August of 1913, when one of us (Brown) was collecting fossils along the shores of Willoughby Bay, Antigua, upon turning over a piece of limestone a few feet above high-water mark, he came across a colony of *Truncatella bilabiata* Pfr. They were very plentiful under the slab, and those that were not disturbed by the lifting of the stone were seen to be in motion. Others at once retracted the body into the shell along with the operculum and assumed the appearance of dead shells. On observing those that continued to move it was at once noticed that they do not employ the same method as the rapidly moving *Colobostylus* and *Tudora* already observed in Jamaica, nor that of the *Cistula* observed in Antigua, but seem to adopt the method of the "measuring worm" in their progression. A number of the shells with the living animal were collected in a specimen bottle, and upon returning to the town of St. John's they were kept under observation for some time. In fact, upon returning to Philadelphia some weeks later, most of them were still quite lively and moved about actively. It was from these survivors that the figures were drawn. Before leaving St. John's, notes upon the method of motion were made. These observations were repeated in Philadelphia.

When disturbed or startled, the animal at once withdraws into the shell and closes the opening by the operculum, which in fact is drawn in beyond the lip. They then resemble pieces of stone or fragments of dead leaves, and without close observation they would escape notice. After they are left to themselves for a short time, the animal protrudes the operculum, with the foot and proboscis, which latter at once begins to feel about until it encounters some firm substance, when the foot is fully protruded. The foot is a squarish pad of about 1 square millimeter in area. The proboscis may be extended to 1½ mm. or more. It is waved to and fro until it encounters the surface over which the animal moves, bending downward at the same time and presenting in front view a certain ludicrous resemblance to the head of a moose, which resemblance is enhanced by the blunt expanded snout of the proboscis and by the tentacles, which are in the position of the ears of the moose. The foot, when fully protruded, is attached firmly to the surface moved over; the proboscis is then raised and waved about again, and crawling commences. The progression begins by a stretching forward of the proboscis, its tip is then applied to the surface moved over, and this tip flattens out until nearly the size of the foot. If the proboscis secures a firm attachment, the foot may now be released, and either drawn up to the attached proboscis by sliding the edge of the foot along the surface, or the entire animal may be supported upon the proboscis and the foot raised clear of the surface and drawn up to the proboscis, when its edge will rest on the surface moved over. Perhaps more often the foot is raised anteriorly and slid forward upon its posterior edge up to the attached proboscis; the position assumed by the body of the animal being now the same as when it is retracted into the shell. Starting from this position, the method of progression may be described as follows: The square pad of the foot is turned down anteriorly until it is firmly attached to the surface moved over, simultaneously the attachment of the proboscis is released and this is moved to find another attachment; as soon as this is found the firm attachment of the proboscis is effected again; then the entire shell is hitched forward as the foot is lifted and brought up in contact with the under side of the proboscis. In case the foot is lifted clear of the surface moved over, the posterior edge of the foot touches the surface first; if not lifted clear of the ground, this edge is slid or dragged over the surface until the foot comes up to the under side of the proboscis. Its posterior edge is then applied to the ground, and, as the proboscis is loosened and raised, the foot turns down until it is firmly in contact with the ground, and the waving about of the proboscis and its final attachment proceeds as before.

The entire cycle of movements comprising the "step" is executed in four seconds or less, so that the animal will make 15 to 17 "steps" in a minute when advancing steadily in one direction; and in these 15 to 17 "steps" it will have moved over 20 to 25 mm. of surface. But it frequently happens that the proboscis does not secure a firm attachment, and, when the step is attempted, the proboscis slides back to the foot and the body is not advanced at all. The proboscis is then raised and waved about, another "step" is attempted, and generally succeeds. The animal may thus move forward in a straight line or it may take quite an erratic course. The shell sometimes rests upon the operculum, sometimes it is simply dragged along the ground; and it is jerked forward when the foot is raised, sometimes supported upon the operculum, but quite as often not. The muscles controlling the movement of the foot and of the proboscis can evidently act quite independently of each other.

The external soft parts of *T. bilabiata* are very pale cartridge buff. There is an ill-defined, flesh-tinted spot on the proboscis, caused by some colored body, perhaps the radula and its sack, shining through. The proboscis has faint annular wrinkles.

Compared with other land operculate snails we have seen alive, *Truncatella* is remarkable for the small size of the foot and the extraordinary development of the proboscis.

The terrestrial prosobranch gastropods show a good deal of diversity in dealing with the problem of progression on a dry surface. The *Cyclophoridæ* glide, like aquatic tænioglossate forms. The *Ericiidæ* move by the forward translation of vertical folds, alternating on the two sides of the foot, while the *Truncatellidæ* step. The gait of *Pomatiopsis lapidaria* is intermediate between the step and the glide, and serves to show how the gait of *Truncatella* was probably evolved. The proboscis and oral disk are used exactly as in *Truncatella*, but the foot moves by gliding or sliding, first the fore part moving forward to the proboscis, then the back part.

Explanation of Plate XIV.

Fig. 1.—*Truncatella bilabiata*. Proboscis and foot both in contact with ground, the front part of foot being raised preparatory to forward movement.

Fig. 2.—Near the end of the forward step of the foot, the shell trailing far behind.

Fig. 3.—End of the forward step of proboscis, the shell trailing far in the rear. This position is slightly anterior to that shown in fig. 1.

Figs. 4, 5.—*Segmentina obstructa geoscopus*, n. subsp.

Fig. 6.—*Truncatella bilabiata*. End of forward step of the foot, the shell pulled forward. This position is slightly later than that shown in fig. 2.

LIST OF LAND AND FRESH-WATER MOLLUSKS OF ANTIGUA.

BY HENRY A. PILSBRY AND AMOS P. BROWN.

The material for this list was collected by one of us (A. P. B.) during August, 1913. Several species were supplied by Mr. W. R. Forrest, to whom we are also indebted for specimens from Barbuda, Anguilla, and other islands.

ERICIIDÆ.

Cistula antiguensis Shuttl.

Willoughby Bay; Wetherill's Bay.

TRUNCATELLIDÆ.

Truncatella bilabiata Pfr.

Willoughby Bay.

AMNICOLIDÆ.

Potamopyrgus coronatus crystallinus (Pfr.)

HELICINIDÆ.

Helicina crosbyi A. P. Brown.

Pleistocene of St. George's Church and Hodge's Bay. It is somewhat remarkable that *Helicina* has not been found living on Antigua. See these PROCEEDINGS for 1913, p. 612, pl. xix, figs. 1, 3, 8.

HELICIDÆ.

Pleurodonte formosa (Fér.).

Hills above Willoughby Bay, St. Philips Parish; also hills above St. Mary's Rectory. Near Hodge's Point and near St. George's Church (Pleistocene). (Also from Barbuda.)

The only places where *P. formosa* was seen living were two, namely, in the southeastern part of the island, in the hills above Willoughby Bay, St. Philip's Parish; and in the southwestern part of the island, near St. Mary's Rectory. It appears to be arboreal in habit now, though perhaps descending to the ground to deposit eggs. No doubt it is found living among the hills all through the southwestern corner of the island; this portion is still fairly well covered with woods and affords good cover. While found fossil in the northern and northeastern portions, as at Hodge's Bay on the north shore and at St. George's Church along the eastern shore, the probability is that the species is extinct in this portion of the island, as all the woods have been cut, thus destroying the natural cover. The northwestern portion of the island is wooded in the vicinity of Wetherill's Bay, but the woods are probably only of recent growth and no recent specimens of this species were found there. In the southwestern portion, in St. Mary's Parish, living specimens are found mainly on the "loblolly" trees (*Pisonia subcaudata*); although the woods are sufficiently dense to afford moist conditions in many places. In the less wooded (and hence arid) parts of St. Mary's the specimens are also found living in the trees. In the region of Willoughby Bay, Parish of St. Philip, the conditions are still more arid, and living specimens were seen only on the trees. The "wild pines" (*Bromeliaceæ*) seem to be the places where the living mollusks are most certainly to be met with. These epiphytes, containing as they do in the axils of their leaves the only water commonly to be found on these dry hills, are evidently resorted to by the mollusks for their supply of moisture; and it is the presence of these "wild pines" with their constant supply of moisture that has tempted the *P. formosa* to acquire an arboreal habit and pass from ground forms to a more or less arboreal life.

Thysanophora subaquila (Shuttl.).

Wetherill's Bay.

BULIMULIDÆ.

Bulimulus guadalupensis (Brug.).

Wetherill's Bay; Marble Hill, 2 miles north of St. John's; Montpelier, St. Philip.

Drymæus elongatus (Bolt.).

St. George's Church. (Also Anguilla and Barbuda.)

ACHATINIDÆ.

Subulina octona (Brug.).

Public Cemetery, St. John's; Wetherill's and Willoughby Bays; Marble Hill.

Opeas micra (Orb.).

Wetherill's Hill; Marble Hill.

Opeas gracile (Hutt.).

Marble Hill.

Opeas beckianum (Pfr.).

Antigua, special locality not noted.

SUCCINEIDÆ.

Succinea barbadensis Guild.

Cemetery, St. John's; Marble Hill; also a Pleistocene fossil.

PUPILLIDÆ.

Pupoides marginatus (Say).

Bifidaria servilis (Gld.).

AURICULIDÆ.

Melampus coffea (L.).

Tralia pusilla (Gmel.).

PLANORBIDÆ.

Planorbis guadalupensis Sowb.

St. Philip.

Planorbis lucidus Pfr.

Antigua.

Planorbis cultratus Orb.

Antigua.

Segmentina obstructa geoscopus n. subsp. Pl. XIV, figs. 4, 5.

The shell is olive-buff, very glossy, having fine growth-lines and very faint spirals. *Last whorl very deeply descending at the end,* bringing the aperture nearly to the horizontal plane. Teeth visible in the mouth, one-fourth to one-third of a whorl from the aperture. Major parietal lamella sigmoid. Alt. 2.1, diam. 6.7 mm.

Type and cotypes 109,160 A. N. S. P..

PHYSIDÆ.

Physa rivalis (M. and R.).

St. Philips.

THE EVOLUTION OF SARCOCYSTIS MURIS IN THE INTESTINAL CELLS OF THE MOUSE.

(PRELIMINARY NOTE.)

BY HOWARD CRAWLEY.

As long ago as 1903, Minchin (1903, p. 308), speaking of the Sarcosporidia, observes that "there is still much to be made out about these interesting parasites, and the field is one ripe for investigation."

Since that time it cannot be said that our knowledge of the group has been materially increased. A number of papers on the Sarcosporidia have indeed been published, but these have been concerned with the character of the spores and cysts rather than with any attempts to elucidate the life history of this group of the Protozoa. The exception is a contribution by Erdmann (1910, p. 377), the results of which are summed up and commented upon by Minchin (1912, pp. 421, 422) as follows:

> "According to Erdmann, the spore germinates in the intestine of the new host, and the first act in the process is the liberation from the spore of its toxin, sarcocystine, which causes the adjacent epithelium of the intestine to be thrown off. At the same time an amœbula is set free from the spore; and, owing to the intestine being denuded of its lining epithelium, the amœbula is able to penetrate into the lymph-spaces of the submucous coat and establish itself there. Before this happens, however, the metachromatinic grains of the spore disappear, and it is suggested that this disappearance is related to the secretion of the sarcocystine, and that the toxin is contained in the metachromatinic grains. If, however, a polar capsule be discharged during the germination of the spore, as in other Cnidosporidia, it might well be that the toxin is contained in the polar capsule and is set free by its discharge, like the poison in the nematocysts of the Cœlentera. However that may be, it would appear as if the sarcocystine were a weapon, as it were, the function of which is to facilitate the invasion of the germ, the amœbula, by destroying the lining epithelium of the gut.
>
> The liberation of the amœbula from the spore initiates the first period of the development, which is passed in the lymph-spaces of the intestine, and which lasts, according to Erdmann, some twenty-eight to thirty days. Analogy with other Neosporidia would lead us to identify this with the planont-phase, initiated, possibly, by sexual processes between different amœbulæ and subsequent active multiplication. The second period of the development begins with

the penetration of the amœbula into a muscle-fiber, in which the parasite grows into a Miescher's tube and forms spores."

The present writer has for some time been in possession of material which illustrates the earlier stages of the cycle of *Sarcocystis muris* in the mouse, but sufficient time has not been available completely to work out this cycle in all of its details. Since, however, Erdmann's conclusions are largely erroneous, and since, moreover, they are becoming incorporated into general works on the Protozoa, it has been considered desirable to publish a brief notice giving the essential facts discovered, which are of considerable theoretical interest. A short note bearing on this matter was published in *Science* (1913, n. s., v. 37, p. 498) last year, but this did not touch upon the more important of the discoveries made.

As stated in the note which appeared in *Science*, the spore when in the lumen of the intestine of the mouse does not set free an amœbula, since it is itself a naked mass of protoplasm. What actually takes place is that the spore, when in the intestine of the mouse, becomes endowed with the ability to display very energetic twisting and boring movements, by virtue of which it forces its way into a cylinder cell of the intestinal epithelium, and there comes to rest. This takes place within 2½ hours after the infecting feed, and possibly much earlier.

The typical spore of *Sarcocystis muris*, which has been figured a number of times in the literature, is a banana-shaped organism about 12μ long. Spores of this sort are found both free in the lumen and in the cylinder cells in mice killed and examined at appropriate periods after the inoculative feed. Besides these, however, others occur, such as are shown in Plate XV, figs. 1 and 2. These are oval bodies, generally about half as long as the typical spore. The cytoplasm has a considerable affinity for chromatin stains and consists of a dense spongioplasm. The nucleus is vesicular and more conspicuous than it is in the typical spores. It apparently always contains either a feebly developed nuclear net (fig. 3) or a karyosome or both, but these last-named structures require heavy staining for their demonstration, and in moderately or lightly stained material the appearance is as shown in figs. 1 and 2.

Figures 2 and 3 represent conditions found in a mouse killed about 2¼ hours after feeding. Since, however, the spores in the lumen of the intestine of this mouse are in precisely the same state as those illustrated in fig. 2, the presumption is that these latter have only been in the cells a very short time. Moreover, the intracellular parasites both in $2\frac{1}{4}$- and $3\frac{1}{4}$-hour stages have, at least in a certain proportion of cases, undergone conspicuous changes. These changes consist in a gradual diminution of the quantity of cytoplasm, which seems either largely or completely to disappear, while concommitantly there is an increase in size and complexity of the nucleus. There is in this way produced a parasite such as is shown in fig. 4, which, so far as both its history and appearance go, is only the nucleus of the original spore. The stage here represented is especially characteristic of the period about six hours after feeding. It may, however, be stated that it is not certain that all of the parasites which invade the cells suffer this loss of the cytoplasm.

In mice killed nine hours after feeding, this same stage (as shown in fig. 4) may also be found, but it is no longer abundant. This period in the evolution of the parasite, that is, nine hours after feeding, is characterized by a great variety of conditions, of which the majority are difficult to interpret. But by this time it has become evident that the parasites are separating into two categories, which become more and more sharply differentiated as time passes, and which reach their full culmination at the end of 18 hours. The end products of these two lines of evolution are shown in figs. 9 and 11, and the interpretation placed upon them is that they are respectively males and females.

The male elements appear to arise from forms like that shown in fig. 4. These, which apparently consist of only the nucleus of the original spore, show a karyosome, and a nuclear net which here and there supports little aggregates of chromatin. Later stages (fig. 5) show a greater quantity of chromatin, but the karyosome has disappeared. Figure 5 is to be taken merely as representing one of a number of forms which, while differing greatly in detail, agree in that each possesses a nuclear net which supports a quantity of chromatin. In some cases the chromatin occurs in a much coarser form than that shown in fig. 5, whereas in others it is present in very minute granules distributed throughout the entire extent of a finely meshed net.

Eventually, however, a stage is reached such as is shown in fig. 7. This consists of an oval body with a stringy matrix and a row of granular aggregates arranged around the periphery. These granular aggregates become more and more compact until finally they come to consist of solid, round balls of deeply staining chromatin (fig. 8). These balls, in their turn, elongate and transform themselves into bodies such as are shown in fig. 9, which can scarcely be other than microgametes. As seen in sectioned material, the microgametes are from 2 to 2.5 microns long, with both ends pointed, but one noticeably broader than the other. They are characterized by an intense affinity for chromatin stains. Stages such as these may occur as early as nine hours, but it is not until later that they become abundant. They reach their full development at the end of 18 hours, and, so far as my studies have yet gone, are no longer present at the end of 24 hours.

It is only in their later developmental phases that the females can be picked out with any certainty. They are illustrated in figs. 10 and 11, which show oval elements containing a vesicle in which is a chromatin body. In the 18-hour stage all of the parasites present, with a certain exception to be noted below, are either in the condition shown in figs. 7, 8, and 9, or that shown in figs. 10 and 11. As was stated above, however, the parasites taken to be early male stages were apparently only nuclei, since if any cytoplasm were present it was reduced to an extremely fine peripheral film. This conclusion was based not only upon the history of these bodies, but also upon their appearance. On the other hand, the bodies shown in figs. 10 and 11 have all the appearance of complete cells, with a considerable bulk of cytoplasm. It may then be that from the very outset some of the parasites retain a part or the whole of their cytoplasm, these being destined to produce the macrogametes. This surmise receives a certain amount of support from what is seen in fig. 6. This parasite appears to have retained at least the greater part of its cytoplasm. But we have here the representative of a condition found nine hours after feeding, whereas the loss of cytoplasm on the part of those parasites which suffer this deprivation may be completed as early as 2½ to 3 hours. It may then be suggested that fig. 6 represents an early female stage, and if this be so it would follow that the females retain most if not all of their cytoplasm. It may also be noted that in the periods from 9 to 18 hours parasites which are clearly females show phenomena which suggest maturation.

Finally, in the 18-hour period there is to be found the condition illustrated in fig. 12. This shows a parasite in all respects like figs. 10 and 11 except for the presence in the cytoplasm of a sharply staining chromatin body. It does not seem unreasonable to look upon this as a microgamete which has fertilized the macrogamete.

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EXPLANATION OF PLATE XV.

The figures were in all cases made by the author from camera outlines, and later copied in ink by Mr. Haines, artist of the Bureau of Animal Industry. The optical system consisted of a 2-mm. apochromatic objective and No. 18 compensating eyepiece, yielding a magnification of about 3,530 diameters. In reproduction the drawings have been reduced in the ratio of 3 to 2, and hence are about 2,350 times larger than the actual object.

Fig. 1.—Shortened spore free in the lumen of the intestine. Two to two and one-half hour period. Giemsa stain.

Fig. 2.—Spores in the cylinder cells of the host. Two to two and one-half hour period. Giemsa stain.

Fig. 3.—Spore in a cylinder cell of the host. Two to two and one-half hour period. Wright's stain.

Fig. 4.—Form from which the males are supposed to arise. Taken from a nine-hour period. Delafield's hæmatoxylin and eosin.

Fig. 5.—Supposed early male stage. Nine-hour period. Iron hæmatoxylin and acid fuchsin.

Fig. 6.—Supposed early female stage. Nine-hour period. Iron hæmatoxylin and acid fuchsin.

Fig. 7.—Microgametocyte with granular nuclei. Eighteen-hour period. Wright's stain.

Fig. 8.—Microgametocyte with solid nuclei. Taken from a mouse killed nine hours after feeding, in which this stage is very rare. Iron hæmatoxylin and acid fuchsin.

Fig. 9.—Microgametocyte in which the microgametes are fully ripe. Eighteen-hour period. Wright's stain.

Fig. 10.—Macrogamete. Seventeen-hour period. Iron hæmatoxylin and acid fuchsin. Stages such as this are more commonly found in the subepithelial spaces than in the cells themselves.

Fig. 11.—Macrogamete. Eighteen-hour period. Wright's stain.

Fig. 12.—Supposed fertilization. Eighteen-hour period. Wright's stain. Parasites showing the supposed fertilization were not found in the cells themselves, but in the spaces beneath the epithelium.

NOTICE OF A RARE ZIPHIOID WHALE, MESOPLODON DENSIROSTRIS, ON THE NEW JERSEY COAST.

BY ROY CHAPMAN ANDREWS.

The Academy of Natural Sciences of Philadelphia has been fortunate in securing the skeleton of a rare Beaked whale, *Mesoplodon densirostris* (Blainville), taken at Corson's Inlet, N. J., June 18, 1913, by Henry W. Fowler and Wm. J. Fox. This specimen makes possible the first positive identification of this animal on the American coast and, since it has hitherto been known only from the seas about Australia and the Indian Ocean, gives important evidence as to the extensive range of the species.

In 1906, Dr. Glover M. Allen,[1] reported upon a young female Beaked whale found dead on the coast at Annisquam, Mass., in August, 1898, the skeleton of which was secured for the Boston Society of Natural History by Prof. Alpheus Hyatt. Dr. Allen referred this specimen to *Mesoplodon bidens* (Sowerby) and gave a description of the skeleton and external anatomy so far as the latter was known. Some years later Dr. F. W. True[2] restudied the specimen, the skull of which is somewhat injured, and decided that it probably represented *Mesoplodon densirostris* (Blainville). In concluding his discussion of this specimen, Dr. True remarks: "Although with such scant material it is not possible to determine satisfactorily the identity of this third species of *Mesoplodon* in the North Atlantic, represented by the Annisquam specimen, I feel convinced that that specimen does not belong to *M. bidens* and that there is a strong probability that it belongs to *M. densirostris.* It is true that the latter species has been found hitherto only in the Indian Ocean and about Australia, but we know so little about the distribution of the ziphioid whales that, in my opinion, that circumstance by itself should not be given very great weight." (*l.c.*, p. 11).

A comparison of the New Jersey whale with the beautiful figures of the skull of *M. densirostris* given by Van Beneden and Gervais

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[1] *Am. Naturalist,* Vol. 40, 1906, pp. 357–367.

[2] An Account of the Beaked Whales of the Family Ziphiidæ in the Collection of the United States National Museum. *U. S. Nat. Mus., Bull.* 73, 1910, pp. 9–11.

in the *Ostéographie des Cétacés,* Plate XXV, demonstrates that it is certainly referable to that species. It also shows the distinctive characters of the rostrum and other parts of the skull present in the Massachusetts skeleton and leaves little doubt that Dr. True's identification of the latter with *M. densirostris* is correct. The New Jersey specimen thus definitely introduces *Mesoplodon densirostris* into the North American fauna.

I have to thank Mr. Henry W. Fowler for the privilege of examining and reporting upon this specimen and to congratulate the Academy upon its acquisition.

It is desirable to give a brief description of the exterior and skeleton as well as figures of certain bones since the osteology of the species, other than the skull, is rather imperfectly known.

Mr. Fowler has furnished the following notes upon the external characters of the specimen: "In color the skin was mostly uniform blackish, smooth and shining. About the head and jaws, below, and irregularly along the ventral surface medianly, were livid pale areas sometimes with very faint bluish tints. Afterward various parts of the body became somewhat reddish in tint due to decomposition going on. The flukes of the tail and the dorsal and pectoral fins were entirely black.

"This whale had been dead but a very short time when discovered, and had evidently been struck with some object, possibly a harpoon, on the side of the neck.

"It has also bled a little at the mouth as may be seen from the photograph (this wrongly suggesting the corner of the mouth). The photograph does not give a good idea of the greatly elevated gums of the lower jaw. . . . . No barnacles or parasites of any kind were found in, or on, this specimen. The stomach was full of undetermined organic material. The whale was 14 feet 5 inches long and 4 feet in circumference."

The skeleton shows that the individual from which it was taken, although not old, was fully adult, for the mesorostral cartilage is thoroughly ossified and all the epiphyses are firmly ankylosed to the vertebral bodies.

The skulls of the Massachusetts and New Jersey specimens agree closely in all important particulars, the only noticeable difference being in the absence in the former of the maxillary tubercle between the anteorbital notch and the base of the rostrum. This is supposedly a character of age, but is even less developed in the adult specimen figured in the *Ostéographie des Cétacés.*

In both the Massachusetts and New Jersey skulls the large foramina in the maxillæ are almost opposite those in the premaxillæ, while in the *Ostéographie* figure the former are considerably in advance of the latter.

The peculiar characters of the skull which distinguish *M. densirostris* are the deep rostrum and the depth and shape of the rostral portion of the premaxillæ; the large, forwardly directed foramina in the maxillæ which connect with the grooves on either side of the rostrum; the appearance of the malar in the bottoms of the anteorbital notches; the large palatines which entirely surround the pterygoids; the trifoliate foramen magnum and the mandible, each ramus of which is greatly swollen in the region of the single triangular tooth.

The skeleton has the following vertebral formula:

C	D	L	Ca		
7	10	11	16	=	44

Certainly one, and possibly two, of the terminal caudal vertebræ are missing, so that the correct formula should probably be:

C	D	L	Ca		
7	10	11	18	=	46

A skeleton of this species from the island of Lord Howe, Australia, has the following formula, according to Van Beneden and Gervais:

C	D	L	Ca		
7	10	11	17	=	45

This whale measured 15 feet 9 inches in length, while the New Jersey specimen was 14 feet 5 inches long.

Allen gives the number of vertebræ in the Massachusetts skeleton as 45, but says it has only nine pairs of ribs, while both others have ten pairs. It is probable that the terminal pair in Allen's specimen may have been lost, as Cetacean skeletons are so frequently deficient in this respect.

The first three cervical vertebræ of the New Jersey whale are solidly ankylosed, but the remaining four are free.

The dorsal and lumbar vertebræ have the thigh, thin spines and short transverse processes so characteristic of the Ziphioid whales.

Nine chevrons are present, but the first and penultimate members of the series seem to be lacking, and I believe that eleven is the normal number.

There are ten pairs of ribs, the first seven on each side articulating by means of a neck and head and the posterior three having only the tubercles; the terminal rib is very slender.

The sternum consists of four segments showing no tendency, as yet, toward ankylosis. The most anterior is concave above with a well-defined median carina below; the three remaining segments are flat with a median notch in both the anterior and posterior borders.

The sternum agrees well with that of the Massachusetts specimen figured by Allen except that the first segment of the New Jersey sternum is a little differently shaped and is much more deeply notched than in the former. This difference has no significance.

The scapula is widely fan-shaped, has a long, thin acromion curved inward and slightly upward, and a straight narrow coracoid directed somewhat upward and almost as long as the acromion.

The scapula resembles that of *Mesoplodon bidens* figured in the *Ostéographie des Cétacés*, Pl. XXII, fig. 2.

Several of the phalanges from each manus have been lost and, consequently, the correct formula cannot be given.

Explanation of Plates XVI, XVII, and XVIII.

Plate XVI.—*Mesoplodon densirostris;* drawing from nature by Mr. Henry W. Fowler.

Plate XVII.—Fig. 1.—Superior view of skull of *M. densirostris.*
Fig. 2.—Inferior view of skull of *M. densirostris.*
Fig. 3.—Lateral view of skull of *M. densirostris.*

Plate XVIII.—Fig. 1.—Sternum of *M. densirostris.*
Fig. 2.—Scapula of *M. densirostris.*
Fig. 3.—First lumbar vertebra of *M. densirostris.*
Fig. 4.—First three cervical vertebræ of *M. densirostris.*
Fig. 5.—First caudal vertebra of *M. densirostris.*
Fig. 6.—First dorsal vertebra of *M. densirostris.*
Fig. 7.—Right ramus of mandible of *M. densirostris.*

DATA ON THE ORTHOPTERAN FAUNISTICS OF EASTERN PENNSYLVANIA AND SOUTHERN NEW JERSEY.

BY HENRY FOX.

In the period from 1908 to 1912, inclusive, I collected Orthoptera extensively in various parts of the area here under consideration, spending as much time in the field as I could spare from other duties. During that time I accumulated data on the regional and habitat distribution of various species of *Acrididæ* and *Locustidæ,* which, although admittedly incomplete, suggest at least the general lines along which the study of such problems may ultimately be developed. In this study I endeavored to ascertain, in the first place, the exact areal distribution of each species and, secondly, the kind of environment in which it normally or prevailingly occurs.

The present paper is based upon the results of my own field observations, but to make it as complete as possible I have freely availed myself of all available sources of information and have frequently included data gathered by others, due acknowledgment of which I have endeavored to make in every case. In this connection I have found the distributional data given in the new N. J. State Report on insects[1] especially valuable. I am also under obligations to Mr. James A. G. Rehn and Mr. Morgan Hebard for generously placing their local collections and those of the Academy of Natural Sciences of Philadelphia at my disposal and for permission to use the data so obtained.

Witmer Stone, in his splendid work on the plants of southern New Jersey,[2] remarks on the incongruity of finding a southern flora and fauna by going eastward, as may be done in the vicinity of Philadelphia. The same incongruity is exemplified by the Orthoptera which in southern New Jersey are predominantly of austral aspect, whereas those of eastern Pennsylvania are mostly of transition types.

As is well known, the region included in the present study includes

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[1] Annual Report of the New Jersey State Museum, including a Report of the Insects of New Jersey, 1909, pp. 177–190.

[2] Annual Report of the New Jersey State Museum, including a Report of the Plants of Southern New Jersey, with Especial Reference to the Flora of the Pine Barrens, 1910.

parts of two great physiographic provinces, the Piedmont Plateau and the Coastal Plain. These correspond, as Stone has clearly shown in the work already cited, respectively to the Transition and Upper Austral biotic zones of Merriam. The dividing line between two is accordingly the "fall-line" which marks the line along which the hard rocks of the Piedmont Plateau meet the soft and incoherent deposits of the Coastal Plain.

Without a more detailed knowledge than we actually possess of the life history and of the developmental and growth requirements of Orthoptera, it is impossible at present to give a full causal explanation of the observed differences between the Orthopteran faunas of the Piedmont Plateau and Coastal Plain. Merriam regards temperature as the controlling factor, and he is probably right if by temperature he means the temperature of the medium in which the organism undergoes its development and growth, and this in a given locality might be very different in one kind of medium from what it is in a different kind, a difference which would not be shown by a record of the atmospheric temperature alone. Some of the Coastal Plain grasshoppers, which in this region are entirely absent from the Piedmont Plateau, exist in much higher latitudes, as in Massachusetts or Ontario, where the sum of the positive atmospheric temperatures for the season of growth and reproduction is much less than in our local Piedmont, but they doubtless exist there under conditions in which they receive a greater amount of heat at the critical time than they would under entirely different conditions in a region which, like our Piedmont, is warmer so far as general atmospheric temperatures are concerned.

Although temperature is probably the fundamental distributional factor, there are good reasons for questioning if it is the only factor. The environment of any organism or group of organisms is a complex of factors, each of which may act directly on the organism and influence its activities. Shelford, for example, has shown that in the case of certain species of tiger-beetles[3] the distribution depends upon the simultaneous presence of a number of conditions, all of which must be fulfilled if the species is to maintain itself.

In our region the great contrast between the biotas of the Piedmont and Coastal Plain provinces is at least empirically—and doubtless in some way causally—correlated with well-marked differences in the prevailing types of soil. In the Piedmont the soils are residual,

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[3] Shelford, V. E., Physiological Animal Geography, *Jour. of Morph.*, Vol. 22, 1911, pp. 551–618.

resulting from the decomposition and disintegration of the underlying rocks. They are of a loamy texture containing relatively high proportions of clay and silt and also holding in most instances a considerable amount of available plant food. The Coastal Plain soils, with some exceptions, represent detrital materials originally transported by water and floating ice from the front of the great continental glacier. They consist almost exclusively of coarse gravels and sands which contain extremely low amounts of clay or silt and are very deficient in available plant foods.

The differences in biota are also correlated with differences in topography. The Piedmont Plateau is a region of considerable relief and consequently of good drainage, so that marshy areas constitute an insignificant feature of the region. The Coastal Plain, with the exception of a portion along its western edge, is a region of extremely low relief and poor drainage, so that marshes form a very prominent feature of the region.

Faunal Subdivisions.—The map accompanying Smith's report on insects in the 1909 report of the New Jersey State Museum subdivides the State into six faunal districts. This map was largely based upon the results of Stone's studies on the distribution of plants, although no acknowledgment of this fact is made in the text. In the map accompanying Stone's report on plants already cited the southern or Coastal Plain portion of the State is subdivided into five districts. Stone does not consider the region north of the fall-line in detail, but simply refers to it as the Northern District without any attempt at further subdivision. In Smith's report the same region is subdivided into three districts, *i.e.*, the Appalachian, the Highlands, and the Piedmont Plateau. All three of these subdivisions are represented in Pennsylvania.

The subdivisions of the Coastal Plain recognized by Stone are (*a*) the Middle District; (*b*) the Pine Barrens; (*c*) the Coastal Strip, including the coast islands and a narrow strip of mainland adjoining the salt marshes; (*d*) the Cape May Peninsula south of the Great Cedar Swamp, and (*e*) the Maritime District, embracing the salt marshes.

In the case of the Orthoptera, these same subdivisions can be readily recognized, but to my mind they are not all of equal faunistic value. As major or primary faunal centres I would class the Appalachian, Piedmont, Pine Barren, and Coastal districts, because each of these is definitely characterized by a number of species which are either entirely absent or relatively infrequent in the other districts.

The remaining subdivisions I am disposed to consider as tension zones in which there is more or less intermingling, overlapping, or interdigitation of the faunas from the surrounding primary districts. The faunistic status of the Highlands is still somewhat doubtful, owing to the lack of sufficient data, but the data at hand indicate that its only distinctive feature is the overlapping of Piedmont and Appalachian types. The Middle District does not have a single distinctive species of Orthoptera,[4] but represents a zone in which there is an intermingling of characteristic Piedmont, Pine Barren, and Coastal types. The Cape May District has some claim to be regarded as a primary district, since two or three Orthoptera have been taken there which have not as yet been recorded elsewhere, but which future collecting may possibly prove to extend into the Middle and Coastal Districts. The Maritime District is very clearly characterized from all the other districts, but I think it preferable to regard it as an ecological subdivision of the Coastal District rather than a separate faunistic region.

I. The Appalachian District.

The Appalachian District includes the region between the Blue Ridge and the Alleghany escarpment, thus taking in all of central and northeastern Pennsylvania and extreme northwestern New Jersey. Topographically, the greater part of the region consists, as is well known, of a succession of roughly parallel ridges and intervening valleys. In northeastern Pennsylvania these merge into a high plateau, the Pocono Plateau. The underlying rocks are all thoroughly indurated sedimentaries, which typically are characterized by steep dips and sharp folds, but in the Pocono Plateau Region are nearly horizontal or only gently folded. The soils for the most part are residual, and are essentially similar to those of the Piedmont. There is much bare rock on the higher ridges and steeper slopes. In the Pocono Region the soils are largely of glacial origin.

I have had no direct personal experience with the Orthopteran fauna of this district and consequently am dependent for information regarding its character upon the reports of other collectors. The chief sources of information are the records included in the New Jersey list and the collection of the Academy of Natural Sciences, the latter including collections of Stewardson Brown and Witmer

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[4] The one exception to this statement, *Melanoplus differentialis,* represents an introduction from the West.

Stone from Wyoming and Sullivan Counties; of Bayard Long from Monroe, Sullivan, Pike, and Wayne Counties; of Rehn from Lehigh Gap, and the official Pennsylvania State Collection, the latter including material from the vicinity of Harrisburg and central Pennsylvania. The Academy collection also includes individual specimens collected by C. W. Johnson, O. Behr, W. S. Huntington, and Dr. Joseph Leidy.

From these sources we have tangible evidence of the occurrence of the following species of Orthoptera in northeastern Pennsylvania, including under this term the counties of Lehigh, Carbon, Wyoming, Sullivan, Monroe, Wayne, and Pike.

Orphullella speciosa
Chlœaltis conspersa
Stenobothrus curtipennis
Mecostethus lineatus
Arphia xanthoptera
Chortophaga viridifasciata
Encoptolophus sordidus
Camnula pellucida
Hippiscus tuberculatus
Spharagemon saxatile
Spharagemon bolli
Trimerotropis citrina
Circotettix verruculatus
Podisma glacialis variegata
Melanoplus fasciatus
“ *atlanis*
“ *minor*
“ *femoratus*
“ *punctulatus*
Scudderia furcata

From the more central portion of Pennsylvania we have records of the following:

Dichromorpha viridis
Orphulella speciosa
Arphia sulphurea
“ *xanthoptera*
Chortophaga viridifasciata
Encoptolophus sordidus
Hippiscus tuberculatus
Spharagemon bolli
Trimerotropis citrina
Melanoplus femur-rubrum
Scudderia texensis
Scudderia curvicauda
“ *furcata*
Amblycorypha oblongifolia
“ *rotundifolia*
Conocephalus triops
“ *ensiger*
Xiphidium fasciatum
“ *brevipenne*
“ *nemorale*
Atlanticus dorsalis
Orchelimum vulgare

The New Jersey list includes the following from the Appalachian portion of the State:

Dichromorpha viridis[5]
Chlœaltis conspersa
Stenobothrus curtipennis[5]
Arphia sulphurea[5]
Chortophaga viridifasciata[5]
Hippiscus tuberculatus
Dissosteira carolina[5]
Spharagemon bolli[5]
Circotettix verruculatus
Melanoplus atlanis[5]
“ *femur-rubrum*[5]
“ *luridus*[5]
“ *femoratus*
Orchelimum vulgare

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[5] No locality records, but species stated to occur throughout the State and doubtless occurs in the district under consideration.

The above lists are doubtless individually incomplete. On the whole, collections made in the Appalachian District are essentially Piedmont in character with the addition of some prevailingly northern species which are absent or rare in the Piedmont. It is probable at least from the data at hand that the following species occur regularly throughout the entire local Appalachian District: *Orphulella speciosa, Chlœaltis conspersa, Stenobothrus curtipennis, Arphia sulphurea, A. xanthoptera, Chortophaga viridifasciata, Encoptolophus sordidus, Hippiscus tuberculatus, Dissosteira carolina, Spharagemon bolli, S. saxatile, Melanoplus fasciatus, M. atlanis, M. femur-rubrum, M. minor, M. femoratus, Scudderia curvicauda, S. furcata, Amblycorypha oblongifolia, A. rotundifolia, Conocephalus triops, C. ensiger, Orchelimum vulgare, Xiphidium fasciatum, X. brevipenne, X. nemorale,* and *Atlanticus dorsalis.*

The following have so far been recorded only for the more northern section of the local Appalachian District, to which it is possible that they may be restricted: *Mecostethus lineatus, Camnula pellucida, Circotettix verruculatus, Podisma glacialis variegata, Melanoplus mancus,*[6] *M. punctulatus,* and *Scudderia pistillata.*[6]

It is rather surprising that we have no local records of *Melanoplus luridus* in the Appalachian District, this being a form which is prevailingly northern in distribution and which has been recorded from the mountains of Virginia, North Carolina, and Georgia.

Another species, *Xiphidium saltans,* probably occurs in the district, but I know of no actual records of its capture.

The most distinctive Orthoptera of the Appalachian District are *Camnula pellucida, Spharagemon saxatile, Trimerotropis citrina Circotettix verruculatus, Podisma variegata, Melanoplus mancus* (probably), and *Xiphidium nemorale.* These species are either confined to the district or recur only in the Highlands.

The majority of Appalachian Orthoptera are Piedmont types. These include *Orphulella speciosa, Dichromorpha viridis,*[7] *Chlœaltis conspersa, Stenobothrus curtipennis, Arphia sulphurea, A. xanthoptera, Chortophaga viridifasciata, Encoptolophus sordidus, Hippiscus tuberculatus, Dissosteira carolina, Spharagemon bolli, Melanoplus atlanis, M. femur-rubrum, M. minor, M. femoratus, Scudderia texensis, S.*

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[6] Recorded from the Highlands of New Jersey, but doubtless occur in the Appalachians.

[7] I am not sure whether this species ought to be ranked as an Appalachian species or not. It is abundant in the Piedmont and has been taken along the edge of the Appalachian, but I know of no records from typical Appalachian country.

curvicauda, *S. furcata*, *Amblycorypha oblongifolia*, *A. rotundifolia*, *Conocephalus triops*, *Orchelimum vulgare*, *Xiphidium fasciatum*, *X. brevipenne*, and *Atlanticus dorsalis*.

Some Appalachian Orthoptera are as yet unrecorded for the Piedmont Region, but recur in the Coastal Plain. Among these are *Mecostethus lineatus*, *Melanoplus fasciatus*, *M. punctulatus*, *Scudderia pistillata*, *S. septentrionalis*, and *Conocephalus ensigner*.

No extensive studies of Appalachian Orthopteran habitats have been made, so far as I am aware. *Spharagemon saxatile* is a saxicolous form and in the New Jersey list is stated to occur on rocky ridges. Doubtless its habitat in this region is like that described by Morse for New England and the Southern States. *Podisma variegata* appears from data recorded by Rehn[8] to be constantly associated with hemlock woods, occurring, according to one observer, Mr. Behr, on the branches of the trees, but according to W. S. Huntington occasionally in grass.

II. The Highlands.

As already mentioned, I am not inclined to regard the Highlands as of primary faunistic rank, but rather as a sort of tension area where the typical Piedmont fauna meets and intermingles with outlying representatives of the Appalachian fauna. The data from the region are unfortunately very meagre and are almost entirely restricted to the New Jersey section, the Pennsylvania Highlands being unrepresented in any of the publications or collections examined by me.

The topography of the Highlands is essentially that of the Appalachian Region, but the ridges are lower and have less precipitous slopes. The soils are of residual origin and are of the same character as the typical Piedmont soils.

The grasshopper fauna of the Highlands has never been fully described, but it will probably be found to include the following forms:

Orphulella speciosa (*a*)[9]
Dichromorpha viridis (*b*)
Chlœaltis conspersa (*a*)
Stenobothrus curtipennis (*a*)

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[8] *Entom. News*, XI, 1900, p. 680.

[9] (*a*) Recorded from Highland localities in New Jersey Report.
(*b*) Reported as occurring throughout the State in the same report.

Mecostethus lineatus (*c*)[9]
Arphia sulphurea (*b*)
" *xanthoptera* (*a*)
Chortophaga viridifasciata (*b*)
Encoptolophus sordidus (*a*)
Hippiscus rugosus (*a*, *d*)
" *tuberculatus* (*a*)
Dissosteira carolina (*b*)
Spharagemon bolli (*b*)
" *saxatile* (*a*)
Circotettix verruculatus (*a*)
Pseudopomala brachyptera (*c*)
Schistocerca americana (*e*)
Melanoplus mancus (*a*)
" *scudderi* (*a*)
" *atlanis* (*b*)
" *femur-rubrum* (*b*)
" *minor* (*a*)
" *luridus* (*b*)
Melanoplus femoratus (*b*)
" *punctulatus* (*a*)
Scudderia texensis (*a*)
" *curvicauda* (*f*)
" *pistillata* (*a*)
" *furcata* (*a*)
" *septentrionalis* (*a*)
Amblycorypha oblongifolia (*a*)
" *rotundifolia* (*a*)
Conocephalus triops (*c*)
" *ensiger* (*a*)
Orchelimum vulgare (*f*)
" *glaberrimum* (*e*)
Xiphidium fasciatum (*f*)
" *brevipenne* (*a*)
" *nemorale* (*c*)
" *saltans* (*f*)
Atlanticus dorsalis (*a*)
" *pachymerus* (*a*)

III. The Piedmont District.

The Piedmont Region of New Jersey consists of a rather narrow belt of gently to moderately rolling country formed almost entirely by the red shales and sandstone of Triassic age, but in Pennsylvania it widens rapidly and includes rocks of many kinds. All of these are thoroughly consolidated and, with the exception of the Triassic series, are more or less extensively metamorphosed. Topographically, the Piedmont possesses considerable relief, but is less rugged than either the Appalachian or Highland Regions, the highest elevations rarely exceeding 600 feet above sea-level. This, however, is sufficient to produce relatively swift-flowing streams and thereby to ensure good drainage. As a result, permanently moist tracts are of limited extent and are largely restricted to soggy patches about spring-heads or to seepage depressions on the level tracts bordering the streams.

The soils of the Piedmont are residual. They are highly variable in composition and texture in accordance with the varied nature of the underlying rock formations. All agree, however, in having a loamy texture, the silt-clay content never, according to the published

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[9] (*c*) Possibly occurring throughout the Highlands, but definitely reported only from Fort Lee on the Hudson, where the Highlands meet a narrow arm from the Coastal Plain.

(*d*) Recorded under "*compactus*" in the New Jersey Report.

(*e*) From Fort Lee only, probably stragglers from the Coastal Plain.

(*f*) No actual records from the Highlands, but are common, widely-distributed species, which doubtless occur there.

analyses of the U. S. Bureau of Soils, falling below 35%. Most of the Piedmont soils have a sufficiently open texture to permit the ready percolation of water, but their high silt content enables them to readily conserve the supply, so that, except in periods of exceptional drought, the amount of moisture available for plant growth is considerable. Being derived either directly or indirectly from crystalline rocks, they are in most instances rich in essential plant-foods, especially potash, lime and magnesium. For these reasons the dominant type of vegetation is mesophytic and with this is correlated the presence of a prevailingly mesophilous grasshopper fauna. Originally the whole region was densely forested, the dominant tree growth consisting of hardwoods, but at the present time this has been largely removed and the country converted into farmlands and pastures.

The grasshopper fauna of the Piedmont, exclusive of tettigids and nocturnal locustids, includes, to my knowledge, the following species:

Pseudopomala brachyptera
Eritettix carinatus
Orphulella speciosa
" *pelidna*
Dichromorpha viridis
Chlœaltis conspersa
Stenobothrus curtipennis
Arphia sulphurea
" *xanthoptera*
Chortophaga viridifasciata
Encoptolophus sordidus
Hippiscus tuberculatus
" *rugosus*
Dissosteira carolina
Spharagemon bolli
Melanoplus scudderi
" *tribulus*
" *atlanis*
Melanoplus femur-rubrum
" *minor*
" *luridus*
" *femoratus*
Scudderia texensis
" *curvicauda*
" *furcata*
Amblycorypha oblongifolia
" *rotundifolia*
Microcentrum sp.
Conocephalus triops
Orchelimum vulgare
" *spinulosum*
Xiphidium fasciatum
" *brevipenne*
" *strictum*
Atlanticus dorsalis

Of these species those most distinctive of the Piedmont Region are *Dichromorpha viridis, Orphulella speciosa, Stenobothrus curtipennis, Encoptolophus sordidus, Hippiscus tuberculatus,* and *Melanoplus minor.* Each of these appears to be either absent, rare or local in the Coastal Plain.

The most abundant species in the Piedmont, as in the entire eastern section of the continent, is the red-legged grasshopper, *Melanoplus femur-rubrum.* This species is present far in excess of any of the other species. Next in point of numbers come such forms as *Dichro-*

morpha viridis, Dissosteira carolina, Encoptolophus sordidus, Melanoplus femoratus, Chortophaga viridifasciata and *Orchelimum vulgare.* Other common, but somewhat restricted, forms are *Stenobothrus curtipennis, Arphia xanthoptera, Arphia sulphurea, Orphulella speciosa, Melanoplus atlanis, Melanoplus minor, Melanoplus scudderi, Xiphidium brevipenne, Xiphidium fasciatum, Conocephalus triops, Orchelimum spinulosum, Scudderia curvicauda,* and *Scudderia furcata.*

The following are not uncommon in certain localities, but apparently are rare or lacking in many parts of the Piedmont: *Hippiscus tuberculatus, Hippiscus rugosus, Xiphidium strictum* and *Amblycorypha oblongifolia.*

The following may in general be regarded as rather scarce members of the Piedmont fauna, although in favorable spots they may be represented in considerable numbers: *Eritettix carinatus, Chlœaltis conspersa, Spharagemon bolli, Melanoplus luridus, Amblycorypha rotundifolia* and *Atlanticus dorsalis.*

Of exceptional occurrence, though in restricted locations sometimes present in surprising numbers, are *Pseudopomala brachyptera, Orphulella pelidna, Melanoplus tribulus* and *Scudderia texensis.* The first and third of these have, I believe, been taken only on the Conowingo Barrens of southeastern Pennsylvania. The other two are abundant Coastal Plain forms which only occur in small or moderate numbers in a few Piedmont localities.

The Orthopteran fauna of the Piedmont is, with some not clearly defined exceptions, monotonously uniform throughout. The only subdivisions that I have in any degree been able to recognize are habitat or ecological groups, and even these are not rigidly circumscribed, the transitions in environmental factors permitting an extensive intermingling of the forms of one habitat with those of the others.

With these limitations in mind, I think we can recognize tentatively three primary habitats or societies based upon the relative moisture content of the substratum.[10] These societies are respectively

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[10] In treating of the various ecological subdivisions, I have in the main adopted the terminology introduced by Morse and Hancock, but have adopted a somewhat different arrangement. Both of these authors primarily subdivide the Orthoptera into ground-frequenting forms (Geophilous society of Morse, Geodytes of Hancock) and plant-frequenting types (Phytophiles of Morse, Phytodytes of Hancock). This subdivision is to me unsatisfactory because any natural habitat, no matter how dry, will show some vegetation and will accordingly contain both ground-frequenting and plant-frequenting types mingled together in hopeless confusion. To me the best practice seems to be to follow that of the plant ecologists by basing our classification of habitats or habitat-groups primarily upon the available moisture content of the substratum. As all collectors of insects know, the fauna of a marsh is strikingly different from that of a dry barren.

xerophilous, mesophilous and hygrophilous. The xerophilous society is characteristic of relatively dry situations. Morse[11] recognizes three subdivisions or associations of this group, *i.e.*, saxicolous or rock-frequenting, arenicolous or sand-frequenting and humicolous or those frequenting soils, loams especially, which although dry, contain a larger percentage of moisture than the sands. The last association naturally merges into the typical mesophilous society. In the Piedmont only the humicolous association appears to be represented and this is naturally not always easily separable from the dominant mesophilous society.

The xerophilous faunule is typically developed in the Piedmont upon the so-called "poor soils." These soils occur on uplands and steep hillsides where, owing to rain wash, the soil is either thin or stony and therefore capable of supporting only a coarse type of vegetation. In some cases the dryness of the ground is due to the texture of soil and underlying rock which allows a relatively rapid percolation of water, as on the ridges formed by the Chickies quartzite and Stockton conglomerates, or to the chemical character of the soil, as on the Conowingo or Serpentine Barrens. Where the woodlands have been removed the vegetation on these areas is of a somewhat open character, numerous bare patches of soil showing between the more or less scattered plants. The dominant plant growth consists of coarse herbaceous types, such as are typical of dry, waste land (bunch-grasses, *Andropogon* spp., *Panicum*, etc., cinquefoil, sheep sorrel, *Rumex acetosella*, blackberry and wild rose bushes). In such surroundings we normally encounter the following species of grasshoppers:

Orphulella speciosa
Arphia sulphurea
" *xanthoptera*
Chortophaga viridifasciata
Encoptolophus sordidus
Hippiscus tuberculatus
" *rugosus*
Dissosteira carolina
Melanoplus atlanis
" *femur-rubrum*
" *minor*
" *femoratus*
Xiphidium strictum

Other species of more sporadic occurrence, but typical xerophiles, are *Eritettix carinatus*, *Pseudopomala brachyptera*, and *Orphulella pelidna*.

Of the above species I would tentatively consider the following as the more distinctively xerophilous: *Orphulella speciosa*, *Arphia*

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[11] Researches on North American Acridiidæ, Carnegie Inst. of Washington, Publication No. 18, 1904, p. 14.

sulphurea, Hippiscus tuberculatus, Hippiscus rugosus, Melanoplus atlanis, Melanoplus minor and *Xiphidium strictum.* All of these may, as I have noticed, occur in reduced numbers in mesophilous habitats, so that they are only predominantly xerophilous, not absolutely so.

Where woodlands prevail, in which numerous small clearings occur, a somewhat different phase of the xerophilous faunule obtains. This, following Morse, we may call the sylvan phase in contradistinction from the open country or campestral phase. The tree growth in these relatively xerophytic habitats consists predominantly of oaks (*Q. alba*, *Q. rubra*, *Q. velutina*, *Q. prinus*), hickory, chestnut and dogwood, with occasional groves of scrub pine (*P. virginiana*) and red cedar (*Juniperus virginiana*). In the cleared portions of the woods, where alone grasshoppers usually occur, a mixed growth of grasses, vines and low shrubbery takes place. In such spots we usually meet with the following Orthoptera:

Orphulella speciosa
Arphia sulphurea
Chortophaga viridifasciata
Hippiscus tuberculatus
Dissosteira carolina
Melanoplus scudderi
" *femur-rubrum*
Melanoplus minor
Scudderia curvicauda
" *furcata*
Amblycorypha oblongifolia
" *rotundifolia*
Microcentrum sp.
Atlanticus dorsalis

In addition to these, we occasionally find associated with them, sometimes in considerable numbers, the following species:

Eritettix carinatus
Spharagemon bolli
Melanoplus luridus

Rarely one meets with the following:

Pseudopomala brachyptera
Orphulella pelidna
Melanoplus tribulus

This woodland or sylvan faunule is not always clearly distinguishable from the adjoining campestral faunule. There are all transitions from the one type of habitat to the other. The clearing away of the forests has extended the habitat of the campestral types. As the trees are thinned out the latter occupy the habitats originally occupied by the sylvan forms, the latter either becoming extinct or persisting locally where conditions are favorable. The more exclusively woodland species in this region are *Spharagemon bolli* and *Melanoplus luridus*, and both of these forms are, at present at least, extremely local in their distribution in the Piedmont Region, though where conditions are favorable they are not uncommon. The other woodland types are apparently better able to adapt themselves to certain features of a campestral environment, such as the thicket and scrub formations which tend to overrun waste lands.

The mesophilous society is the dominant faunal group of the Piedmont Region, especially as represented by its campestral phase. This is the faunule which one everywhere encounters in the rich farming country, such as is typically found throughout the limestone valleys. The prevailing vegetation consists of bright green succulent grasses that form a firm sod. Roads, paths and plowed fields provide, however, abundance of bare ground suitable for geophilous types.

The campestral mesophile faunule typically yields the following species:

Dichromorpha viridis
Chortophaga viridifasciata
Encoptolophus sordidus
Dissosteira carolina
Melanoplus femur-rubrum
" *femoratus*
Conocephalus triops
Orchelimum vulgare

The sylvan phase of the mesophilous society is not always clearly distinguishable from the campestral for the reason already mentioned. It consists typically of the following:

Chortophaga viridifasciata
Melanoplus scudderi
" *fenur-rubrum*
" *femoratus*
Scudderia curvicauda
" *furcata*
Xiphidium brevipenne

As a sporadic member of this phase we may add *Scudderia texensis.*

Hygrophilous Orthoptera inhabit areas of damp, moist or wet soils. Of these we may, like Morse, distinguish two categories, namely, humicolous hydrophiles and paludicolous hydrophiles. The former are frequenters of areas in which the soil, though usually damp, is normally not wet or soggy. The latter inhabit tracts which are actually wet. In the Piedmont there is no hard-and-fast line separating these two groups. As already mentioned, hygrophilous habitats in the Piedmont Region are of extremely restricted extent, owing to the very perfect drainage of the whole region.

The campestral phase of the humicolous hygrophiles is typically represented by the fauna of the open grassy meadows which in many places border the streams. The soil of these meadows is usually a fine, alluvial clay-loam corresponding approximately to the Lickdale clay-loam of the Bureau of Soils. The vegetation is dominated by succulent grasses, which are extensively utilized for pasture. Associated with the grasses is a large variety of other plants, among which we may mention buttercups (*Ranunculus bulbosus*), quaker-ladies (*Houstonia cærulea*), spring-beauty (*Claytonia virginica*), golden ragwort (*Senicio aureus*), cynthia (*Adopogon virginicum*), elder (*Sambucus canadensis*), iron-weed (*Vernonia noveboracensis*)) blue vervain (*Verbena hastata*), joe-pye weed (*Eupatoriun purpureum*, and boneset (*Eupatorium perfoliatum*).

The Orthoptera inhabiting these meadowlands and pastures include regularly the following species:

Dichromorpha viridis
Chortophaga viridifasciata
Melanoplus femur-rubrum
“ *femoratus*
Scudderia curvicauda
Scudderia furcata
Conocephalus triops
Orchelimum vulgare
Xiphidium fasciatum
“ *brevipenne*

Scudderia texensis is an occasional member of this faunule.

This faunule includes no peculiar types, but is chiefly distinguished from the mesophilous by the absence of the more geophilous forms) and by the proportionately much greater numbers of the hygrophilous species, such as *D. viridis*, *C. triops*, *O. vulgare* and *X. fasciatum*.

A slightly different phase of the humicolous hygrophilous society is found in open woodland occupying damp or slightly moist depressions marking usually the head-waters of some rivulet. The Orthoptera occurring in such places consist of the following species:

Chlœaltis conspersa (local)
Melanoplus femur-rubrum
“ *femoratus*
Scudderia curvicauda
Scudderia furcata
Orchelimum vulgare
Xiphidium brevipenne

Paludicolous Orthoptera are the swamp dwellers. In the Piedmont swamps are of relatively small extent and are most commonly represented by local depressions in the meadowlands where the water-table is normally so close to the surface that the latter is kept permanently moist or even covered with water. In these swamps the vegetation consists of a mixture of succulent grasses—*e.g.*, *Homalocenchrus oryzoides*—and sedges among which species of *Carex* are prominent, especially the tussock sedge (*C. stricta*). Such locations constitute the favorite habitat of such Orthoptera as *Stenobothrus curtipennis* and *Orchelimum spinulosum*, which appear to be the only paludicolous forms represented in the Piedmont. Owing to the small size of the swamps, Orthoptera from the adjoining drier lands frequently invade them, making it difficult to clearly discriminate this faunule from the meadow faunule.

IV. The Coastal Plain.

The Coastal Plain includes all of the country south and east of the fall-line. It consists essentially of a low plain of very slight relief and hence, for most of its extent, at least, of very imperfect drainage. This is especially true of that portion east and south of the range of low hills marking the divide between the Delaware and Atlantic drainage systems. In this part the seaward slope is exceedingly gradual and consequently the stream flow is very sluggish and the drainage very inadequate, resulting in the formation of extensive bogs. West of the divide the stream gradient is considerably greater, so that this part, constituting the Delaware Valley or Middle District of Stone, is on the whole fairly well drained, though in their lower courses the streams are so near tide-level that they become very sluggish and form wide mud-flats through which the streams tortuously meander.

The all but universal soil of the Coastal Plain is a coarse sand corresponding approximately to the Norfolk sand of the Bureau of Soils. Associated with this are frequent areas of coarse gravel similar to the Sassafras gravelly loam of the same Bureau.[12] East of the Delaware-Atlantic divide these sands and gravels form a practically unbroken cover, but west of that line, in the Middle District, they are frequently interrupted by more or less extensive areas of clays and loams, some of which are due to the exposure of the underlying Cretaceous and Miocene deposits consequent upon the removal by erosion of the original capping of sand and gravel. In consequence of this variety of soil types, the Middle District is characterized by a greater diversity of flora and fauna than the remaining subdivisions of the New Jersey Coastal Plain.

The two general features in which the Coastal Plain most markedly differs from the Piedmont Region are: (1) the almost universal presence of coarse sands, and (2) the development of extensive tracts of permanently wet areas. With these is correlated the prevalence of two widely different types of fauna, a xerophilous fauna characteristic of the sandy districts and a hygrophilous fauna characteristic of the bogs and marshes. The mesophilous fauna is of relatively limited extent, being fully represented only on the clay and loamy soils of the Middle District, but tending to spread into the other

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[12] For the characteristics of these different types of Coastal Plain soils see Soil Survey of the Salem, N. J., Area, Field Operations of the Bureau of Soils, 1901.

districts with the conversion of the country into farm and truck lands.

The grasshopper fauna (exclusive of *Tettiginæ* and the more nocturnal *Locustidæ*) of the Coastal Plain includes the following species:

Tryxalis brevicornis
Pseudopomala brachyptera
Mermiria vigilans
Syrbula admirabilis
Eritettix carinatus
Dichromorpha viridis
Clinocephalus elegans
Orphulella speciosa
" *pelidna*
" *olivacea*
Chlœaltis conspersa
Stenobothrus curtipennis
Mecostethus lineatus
Arphia sulphurea
" *xanthoptera*
Chortophaga viridifasciata
Encoptolophus sordidus
Hippiscus phœnicopterus
" *rugosus*
Dissosteira carolina
Spharagemon bolli
" *wyomingianum*
Trimerotropis maritima
Psinidia fenestralis
Scirtetica marmorata
Schistocerca americana
" *damnifica*
" *alutacea*
" *rubiginosa*
" sp. cf. *obscura*
Hesperotettix brevipennis
Dendrotettix quercus
Melanoplus scudderi
" *tribulus*
" *fasciatus*
" *atlanis*
" *femur-rubrum*
" *minor*
" *impudicus*
" *luridus*
" *stonei*
Melanoplus differentialis
" *femoratus*
" *punctulatus*
Paroxya floridiana
" *scudderi*
Scudderia texensis
" *curvicauda*
" *pistillata*
" *furcata*
" *septentrionalis*
" *truncata*
Amblycorypha oblongifolia
" *rotundifolia*
" *uhleri*
Microcentrum rhombifolium
" *retinerve*
Conocephalus robustus
" *triops*
" *ensiger*
" *lyristes*
" *exiliscanorus*
" *nebrascensis*
" *caudellianus*
" *palustris*
Orchelimum vulgare
" *glaberrimum*
" *erythrocephalum*
" *herbaceum*
" *spinulosum* (? *validum*)
" *pulchellum*
" *campestre*
" *minor*
" *fidicinium*
Xiphidium fasciatum
" *brevipenne*
" *strictum*
" *saltans*
" *spartinæ*
" *nigropleuroides*
Atlanticus dorsalis
" *pachymerus*

As indicated earlier in this paper, the Coastal Plain fauna is made up of representatives of four primary regional faunules, namely, Appalachian, Piedmont, Coastal and Pine Barren.

The *Appalachian faunule* is represented by a few types that recur locally or in diminished numbers in the Coastal Plain, such as *Scudderia pistillata, S. septentrionalis, Conocephalus ensiger* and *Xiphidium saltans.*

The *Piedmont faunule* include species whose local centre of distribution is in the Piedmont, but which occur in smaller numbers or locally in the Coastal Plain. To this group I would refer the following species:

Dichromorpha viridis
Orphulella speciosa
Stenobothrus curtipennis
Encoptolophus sordidus
Melanoplus minor

This faunule is best represented in the Middle District, to which, indeed, two of the species, *D. viridis* and *E. sordidus*, appear to be entirely confined, or at most barely enter the other districts. The other three species have been taken throughout, but only in widely separated localities and usually in very small numbers.

IV (*a*). The Coastal Subdivision or District.

The *Coastal faunule* is typical of the marshes and low forelands bordering the ocean, the lower portions of the Delaware River and all tidal estuaries. Of this faunule we can distinguish several minor components of an ecological nature, each of which is characteristic of some well-defined physiographic feature of the region.

As is well known, the coast of New Jersey is formed by a succession of long, narrow sand-spits heaped up by wind and wave. These are the coast-islands or barrier-beaches, all of which in New Jersey are fast being transformed into summer resorts. Back of the barrier-beaches come the salt marshes, low grassy flats daily inundated by the tide. Beyond these, rising very gradually out of the marshes, comes the mainland. A narrow strip of the mainland immediately bordering the salt marshes has different faunal and floral characteristics from those of the interior—a difference first recognized by Stone, who has called it the Coastal Strip. The Coastal Strip is similar in every essential respect to the low forelands bordering the maritime marshes of the Delaware River and Bay.

In the Coastal District I recognize the following ecological groups: (1) the Subcoastal; (2) the Littoral or Dune; (3) the Submaritime, and (4) the Maritime.

The Subcoastal group is characteristic of the Coastal Strip, more especially of its drier portions. It is very rich in species, due doubtless to the diversity of conditions consequent upon the transition from a dry, sandy upland to the low, marshy areas bordering the salt marshes. The soil throughout is a coarse sand similar to the Norfolk type. In the more elevated areas it may be quite dry at the surface, but is usually underlaid at no great depth by the water-table. The sand is very porous, but its proximity to underground water makes it a good corn and truck soil, as a result of which it has been extensively cleared and cultivated. Where the surface of the sand approaches within a foot or so of permanent water-level it is often highly impregnated with organic matter, and in such cases assumes the character of a sandy loam.

Most of the Coastal Strip is of the open campestral type, though groves and thickets of limited extent are frequent in the shallow depressions leading down to the salt marshes. Where the fields are not cultivated they soon become overrun with native and introduced weeds and bushes, among which we may mention such forms as the tall bunch-grasses of the genus *Andropogon,* timothy (*Phleum pratense*), sand-bur (*Cenchrus carolinianus*), *Juncus tenuis,* species of smart-weed (*Polygonum*), *Scleranthus annuus,* bayberry (*Myrica caroliniensis,* beach plum (*Prunus maritima*), wild indigo (*Baptisia tinctoria*), sensitive pea (*Cassia nictitans* and *chamæcrista*), bush-clovers (*Lespedeza* spp.), low evening primrose (*Œnothera laciniata*), butterfly-weed (*Asclepias tuberosa*), blue toad-flax (*Linaria canadensis*), horse-mint (*Monarda punctata*), low cynthia (*Adopogon carolinianum*), rag-weed (*Ambrosia artemiifolia*), black-eye susan (*Rubeckia hirta*), white boneset (*Eupatorium album,* etc.), golden aster (*Chrysopis mariana*), and goldenrods (*Solidago* and *Euthamnia* spp.).

This vegetation is evidently of a mild xerophytic type. The Orthoptera associated with it may therefore be regarded as a xerophilous faunule of the humicolous subtype and campestral station. To this faunule I would refer the following species:

Syrbula admirabilis
Eritettix carinatus
Orphulella pelidna
Arphia sulphurea
“ *xanthoptera*
Chortophaga viridifasciata
Hippiscus phœnicopterus
“ *rugosus*
Dissosteira carolina
Trimerotropis maritima
Psinidia fenestralis
Schistocerca americana
“ *damnifica*
Melanoplus scudderi
Melanoplus atlanis
“ *femur-rubrum*
“ *femoratus*
Scudderia texensis
“ *furcata*
Amblycorypha oblongifolia
“ *uhleri*
Microcentrum sp.
Conocephalus robustus
“ *triops*
Orchelimum vulgare
Xiphidium strictum
“ *saltans*

The most abundant species is *Melanoplus femur-rubrum*, which literally swarms in the low, weedy fields and pastures just above the salt meadows, but is somewhat less frequent in the drier uplands, where it is almost equalled in numbers by such forms as *Melanoplus atlanis* and *Orphulella pelidna*. Other common species of this faunule are *Arphia xanthoptera, Chortophaga viridifasciata, Dissosteira carolina, Psinidia fenestralis, Scudderia texensis, Orchelimum vulgare* and *Xiphidium strictum*.

Frequent, but not especially common, species are *Syrbula admirabilis, Hippiscus rugosus, Melanoplus femoratus, Scudderia furcata*, both species of *Amblycorypha, Conocephalus robustus* and *triops*.

Frequent locally, particularly in thicketed areas and along the borders of woodlands, are such species as *Arphia sulphurea, Hippiscus phœnicopterus, Schistocerca damnifica*, and *Melanoplus scudderi*. These seem to be essentially sylvan types, which in the Coastal District succeed in holding their own in the locations mentioned.

The following members of the Subcoastal faunule appear to be rare or very exceptional: *Eritettix carinatus, Trimerotropis maritima, Schistocerca americana* and *Xiphidium saltans*.

The Littoral or, more properly, Dune group is characteristic of the higher, drier parts of the beaches. As already mentioned, these beaches are formed of sand heaped up by the combined action of wind, wave and tide. In southern New Jersey, where I am most familiar with them, they all present the same physiographic features. On the ocean side there is the beach or strand, consisting of two portions, a lower beach covered regularly daily by the tide and totally devoid of all vegetation, and an upper beach, which is only covered at intervals, as during severe storms. The upper beach normally consists of dry, white quartz sand. It is largely bare, but supports an open growth of several plants, the most abundant and characteristic of which is the sea-rocket, *Cakile edentula*, other frequent associates being *Salsola kali* and *Ammodenia peploides*. Above the upper beach comes the outer or frontal dune and back of it and extending to the salt meadows stretches a variable series of minor dunes with intervening depressions, many of which are deep enough to reach to and expose the underlying marsh mud. The frontal dune is dominated by a nearly pure growth of the sand-binding grass, *Ammophila arenaria*, which also constitutes the dominant vegetation for several rods back of the frontal dune, but is gradually replaced on more leeward dune areas by a mixed growth, consisting of such forms as *Andropogon littoralis*, several species of *Panicum*, *Cenchrus tribuloides*, species of *Cyperus* and *Carex*, sand-myrtle, *Hudsonia tomentosa*, and prickly-pear cactus, *Opuntia opuntia*. Further back these are replaced by the bayberry, *Myrica carolinensis*, thicket formation. This extends close to the edge of the salt marsh, but is separated from the latter by a usually narrow zone consisting chiefly of *Iva oraria* and *Baccharis halimifolia*, the distinctive salt-marsh border plants. The dune depressions harbor a hydrophytic flora similar to that characteristic of the Submaritime zone.

The chief distinguishing features of the Orthopteran fauna of the beaches are positively the abundance of *Trimerotropis maritima*, the presence of a peculiar race or possibly species of *Schistocerca* and the relative frequency of *Schistocerca americana;* negatively the absence or scarcity of several mainland species.

The following list gives all the species which to my knowledge have been taken or recorded from the beaches, excepting, however, all forms that I regard as more properly belonging to the Submaritime faunule.

Orphulella speciosa
" *pelidna*
Chortophaga viridifasciata
Hippiscus phœnicopterus
Dissosteira carolina
Trimerotropis maritima
Psinidia fenestralis
Scirtetica marmorata
Schistocerca americana
Schistocerca sp. cf. *obscura*
Melanoplus femur-rubrum
" *femoratus*
Scudderia texensis
" *furcata*
Conocephalus robustus
" *triops*
Orchelimum vulgare
Xiphidium strictum

There is a close correspondence between the distribution of Orthoptera on the beaches and that of the vegetation already referred to. On the outermost dunes in the *Ammophila arenaria* areas *Trimerotropis maritima* abounds to the almost total exclusion of other species. Further back, where the *Ammophila* begins to be replaced by a mixed vegetation, the *Trimerotropis* gradually becomes reduced in numbers, its place being taken by such species as *Psinidia fenestralis* and *Dissosteira carolina*, both of which are abundant on bare sandy spots. The vegetation in this zone is a very open one and consequently there are numerous exposed areas of dry sand on which these forms delight to rest. Still further back from the sea we come to the bayberry thickets in which the peculiar maritime species or variety of *Schistocerca* is of frequent occurrence. This form of the genus is apparently restricted to the beaches. In coloration it closely resembles *S. rubiginosa* of inland districts, but is always much larger, and, as Mr. Rehn has suggested to me, may represent a non-striped race of *S. obscura* just as *rubiginosa* may be a similar phase of *S. alutacea.* Where the bayberry formation is more open, the grassy tracts extending about and between the bushes abound in *Melanoplus femur-rubrum* and *Orphulella pelidna,* while associated with them are much smaller, but not inconsiderable numbers of *Orchelimum vulgare, Scudderia texensis, Conocephalus robustus* and, locally at least, *Schistocerca americana.* Along the edges of the salt meadows and about the dune depressions these forms meet and more or less intermingle with the Submaritime species.

At the present time it is difficult to decide which of the species given in the above list are indigenous to the islands and which have been secondarily introduced through human agency. There can be no doubt that human occupancy by destroying primitive conditions, introducing artificial conditions and establishing railroads, turnpikes and other avenues of communication with the mainland has effected and is still effecting far-reaching changes in the faunal and floral features of the islands. The clearing away of the bayberry thickets over large tracts and the levelling of the dunes into building lots, together with the importation of gravel from the mainland, have resulted in the introduction of the common grasses and weeds of the mainland, with the result that near all thickly populated parts the vegetation is almost exclusively of the weedland type. In such places one regularly meets such Orthoptera as *Melanoplus femur-rubrum, Chortophaga viridifasciata, Dissosteira carolina,* and *Orchelimum vulgare.*

Certain species, common on the neighboring mainland, are so rare or exceptional on the beaches that there can be little doubt that they represent quite recent introductions. Among these we may mention *Hippiscus phœnicopterus* (1 individual taken in a vacant lot at Sea Isle City, apparently the only instance of its occurrence on the beaches), *Melanoplus femoratus* (a few taken at Anglesea), *Conocephalus triops* (1 taken on Seven-mile Beach) and *Xiphidium strictum* (1 each from Avalon and Cape May). Two additional species apparently very rare on the beaches are *Scirtetica marmorata* and *Scudderia furcata.* It is doubtful whether these last two forms are recent introductions or relicts from a time when the islands were more extensively wooded. My own specimens of these forms from the beaches came from Seven- and Five-mile Beaches, both of which were until recently extensively wooded.

I have never seen *Orphulella speciosa* on any of the beaches, but the Academy of Natural Sciences of Philadelphia has several examples from Anglesea, the only known instance, I believe, of the occurrence of this species in the Coastal District.

The Submaritime group characterizes the narrow zone which marks the transition from salt marsh to sandy upland. The soil of this zone is a silt darkened by organic matter. Normally it is quite damp, but, except in the more depressed areas where the ground is soggy, it forms a firm sod due to the interlacing rootlets of the thick vegetation which covers it. The Submaritime zone evidently marks the line along which the seepage of fresh water takes place from the mainland. Chemical analysis of the water from the same zone at Cold Spring Harbor, Long Island, showed it to be entirely fresh,[13] though salt water occasionally invades the zone at the highest tides or during severe storms. The dominant vegetation consists of a mixed growth of *Spartina patens* and *Juncus gerardi* on the firmer areas and of a nearly pure growth of *Scirpus americanus* in the wet depressions. Other plants more or less frequent in this zone are *Echinochloa walteri, Distichlis spicata, Scirpus olneyi* and *robustus. Dondia maritima, Tissa marina, Kosteletzkya virginica, Ptilimnium capillaceum, Sabatia stellaris, Asclepias lanceolata, Gerardia purpurea* and *maritima, Pluchea camphorata, Iva oraria* and *Baccharis halimifolia.*

The Orthopteran faunule of the Submaritime zone is especially distinguished by the abundance of *Clinocephalus elegans,* which frequents the *Spartina patens-Juncus gerardi* areas, and of *Orchelimum herbaceum,* which is partial to the patches of *Scirpus americanus.* The entire faunule includes the following species:

Tryxalis brevicornis
Pseudopomala brachyptera
Mermiria vigilans
Clinocephalus elegans
Chlœaltis conspersa
Melanoplus femur-rubrum
Paroxya floridiana
Conocephalus lyristes
“ *exiliscanorus*
Conocephalus nebrascensis
“ *caudellianus*
“ *palustris*
“ *fuscostriatus* (?)
Orchelimum herbaceum
“ *spinulosum*
Xiphidium fasciatum
“ *spartinæ*

Of these species the most abundant in the Submaritime zone is *Melanoplus femur-rubrum.* Next to it in point of numbers comes *Xiphidium fasciatum.* Other abundant species are *Clinocephalus elegans, Paroxya floridiana* and *Orchelimum herbaceum.* Locally *Tryxalis brevicornis* is common in the *Scirpus* areas. The remaining

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[13] E. N. Transeau, Relation of Plant Societies to Vegetation, *Bot. Gaz.*, XLV, 1908.

species are much less frequent, though such forms as *Conocephalus lyristes* and *caudellianus* and *Orchelimum spinulosum* are not uncommon. *Pseudopomala brachyptera* and *Chlœaltis conspersa* are both very exceptional and, when found, are usually in close proximity to *Iva oraria* thickets. *Mermiria vigilans* has been taken regularly only in the vicinity of Cape May City and rarely in other localities in Cape May County, but not, so far as I am aware, outside of that county. *Conocephalus fuscostriatus* was taken once by Mr. Henry Fowler near Cape May Point. *Xiphidium spartinæ* is not infrequent in the *Spartina patens* areas, but is to be regarded as a stray from the true Maritime faunule rather than as a regular member of the present faunule.

The Maritime faunule occurs in the true salt marshes. The soil in these marshes is a soft, gelatinous muck or ooze containing a relatively high amount of salt. In spite of its softness, the greater part of the salt marsh is quite firm, owing to the thick covering of coarse grasses, the interlacing roots of which bind the soft material into a tough sod. The vegetation of the salt marsh consists of an almost pure growth of the characteristic salt marsh-grass, *Spartina strica* (=*glabra*). Of this there are two varieties easily recognizable in the New Jersey salt marshes. The more common variety is a short form that covers the flat areas away from and between the waterways; the other a much taller variety that forms reed-like growths along the tidal creeks and ditches which traverse the marshes in every direction. Wet sandy areas not occupied by the grass are frequently characterized by an open growth of salt-worts, *Salicornia europæa*, *biglovii* and *ambigua*. The only other plant that is at all conspicuous in the salt marsh is the sea-lavender, *Limonium carolinum*, which is of frequent occurrence throughout the flats covered with the short variety of *Spartina*.

The Orthoptera of the salt marsh form a very distinct faunule. In the short variety of *Spartina* occur large numbers of *Orphulella olivacea* and *Xiphidium spartinæ*, while the tall variety along the waterways is characterized by *Orchelimum fidicinium* and *Xiphidium nigropleuroides*, both of which occur there in abundance, especially the former. In addition to these, both varieties of the grass harbor moderate numbers of *Conocephalus lyristes*.

The Maritime or true salt-marsh faunule thus contains the following grasshoppers:

Orphulella olivacea
Conocephalus lyristes
Orchelimum fidicinium
Xiphidium spartinæ
"   *nigropleusroide*

IV (*b*). THE PINE BARREN DISTRICT.

The *Pine Barren Faunule* is the fourth primary faunal group represented in the Coastal Plain. It is typically developed in the sandy barrens lying between the Delaware-Atlantic divide and the Coastal Strip. As already mentioned, this is a region of exceedingly slight relief, the surface sloping almost imperceptibly toward the ocean. The surface, however, is not entirely flat, but is more or less gently undulating, the hollows being occupied by the cedar bogs which form a highly characteristic physiographic feature of the district. The all but universal soil is a coarse sand similar in character to the Norfolk and Winsor sands of the Bureau of Soils. In places the sand contains many pebbles and these may become such an important constituent of the soil that it becomes a gravel similar in essential respects to the Sassafras gravelly loam. In very dry situations, where there is very little plant cover, the sand has a decidedly bleached appearance, but the subsoil is always of a deeper color, usually a pale orange or buff tint. In damper spots, where the plant covering is thicker, the sand usually has a dark gray or even black tint, due to the accumulation of organic debris.

The vegetation of the Pine Barrens is of a decidedly xerophytic aspect, owing to the coarse texture of the sand which allows the ready percolation of water. Most of the region is forested, the dominant trees on the sands and gravels being the pitch pine, *Pinus rigida*, and several oaks, especially black-jack oak, *Quercus marylandica*, scrub oak, *Q. ilicifolia*, post oak, *Q. stellata*, and scrub chestnut oak, *Q. prinoides*. Practically all of the timber at the present time is of secondary growth, the region having been cut over repeatedly and frequently swept by destructive forest fires. The woods are accordingly of a rather open character, the taller trees being much scattered, but usually with a dense undergrowth of oak and pine saplings, the former predominating. Where this undergrowth is not too thick, there are associated with these various smaller shrubs, such as bracken-fern (*Pteridium aquilinum*), sweet-fern (*Comptonia asplenifolia*), wild indigo (*Baptisia tinctoria*), mountain laurel (*Kalmia latifolia*) and blueberries (*Vaccinium vacillans* and *Gaylussacia baccata*). Where clearings have been made varying conditions prevail according to the stage of reforestation reached. In very dry, exposed situations the sand, exposed to wind action, may remain bare for a long time, giving rise to formations similar to the "blow-outs" of the Middle West. Gradually, however, a low, mat-like vegetation, composed of such forms as reindeer-moss (*Cladonia* sp.), sandwort (*Arenaria* *caroliniana*), wild ipecac (*Euphorbia ipecacuanhæ*), *Hudsonia ericoides*, sand myrtle (*Dendrium buxifolium*), arbutus (*Epigæa repens*) and pyxie (*Pyxidanthera barbulata*), takes possession and following or accompanying these are bunch-grasses, like the *Andropogons* and rosette grasses mostly of the genus *Panicum* (*P. commonsianum, addisoni, columbianum*, etc.). These prepare the way for a low shrub vegetation of blueberries and associated plants.

The bogs of the Pine Barrens are the results, as already mentioned, of the imperfect drainage of the region. The rain-water from the sands passes by seepage into the depressions and there accumulates until it finds an outlet into one of the general drainage systems. Owing to the low relief of the country, the water never accumulates to any great depth and is consequently choked by a luxuriant vegetation of a typical peat-bog aspect. Originally, especially in the wetter parts of the bogs, the dominant tree was the white cedar, *Chamæcyparis thyoides*, whence the term cedar-bog so frequently applied to the Pine Barren bogs. In many swamps, however, this tree has been largely removed and its place taken by a mixed growth, of which the dominant tree is the red maple, *Acer rubrum*. Along with this are large numbers of sour-gum, *Nyssa sylvatica*, and swamp magnolia, *M. virginiana*. Beneath these is usually a dense undergrowth of tall shrubs like clammy azalea, *Azalea viscosa*, sweet pepper bush, *Clethra alnifolia*, high bush-huckleberry, *Vaccinium corymbosum*, and withe-rod, *Viburnum nudum*. Where the taller vegetation is not too dense there is a lower undergrowth of cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), chain fern (*Woodwardia virginica*) chokeberry (*Aronia arbutifolia*), inkberry (*Ilex glabra*) and such ericaceous shrubs as leucothoe (*L. racemosa*), privet andromeda (*Xolisma ligustrina*) and cassandra (*Chamædaphne calyculata*). In still more open places, where the shrubby growth has been cut away, a varied herbaceous growth prevails consisting predominantly of chain fern (*Woodwardia virginica*) and certain tall species of sedges and rushes (*Eleocharis* spp., *Rhynchospora alba*, *Eriophorum virginicum*, *Juncus canadensis*, *J. dichotomus*, *J. acuminatus*, *J. effusus*, etc.). Cushions of bog-moss (*Sphagnum* spp.) are frequent about the bases of these plants and in these grow several species of sundew (*Drosera*). Other plants not infrequent in these places are swamp pink (*Helonias bullata*), white fringed orchid (*Blephariglottis blephariglottis*), rose pogonia (*Pogonia ophioglossoides*), grass-pink (*Limodorum tuberosum*) and the cranberry (*Oxycoccus macrocarpon*).

In addition to the sandy pine lands and the peat bogs, which represent the two native Pine Barren types of environment, there is a minor third type consequent upon the operations of man. Where the country is cleared and settled and the land placed under cultivation, conditions are produced which favor a fauna and flora essentially like that prevailing in the Delaware Valley and Coastal districts. In such places a weedy type of vegetation predominates, characterized by forms common in the low-lying sandy areas of those districts, among which we may mention the following: *Syntherisma sanguinalis, Phleum pratense, Chætochloa viridis, Cenchrus carolinianus, Sisymbrium officinale, Draba verna, Trifolium arvense, T. pratense, T. procumbens, Melilotus officinalis, Cassia nictitans, Strophostyles helvola, Asclepias tuberosa, Monarda punctata, Verbascum thapsus, Linaria canadensis, Plantago lanceolata, Specularia perfoliata, Ambrosia artemisiifolia.*

There are thus three types of habitat characteristic of the Pine Barrens, *i.e.*, (1) the sand barrens; (2) the peat bogs; (3) the cultivated areas. Each of these is distinguished by certain peculiarities of flora and fauna.

The entire grasshopper fauna of the Pine Barrens (exclusive of the groups not considered in this paper) includes, to my knowledge, the following species. Some of these are referred to this fauna with a query, owing to the fact that all records of their capture are close to the borders of the Pine Barrens, a fact indicative of the possibility of their being merely stragglers from the adjoining districts.

Mermiria vigilans (?)
Syrbula admirabilis
Eritettix carinatus
Orphulella speciosa (?)
“ *pelidna*
Clinocephalus elegans (?)
Dichromorpha viridis (?)
Chlœaltis conspersa
Stenobothrus curtipennis
Mecostethus lineatus
Arphia sulphurea
“ *xanthoptera*
Chortophaga viridifasciata
Encoptolophus sordidus (?)
Hippiscus phœnicopterus
“ *rugosus*
Dissosteira carolina
Spharagemon bolli
“ *wyomingianum*
Trimerotropis maritima
Psinidia fenestralis
Scirtetica marmorata
Schistocerca americana
“ *damnifica*
“ *alutacea*
“ *rubiginosa*
Hesperotettix brevipennis
Dendrotettix quercus
Melanoplus scudderi
“ *fasciatus*
“ *tribulus*
“ *atlanis*
“ *femur-rubrum*
“ *minor*
“ *impudicus*
“ *luridus*
“ *stonei*
“ *femoratus*

Melanoplus punctulatus
Paroxya floridiana
“ *scudderi*
Scudderia texensis
“ *curvicauda*
“ *furcata*
“ *septentrionalis*
“ *truncata*
Amblycorypha oblongifolia
“ *rotundifolia*
“ *uhleri*
Conocephalus robustus
“ *triops*
“ *exiliscanorus* (?)
“ *lyristes* (?)
Conocephalus caudellianus (?)
Microcentrum sp.
Orchelimum vulgare
“ *glaberrimum*
“ *erythrocephalum*
“ *spinulosum*
“ *pulchellum*
“ *minor*
Xiphidium fasciatum
“ *brevipenne*
“ *strictum*
“ *saltans*
Atlanticus dorsalis
“ *pachymerus*

The most distinctive Pine Barren species, *i.e.*, those not taken outside of the Pine Barrens, are *Hesperotettix brevipennis*,[14] *Dendrotettix quercus*, *Melanoplus impudicus*, *Melanoplus stonei*, *Paroxya scudderi*, *Scudderia truncata* and *Orchelimum erythrocephalum*.

The following are essentially Pine Barren species, that is, have their centre of distribution in the Pine Barrens, but may occur in reduced numbers or in exceptional locations in one or more of the adjoining districts:

Hippiscus phœnicopterus
Spharagemon bolli
“ *wyomingianum*
Scirtetica marmorata
Schistocerca damnifica
“ *alutacea*
“ *rubiginosa*
Melanoplus fasciatus
“ *tribulus*
“ *luridus*
“ *punctulatus*
Orchelimum glaberrimum (?)
“ *pulchellum*
“ *minor*

In the following list I give those species which appear to be of common occurrence throughout the entire Pine Barrens:

Orphulella pelidna
Arphia sulphurea
“ *xanthoptera*
Chortophaga viridifasciata
Hippiscus phœnicopterus
Dissosteira carolina
Spharagemon bolli
“ *wyomingianum*
Psinidia fenestralis
Scirtetica marmorata
Schistocerca damnifica
“ *alutacea*
Schistocerca rubiginosa
Melanoplus scudderi
“ *fasciatus*
“ *atlanis*
“ *luridus*
“ *femoratus*
Paroxya scudderi
Scudderia curvicauda
“ *furcata*
Amblycorypha oblongifolia
Microcentrum sp.
Orchelimum erythrocephalum

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[14] Taken once, however, at “Anglesea,” Cape May County, by John B. Smith.

Other species regularly found in the Pine Barrens, but either scarce throughout or of only local frequency, include the following:

Syrbula admirabilis
Eritettix carinatus
Chlœaltis conspersa
Hippiscus rugosus (?)
Hesperotettix brevipennis
Dendrotettix quercus
Melanoplus tribulus
“ *femur-rubrum*[15]
“ *impudicus*
“ *stonei*
“ *punctulatus*
Scudderia texensis
Amblycorypha rotundifolia
“ *uhleri*
Conocephalus robustus
Orchelimum glaberrimum
“ *spinulosum*
“ *pulchellum*
“ *minor*
Xiphidium brevipenne
“ *strictum*
“ *saltans*
Atlanticus dorsalis
“ *pachymerus*

The species in the following list appear from available records to be of only very infrequent or exceptional occurrence in the Pine Barrens, and are evidently stragglers or invaders from the Delaware Valley, Coastal or Cape May Districts. Certain of these forms, however, may occur in fair numbers in places much modified by human angency.

Mermiria vigilans
Orphulella speciosa
Clinocephalus elegans
Dichromorpha viridis
Stenobothrus curtipennis
Mecostethus lineatus
Encoptolophus sordidus
Trimerotropis maritima
Schistocerca americana
Melanoplus minor
Paroxya floridiana
Conocephalus triops
“ *exiliscanorus*
“ *lyristes*
“ *caudellianus*
Xiphidium fasciatum

As previously mentioned, we distinguish three types of Pine Barren habitats, each of which is characterized by certain well-defined peculiarities of moisture, substratum and flora. Correlated with these we have equally well-marked differences in the Orthopteran faunule of each habitat.

The Orthopteran faunule of the Sand Barrens is a markedly xerophilous one, this being especially true of those forms that inhabit bare, open stretches of clear, white sand. In such places the dominant species are the geophilous arenicoles, *Scirtetica marmorata* and *Psinidia fenestralis,* while associated with them are usually smaller, but considerable, numbers of *Spharagemon wyomingianum* and very rarely a few examples of *Trimerotropis maritima.* Where the sand

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[15] Abundant locally in farming and residential districts, but scarce in typical Pine Barrens.

has become covered with a low open blueberry scrub, numerous additional species are of frequent occurrence, such as *Melanoplus luridus, Spharagemon bolli, Orphulella pelidna, Hippiscus phœnicopterus, Dissosteira carolina, Melanoplus fasciatus,* and *M. impudicus.* In higher and denser scrub, such as is formed by a mixture of blueberry bushes and oak saplings, the more strictly arenicolous types become infrequent, while sylvan types become dominant. Among these we may mention as especially frequent the following: *Melanoplus luridus, Spharagemon bolli, Schistocerca rubiginosa, Melanoplus impudicus, Melanoplus scudderi, Melanoplus fasciatus, Scudderia curvicauda* and *Scudderia furcata.* The typical Sand Barrens faunule, taken as a whole, consists of the following species:

Orphulella pelidna
Arphia sulphurea
Hippiscus phœnicopterus
Dissosteira carolina
Spharagemon bolli
" *wyomingianum*
Psinidia fenestralis
Scirtetica marmorata
Schistocerca damnifica
" *rubiginosa*
Hesperotettix brevipennis
Melanoplus scudderi
" *fasciatus*
" *tribulus*
" *impudicus*
" *luridus*
" *femoratus*
Scudderia curvicauda
" *furcata*
Amblycorypha oblongifolia
" *rotundifolia*
Microcentrum sp.

Belonging to this faunule, but usually rare and local in distribution, are the following:

Eritettix carinatus
Trimerotropis maritima
Dendrotettix quercus
Melanoplus minor
Melanoplus stonei
" *punctulatus*
Orchelimum minor
Xiphidium brevipenne

In the more extensive clearings, such, for example, as the firebreaks along the railroads, where the scrub growth is short and quite open with considerable grassy areas intermixed, a campestral-like modification of the Sand Barren faunule takes place, characterized by the presence of large numbers of species typical of the Coastal District. The more abundant of these apparently secondary species are *Melanoplus atlanis, Arphia xanthoptera, Chortophaga viridifasciata* and *Melanoplus femoratus.* With these are the usual typical Pine Barren species.

The Peat Bog faunule of the Pine Barrens is usually typified by the following species of Orthoptera: *Schistocerca alutacea, Paroxya scudderi, Orchelimum glaberrimum, erythrocephalum* and *pulchellum.* As rare or occasional constituents we may mention *Chlœaltis conspersa,* *Stenobothrus curtipennis, Mecostethus lineatus, Clinocephalus elegans, Paroxya floridiana, Orchelimum vulgare, O. spinulosum* and *Xiphidium fasciatum. Mermiria vigilans* I took once in a rather open bog at Belle Plain along the southern edge of the Pine Barrens. All of these species are most frequent in the more open, well-lighted parts of the bogs. In the densely wooded parts they are absent or exceedingly scarce.

In cleared and cultivated districts a type of faunule occurs which in essential respects resembles the Subcoastal faunule of the Coastal District. This faunule is characterized by the dominance of *Melanoplus femur-rubrum*, a grasshopper that is remarkedly exceptional in the less disturbed portions of the Pine Barrens, as Rehn has pointed out. Common associates of this species in the settled parts of the Barrens are *Dissosteira carolina, Orphulella pelidna, Melanoplus atlanis, Arphia xanthoptera, Chortophaga viridifasciata* and *Melanoplus femoratus.* Much less frequent and, on the whole, rather local forms appear to be such species as *Conocephalus robustus, C. triops, Orchelimum vulgare, Xiphidium strictum, Amblycorypha uhleri* and *Hippiscus rugosus.* This faunule is most typically represented in old and neglected fields well overrun with weedy vegetation.

IV (*c*). THE MIDDLE DISTRICT OR DELAWARE VALLEY.

As already mentioned, I am not disposed to consider the Middle District of the Coastal Plain as having the same faunal value as the Coastal and Pine Barren Districts. It contains no distinctive species of Orthoptera, its claim to recognition as a separate Orthopteran faunal province being based solely upon the intermingling of faunules which in the other districts rarely or never intermingle and the absence of certain of the more distinctive Pine Barren types.

The Middle District includes all that part of New Jersey which lies south of the fall-line and west and north of the Delaware-Atlantic Divide, together with the more hilly districts of northern Coastal Plain New Jersey and a narrow strip of relatively low land in Pennsylvania bordering the Delaware River south of Trenton. As Stone has shown, this part of Pennsylvania has many distinctive Coastal Plain plants. A similar agreement is to be seen in the Orthoptera, especially in those inhabiting the marshes.

This strip of Coastal Plain country in Pennsylvania has so many characteristics differentiating it from the more typical Coastal Plain as exemplified in New Jersey that it requires separate consideration. It represents a series of successive flood-plains of the Delaware River, each of which is separated from the next succeeding one by a low escarpment or terrace. The youngest of these is practically on a level with the river and forms a strip of marshland varying in width from a fraction of a mile to three or four miles. The most typical representative of this level is the well-known Tinicum Marshes immediately south of Philadelphia. In physiographic and floristic features these marshes bear a close resemblance to the undrained, open bottomlands of the Central States. Except where ditched and diked, these marshes are permanently covered with water backed up by the tide. They support a luxuriant growth of hydrophytic grasses and sedges. The soil is a rich, dark muck, the dark color being due to the decay of the marsh vegetation.

Back of these river marshes is a terrace, about forty feet in height, which marks the border of a level tract corresponding to an earlier stage of deposition (Cape May Stage). A still earlier stage is represented by a second terrace a mile or two further away from the river (Pensauken Stage). This extends back to the escarpment that marks the position of the fall-line. The deposits forming these terraces are alluvial in origin and consist of light-colored gravels and clay loams essentially similar in appearance and texture to the typical Piedmont soils. The soil is quite fertile and is extensively cultivated, so that the region consists mostly of open fields and pastures.

The Orthoptera of these upland terraces are, with two exceptions, common Piedmont types, so that from the standpoint of their grasshopper fauna these terraces are a part of the Piedmont. The two exceptions are *Orphulella pelidna* and *Melanoplus differentialis*, the former of which I have found to be locally quite frequent along the edge of the lower terrace, as at Bartram's Gardens, but it is not quite as common or as evenly distributed as its congener, *O. speciosa*, which is a typical Piedmont species. *Melanoplus differentialis* is in a class by itself. It appears to have been introduced from the West. It is now abundant in the low lands bordering the Delaware River and frequently migrates from them to the neighboring uplands.

One Piedmont species has never, so far as I am aware, been recorded from these terraces. I refer to *Hippiscus tuberculatus*.

In the following list I give the species of grasshoppers, which, so far as known, occur on these terrace lands:

Dichromorpha viridis
Orphulella speciosa
" *pelidna*

Arphia sulphurea
" *xanthoptera*
Chortophaga viridifasciata

Encoptolophus sordidus
Dissosteira carolina
Melanoplus atlanis
" *femur-rubrum*
" *minor*
" *differentialis*
Melanoplus femoratus
Conocephalus triops
Orchelimum vulgare
Xiphidium fasciatum
" *brevipenne*

This list is doubtless incomplete. Further examination of the country would probably show the presence of other typical or common Piedmont forms not here listed.

The river marshes are characterized by a fauna which in many respects approximates that typical of the wet lands of the Coastal Plain, but which retains a strong Piedmont cast. In southeastern Pennsylvania these marshes have yielded a rich Orthopteran fauna consisting of the following species:

Dichromorpha viridis
Orphulella speciosa
" *pelidna*
Stenobothrus curtipennis
Mecostethus lineatus
Arphia xanthoptera
Chortophaga viridifasciata
Encoptolophus sordidus
Dissosteira carolina
Schistocerca alutacea[16]
Melanoplus atlanis
" *femur-rubrum*
" *minor*
" *differentialis*
" *femoratus*
Paroxya floridiana
Scudderia texensis
" *curvicauda*
Amblycorypha rotundifolia[16]
Conocephalus robustus
" *triops*
" *nebrascensis*
" *palustris*
Orchelimum vulgare
" *spinulosum*
Xiphidium fasciatum
" *saltans*[16]
" *brevipenne*
" *strictum*

In this list two minor groups are represented, *i.e.*, that characteristic of dry ground, such as occurs on the low elevations which occur here and there on the marshes, and that of the marshes proper. The former includes such species as *Orphulella speciosa, O. pelidna, Arphia xanthoptera, Chortophaga viridifasciata, Encoptolophus sordidus, Dissosteira carolina, Melanoplus atlanis, M. minor, Conocephalus robustus,* and *Xiphidium strictum.* The second group includes *Stenobothrus curtipennis, Mecostethus lineatus, Paroxya floridiana, Conocephalus nebrascensis, C. palustris* and *Orchelimum spinulosum.* The remaining species occur indifferently in both kinds of habitat, though certain of them may exhibit a stronger preference for one of the habitats as compared with the other.

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[16] Apparently very unusual, but represented by specimens in the collection of the Academy of Natural Sciences.

The Coastal Plain affinities of these lowlands is shown in the presence of such Orthoptera as *Paroxya floridiana*, *Conocephalus robustus*, *C. nebrascensis* and *C. palustris*, and in the comparative abundance of such forms as *Orphulella pelidna* and *Scudderia texensis*. On the other hand, the influence of the Piedmont is evidenced by the abundance of species like *Dichromorpha viridis*, *Orphulella speciosa*, *Stenobothrus curtipennis* and *Encoptolophus sordidus*.

In this narrow strip of Coastal Plain country the most abundant grasshopper is *Melanoplus femur-rubrum*. It far outnumbers all the other species and is especially abundant in the low humid tracts adjoining the river marshes. Less common, but quite frequent species are *Dichromorpha viridis*, *Stenobothrus curtipennis*, *Dissosteira carolina*, *Chortophaga viridifasciata*, *Encoptolophus sordidus*, *Orphulella speciosa*, *Orchelimum vulgare*, *Melanoplus differentialis*, *M. femoratus*, *Xiphidium fasciatum*, *Orchelimum spinulosum*, *Xiphidium strictum*, *X. brevipenne* and *Arphia xanthoptera*. Other forms of not uncommon occurrence are *Orphulella pelidna*, which in spots may be a close rival of its congener, *O. speciosa*, *Conocephalus robustus*, *C. triops*, and *Scudderia texensis*. The remaining species are more or less infrequent or local in distribution.

Further south at Newcastle, Delaware, the Coastal Plain component of the fauna becomes more prominent, due to the influx of the more strictly Coastal types, such as *Tryxalis brevicornis*, *Syrbula admirabilis* and *Orchelimum herbaceum*. My study at this locality was very superficial, but during a few hours' collecting there I noted the following species:

Tryxalis brevicornis
Syrbula admirabilis
Dichromorpha viridis
Orphulella speciosa
  “ *pelidna*
Arphia xanthoptera
Dissosteira carolina
Melanoplus femur-rubrum
Melanoplus differentialis
  “ *femoratus*
Paroxya floridiana
Scudderia texensis
Conocephalus triops
Orchelimum herbaceum
Xiphidium fasciatum

East of the Delaware River in New Jersey the Middle District forms a zone varying between 10 and 25 miles in width. The underlying geological formations are unconsolidated sediments of sand, clay and glauconitic marls with occasional shell beds belonging to the Cretaceous and Miocene Ages, but, except where they have been exposed by stream erosion, these are everywhere covered by a sheet of Pleistocene sand and gravel. Close to the Delaware-Atlantic divide the land possesses a moderate amount of relief; here the streams have cut ravines of from 50 to 100 feet in depth. Near the Delaware, however, the surface is an almost level plain with the streams meandering sluggishly through wide tidal mud-flats. In their upper courses there is sufficient fall to enable the streams to effect fairly adequate drainage, so that extensive inland bogs comparable to those at the heads of the Pine Barren streams, are exceptional. In their lower reaches the streams are so near tide level that drainage is extremely imperfect and, as a result, the low flats bordering the streams are kept in a state of perpetual saturation.

The soils of the Middle District are much more varied than are those of the other subdivisions of the Coastal Plain. The most frequent is the Norfolk sand which occurs at practically all levels. As a rule, it is thinner than in the Pine Barrens and the resultant proximity to the water-table probably accounts for the somewhat less xerophytic aspect of the vegetation which in West Jersey grows on this type of soil. At higher elevations, where Norfolk sand is naturally drier, it is not readily cultivable and is accordingly mostly forested, the dominant tree growth consisting of pines (*Pinus virginiana* and *rigida*), oaks (*Quercus alba, stellata, prinus, marylandica* and *ilicifolia*) and hickories (*Hichoria alba* and *glabra*). At lower levels, as in the immediate vicinity of the Delaware River, where the surface of the sand approaches close to tide level, conditions obtain similar to those of the Coastal Strip. The sand here is quite productive, and consequently most of the country is cleared and used for farming purposes.

Locally there are extensive tracts of loamy soils developed in West Jersey which in many respects closely approach the Piedmont soils. The more important of these are the Collington sandy loam and the Sassafras loam. The former is derived from the green sand or glauconitic marls of the Cretaceous series. This material is highly retentive of moisture and is also extremely rich in available plant-foods. The Collington sandy loam is largely confined to the vicinity of the streams along which the greensand layers have been exposed by erosion. Owing to its richness, nearly all areas of this soil are under cultivation; the forests persisting only on the steeper slopes along the streams. The vegetation is decidedly mesophytic in aspect, the usual tree growth consisting of white, black and red oaks, hickories, chestnut, beech, tulip-trees, red cedar, sweet gum, red maple and dogwood.

The Sassafras loam is typically represented in the vicinity of

Bridgeton. As analyzed by the Bureau of Soils, it is remarkable for its low sand content (9–25%) and high percentage of silt (55–75%) and clay (10–15%). It is a highly fertile soil and is almost entirely under cultivation.

The grasshopper fauna of the New Jersey portion of the Middle District includes the following species:

Tryxalis brevicornis
Pseudopomala brachyptera
Syrbula admirabilis
Eritettix carinatus[17]
Dichromorpha viridis
Clinocephalus elegans
Orphulella speciosa
" *pelidna*
" *olivacea*[17]
Chlœaltis conspersa
Stenobothrus curtipennis
Mecostethus lineatus
Arphia sulphurea
" *xanthoptera*
Chortophaga viridifasciata
Encoptolophus sordidus
Hippiscus phœnicopterus
" *rugosus*
Dissosteira carolina
Spharagemon bolli
" *wyomingianum*
Trimerotropis maritima
Psinidia fenestralis
Scirtetica marmorata
Schistocerca americana[17]
" *damnifica*
" *alutacea*
" *rubiginosa*
Melanoplus scudderi
" *atlanis*
" *femur-rubrum*
" *minor*
Melanoplus luridus
" *differentialis*
" *femoratus*
Paroxya floridiana
Scudderia texensis
" *curvicauda*
" *pistillata*
" *furcata*
Amblycorypha oblongifolia
" *rotundifolia*
" *uhleri*
Microcentrum spp.
Conocephalus robustus
" *triops*
" *ensiger*
" *nebrascensis*
" *lyristes*[17]
" *palustris*[17]
Orchelimum vulgare
" *herbaceum*
" *spinulosum*
" *pulchellum*
" *minor*
" *fidicinium*[17]
Xiphidium fasciatum
" *brevipenne*
" *strictum*
" *saltans*
" *spartinæ*
" *nigropleuroides*[17]
Atlanticus dorsalis

The dominant and more uniformly distributed types in the Middle District are the species belonging to the Coastal fauna, but in the northern half these are associated with a considerable number of typical Piedmont species, such as *Dichromorpha viridis*, *Stenobothrus curtipennis* and *Encoptolophus sordidus*. All three of these are com-

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[17] Not, so far as I am aware, actually recorded from the Middle District, but occurrence highly probable.

mon in the upper portions of the district, though, on the whole, considerably less frequent than in the Piedmont Region. *Orphulella speciosa* has been taken in the Middle District, but appears to be exceedingly scarce, in marked contrast to its abundance on the west shores of the Delaware. During four seasons' collecting I took only two specimens. The Piedmont component of the fauna gradually thins out as one goes southward. *Encoptolophus sordidus* I have not taken south of Laurel Springs, Camden County, while the southern limits of *Dichromorpha viridis* are, according to my observations, in the vicinity of Bridgeton, Cumberland County. *Stenobothrus curtipennis* extends into the Cape May Peninsula, but is there of very local occurrence.

The most abundant grasshopper is *Melanoplus femur-rubrum*. Other forms which appear to be of common occurrence are *Orphulella pelidna, Melanoplus atlanis, Dissosteira carolina, Chortophaga viridifasciata, Arphia xanthoptera, Orchelimum vulgare, Melanoplus femoratus, Psinidia fenestralis, Xiphidium fasciatum, Xiphidium strictum, Paroxya floridiana, Melanoplus differentialis* (locally on the Delaware below Gloucester), *Encoptolophus sordidus* (in the northern half only), *Xiphidium brevipenne*, and *Arphia sulphurea*. Somewhat less frequent, but of not uncommon occurrence, are *Syrbula admirabilis, Melanoplus scudderi, Scudderia texensis, curvicauda* and *furcata, Conocephalus robustus, C. triops, Spharagemon bolli, Hippiscus rugosus, Dichromorpha viridis* (northern section only) and *Stenobothrus curtipennis* (frequent, but somewhat local, in northern section, exceptional in southern section). The remaining species are either rare or, if frequent, only under exceptional circumstances.

Locally, where there are considerable areas of nearly pure sand of moderately high elevation, conditions prevail closely resembling those of the Pine Barrens. An isolated patch of this kind occurs just west of Jericho, Cumberland County (shown in pink on the map accompanying the State report on insects). In such places the Orthoptera have a strong Pine Barren aspect. The prevailing species are *Scirtetica marmorata, Melanoplus luridus, Psinidia fenestralis, Spharagemon bolli, Spharagemon wyomingiana, Orphulella pelidna, Arphia sulphurea, Hippiscus phœnicopterus* and *Schistocerca rubiginosa*. With these are other species, such as *Dissosteira carolina, Melanoplus atlanis, Arphia xanthoptera, Chortophaga viridifasciata, Schistocerca damnifica, Melanoplus scudderi, M. femoratus, M. femur-rubrum* (a minor constituent of this association), *Syrbula admirabilis, Scudderia curvicauda* and *furcata* and *Xiphidium brevipenne*.

On those areas where the dominant soil is a loam, as in the "marl-belt" and the Sassafras loam district, the Orthoptera have a pronounced mesophilous aspect, the fauna closely resembling that of the Piedmont Region. This faunule is dominated by *Melanoplus femur-rubrum*, with which are usually associated *Dissosteira carolina, Melanoplus femoratus, Arphia xanthoptera, Orphulella pelidna, Dichromorpha viridis, Chortophaga viridifasciata, Encoptolophus sordidus* and *Orchelimum vulgare.*

IV (*d*). The Cape May District.

This, according to Stone, includes the Cape May Peninsula south of the Great Cedar Swamp. Floristically, the district is characterized by the presence of a considerable number of Lower Austral types which do not extend north of the district. In the Orthopteran fauna this distinction is not so pronounced, the only species which are peculiar to the region or extend but a short distance beyond it being *Mermiria vigilans* and *Conocephalus fuscostriatus.* Negatively, the district is characterized by the absence or relative scarcity of certain Middle District and Pine Barren species. Of Middle District species the following are as yet unknown from the Cape May Peninsula: *Dichromorpha viridis, Encoptolophus sordidus, Melanoplus differentialis* and *Atlanticus dorsalis; Orphulella speciosa* and *Stenobothrus curtipennis* occur, but are local and usually quite rare.

Of typical Pine Barren species there appear to be no records of the existence of the following species in the Cape May Peninsula, though some of them may occur as far south as the southern edge of the Great Cedar Swamp, as at Sea Isle Junction, where I have taken several species which I have not been able to find elsewhere in the Peninsula:

Sphöragemon wyomingianum
Dendrotettix quercus
Melanoplus impudicus
“ *tribulus*[18]
“ *fasciatus*[18]
“ *stonei*

Melanoplus punctulatus
Paroxya scudderi[18]
Orchelimum erythrocephalum[18]
“ *pulchellum*[18]
“ *minor*[18]
Atlanticus dorsalis

I have never been able to find *Hesperotettix brevipennis* south of the Great Cedar Swamp, but there is a single female in the Academy collection taken by John B. Smith at "Anglesea."

The following list includes all the species of Acrididæ (exclusive

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[18] Taken at Sea Isle Junction.

of Tettiginæ) and Locustidæ (exclusive of Gryllacrinæ and Stenopelmatinæ) known to me to occur in the district:

Tryxalis brevicornis
Pseudopomala brachyptera
Mermiria vigilans
Syrbula admirabilis
Eritettix carinatus
Clinocephalus elegans
Orphulella speciosa
" *pelidna*
" *olivacea*
Clœaltis conspersa
Stenobothrus curtipennis
Mecostethus lineatus
Arphia sulphurea
" *xanthoptera*
Chortophaga viridifasciata
Hippiscus phœnicopterus
" *rugosus*
Dissosteira carolina
Spharagemon bolli
Trimerotropis maritima
Psinidia fenestralis
Scirtetica marmorata
Schistocerca americana
" *damnifica*
" *alutacea*
" *rubiginosa*
" sp. (*obscura*)
Hesperotettix brevipennis
Melanoplus scudderi
" *atlanis*
" *femur-rubrum*
Melanoplus minor
" *luridus*
" *brevipenne*
" *strictum*
" *saltans*
" *spartinæ*
" *nigropleuroides*
" *femoratus*
Paroxya floridiana
Scudderia texensis
" *curvicauda*
" *furcata*
Amblycorypha oblongifolia
" *rotundifolia*
" *uhleri*
Microcentrum sp.
Conocephalus robustus
" *triops*
" *lyristes*
" *exiliscanorus*
" *caudellianus* (?)
" *nebrascensis*
" *palustris*
Orchelimum vulgare
" *glaberrimum*
" *herbaceum*
" *spinulosum*
" *campestre*
" *fidicinium*
Xiphidium fasciatum

In the Cape May Peninsula two subdivisions, each with certain distinctive physiographic and biotic features, can usually be distinguished. One of these, which in every respect agrees with the Coastal District as already described, includes the salt marshes, the low forelands just inside of the salt marshes and the beaches. The other subdivision we may speak of as the Interior District. This in its general aspect closely resembles the true Pine Barrens, though differing from the latter in some important respects. It consists of a flat sandy plain, which, except where cleared by human agency, is covered with a practically continuous stretch of oak and pine forest.

The characteristics of the Coastal District, so far as they come within the scope of this article, have already been considered. In the Cape May region the Coastal District is represented by a narrow strip along the ocean, locally known as "The Seaside," and a similar strip along the shore of Delaware Bay, known as "The Bayside." Both are alike in essential respects, although the beaches are absent or exceptional on the bayside. North of Wildwood Junction the seaside and bayside are entirely separated by the wooded interior, but south of that point, as noted by Stone, the two converge and unite to form a continuous belt of Coastal District country extending clear across the lower third of the peninsula.

The Interior District, as previously mentioned, partakes of the nature of the Pine Barrens. The soil is typically a coarse sand of the Norfolk type. It is similar apparently to the sands of the Pine Barrens, but differs in its usually more humid condition and its higher content of organic matter, a state of affairs doubtless due to the extremely low elevation (rarely over 25 feet above sea-level) and consequent proximity of the surface to underground water. The tree growth consists predominantly of pitch pine (*Pinus rigida*), white oak (*Quercus alba*), post oak (*Q. stellata*) and pig-nut hickory (*Hichoria glabra*); of less frequent occurrence are Jersey pine (*P. virginiana*), black oak (*Q. velutina*), Spanish oak (*Q. triloba*), black-jack (*Q. marylandica*), sassafras (*Sassafras sassafras*) and holly (*Ilex opaca*).

The bogs of the Interior in their general appearance closely resemble those of the Pine Barrens, but, with a few exceptions in the northernmost part of the district, differ from the latter in the conspicuous absence of the white cedar (*Chamæcyparis thyoides*). The usual tree growth consists of red maple (*Acer rubrum*), sour-gum (*Nyssa sylvatica*), magnolia (*M. virginiana*), sweet-gum (*Liquidamber styraciflua*), Spanish oak (*Q. triloba*) and willow oak (*Q. phellos*). The lower scrub growth consists largely of *Clethra alnifolia* and *Azalea viscosa*. In clearings the dominant plants are *Woodwardia virginica*, *Juncus* (tall species, probably *canadensis*) and sedges (*Eriophorum virginicum* and *Rhynchospora alba*); with these are associated lesser numbers of such plants, as *Lilium superbum*, *Aletris farinosa*, *Blephariglottis blephariglottis*, *Pogonia ophioglossoides*, *Drosera longifolia*, *Polygala lutea*, *P. cruciata*, *Rhexia virginiana*, *R. mariana*, *Asclepias pulchra* and *Oxypolis rigidior*.

South of Wildwood Junction the character of the vegetation undergoes a gradual change, assuming more the aspect of the vegetation which is characteristic of the lowland woods of the Delaware Valley and Coastal District. The pitch pine becomes a less important constituent of the flora, though not uncommon in spots throughout the whole lower part of the peninsula.

Orthoptera, such as we are concerned with in this article, occur in numbers only in those parts of the Interior District where more or less extensive clearings exist in the otherwise continuous forests. Where the clearings are small and entirely surrounded or bordered by the woods, a sylvan type of fauna obtains similar in facies to that of the Pine Barrens, but lacking some of the more distinctive species of the latter, such as *Spharagemon wyomingianum*, *Melanoplus fasciatus* and *impudicus* and *Orchelimum erythrocephalum*. This faunule is best developed in the northern section of the district; in the southern section it appears to be only locally represented.

The species usually associated with the dry pine and oak woods are the following:

Orphulella pelidna
Arphia sulphurea
Hippiscus phœnicopterus
Spharagemon bolli
Psinidia fenestralis
Scirtetica marmorata
Schistocerca damnifica
Schistocerca rubiginosa
Melanoplus scudderi
“ *luridus*
Scudderia curvicauda
“ *furcata*
Amblycorypha oblongifolia
Microcentrum sp.

The bogs are characterized by the presence of the following:

Schistocerca alutacea
Scudderia curvicauda
Scudderia furcata

In the extreme southern portion of the peninsula some of the species here listed are apparently only locally represented. This is especially the case with the more characteristic Pine Barren forms, such as *Scirtetica marmorata*, *Melanoplus luridus* and *Schistocerca alutacea* and *rubiginosa*, all of which are abundant in the northern section, but are of only exceptional occurrence in the southern section. Their scarcity is evidently correlated with the absence of typical Pine Barren conditions.

In the Interior District removal of the forest on any extensive scale and the utilization of the land for agricultural purposes is followed by changes in the character of the fauna and flora similar to those taking place under like conditions in the Pine Barrens. The more exclusively sylvan species disappear and their place is taken by campestral types like those of the neighboring Coastal District. I have given especial attention to this matter in the vicinity of South Seaville, where the country adjoining the road connecting the seaside with the bayside has been largely cleared and placed under cultivation. In this region neglected fields are occupied by a weed vegetation similar to that occurring in similar situations in the Coastal Strip, and this is correlated with the presence of similar species of Orthoptera, the more important species being the following:

Syrbula admirabilis
Orphulella pelidna
Arphia xanthoptera
Chortophaga viridifasciata
Hippiscus rugosus
Dissosteira carolina
Psinidia fenestralis (local, on bare sandy spots)
Melanoplus atlanis
Melanoplus femur-rubrum
" *femoratus*
Scudderia curvicauda
" *furcata*
Amblycorypha uhleri
Conocephalus robustus
" *triops*
Orchelimum vulgare
Xiphidium strictum

Summary.

1. In the region covered by eastern Pennsylvania and New Jersey two strikingly different types of Orthopteran faunas are exemplified, namely, a Transition fauna in eastern Pennsylvania and northern New Jersey and an Upper Austral fauna in southern New Jersey.

2. In this region the Transition fauna coincides in distribution with the Appalachian Mountain System and the Piedmont Plateau; the Upper Austral fauna with the Coastal Plain.

3. It is not possible with the data at present available to give a complete causal explanation of the observed facts of distribution as exemplified by the Orthoptera of this region.

4. Atmospheric temperature alone does not afford a satisfactory explanation of the facts of distribution; more pertinent is the temperature of the medium in which or on which the organism, or any stage of the organism, dwells. The areal distribution of an organism is probably a resultant of the interaction of a number of factors and not of any one single factor.

5. In the region included in this study the striking differences between the biotas of the Piedmont Plateau and the Coastal Plain are closely correlated with equally striking differences in topography, drainage and soils.

6. The Piedmont Plateau is a region of considerable elevation and good drainage. Permanently wet areas constitute a relatively insignificant feature of the region.

7. The Coastal Plain is a region of very slight elevation and usually poor drainage. Permanently wet areas constitute highly important physiographic features of the region.

8. The soils of the Piedmont Plateau are loams of residual origin.

They are usually rich in moisture and available plant-food elements.

9. The soils of the Coastal Plain are prevailingly relatively coarse sands of detrital origin. They are frequently deficient in moisture and available plant-food elements.

10. From an Orthopteran faunistic standpoint, four primary subdivisions are recognizable in the eastern Pennsylvania-New Jersey region, namely, Appalachian, Piedmont, Coastal and Pine Barren. The first two are subdivisions of the Transition Zone, the last two of the Coastal Plain. Each may be regarded as a local centre of dispersal.

11. From the same standpoint, the Highlands, the Middle District and the Cape May Peninsula are to be considered as of secondary value, each representing a sort of tension zone in which there is an intermingling, overlapping or interdigitation of species from adjoining primary districts.

12. The Orthopteran fauna of the Appalachian District has never been adequately studied from a faunistic standpoint. The available data indicate that it is fundamentally Piedmont in type with the addition of a number of distinctively northern (boreal) species.

13. The Orthopteran fauna of the Highlands has also never been adequately studied. The available evidence indicates that it is thoroughly Piedmont in type with a few stragglers from the Appalachian District.

14. The Orthopteran fauna of the Piedmont Plateau is predominantly mesophilous. This is correlated with the presence of a dominant mesophytic type of vegetation.

15. The Orthopteran ecological associations of the Piedmont Plateau are usually not clearly delimited. In a general way three such groups correlated with the relative moisture content of the habitat may be recognized. These are the mesophilous, xerophilous and hygrophilous associations. Each of these may exhibit an open-country or campestral phase and a woodland or sylvan phase.

16. The mesophilous association is characteristic of rich loamy soils and a luxuriant vegetation, of which the dominant members are bright green, succulent, sod-forming grasses.

17. The xerophilous association of the Piedmont Plateau consists exclusively of the humicolous subdivision; arenicolous and saxicolous species are lacking owing to the absence of pure sand and the scarcity of bare rock surfaces. This association typically occurs on uplands or hillsides where the soil is unsuited for agricultural purposes. The associated vegetation is of a mildly xerophytic type.

18. The hygrophilous association of the Piedmont Plateau is of relatively subordinate importance owing to the limited extent of permanently moist lands. It is not sharply separable from the dominant mesophilous association. It occurs in stream meadows and small wet areas about springs or in seepage depressions. The associated vegetation consists of hydrophytes and mesophytes with hydrophytic tendencies.

19. In each of these associations the dominant phase in the Piedmont Plateau region is the campestral. The sylvan constitutes a relatively insignificant part of the fauna. The removal of the forests and the utilization of the land for farming purposes evidently favor the campestral types, while they restrict the more exclusively sylvan types.

20. The Orthopteran fauna of the Coastal Plain consists of two widely diverse, but important, constituent associations. One of these is a xerophilous association characteristic of the upland, the other a hygrophilous association characteristic of wet or humid areas. Besides these there is a mesophilous association which, however, is of relatively minor importance.

21. In contrast with their indefinite character in the Piedmont, the Orthopteran ecological groups of the Coastal Plain are usually quite clearly defined.

22. The xerophilous association of the Coastal Plain includes both arenicolous and humicolous species. It is typically developed on dry, sandy soils and is associated with a more or less xerophytic type of vegetation.

23. The hygrophilous association of the Coastal Plain is highly developed. It shows three different types in accordance with the nature of the respective environments. These are: (1) the fresh-water-marsh type, (2) the maritime or salt-marsh type, and (3) the peat-bog type. They are associated with hydrophytic (fresh-marsh type) or zerophytic (salt-marsh and peat-bog types) types of vegetation.

24. The mesophilous association of the Coastal Plain is typical of rich, loamy soils and is best represented in the productive farming districts of the Middle District. This association tends to invade other districts when these are placed under cultivation.

25. Primary faunistic subdivisions, or centres of dispersal, of the Coastal Plain are the Coastal and Pine Barren districts; secondary subdivisions, or zones of tension, are the Middle District and Cape May Peninsula. The latter is a minor centre of dispersal for a limited number of southern Orthoptera.

26. The Coastal faunule is composed of four associations, namely, (a) Subcoastal, (b) Littoral, (c) Submaritime and (d) Maritime.

27. The Subcoastal association is characteristic of the upland portions of the Coastal Strip and is associated with a sandy soil, moderate humidity, open campestral country and a mildly xerophytic type of vegetation. The dominant Orthoptera are humicolous xerophiles of the campestral phase, though arenicoles may be locally common. This at the present time appears to be the dominant Orthopteran association of the Coastal Plain. It tends to spread inland with the removal of the forests and there displace the Pine Barren types.

28. The Littoral association is characteristic of the sea-beaches. It is associated with wind-drifted sands and a highly xerophytic type of vegetation. A fairly definite zonation in the distribution of the Orthoptera can be recognized, the outer or frontal dunes being characterized by arenicoles, the leeward dunes by humicoles. Open grass formations prevail on the frontal dunes, dense thickets on the leeward dunes.

29. Human occupation of the beaches is evidently effecting far-reaching changes in the composition of the beach fauna and flora. A number of Subcoastal Orthoptera appear to have been introduced directly or indirectly through human agency.

30. The Submaritime association is a somewhat modified representative of the fresh-water marsh group and is characteristic of the low lands adjoining the salt marshes. It is associated with a muck soil, abundant moisture and a mixed type of vegetation varying from hydrophytes to xerophytes according to location, but consisting mostly of the former.

31. The Maritime association is characteristic of the salt marshes. It is associated with a soil saturated with water and organic debris and with a highly halophytic type of vegetation.

32. The Pine Barren faunule is fundamentally a sylvan group, divisible into a Sand Barren (Pine Barren in the narrower sense) association and a Peat Bog (Cedar Swamp) association. In cultivated areas the sylvicoles are replaced by a campestral association corresponding in essential features to the Subcoastal association of the Coastal District.

33. The Sand Barren association is a distinctively xerophilous group and includes both arenicoles and humicoles, the former prevailing on exposed patches of sand, the latter in the vegetation. It is associated with a sandy soil, low humidity, forested country and a strongly xerophytic type of vegetation.

34. The Peat Bog association is a hygrophilous group associated with a peaty substratum, abundant moisture, forested surroundings and a prevailingly xerophytic type of vegetation.

35. The claim of the Middle District to recognition as a distinct Orthopteran faunistic subdivision of the Coastal Plain rests solely upon the intermingling and overlapping of faunules from the adjoining centres of dispersal. Certain characteristic Piedmont species are entirely or almost entirely limited to this part of the Coastal Plain.

36. The Middle District includes a narrow strip of relatively low land adjoining the Delaware River in southeastern Pennsylvania. Faunistically, this shows considerable differences from the typical Middle District as represented in west Jersey.

37. The Orthopteran faunule of the Pennsylvania subdivision of the Middle District is essentially a Piedmont fauna with which is intermixed a minor constituent of Coastal Plain origin. The latter is best represented in the river marshes.

38. In the Middle District of west Jersey the dominant faunule is the Coastal faunule, the Piedmont faunule being a decidedly minor constituent of the Orthopteran fauna. The Pine Barren faunule is only locally represented.

39. The Piedmont types are frequent in the northern half of the Middle District, but disappear rapidly in the southern section. They are typically associated with the presence of loam soils, a moderate supply of moisture and mesophytic vegetation.

40. The Cape May District includes representatives of two faunules. One, corresponding to the Coastal faunule, characterizes the two sides of the Peninsula and its entire lower third; the other, representing a southward extension of part of the Pine Barren faunule, occupies the interior districts of the northern section.

42. The Interior Orthopteran association of the Cape May District is a typical sylvan group. Clearing of the country and its conversion into farm lands is accompanied by a disappearance of the sylvan types and an invasion of the campestral Subcoastal association.

Annotated List of Species.[19]

TRYXALIS Fabr.

T. brevicornis Johann.

General Range.—Southern Ontario and Long Island to southern

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[19] In view of the more or less unsettled state of taxonomic nomenclature at the present time, I have chosen to designate the species by the names which have been in current use during the last decade rather than those which belong to them according to the rule of priority.

Florida, west to Texas and eastern Nebraska, typically an Austral species; also in Central and South America.

Local Distribution.—Very rare or accidental in the Piedmont Plateau; frequent, but more or less local in the Middle and Coastal Districts of the Coastal Plain, apparently most abundant in the lower Delaware Valley.

Ecological Distribution.—Largely a Submaritime species, being especially frequent in the patches of *Scirpus americanus* along the borders of the salt marshes, in smaller numbers extending a short distance inland along tidal streams.

Locality Records.—

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.).

Middle District.—Newcastle, Del. (Fox).

Jamesburg (Johnson); Delair (N. J. Coll.); Lucaston (Daecke); Almonesson (Wenzel); Canton (Fox); Dorchester (Fox).

Coastal District.—West Creek (Rehn); Ocean View (Fox); Anglesea (N. J. Coll.); Cold Spring (Long, Fox); Cape May Point (Fox); Goshen (Fox); Dennisville (Davis).

PSEUDOPOMALA Morse.

P. brachyptera Scudd.

General Range.—New England States to Florida, west to Minnesota and Nebraska, most frequent in the northern States, apparently exceptional south of the Middle Atlantic States.

Local Distribution.—Usually quite rare and local in both the Piedmont Plateau and Coastal Plain, exceptionally frequent locally. No records from the Pine Barrens.

Ecological Distribution.—Rather variable in its habitat preferences, frequenting dry, scrubby areas, usually in sylvan surroundings, in inland localities, but along the coast occurring in the Submaritime zone, where it is partial to the *Iva oraria* fringes along the edge of the salt marshes, occasionally spreading to scrubby areas on the adjoining upland.

Locality Records.—

Piedmont Plateau.—Fort Lee, N. J. (Beutenmuller).

Williamson's School, Delaware Co., Pa., on serpentine barren (Long); Fern Hill, Chester Co., Pa., on serpentine, exceptionally common (Hebard and Rehn).

Middle District.—Clementon, N. J., in dry, sandy oak and pine barren (Fox).

Coastal District.—Ocean View, one specimen taken on sandy upland (Subcoastal); another in Submaritime zone along the edge of the salt marsh (Fox); Goshen, several males taken or observed in *Iva oraria* and *Scirpus americanus* along the edge of the salt marsh (Fox).

MERMIRIA Stal.

M. vigilans Scudd.

General Range.—Southern New Jersey to Florida near the coast.

Local Distribution.—Not recorded outside of Cape May County, usually rare and local, most frequent at the extreme southern extremity of the peninsula, apparently very exceptional in the upper part of the county, typically found in the immediate proximity of the coast, but occasionally occurring a short distance inland.

Ecological Distribution.—Typically a member of the Submaritime association, frequenting the tall sedges and associated thickets along the borders of the salt marshes, rarely occurring inland in open bogs of Pine Barren aspect.

Locality Records.—

Pine Barrens (?).—Belle Plain, Cape May Co., in a bog containing a mixture of Middle District (or Coastal) and Pine Barren plants (*Acer rubrum, Betula populifolia, Lobelia canbyi, Sabatia lanceolata, Spirea tomentosa*) (Fox).

Coastal District.—Ocean City (N. J. St. Mus. Rep.); Anglesea (N. J. St. Mus. Rep.); Cape May (N. J. St. Mus. Rep., Fox); Cape May Point (Fox).

SYRBULA Stal.

S. admirabilis Uhl.

General Range.—New Jersey to Florida, west to northern Indiana, Illinois, Kansas and Texas.

Local Distribution.—Restricted to the Coastal Plain, most frequent in the lower Middle District and Coastal Strip; less frequent and apparently more or less local in the Pine Barrens. Absent on the beaches.

Ecological Distribution.—Adapted to a rather wide range of conditions, but occurring most abundantly in dry grasslands on sandy soils, less frequent apparently in open woodland scrub. Typically a member of the Subcoastal association, being frequent in old fields in the Coastal Strip and lower Delaware Valley and in similar situations in the interior of the Cape May Peninsula. In the Pine Barrens it appears to be more common in the vicinity of human habitations than in the more remote and typical portions.

Locality Records.—

Middle District.—Newcastle, Del. (Fox).

Washington Park (Fox); North Woodbury (Viereck); Almonesson (Fox); Blackwood (Fox); Laurel Springs (Fox); Clementon (Fox); Jericho (Fox); Canton (Fox).

Pine Barrens.—Taunton (Stone); Clementon (Fox); Stafford's Forge (Rehn); West Creek (Rehn); Atsion (Hebard); Parkdale (Rehn and Hebard); Manumuskin (Daecke, Fox); Belle Plain (Fox); Mt. Pleasant (Fox); head of Tuckahoe River (Fox).

Coastal District.—Petersburg (Fox); Ocean View (Fox); Cape May (Daecke); Cape May Point (Fox).

Cape May Interior.—Sea Isle Junction (Fox); South Seaville (Fox); Dennisville (Fox); Clermont (Fox).

ERITETTIX Bruner.

E. carinatus Scudd. (= *Simplex* Scudd.).

General Range.—New England to Maryland and southern New Jersey, south in the mountains to northern Alabama.

Local Distribution.—Very local and usually rather scarce, occurring in both the Piedmont Region and the Coastal Plain. Not positively recorded from the Middle District and doubtless absent from the beaches.

Ecological Distribution.—Apparently a humicolous xerophile, preferring dry upland localitions on barren soils, covered with coarse grasses and low scrub growth.

Locality Records.—

Piedmont Plateau.—Schwenksville, Montgomery Co., Pa., on trap ridge (Fox); Ashbourne, Philadelphia Co., Pa. (Rehn); Pink Hill, near Newtown Square, Delaware Co., Pa., on serpentine (Rehn and Hebard, Fox); Fern Hill, near West Chester, Pa., on serpentine (Rehn and Hebard).

Pine Barrens.—Between Penbryn and Williamstown Junction, in low blueberry scrub (Fox).

Coastal District.—Ocean View, in dry pasture (Fox).

Cape May Interior.—Sea Isle Junction, in low grass on sand (Fox); Clermont, in low scrub (Fox).

ORPHULELLA Giglio-Tos.

O. speciosa Scudd.

General Range.—Southern Canada and northern United States south to the latitude of Maryland, and in the mountains to northern Alabama, west to Nebraska.

Local Distribution.—Quite common, though somewhat local, in the Appalachian, Highland and Piedmont Districts and the Pennsylvania portion of the Middle District, extremely scarce and local in the Coastal Plain.

ECOLOGICAL DISTRIBUTION.—A humicolous xerophile, inhabiting fields, pastures, hillsides and woodland borders, preferring areas of coarse grasses on dry, more or less barren or undisturbed soils.

LOCALITY RECORDS.—

Appalachian District.—Ricketts, Wyoming Co., Pa. (Stewardson Brown); Ganoga Lake, Sullivan Co., Pa. (Stewardson Brown); Rockville.

Piedmont Plateau.—Rock Hill, Bucks Co., Pa. (Fox); Perkasie, Bucks Co., Pa. (Fox); Fort Washington, Montgomery Co., Pa. (Fox); Mt. Airy, Philadelphia Co., Pa. (Fox); Germantown, Philadelphia Co. (Fox); Fern Hill, Chester Co. (Hebard and Rehn); Pink Hill, Delaware Co. (Fox); Castle Rock, Delaware Co. (Rehn and Hebard); Bound Brook, N. J. (N. J. St. Mus. Rep.).

Highlands.—Sparta, N. J. (N. J. St. Mus. Rep.); Orange Mts., N. J. (N. J. St. Mus. Rep.).

Middle District.—Bartram's Garden, Philadelphia, Pa. (Fox); common; Elmwood, Philadelphia Co., frequent in dry grassy tracts along the edge of the Tinicum marshes (Fox); Essington, Delaware Co., Pa. (Fox).

Newcastle, Delaware, frequent (Fox).

Washington Park, 1 male (Fox), Almonesson, 1 male, var. *bilineata*, on sandy barren (Fox).

Pine Barrens.—Stafford's Forge, 2 females (Rehn).

Coastal District.—Anglesea, 1 female (N. J. St. Mus.).

REMARKS.—Both the normal and the *bilineata* types occur in our range, the normal being vastly in excess of the latter type, which may be regarded as relatively scarce. In addition there is much variability as regards color and markings in different individuals, these occurring indifferently in both the normal and *bilineata* types. Of the color varieties there are, (*a*) a form with the ground color a light olivaceous; (*b*) one in which it is green; (*c*) a form which may have either of these two ground colors, but has more or less of the upper surface a bright crimson or orange, instead of the usual pale brown. Of the variations in markings there are two forms, one in which the body color is practically uniform, another in which it is conspicuously mottled with darker blotches of black or brown. In our region the most frequent type is the uniformly colored, olivaceous variety, but the others are by no means infrequent.

O. pelidna Burm.

General Range.—Southern New England, Ontario, Michigan and Minnesota, south to Florida and the Gulf States, west to Colorado and New Mexico; most abundant in the Austral zones, especially near the coast, more or less local in the northern and central States.

Local Distribution.—Rare or only occasionally frequent locally in the Piedmont Plateau; common locally in the Pennsylvania portion of the Middle District; abundant in all parts of the Coastal Plain, including the beaches.

Ecological Distribution.—Habitat preferences rather variable, but typically a humicolous xerophile. In the Piedmont Region it is associated with *O. speciosa;* in the Coastal Plain it usually occurs on dry sands or sandy loams wherever there is at least a moderate amount of plant cover in the form of grass or low herbage; less frequently it occurs in open peat-bogs and meadows.

Locality Records.—

Piedmont Plateau.—Perkasie, Bucks Co., Pa., 2 out of 106 *Orphulellæ* were of this species (Fox); Mt. Airy, Philadelphia Co., 19 out of 108 of this species, the rest *speciosa* (Fox); Pink Hill, Delaware Co. (Rehn, Fox); in my own collection 4 out of 49 *Orphulellæ* were of this species.

Middle District.—Bartram's Garden, Elmwood, Philadelphia Co., of 125 *Orphulellæ* 45 were *pelidna* (Fox); Essington, Chester Co., 14 *pelidna* out of a total of 26 *Orphulellæ* (Fox).

Newcastle, Del., frequent (Fox).

Riverton, N. J. (Viereck); Washington Park (Fox), abundant; Almonesson (Fox); Mantua (Fox); Laurel Springs (Fox); Medford (Rehn); Jericho (Fox); Canton (Fox).

Pine Barrens.—Taunton (Stone); Bear Swamp, Burlington Co. (Rehn); Speedwell (Rehn); Clemonton (Rehn, Fox); Penbryn (Fox); between Cedar Grove and Chatsworth (Rehn); Stafford's Forge (Rehn); West Creek (Rehn); Atsion (Hebard); Winslow (Fox); Rosedale (Rehn and Hebard); Parkdale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox); head of Tuckahoe River (Fox).

Coastal District.—Petersburg (Fox); Palermo (Fox); Seaville (Fox); Ocean View (Fox); Goshen (Fox); Sea Isle City (Fox); Seven-mile Beach (Fox); Anglesea (Fox); Cape May (Viereck, Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); South Seaville (Fox); Dennisville (Fox); Clermont (Fox); Swain (Fox); Rio Grande (Fox); Bennett (Fox).

REMARKS.—Same color variations in this as in the preceding species.

O. olivacea Morse.

GENERAL RANGE.—Southern Connecticut to Florida, Louisiana and Panama along the coast.

LOCAL DISTRIBUTION.—Common in salt marshes in the Coastal and doubtless also in the lower Middle District.

ECOLOGICAL DISTRIBUTION.—Common on the salt marshes in the short variety of *Spartina glabra;* much less frequent in the Submaritime zone and rare on the mainland adjoining the salt marsh.

LOCALITY RECORDS.—

Coastal District.—Atlantic City (Rehn); Beesley's Point (Fox); Sea Isle City (Fox); Ocean View (Fox); Anglesea (A. N. S.); Goshen (Fox).

REMARKS.—This species is much less variable than the two preceding species. The usual color is an olivaceous brown with paler dorsal parts. Individuals with more or less green are not uncommon, but I have never seen a single specimen with the reddish upper parts. Both uniformly colored and mottled individuals occur, the former being more frequent.

DICHROMORPHA Morse.

D. viridis Scudd.

GENERAL RANGE.—Southern New England to Florida, west to Minnesota, Nebraska and Texas.

LOCAL DISTRIBUTION.—Abundant in the Piedmont Region and the Pennsylvania portion of the Middle District; less frequent and largely local in the New Jersey Middle District, becoming rare in its southern part; very local in the northern half of the Pine Barrens; apparently entirely absent from the southern Pine Barrens, Coastal District and Cape May Peninsula.

ECOLOGICAL DISTRIBUTION.—Prevailingly a frequenter of low, humid areas, especially rich, grassy meadows; less frequent but not uncommon in upland situations where there is a thick growth of succulent grasses; occasional in quite dry locations, such as stony hillsides.

LOCALITY RECORDS.—

Highlands.—Boonton, N. J. (G. M. Greene, A. N. S.).

Piedmont Plateau.—Highspire, Dauphin Co., Pa. (Pa. St. Dept. Zool.); Rock Hill, Bucks Co., Pa. (Fox); Perkasie, Bucks Co., Pa. (Fox); Collegeville, Montgomery Co., Pa. (Fox); Fort Washington, Montgomery Co. (Fox); Mt. Airy, Philadelphia Co. (Fox); Fern

Hill, Chester Co. (Rehn and Hebard); Pink Hill, Delaware Co., Pa. (Rehn and Hebard, Fox); Castle Rock, Delaware Co. (Rehn and Hebard).

Middle District.—Tullytown, Bucks Co., Pa. (Fox); Philadelphia Neck (Rehn); Elmwood, in Tinicum Meadows (Fox); Paschalville, Philadelphia Co., in Tinicum Meadows (Fox); Essington (Fox).

Newcastle, Del. (Fox).

Washington Park, Gloucester Co., N. J. (Fox); Mantua (Fox); Almonesson, scarce (Fox); Blackwood, moderately frequent in succulent grass on bank of stream (Fox); Laurel Springs (Fox), not common; Clementon, occasional in open bogs and pond borders (Fox); Bridgeton, several in a small, humid depression (Fox); Jericho, scarce in an open meadow along stream (Fox).

Pine Barrens.—Bear Swamp, Burlington Co. (Rehn); Clementon, occasional (Fox); Penbryn, edge of cedar bog, scarce (Fox); Atsion (Hebard).

REMARKS.—Both brown and green phases occur in our region in approximately equal numbers.

CLINOCEPHALUS Morse.

C. elegans Morse.

GENERAL RANGE.—New Jersey to Florida and Louisiana, mostly near the coast.

LOCAL DISTRIBUTION.—Abundant in the Coastal District and the Maritime portions of the Delaware Valley; rare inland.

ECOLOGICAL DISTRIBUTION.—A characteristic species of the Submaritime zone, frequenting especially the mixed growth of *Spartina patens* and *Juncus gerardi* along the edges of the salt marsh; very exceptional inland in cranberry bogs.

LOCALITY RECORDS.—

Middle District.—Canton, Salem Co., N. J., in Submaritime zone (Fox).

Pine Barrens.—Ocean County, on cranberry bogs, rare (Smith in N. J. St. Mus. Rep.); Belleplain, Cape May Co., in a small, neglected cranberry bog in oak-pine woods, 1 male (Fox).

Coastal District.—West Creek (Rehn); Beesley's Point (Fox); Ocean View (Fox); Sea Isle City (Fox); Seven-mile Beach (Fox); Anglesea (Wenzel); Cape May (Viereck, N. J. St. Mus. Rep., Fox); Goshen (Fox); Cold Spring (Long).

CHLŒALTIS Harris.

C. conspersa.

GENERAL RANGE.—Canadian Provinces to southern New Jersey, Maryland and Illinois, south in the mountains to North Carolina and Arkansas, west to Alberta, Minnesota and Nebraska.

Local Distribution.—Rare and local throughout, except on the beaches from which we have no records.

Ecological Distribution.—Typically a denizen of moist woodland, frequenting grasses and sedges around wet depressions; in the Coastal District occurring along the outer edge of the Submaritime zone where the latter joins the upland in association with *Iva oraria* scrub.

Locality Records.—

Appalachian District.—Sullivan Co., Pa. (A. N. S.); Culvers Lake, Sussex Co., N. J. (N. J. St. Mus. Rep.).

Highlands.—Lake Hopatcong, Newfoundland (N. J. St. Mus. Rep.).

Piedmont Plateau.—Fort Lee, N. J. (Beutenmuller).

Valley Forge, Chester Co., Pa. (Hebard); Fern Hill, Chester Co. (Rehn and Hebard); Pink Hill, Delaware Co., Pa., grassy borders of stream and adjoining slope on edge of a small grove (Fox); Angora (Greene).

Middle District.—Almonesson, boggy depression in low oak woods (Fox); Clementon, boggy spot in mixed oak and pine woods (Fox).

Pine Barrens.—Lakehurst (Davis); Tuckerton (Davis); Browns Mills Junction (Daecke in N. J. St. Mus. Rep.); Speedwell (Rehn); Atsion (Rehn); Winslow, grassy and scrub undergrowth in moist pine woods (Fox); Parkdale (Rehn and Hebard); Belleplain, grassy and bushy undergrowth in low oak woods surrounding an extensive bog (Fox).

Coastal District.—Ocean View, scarce, but taken regularly in Submaritime zone several seasons in succession (Fox).

STENOBOTHRUS Fisch. (= *Chorthippus* Fieb.).

S. curtipennis Harris.

General Range.—Canadian Provinces to Maryland and Indiana, in the mountains to North Carolina; west to Alberta and eastern Nebraska.

Local Distribution.—Abundant in the Appalachian and Piedmont Districts and along both banks of the Delaware River; rare and local elsewhere in the Coastal Plain.

Ecological Distribution.—A hygrophilous type typical of grassy and sedgy swamps, ditches and stream borders, especially abundant in meadowlands. In the Coastal Plain appears to be largely restricted to the succulent grasses bordering the more open bogs; exceptional in sphagnum and cranberry bogs.

LOCALITY RECORDS.—

Appalachian District.—Ricketts, Wyoming Co., Pa. (S. Brown); Bellasylva, Wyoming Co., Pa. (S. Brown); Ganoga Lake, Sullivan Co., Pa. (S. Brown); Turnersville, Wayne Co., Pa. (B. Long); South Sterling, Wayne Co., Pa. (Long); Loanna, Pike Co., Pa. (Long).

Highlands.—Lake Hopatcong, Sparta, Culvers Lake, Newfoundland, Orange Mts., N. J. (N. J. St. Mus. Rep.).

Piedmont Plateau.—Caldwell, N. J. (N. J. St. Mus. Rep.); Rock Hill, Pa. (Fox); Collegeville, Pa. (Fox); Fort Washington, Pa. (Fox); Fern Hill, Pa. (Rehn and Hebard); Pink Hill, Pa., in "hummock" bog, valley of Fawkes Run (Fox).

Middle District.—Tullytown, Pa. (Fox); Elmwood, Pa. (Fox); Paschalville, Pa. (Fox); Essington, Pa. (Fox).

Jamesburg, N. J. (N. J. St. Mus. Rep.); Washington Park (Fox); Almonesson (Fox); Clementon (Fox).

Pine Barrens.—"Ocean Co." (Smith, in N. J. St. Mus. Rep.); Folsom, in open bog border, several (Fox); Belleplain, one individual in small cranberry bog in oak and pine woods (Fox).

Coastal District.—Ocean View, very local, moderately frequent in the succulent grass surrounding a *Scirpus americanus* depression near Devaul Run (Fox); Petersburg, small numbers in succulent grass on slope adjoining overflow marsh on Cedar Swamp Creek (Fox); Anglesea (Rehn).

MECOSTETHUS Fieb.

M. lineatus Scudd.

GENERAL RANGE.—Canadian Provinces to southern New Jersey, Indiana and Illinois, west to eastern Nebraska.

LOCAL DISTRIBUTION.—Appalachian District and Coastal Plain, very local and only exceptionally frequent, usually scarce. Only one record from the Piedmont Plateau. In our region most frequent apparently on the shores of the Delaware River.

ECOLOGICAL DISTRIBUTION.—A strongly hygrophilous species, preferring marshes in which there is a tall and dense growth of grasses and sedges.

LOCALITY RECORDS.—

Appalachian District.—Lopez, Sullivan Co. (Long).

Piedmont Plateau.—Fort Lee (Beutenmüller).

Middle District.—Elmwood in a *Homalocenchrus oryzoides* bog on Tinicum Meadows (Fox); Tinicum Meadows (Rehn and Hebard).

Between Washington Park and Red Bank in a small "hummock" (*Carex stricta ?*) swamp (Fox).

Pine Barrens.—"Ocean Co." on cranberry bog (N. J. St. Mus. Rep.); Lakehurst (*idem.*); between Winslow and Folsom, 1 individual taken in *Woodwardia virginica* patch in peat bog (Fox); Folsom (Rehn and Hebard); Hammonton (N. J. St. Mus. Rep.); Belleplain (Fox), 1 taken in bog.

Coastal District.—Anglesea (N. J. St. Mus. Rep.).

ARPHIA Stal.

A. sulphurea Fabr.

General Range.—Southern New England and Ontario to northern Florida, west to eastern Nebraska and Texas.

Local Distribution.—Frequent, though more or less local, throughout the Piedmont Plateau and Coastal Plain; absent on the beaches.

Ecological Distribution.—A xerophilous species frequenting especially bare soil surfaces usually in the vicinity of woodlands; not infrequent in dry grasslands.

Locality Records.—

Appalachian District.—Rockville (Pa. St. Dept. Zool.).

Piedmont Plateau.—Rock Hill (Fox); Cliffs of the Delaware below Kintnersville (Fox); Trappe (Fox); Valley Forge (Hebard, Fox); Mt. Airy (Fox); Fern Hill (Rehn and Hebard); Pink Hill (Rehn and Hebard, Fox); Castle Rock (Daecke); Williamson School (Long).

Middle District.—Tullytown, on sandy eminence in open woods (Fox); Philadelphia (A. N. S.).

DaCosta (Daecke); Westville (Rehn); Barnesboro (Fox); Almonesson (Fox).

Pine Barrens.—West Plains (Rehn); Clementon (Rehn, Fox); Penbryn (Fox); Winslow (Fox); Parkdale (Rehn and Hebard); Manumuskin (Daecke); Belleplain (Fox); Formosa Bog (Fox).

Coastal District.—Petersburg (Fox); Ocean View (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville (Fox); Dennisville (Fox).

A. xanthoptera Burm.

General Range.—Southern New England and Wisconsin, south to Florida and Texas, west to Nebraska.

Local Distribution.—Essentially the same distribution as the preceding, but rather more frequent; somewhat local in the Piedmont

Region and Pine Barrens, but common almost everywhere in the Middle and Coastal Districts. Absent or rare on the beaches.

Ecological Distribution.—Essentially a humicolous xerophile, apparently preferring campestral stations, but not uncommon in very open woodland. Especially frequents dry grasslands; also occurs in numbers on bare loamy and clayey soils, but seems to avoid bare sand.

Locality Records.—

Appalachian District.—Ricketts, Ganoga Lake (S. Brown).

Highlands.—Orange Mts. (N. J. Mus. Rep.); Middlesex Co. (*idem.*).

Piedmont Plateau.—Fort Lee (Beutenmuller).

Rockville (Pa. St. Dept. Zool.); Perkasie, frequent in hillside pasture on stony soil (Fox); Trappe (Fox); Collegeville, upland cornfields, stubble-fields and roadsides, frequent (Fox); Valley Forge, frequent on dry grassy hillsides (Fox); Edge Hill (Long); Ashbourne (Long); Mt. Airy (Fox); Germantown (Fox); Fern Hill (Rehn and Hebard); Pink Hill (Fox).

Middle District.—Philadelphia (Viereck); Elmwood (Fox); Essington (Fox); Newcastle, Del. (Fox).

Riverton (Rehn); Washington Park (Fox); Almonesson (A. N. S., Fox); Blackwoods (A. N. S.); Atco (Rehn); Medford (Stone); Laurel Springs (Fox); Clementon (Rehn, Fox); Jericho (Fox).

Pine Barrens.—Whitings (Rehn); between Cedar Grove and Chatsworth (Rehn); Staffords Forge, in pine woods undergrowth (Rehn); West Creek (Rehn); Atsion (Hebard); Clementon (Rehn, Fox); Manumuskin, most frequent in settlements, infrequent in dry, open patches of bare sand in pine woods (Fox); Belleplain (Fox), mostly in open places; Mt. Pleasant (Fox); Formosa Bog common in a neglected field near an old house, but unusual in the surrounding oak and pine woods (Fox).

Coastal District.—Ocean View, quite frequent in old grassy and weedy fields (Fox); Anglesea (A. N. S.).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville, especially frequent in old fields (Fox); Clermont (Fox); Dennisville (Fox); Swain (Fox); Bennett (Fox).

Remarks.—Only the yellow-winged phase of this species seems to occur in any numbers in our region. The red or orange-winged phase I have never seen in the field, though it is possible that it may occur as a very rare variant. This is in marked contrast to the frequency of the red-winged phase in the Central Western States where it is nearly or quite as common as the yellow phase. The usual explanation that the red-winged phase is due to greater humidity is difficult to harmonize with the almost exclusive prevalence of the yellow-winged type in our region, which is more humid than the States west of the Appalachians.

CHORTOPHAGA Sauss.

C. viridifasciata De Geer.

General Range.—New England States and southern Canada, to Georgia, Minnesota, Colorado and Texas.

Local Distribution.—Common throughout the Piedmont Plateau and Coastal Plain, probably also in the Appalachian District. Perhaps a secondary introduction on the beaches. Somewhat local in the Pine Barrens, occurring chiefly near human habitations.

Ecological Distribution.—Occurs in a wide range of habitats; most typical apparently of relatively dry, open grasslands, but not infrequent in more humid surroundings, such as meadowlands; avoids locations that are actually wet. Less frequent in sylvan habitats than in campestral. Exceptional on bare sand and in low scrubby vegetation.

Locality Records.—

Appalachian District.—Honesdale (Pa. St. Coll.); Rockville (Pa. St. Coll.); Pocono (A. N. S.).

Piedmont Plateau.—Perkasie (Fox); cliffs of the Delaware below Kintnersville (Fox); Schwenksville (Fox); Trappe (Fox); Collegeville (Fox); Eagleville (Fox); Valley Forge (Hebard, Fox); Willow Grove (Fox); Fort Washington (Fox); Edge Hill (A. N. S.); Mt. Airy (Fox); Germantown (Fox); Pink Hill (Rehn and Hebard, Fox); Castle Rock (Rehn and Hebard).

Middle District.—Tullytown (Fox); Elmwood (Fox); Essington (Fox).

Riverton (Rehn); Washington Park (Fox); Medford (Rehn); Lindenwold (Long); Almonesson (Fox); Blackwood (Fox); Barnesboro (Fox); Ashland (Fox); Laurel Springs (Fox); Clementon (Fox); Canton (Fox).

Pine Barrens.—Speedwell (Rehn); Bear Swamp (Rehn); Clementon (Fox); Penbryn (Fox); Winslow (Fox); Elm (Fox); Folsom (Rehn and Hebard); near West Creek (Rehn); head of the Tuckahoe River (Fox); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox).

Coastal District.—Ocean View (Fox); Petersburg (Fox); Sea

Isle City, mostly in neglected lots, on roadsides and railway embankments (Fox); Piermont (Fox); Angelsea (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville (Fox); Clermont (Fox); Dennisville (Fox); Swain (Fox); Rio Grande (Fox); Bennett (Fox).

ENCOPTOLOPHUS Scudd.

E. sordidus.

General Range.—Southern Canada to Florida and Texas, west to Nebraska.

Local Distribution.—An abundant and characteristic species of the Appalachian and Piedmont Regions; scarce or lacking in the greater part of the Coastal Plain, occurring in numbers only in the Middle District; barely entering the Pine Barrens along their northern and western borders. No records from the remainder of the Pine Barrens, the Coastal District or the Cape May Peninsula.

Ecological Distribution.—Typically a species of dry grassland, preferring campestral stations; common in old and neglected fields, roadsides, pastures, etc.

Locality Records.—

Appalachian District.—Ricketts (Brown); Ganoga Lake (Brown); Wyoming Co. (A. N. S.); Rockville, Marysville (Pa. St. Dept. Zool.).

Highlands.—Newfoundland (N. J. St. Mus. Rep.).

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Perkasie (Fox); Trappe (Fox); Collegeville (Fox); Valley Forge (Fox); Edge Hill (Long); Ashbourne (Long); Lawndale (A. N. S.); Mt. Airy (Fox); Germantown (Fox); Fern Hill (Rehn and Hebard); Pink Hill (Fox); Castle Rock (Rehn and Hebard); Caldwell, Newark, New Brunswick (N. J. St. Mus. Rep.).

Middle District.—Elmwood, Essington, abundant in all relatively dry locations (Fox); Philadelphia (A. N. S.).

Washington Park, abundant in dry grassy locations (Fox); Laurel Springs, frequent in grasslands (Fox).

Pine Barrens.—Ocean Co. (N. J. St. Mus. Rep.); Speedwell (Stone).

CAMNULA Stal.

C. pellucida Scudd.

General Range.—Canadian Provinces to northern Pennsylvania, Indiana and Illinois, west to the Pacific States.

Local Distribution.—Apparently quite scarce in the Appalachian District, absent elsewhere. Known by positive record only from northeastern Pennsylvania.

Ecological Distribution.—Not known from personal investigation, but apparently, according to descriptions of authors, a denizen of dry grasslands.

Locality Records.—

Appalachian District.—Wayne Co., Pa. (Long).

HIPPISCUS Sauss.

H. tuberculatus Beauv. (= *apiculatus* Harris).

General Range.—Canadian Provinces south to southern Pennsylvania, northern Indiana and Illinois, extending in the mountains to North Carolina; west to Alberta, Northwest Territories and Colorado.

Local Distribution.—Apparently frequent in the Appalachian District; not uncommon, but more or less local in the Piedmont Plateau. Absent from the Coastal Plain or at most barely entering it along its northern border.

Ecological Distribution.—Typically restricted to dry grass and scrub lands, usually in the vicinity of woodlands; rarely occurring in damp, upland stream meadows.

Locality Records.—

Appalachian District.—Wayne Co. (Long); Tyrone (Pa. St. Dept. Zool.); Honesdale (*ibid.*); Bendersville (*ibid.*); Huntingdon (*ibid.*); Langsdorf (*ibid.*).

Highlands.—Hewitt (N. J. St. Mus. Rep.); Newfoundland (N. J. St. Mus. Rep.); Great Notch (N. J. St. Mus. Rep.); High Bridge (N. J. St. Mus. Rep.).

Piedmont Plateau.—Cliffs of the Delaware below Kintnersville (Fox); Schwenksville, several in dry roadside vegetation along edge of woods (Fox); Trappe, 1 individual in low thickets near edge of woods (Fox); Eagleville, exceptionally frequent in an upland meadow in long grass adjoining a small stream, not near woodland (Fox); Valley Forge, frequent in clearings and along the edge of woods on high ridge (Fox); Mt. Airy, several taken in a dry, grassy upland field adjoining a small stream (Fox).

Middle District.—Farmingdale (Johnson, in N. J. St. Mus. Rep.).

H. phœnicopterus Germ.

General Range.—Southern New Jersey and southern Illinois to Georgia, Mississippi and Texas, west to southeastern Nebraska.

Local Distribution.—Largely restricted to the Coastal Plain, where it is common in the Pine Barrens and Cape May Peninsula, less frequent and more local in the Middle District and probably accidental on the beaches and in the Piedmont of New Jersey.

ECOLOGICAL DISTRIBUTION.—Characteristic of low, rather open thickets and scrub growth on relatively pure sands, usually in the vicinity of woodlands; less frequent, but not always uncommon in dry, open grasslands.

LOCALITY RECORDS.—

Piedmont Plateau.—Little Falls, Caldwell, New Brunswick (N. J. St. Mus. Rep.).

Middle District.—Almonesson, on sandy barrens, not common (Fox); Turnersville, frequent on upland sand barrens and sandy fields adjoining the woods (Fox).

Pine Barrens.—Speedwell (Rehn); Clementon (Rehn, Fox); Winslow (Fox); Atsion (Hebard and Rehn); head of Batsto (Rehn); Manumuskin (Fox); Mt. Pleasant (Fox).

Coastal District.—Palermo (Fox); Ocean View (Fox); Sea Isle City, 1 individual observed in a vacant lot in the centre of the town, probably accidentally brought over from the mainland (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville, largely restricted to wooded areas (Fox); Greenfield (Fox); Clermont (Fox); Swain (Fox); Rio Grande (Fox); Bennett (Fox).

H. rugosus Scudd. (incl. *H. compactus* Scudd.).

GENERAL RANGE.—New England States and Minnesota, south to Florida and Texas, west to Nebraska.

LOCAL DISTRIBUTION.—Very local in the Piedmont Region, but occasionally quite frequent; more abundant, but also somewhat local in the Coastal Plain, apparently having its stronghold in the lower Delaware Valley and Coastal Districts. Seems to be quite exceptional in the Pine Barrens. Rare, possibly accidental, on the beaches.

ECOLOGICAL DISTRIBUTION.—A species of dry or moderately humid grasslands and low scrub, frequenting especially old, neglected fields and woodland borders.

LOCALITY RECORDS.—

Highlands.—Orange Mts. (N. J. St. Mus. Rep.).

Piedmont Plateau.—Bound Brook, New Brunswick, Caldwell (N. J. St. Mus. Rep.).

Perkasie (Fox); Valley Forge (Fox); Fern Hill (Rehn and Hebard); Pink Hill (Fox); Collingdale (Rehn).

Middle District.—Lahaway (N. J. St. Mus. Rep.); Canton (Fox).

Pine Barrens.—Lakewood (N. J. St. Mus. Rep.); head of Tuckahoe River (Fox).

Coastal District.—Ocean View, frequent in old, briery fields and along edge of woods (Fox); Anglesea (N. J. St. Mus. Rep.).

Cape May Interior.—S. Seaville (Fox); Dennisville (Fox); Clermont (Fox)[20]; Swain (Fox).

Remarks.—All individuals of this species taken by me were of the yellow-winged variety.

DISSOSTEIRA Scudd.

D. carolina Linn.

General Distribution.—All temperate North America from the Atlantic to the Pacific.

Local Distribution.—Abundant in all districts with the possible exception of certain parts of the Pine Barrens.

Ecological Distribution.—Found in all dry or moderately humid locations where there is more or less bare ground; largely a campestral species, less frequent in sylvan haunts; occurs in fields, meadows, and open woodland, especially abundant on roads, paths, trails, etc.

Locality Records (list includes my own records only).

Piedmont Plateau.—Rock Hill, Perkasie, Collegeville, Valley Forge, Fort Washington, Mt. Airy, Germantown, Pink Hill, Philadelphia.

Middle District.—Tullytown, Elmwood, Paschalville, Essington, Newcastle.

Washington Park, Mantua, Almonesson, Laurel Springs, Clementon, Jericho, Canton.

Pine Barrens.—Clementon, Penbryn, Winslow, most frequent in cleared land, less common in scrub land; Manumuskin, Belleplain, Mt. Pleasant, Formosa Bog, mostly on more open roads and in abandoned fields, infrequent in woodland clearings.

Coastal District.—Petersburg, Palermo, Seaville, Ocean View, Court House, Goshen, Green Creek, Sea Isle City, Townsend Inlet, Seven-mile Beach, Anglesea, Wildwood, Cape May, Dennisville.

SPHARAGEMON Scudd.

S. saxatile Morse.

General Range.—New England States south in the mountains to southern Virginia, locally westwards to Arkansas.

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[20] The record for Cedar Grove attributed to me in the N. J. St. Mus. Report refers to this Cape May County locality, which is also called Cedar Grove, and not to the Pine Barren locality described under that name in the list of localities.

Local Distribution.—Restricted to the Appalachian and Highlands Districts.

Ecological Distribution.—A distinctively saxicolous species, occurring, according to Morse, on bare rock surfaces, ledges and thinly grassed rocky soil.

Locality Records.—

Appalachian Region.—Lehigh Gap (Rehn).

Highlands.—Newfoundland (Davis, N. J. St. Mus. Rep.).

S. bolli Scudd.

General Distribution.—Temperate North America, west to Colorado and Manitoba.

Local Distribution.—Occurs in the Appalachian District; very local and only rarely frequent in the Piedmont Region; more frequent but local in the Middle and Coastal Districts; especially common throughout the Pine Barrens. Not known to occur on the beaches.

Ecological Distribution.—A typical sylvan species, frequenting the grassy and scrubby undergrowth of dry woodlands.

Locality Records.—

Appalachian Region.—Enola, Rockville (Pa. St. Dept. Zool.); Bella Sylva (Brown); S. Sterling (Long); Pike Co. (Long).

Piedmont Plateau.—Valley Forge (Fox); Mt. Airy, frequent in dry grasses and open scrub in deciduous woodland (Fox); Fern Hill (Rehn and Hebard); Fairview (Rehn).

Middle District.—Almonesson, scarce (Fox); Laurel Springs, frequent (Fox); Jericho, common in sandy barrens (Fox); Canton, in woods (Fox).

Pine Barrens.—Clementon, frequent (Fox); Penbryn (Fox); Winslow, common in blueberry scrub (Fox); Parkdale, common (Rehn and Hebard); Atsion (Hebard); between Cedar Grove and Chatsworth (Rehn); Staffords Forge (Rehn, Rehn and Hebard) in "pine woods undergrowth"; Manumuskin, in blueberry scrub of open pine and oak woods (Fox); Belleplain, common in dry blueberry scrub (Fox); head of Tuckahoe River (Fox); Mt. Pleasant, common in oak and pine woods; Formosa Bogs (Fox); Dennisville, in dry, sandy woods (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville, in wooded districts, common (Fox); South Dennisville (Fox); Greenfield (Fox); Clermont (Fox); Swain (Fox); Rio Grande (Fox); Bennett, not common, very local (Fox).

S. collare wyomingianum Thos.

General Range.—Locally throughout the greater part of the continent, occurring from Canada to the Gulf and west at least to Utah.

Local Distribution.—Restricted almost entirely to the Pine Barrens, where it is locally at least quite frequent; occurring also in an outlying sand barren in the lower Delaware Valley.

Ecological Distribution.—A sand-loving species, frequenting bare patches of relatively pure, white sand and open blueberry scrub on sand.

Locality Records.—

Middle District.—Jericho, in dry wooded sand barrens (Fox).

Pine Barrens.—Clementon, locally frequent on clear, white sand and in thin vegetation (Rehn, Fox); Penbryn, in sandy field (Fox); Jamesburg, on "cranberry bogs" (N. J. St. Mus. Rep.); Atsion (Hebard); Da Costa (Skinner); Folsom, several on sandy railroad bank and in adjoining field (Fox); Parkdale (Rehn and Hebard); Manumuskin, abundant on bare sand and in open scrub in or along the borders of mixed oak and pine woods (Fox).

TRIMEROTROPIS Stal.

T. maritima Harr.

General Range.—Maine to Florida (Caudell) along the coast; also on the shores of the Great Lakes.

Local Distribution.—Abundant on the beaches; occasional inland in the remaining parts of the Coastal Plain.

Ecological Distribution.—Restricted to areas of loose and more or less shifting white sand; especially characteristic of the *Ammophila* covered dunes of the seashore; elsewhere occurring on loose sands in association with a very open formation of coarse grasses.

Locality Records.—

Middle District.—Washington Park, several on loose sand (Fox); Bayside (N. J. St. Mus. Rep.).

Pine Barrens.—Lakehurst (Davis); Folsom, associated with *Spharagemon collare*, several (Fox); Manumuskin, several on sandy bluff overlooking tidal stream (Fox); Mt. Pleasant, one on gravelly road (Fox).

Coastal District.—Sandy Hook (N. J. St. Mus. Rep.); Seaside Park (Long); Atlantic City (Fox); Ocean City (Fox); Sea Isle City (Fox); Townsend Inlet (Fox); Beesley's Point (Fox); Seven-mile Beach; Anglesea (Fox); Cape May (Fox); Cape May Point (Fox); Town bank (Fox).

Cape May Interior.—Sea Isle Junction, a permanent colony in a sand pit (Fox); S. Seaville, stray individual (Fox).

T. citrina Scudd.

General Range.—Apparently widely distributed throughout the eastern and central section of the continent from Canada to the Gulf, but usually very local; most frequent in the Southern States.

Local Distribution.—Very rare and local, so far taken in only one locality close to the Appalachian front.

Ecological Distribution.—Stated to occur on sandy and gravelly river banks and bars.

Locality Records.—Harrisburg (Pa. St. Dept. Zool.).

PSINIDIA Stal.

P. fenestralis Serv.

General Range.—Massachusetts to Florida, mostly in the Atlantic Coastal Plain; also on the shores of the Great Lakes and very local, in isolated sandy areas, in the interior as far west as Nebraska.

Local Distribution.—Abundant on bare sandy areas throughout the entire Coastal Plain of New Jersey; no records west of the Delaware River.

Ecological Distribution.—A sand-loving species frequenting areas of pure white sand, bare or but thinly clothed with low herbage; occurs in both campestral and sylvan locations.

Locality Records.—

Middle District.—Washington Park (Fox); Westville (Rehn); Riverton (G. M. Greene); Almonesson (Fox); Turnersville (Fox); Atco (Rehn); Clementon (Fox); Jericho (Fox).

Pine Barrens.—Whitings (Rehn); Taunton (Stone); Clementon (Rehn, Fox); Sumner (Rehn, Fox); Albion (Rehn, Fox); Penbryn (Fox); Staffords Forge (Rehn); Atsion (Rehn); Winslow (Fox); Parksdale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox); Mt. Pleasant (Fox).

Coastal District.—Spray Beach (Rehn); Atlantic City (Rehn); Beesley's Point (Fox); Ocean View (Fox); Sea Isle City (Fox); Seven-mile Beach (Fox); Anglesea (Fox); Cape May (Fox); Cape May Point (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville (Fox); Dennisville (Fox); Greenfield (Fox); Clermont (Fox); Swain (Fox); Rio Grande (Fox); Bennett (Fox).

Remarks.—The vast majority of specimens have decidedly reddish hind wings; many have orange and occasional examples have them a clear yellow. Light straw or nearly colorless hind wings I have never seen in local material.

SCIRTETICA Sauss.

S. marmorata Harris.

General Distribution.—Coastal Plain from southern Connecticut to Louisiana; locally recorded from southern Ontario and Michigan.

Local Distribution.—Abundant in the Pine Barrens and the northern half of the Cape May Peninsula; local elsewhere in the Coastal Plain.

Ecological Distribution.—A sand-loving species almost entirely restricted to sylvan situations. Occurs on bare sand or in open scrub on sandy soil.

Locality Records.—

Middle District.—Almonesson, scarce (Fox); Turnersville, frequent in sandy upland woods (Fox); Medford (Stone); Jericho, abundant in the wooded sand barrens (Fox); Lucaston (Rehn).

Pine Barrens.—Whitings (Rehn); Speedwell (Rehn); between Harris and White Horse (Rehn); Taunton (Stone); Atco (Rehn); Clementon (Rehn, Fox); Sumner (Fox); Penbryn (Fox); Atsion (Rehn); between Cedar Grove and Chatworth (Rehn); Staffords Forge (Rehn); West Creek (Rehn); East Plains (Rehn); Iona (Daecke); Da Costa (Daecke); Winslow (Fox); Folsom (Rehn and Hebard, Fox); Parkdale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox).

Coastal District.—Piermont, 1 individual taken on sand at leeward edge of the dune area not far from the so-called "forest."

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville, in dry woods (Fox); Dennisville, in open scrub and on sandy paths in oak and pine woods (Fox); Greenfield (Fox); Clermont (Fox); Swain (Fox); Rio Grande, local (Fox); Cape May Point, frequent on wooded dunes (Fox).

Remarks.—Three color phases of this species occur in New Jersey. The most frequent is pale gray with darker mottling, giving a color closely simulating sand; a second type is darker, the gray being suffused with dusty-brown; the third type resembles the first, but the body is much speckled with a pale green, giving the creatures a striking resemblance to the crusts of reindeer-moss that are frequent features of their habitat.

CIRCOTETTIX Scudd.

C. verruculatus Kirby.

General Range.—British Provinces and northernmost United States south to the northern borders of New Jersey and Pennsylvania, west to British Columbia.

Local Distribution.—Restricted to the mountainous parts of both States.

Locality Records.—

Appalachian District.—Delaware Water Gap (N. J. St. Mus. Rep.).

Highlands.—Dover (N. J. St. Mus. Rep.).

PODISMA.

P. variegata Scudd.

General Range.—Boreal, south in the mountains to North Carolina.

Local Distribution.—Restricted to the Appalachian District; apparently rather local.

Ecological Distribution.—Sylvan, associated especially with hemlock (*Tsuga Canadensis*) woods (Rehn).

Locality Records.—

Appalachian District.—North Mt. (Johnson); Ganoga Lake (Brown); Bellasylva (Behr); Glen Onoko (Huntington).

SCHISTOCERCA Stal.

S. americana Drury.

General Range.—Extreme southwestern Connecticut and southern Ontario to Florida, Texas and South America, especially abundant in the Austral zones.

Local Distribution.—Usually rare and local in the Coastal Plain, apparently most frequent and regular on the beaches.

Ecological Distribution.—So far as I have observed, occurs usually in tall grasses and open scrub; on the beaches frequents the *Andropogon* areas and bayberry scrub.

Locality Records.—

Piedmont Region.—Ft. Lee (Beutenmuller).

Middle District.—Newark (N. J. St. Mus. Rep.); Lahaway (N. J. St. Mus. Rep.); Philadelphia (Skinner, Hebard, Seiss.).

Pine Barrens.—Lakewood (N. J. St. Mus. Rep.).

Coastal District.—Seaside Park (Long); Avalon, scarce (Fox); Anglesea (N. J. St. Mus. Rep.), moderately frequent (Fox); Cape May (N. J. St. Mus. Rep.).

S. damnifica Sauss.

General Range.—New Jersey and southern Indiana to Georgia and Texas.

Local Distribution.—Locally frequent throughout the Coastal Plain, except the beach islands on which it seems not to occur.

Ecological Distribution.—A sylvan species occurring typically in or near dry woodlands, inhabiting low thickets and underbrush; local in open campestral country, persisting in tall grass formations and thickets.

Locality Records.—

Middle District.—Manasquan (Davis); Medford (Stone); Lucaston (N. J. St. Mus. Rep.); Florence (Calvert); Westville (Skinner); Woodbury (Viereck); Almonesson (Fox); Jericho (Fox).

Pine Barrens.—Clemonton (Rehn, Daecke, Viereck); Penbryn (Fox); between head of Batsto and Speedwell (Rehn); Winslow (Fox); Hammonton (N. J. St. Mus. Rep.); Lakehurst (Davis); Lakewood (Davis); Staffords Forge (Rehn).

Coastal District.—Palermo (Fox); Ocean View (Fox).

Cape May Interior.—Ocean View Cemetery (Fox); Bennett (Fox); Clermont (Fox).

S. alutacea Harris (Typical race).

General Range.—Southern Massachusetts to Illinois, Nebraska, Florida, Texas and New Mexico.

Local Distribution.—Common in the Pine Barrens and the upper portion of the Cape May Peninsula; very local in the Middle and Coastal Districts; not known with certainty on the beaches.

Ecological Distribution.—Typically frequenting the rank herbage of sphagnum and cranberry bogs, usually associated with a sylvan environment.

Locality Records.—

Middle District.—Tinicum (Stone).

Riverton (Viereck); Red Bank, 1 female, very aberrant, possibly a hybrid with *americana* (Fox); Jericho (Fox).

Pine Barrens.—Clementon (Rehn, Fox); Winslow (Fox); Folsom (Rehn and Hebard); Atco (Rehn); Speedwell (Rehn); Manahawken (Rehn); West Creek (Rehn); between Cedar Grove and Chatsworth (Rehn); Staffords Forge (Rehn); Whitings (Rehn); Atsion (Hebard); Parkdale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox).

Coastal District.—Cape May Court House, in a meadow containing *woodwardia virginica, Sanguisorba canadensis, Eupatorium maculatum,* etc. (Fox).

Cape May Interior.—Sea Isle Junction, in Great Cedar Swamp (Fox); S. Seaville, 1 individual in thicket near head of marshy depression (Fox); Dennisville, in woodland swamp (Fox); Swain (Fox); Nummytown (Fox).

S. rubiginosa Harris (= *rubiginosa* phase of *alutacea*).

General Range.—Apparently co-extensive with that of *alutacea.*

Local Distribution.—Occasional or possibly accidental in the Piedmont Plateau; common in the Pine Barrens and upper part of the interior district of the Cape May Peninsula; rare or local in the Middle and Coastal Districts; absent on the beaches.

Ecological Distribution.—Typical of dry, scrubby areas in oak and pine woods on sandy soils.

Locality Records.—

Piedmont Plateau.—Rockville (Pa. St. Dept. Zool.).

Middle District.—Almonesson, scarce (Fox); Jericho, frequent in sand barrens (Fox).

Pine Barrens.—Whitings (Rehn); between Cedar Grove and Chatworth (Rehn); between Harris and Whitehorse (Rehn); Taunton (Rehn); Staffords Forge (Rehn); Atsion (Hebard); Parkdale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox); Woodbine (Fox); Mt. Pleasant (Fox).

Coastal District.—Ocean View, scarce (Fox).

Cape May Interior.—Sea Isle Junction, common in relatively dry locations, not found in Great Cedar Swamp (Fox); Ocean View Cemetery, frequent in low blueberry scrub (Fox); S. Seaville, in open woods and woodland scrub (Fox); Dennisville, in similar locations (Fox); Greenfield (Fox); Clermont (Fox); Swain (Fox); Bennett, scarce in dry wood borders (Fox).

Remarks.—In addition to typical representatives of the two foregoing races, intermediates, which it is difficult to assign definitely to either race, are common and occur in association with the typical forms.

S. sp. cf. **obscura** Burm. (= unicolorous phase of *S. obscura* parallel to the *rubiginosa* phase of *alutacea;* a possibility suggested to me by Mr. Rehn).

General Range.—Not known. Typical *obscura* occurs from Maryland to Florida, Texas and Nebraska.

Local Distribution.—Restricted to and locally common on the beaches.

ECOLOGICAL DISTRIBUTION.—Characteristic of the fixed dune areas, where it frequents the tall grasses (*Andropogon*) and wax-myrtle thickets.

LOCALITY RECORDS.—

Coastal District.—Beach Haven (Long); Spray Beach (Long); Seaside Park (Long); Townsend's Inlet (Fox); Avalon (Fox); Piermont (Fox); Anglesea (Fox); Cape May (Fox).

HESPEROTETTIX Scudder.

H. brevipennis Thomas.

GENERAL RANGE.—Eastern Massachusetts to Georgia and Alabama.

LOCAL DISTRIBUTION.—Almost entirely restricted to the Pine Barrens, where it is usually rather infrequent, though occasionally moderately frequent in spots. One specimen is recorded from the Cape May Peninsula.

ECOLOGICAL DISTRIBUTION.—Frequents low scrub and undergrowth in mixed pine and oak woods and about the borders of sphagnum bogs.

LOCALITY RECORDS.—

Pine Barrens.—Lakehurst (Davis); Staffords Forge (Rehn); Atsion (Hebard and Rehn); between Winslow and Folsom (Fox); Belleplain (Fox); Mt. Pleasant (Fox); Great Cedar Swamp, north border, near Sea Isle Junction (Fox).

Cape May Peninsula.—Anglesea (Smith), 1 female, exact location of capture not known; it might have been on the mainland opposite the beach.

DENDROTETTIX Riley.

D. quercus Riley.

GENERAL RANGE.—A western species (Nebraska, Missouri, Illinois, Iowa, Texas), known in the east only from New Jersey.

LOCAL DISTRIBUTION.—Usually rare and local in the Pine Barrens, occasionally common (Davis).

ECOLOGICAL DISTRIBUTION.—Frequenting trees and scrub in oak and pine woods (Rehn); feeding on oaks and sumach (Davis).

LOCALITY RECORDS.—

Pine Barrens.—Bamber (Daecke); Ridgeway (Davis); Lakehurst (Davis).

MELANOPLUS Stal.

M. scudderi Uhler.

GENERAL RANGE.—New England to Georgia and Texas, west to Minnesota and Nebraska.

LOCAL DISTRIBUTION.—Locally frequent throughout, except on the beaches where it seems to be lacking; no actual records from the Appalachian Region, but probably occurs there.

ECOLOGICAL DISTRIBUTION.—Typically a sylvan species frequenting grassy and scrubby areas in dry woods; sometimes found away from woodland in thickets, along fences, etc.

LOCALITY RECORDS.—

Highlands.—Hopatcong, Newfoundland (N. J. St. Mus. Rep.).

Piedmont Plateau.—Collegeville (Fox); Chestnut Hill (Hebard); Mt. Airy (Fox); Germantown (Fox); Ashbourne (Long); Castle Rock (Rehn and Hebard).

Middle District.—Riverton (Johnson); Medford (Rehn); Lucaston (Daecke); Almonesson (Wenzel); Laurel Springs (Fox); Jericho (Fox).

Pine Barrens.—Lakehurst (Davis); Atsion (Rehn, Hebard); Da Costa (Daecke); Staffords Forge (Rehn); head of Tuckahoe River (Fox); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox).

Coastal District.—Palermo (Fox); Ocean View (Fox); Goshen (Fox).

Cape May Interior.—Sea Isle Junction (Fox); S. Seaville (Fox); Dennisville (Fox); Greenfield (Fox); Clermont (Fox); Bennett (Long, Fox); Cape May Point (Fox).

M. mancus Smith.

GENERAL RANGE.—New England to northern New Jersey in mountains.

LOCAL DISTRIBUTION.—As yet recorded only from the Highlands of New Jersey.

LOCALITY RECORDS.—

Highlands.—Lake Hopatcong (N. J. St. Mus. Rep.).

M. tribulus Morse.

GENERAL RANGE.—Southern Pennsylvania and New Jersey to Georgia.

LOCAL DISTRIBUTION.—Rare and local, recorded so far from the Serpentine (or Conowingo) Barrens of southeastern Pennsylvania and from the Pine Barrens and northern border of the Cape May Peninsula.

ECOLOGICAL DISTRIBUTION.—Grassy and scrubby undergrowth of dry woodlands and thickets along their borders.

Locality Records.—

Piedmont Plateau.—Pink Hill (Rehn and Hebard).

Pine Barrens.—Staffords Forge (Rehn); Belleplain (Fox).

Cape May Interior.—Sea Isle Junction (Fox).

M. fasciatus Walker.

General Range.—Canadian Provinces to northern Illinois and Indiana and southern New Jersey, south in the mountains to northern Alabama, west to Colorado and British Columbia.

Local Distribution.—Occurs in the Appalachian Region. No records of its occurrence in the Piedmont Plateau. Locally frequent throughout the Pine Barrens; occasional in the extreme upper part of the Cape May Peninsula.

Ecological Distribution.—Frequents the low scrub and undergrowth of dry woods; at times also found about the margins of bogs.

Locality Records.

Appalachian District.—Bellasylva (Stone); Lehigh Gap (Rehn).

Pine Barrens.—Jamesburg (Beutenmüller); Clementon (Fox); Whitings (Rehn); Speedwell (Rehn); Whitehorse (Rehn); Cedar Grove (Rehn); Staffords Forge (Rehn); Atsion (Rehn); between Winslow and Folsom (Fox); Parkdale (Rehn and Hebard); Da Costa (Daecke); Manumuskin (Daecke, Fox).

Cape May Interior.—Sea Isle Junction (Fox).

M. atlanis Riley.

General Range.—Canadian Provinces to Florida, Texas, Utah and Arizona.

Local Distribution.—Recorded from the Appalachian District; common, though somewhat local, in the Piedmont Plateau; plentiful in the Coastal Plain, especially in the Middle and Coastal Districts; more local in the Pine Barrens. Absent from the beaches.

Ecological Distribution.—A xerophilous species of campestral tendencies, preferring open, dry grasslands on sandy soils.

Locality Records.—

Appalachian District.—Lehigh Gap (Rehn).

Piedmont Plateau.—Valley Forge (Fox); Germantown (Fox); Pink Hill (Fox); Castle Rock (Rehn and Hebard).

Middle District.—Tullytown (Fox); Philadelphia (A. N. S.); Elmwood (Fox).

Riverton (Viereck); Atco (Rehn); Washington Park (Fox); Woodbury (Viereck); Mantua (Fox); Almonesson (Fox); Laurel Springs (Fox); Clementon (Fox).

Pine Barrens.—Clementon (Fox); Albion (Rehn); Penbryn (Fox); Winslow (Fox); Atsion (Hebard); Folsom (Rehn and Hebard); Parkdale (Rehn); Staffords Forge (Rehn); Manumuskin (Fox); Belleplain (Fox); Mt. Pleasant (Fox).

Coastal District.—Petersburg (Fox); Ocean View (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville (Fox); Dennisville (Fox); Clermont (Fox); Cape May Court House (Long); Bennett (Fox); Cape May Point (Fox).

M. femur-rubrum De Geer.

GENERAL RANGE.—Canadian Provinces to the Gulf States, west to British Columbia, Utah and New Mexico, most abundant east of the Rocky Mountains.

LOCAL DISTRIBUTION.—The most abundant species throughout, except in the Pine Barrens where it is rather local, occurring almost exclusively in cultivated areas and old fields (Rehn).

ECOLOGICAL DISTRIBUTION.—Adapted to a wide range of environmental conditions, but partial to more or less humid surroundings; largely avoids extremely dry areas, such as bare sand, or open plant formations on dry soils. Its stronghold is in the low, marshy grasslands in the river valleys and along the edges of the salt marshes, but it is also abundant, though perhaps slightly less so, in all upland districts which are under cultivation and which have a nearly continuous cover of grasses.

LOCALITY RECORDS.—It is needless to give a list of localities, since it would include about every place in which Orthoptera have been collected.

M. minor Scudd.

GENERAL RANGE.—Largely boreal, from the Canadian Provinces to southern New Jersey, Virginia, Indiana, Illinois, Nebraska and Colorado.

LOCAL DISTRIBUTION.—Frequent locally in the Piedmont Plateau, doubtless also in the Appalachian Region; rare in the Coastal Plain.

ECOLOGICAL DISTRIBUTION.—Typical of relatively dry ground covered with coarse grasses and low scrub in the vicinity of woodlands.

LOCALITY RECORDS.—

Appalachian Region.—S. Sterling (Long).

Piedmont Plateau.—Palisades of the Hudson (Beutenmüller); cliffs of the Delaware below Kintnersville (Fox); Valley Forge, frequent in open places in dry woods and in dry, grassy fields adjoining the woods (Fox); Fort Washington (Fox); Mt. Airy, frequent on dry hillside associated with *Andropogon* (Fox); Germantown (Fox); Fern Hill (Rehn and Hebard); Williamson's School, on Serpentine (Long); Pink Hill (Rehn and Hebard, Fox); Castle Rock (Rehn and Hebard).

Middle District.—Philadelphia (Rehn); Essington (Fox).

Jamesburg (Davis); Atco (Seiss); Westville (Johnson).

Pine Barrens.—Lakehurst (Davis); Speedwell (Rehn); Clementon (Long); Belleplain (Fox).

Cape May Interior.—Sea Isle Junction, several taken in low bunch-grasses on sandy soil (Fox).

M. luridus Dodge.

General Range.—Canada to southern New Jersey and in the mountains to Georgia, west to Manitoba, Minnesota, Colorado, Oklahoma and Texas.

Local Distribution.—Very common in the Pine Barrens and upper Cape May Peninsula; local in the Piedmont Plateau and Middle District. No records from the Coastal District.

Ecological Distribution.—A characteristic sylvan species, frequenting the undergrowth and border vegetation of dry woodlands.

Locality Records.—

Piedmont Plateau.—Mt. Airy, frequent in a grove associated with *Spharagemon bolli* and *Orphulella speciosa* and *pelidna* (Fox); Fairmount Park, Philadelphia (Rehn).

Middle District.—Laurel Springs (Fox); Jericho, in sandy barrens (Fox).

Pine Barrens.—Whitings (Rehn); between Cedar Grove and Chatsworth (Rehn); Staffords Forge (Rehn); Atsion (Rehn); White Horse (Rehn); Clementon (Fox); Penbryn (Fox); Sumner (Long);[21] between Winslow and Folsom (Fox); Manumuskin (Fox); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); Dennisville (Fox); Greenfield (Fox); Clermont (Fox); Swain (Fox).

M. impudicus Scudder.

General Range.—Southern New Jersey and southern Indiana and Illinois to the Gulf States, west to Oklahoma.

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[21] I include the *M. keeleri* of the State Mus. Report under this species.

Local Distribution.—Restricted to the Pine Barrens, where it appears to be only locally frequent.

Ecological Distribution.—Apparently similar to *luridus*, with which it was associated in the only locality where I have collected it. Always in our region in pine or mixed pine and oak woods.

Locality Records.—

Pine Barrens.—Jamesburg (Davis); East Plains (Davis); Lakehurst (Davis); White Horse (Rehn); near Harris (Rehn); Staffords Forge (Hebard); Atsion (Rehn, Hebard); Manumuskin, quite common in the undergrowth and in the border shrubbery of mixed oak and pine woods (Fox).

M. stonei Rehn.

General Range.—Pine Barrens of New Jersey.

Local Distribution.—Restricted to the Pine Barrens, and so far reported only from its northern portion.

Ecological Distribution.—"Low scrub under mixed pine and oak and bare sand near pine woods" (N. J. St. Mus. Rep.).

Locality Records.—

Pine Barrens.—Between Harris and White Horse (Stone and Rehn); Atsion (Rehn); Staffords Forge (Rehn).

M. differentialis (Thomas).

General Range.—Southern Michigan and Minnesota to southeastern Tennessee, Louisiana and Texas, west to the Rocky Mts.; local east of the Alleghanies in the vicinity of Philadelphia.[22]

Local Distribution.—Abundant, at least locally, in the low marshy lands adjoining the lower Delaware River and its tributaries.

Ecological Distribution.—Characteristic of alluvial lowlands, frequenting the dense succulent grasses of the marshes—*e.g.*, *Homalocenchrus oryzoides*—and the rank vegetation about their borders, especially the tall ragweed (*Ambrosia trifida*); spreading from such locations to the adjoining upland fields and gardens.

Locality Records.—

Middle District.—Philadelphia (Seiss, Rehn); West Philadelphia, in Botanic Gardens of the Univ. of Pa. on gravelly upland (Fox); Bartram's Garden, in fields and thickets on upland terrace (Fox); Philadelphia Neck (Rehn); Elmwood, in Tinicum Meadows, abundant (Fox); Essington, in Tinicum Meadows, frequent (Fox); Newcastle, frequent in rank vegetation bordering Delaware River marshes (Fox).

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[22] See Rehn, *Canad. Entom.*, Vol. XXXII, 1900, p. 28.

Riverton (Rehn); Camden (Kemp, N. J. St. Mus. Rep.); Westville (Johnson); Red Bank, common in rank growth along river marshes (Fox); Dennisville, 1 male, moist environment, evidently near salt marsh (Davis in personal letter).

M. femoratus Burm.

General Range.—Canadian Provinces to Virginia and Kentucky, in the mountains to Georgia and Alabama, west to the Pacific States, mostly northern in distribution.

Local Distribution.—Very common in the Piedmont Plateau and probably also in the Appalachian Region; common, but rather more local in the Coastal Plain, least frequent in the Pine Barrens and on the beaches, probably being a secondary introduction on the latter.

Ecological Distribution.—Adapted to a wide variety of conditions, but seems to prefer more or less humid tracts with a continuous cover of succulent grasses and other vegetation; not infrequent, however, in quite dry situations where there is considerable cover. It occurs in both campestral and sylvan stations.

Locality Records.—

Appalachian Region.—Pike County (A. N. S.); S. Sterling (Long); Lehigh Gap (Rehn).

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Rock Hill (Fox); Fort Washington (Fox); Valley Forge (Hebard); Mt. Airy (Fox); Germantown (Fox); Fern Hill (Rehn and Hebard); Williamson School, Serpentine Barrens (Long); Pink Hill (Fox); Castle Rock (Rehn and Hebard); West Philadelphia (Fox).

Middle District.—Tullytown (Fox); Elmwood, in Tinicum meadows (Fox); Paschalville (Fox); Essington (Fox); Newcastle (Fox).

Washington Park (Fox); Red Bank (Fox); Almonesson (Fox); Blackwood (Fox); Mantua (Fox); Jericho (Fox); Canton (Fox).

Pine Barrens.—Between Cedar Grove and Chatsworth (Rehn); West Creek (Rehn); Atsion (Rehn); Clementon (Fox); Winslow (Fox); Parkdale (A. N. S.); Rosedale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox), most frequent in cultivated areas; Mt. Pleasant (Fox); Formosa Bog (Fox); head of Tuckahoe River (Fox).

Coastal District.—Ocean View, frequent in grassy areas and thickets (Fox); Anglesea, scarce (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville (Fox); Dennisville (Fox).

M. punctulatus Scudd.

General Range.—Northern; Canadian Provinces to New Jersey, North Carolina, Indiana and Nebraska.

Local Distribution.—Reported from the New Jersey Highlands and the northern section of the Pine Barrens.

Ecological Distribution.—A sylvan species of more or less arboreal habits, frequenting the trunks and branches of trees especially pine trees (Walker).

Locality Records.—

Highlands.—Newfoundland (Davis).

Pine Barrens.—Lakehurst (Davis); Browns Mills (Daecke); Staffords Forge (Hebard); Ocean Co. about cranberry bogs (Smith).

PAROXYA Scudder.

P. floridiana Scudder.

General Distribution.—Eastern Massachusetts and southern Ontario to Florida and Texas, mostly near the coast.

Local Distribution.—Very exceptional in the Piedmont Region; abundant in suitable locations in the Middle and Coastal Districts; much less frequent and apparently quite local in the Pine Barrens and upper part of the interior of the Cape May Peninsula. Abundant on the beaches.

Ecological Distribution.—A strongly hygrophilous species, frequenting the dense rank grasses and sedges of open marshes, fresh water and submaritime, but not occurring in true salt marsh.

Locality Records.—

Piedmont Plateau.—Harrisburg, in Wetzel's Swamp (Pa. St. Dept. Zool.).

Middle District.—Cornwalls (Rehn); Elmwood, in Tinicum marshes (Fox); Paschalville, in Tinicum marshes (Fox); Essington, in Tinicum marshes, especially in the rank growth of *Sagittaria* and associated plants along ditches (Fox); Newcastle (Fox).

Riverton (Viereck); Washington Park (Fox); Westville (Viereck); Blackwood (Fox); Clementon, in sedgy bog (Fox); Jericho, in open meadow along stream (Fox); Canton, in wet places along the edge of the salt marsh (Fox).

Pine Barrens.—Bear Swamp (Rehn); Clementon (Rehn); Folsom, frequent in open bog associated with *P. scudderi* (Fox); Rosedale (Rehn and Hebard); Manumuskin, in rank growth of rice grass, *Zizania palustris*, on tidal mudflats (Fox); Belleplain, in open bog containing mixture of Pine Barren and Coastal floras (Fox); Great Cedar Swamp near Sea Isle Junction, not common (Fox).

Coastal District.—Near West Creek (Rehn); Ocean View, common in tall grasses and sedges along the borders of the salt meadows (Fox); Dennisville, abundant in dense growths of tall grass, *Spartina cynosuroides*, bordering the salt marsh (Fox); Cape May Court House, abundant in a low marshy area leading toward the salt marsh (Fox); Goshen, in *Spartina cynosuroides* on tidal flat (Fox); Ocean City (A. N. S.); Avalon, in humid tracts in the dune depressions or along the edges of the salt marsh (Fox); Piermont (Fox); Anglesea (A. N. S., Fox); Cape May (Fox).

Cape May Interior.—Swain, in peat bogs (Fox).

P. scudderi Blatchley.

General Range.—Reported so far from northern Indiana and Illinois and the Pine Barrens of New Jersey and North Carolina.

Local Distribution.—Moderately frequent in the bogs of the Pine Barrens, apparently occasionally intruding into the Coastal District along their edges.

Ecological Distribution.—A characteristic species of the sphagnum bogs, frequenting especially the areas of chain-fern, *Woodwardia virginica.*

Locality Records.—

Pine Barrens.—Jamesburg (Davis); Lakehurst (Davis); Speedwell (Rehn); Bear Swamp (Rehn); Atco (Rehn); Atsion (Rehn); Staffords Forge (Rehn); Folsom (Rehn and Hebard, Fox); Rosedale (Rehn and Hebard); Parkdale (Rehn and Hebard); Belleplain (Fox); Great Cedar Swamp near Sea Isle Junction (Fox).

Coastal District.—Seaville, 1 individual taken in a *Scirpus americanus* bog adjoining a rivulet draining a near-by cedar-bog (Fox).

SCUDDERIA Stal.

S. texensis Sauss.-Pict.

General Distribution.—New England and Ontario to Florida and Texas, west to the Great Plains.

Local Distribution.—Relatively infrequent and local in the Piedmont Plateau; common in the Middle and Coastal Districts; apparently less frequent in the Pine Barrens and the interior of the upper Cape May Peninsula. Frequent on the beaches.

Ecological Distribution.—Typical of low humid areas, frequenting the rank vegetation in the vicinity of marshes; less frequent, but not uncommon, on the adjoining uplands and along the borders of dry or moist woodlands.

Locality Records.—

Appalachian Region.—Rockville (Pa. St. Dept. Zool.).

Highlands.—Hewitt (Davis).

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Perkasie (Fox), on hillside in scrubby area along edge of a small grove; Montgomery Co. (Rehn).

Middle District.—Philadelphia Neck (Rehn); Tinicum (Rehn and Hebard); Elmwood, in Tinicum meadows (Fox); Paschalville, in Tinicum meadows (Fox); Essington (Fox); Newcastle (Fox).

Washington Park (Fox).

Pine Barrens.—Between Cedar Grove and Chatsworth (Rehn); Atsion (Hebard); Staffords Forge (Rehn).

Coastal District.—Ocean View, common in fresh meadows (Fox); Goshen (Fox); Sea Isle City (Fox); Seven-mile Beach (Fox); Anglesea (Fox); Cape May (Fox).

S. curvicauda (De Geer).

GENERAL RANGE.—Canadian Provinces to Florida and Texas, west to the Plains.

LOCAL DISTRIBUTION.—Frequent throughout, except in the Coastal District from which I have no records of its occurrence.

ECOLOGICAL DISTRIBUTION.—Essentially a sylvan species, frequenting the trees and underbrush of both dry and moist woodlands, less frequent in the border-thickets of open meadowlands.

LOCALITY RECORDS.—

Appalachian District.—Rockville (Pa. St. Dept. Zool.).

Piedmont Plateau.—Caldwell (Crane); Penryn (Pa. St. Dept. Zool.); Rock Hill (Fox); Fort Washington (Fox); Montgomery Co. (Rehn); Mt. Airy (Fox); Pink Hill (Fox).

Middle District.—Philadelphia Neck (Rehn); Tinicum (Rehn and Hebard); Elmwood (Fox); Riverton (Viereck); Laurel Springs (Fox).

Pine Barrens.—Clementon (Fox); Atco (Rehn); Atsion (Rehn); between Harris and White Horse (Rehn); Parkdale (Rehn and Hebard); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Swain (Fox); Rio Grande (Fox).

S. furcata Bruner.

GENERAL RANGE.—Canadian Provinces to the Gulf States, west to the Rocky Mts.

LOCAL DISTRIBUTION.—Frequent throughout, except on the beaches, where it seems to be rather scarce.

ECOLOGICAL DISTRIBUTION.—Occurs in a variety of habitats, both sylvan and campestral, frequenting trees, scrubby areas and thickets.

LOCALITY RECORDS.—

Appalachian District.—Wayne Co. (Long).

Piedmont Plateau.—Honesdale (Pa. St. Dept. Zool.); Dauphin (*ibid.*); Camphill (*ibid.*); Catawissa (*ibid.*); Harrisburg (*ibid.*); Rock Hill (Fox); Collegeville (Fox); Valley Forge (Fox); Mt. Airy (Daecke); Collingdale (Rehn); Swarthmore (Rehn).

Middle District.—Riverton (Viereck); Woodbury (Hardenburg); Jericho (Fox); Canton (Fox).

Pine Barrens.—Clementon (Rehn); Staffords Forge (Rehn); Belleplain (Fox); Mt. Pleasant (Fox); Formosa Bog (Fox).

Coastal District.—West Creek (Rehn); Ocean View (Fox); Goshen (Fox); Avalon, rare (Fox); Anglesea, rare (Fox).

Cape May Interior.—Ocean View Cemetery (Fox); Greenfield (Fox); Clermont (Fox); Cape May Point (Fox).

S. pistillata Bruner.

GENERAL RANGE.—Canadian Provinces to New Jersey and northern Indiana, west to Manitoba.

LOCAL DISTRIBUTION.—Apparently scarce, probably largely restricted to the northern districts.

ECOLOGICAL DISTRIBUTION.—"Occurs with the other species" (Beutenmüller, in N. J. St. Mus. Rep.).

LOCALITY RECORDS.—

Highlands.—Chester (N. J. St. Mus. Rep.).

Middle District.—Lucaston (Daecke).

S. septentrionalis Serv.

GENERAL RANGE.—Apparently boreal, south to New Jersey.

LOCAL DISTRIBUTION.—Apparently scarce; reported from the Highlands and Pine Barrens.

ECOLOGICAL DISTRIBUTION.—No data seen.

LOCALITY RECORDS.—

Highlands.—Ramsey, Lake Hopatcong (N. J. St. Mus. Rep.).

Pine Barrens.—Vineland (N. J. St. Mus. Rep.).

S. truncata Beut.

GENERAL RANGE.—So far as I am aware, not taken outside the Pine Barrens of New Jersey.

LOCAL DISTRIBUTION.—Probably very rare, known only, so far as I am aware, from one locality in the Pine Barrens.

Ecological Distribution.—No data seen.

Locality Record.—

Pine Barrens.—Vineland (Beutenmüller).

AMBLYCORYPHA Stal.

A. oblongifolia De Geer.

General Distribution.—Southern Canada south to Georgia, west to the Great Plains.

Local Distribution.—Moderately frequent throughout, except on the beaches, where it seems to be lacking.

Ecological Distribution.—A sylvan species, frequenting scrub growth and borders of woodland.

Locality Record.—

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Camphill (Pa. St. Dept. Zool.); Highspire (Pa. St. Dept. Zool.); Eberly's Mill (Pa. St. Dept. Zool.); Chestnut Hill (Hebard); Mt. Airy (Daecke); Ashbourne (Long).

Middle District.—Canton (Fox).

Pine Barrens.—Da Costa (Daecke); Atsion (Rehn); Atco (Rehn); Staffords Forge (Rehn and Hebard).

Coastal District.—Absecon (A. N. S.); Ocean View (Fox).

Cape May Interior.—Greenfield (Fox).

A. rotundifolia Scudder.

General Range.—Similar to that of the preceding.

Local Distribution.—As in the preceding, but less frequent apparently.

Ecological Distribution.—As in the preceding species.

Locality Records.—

Appalachian District.—Rockville (Pa. St. Dept. Zool.).

Highlands.—Sparta (Davis); Newfoundland (Davis); Chester (N. J. St. Mus. Rep.).

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Ft. Lee (Davis).

Middle District.—Tinicum (Rehn and Hebard).

Pine Barrens.—Lakehurst (Davis); Staffords Forge (Rehn); Weymouth (Daecke); Atco (Rehn); Manumuskin (Daecke).

Coastal District.—Morgan (Davis).

Cape May Interior.—Sea Isle Junction (Fox).

A. uhleri Bruner.

General Range.—Southern New Jersey to Florida and southern Illinois and Indiana.

Local Distribution.—Confined to the Coastal Plain, where it usually appears to be of infrequent occurrence, though in some seasons it may be fairly common. Does not seem to occur on the beaches.

Ecological Distribution.—Seems, so far as my experience with it goes, to be more campestral in its habitat preferences than the other species of the genus. Frequents low scrub and grassy thickets in dry locations.

Locality Records.—

Middle District.—Lucaston (N. J. St. Mus. Rep.); Jericho, in sandy barrens (Fox).

Pine Barrens.—Atsion (Hebard);. Parkdale (Rehn and Hebard).

Coastal District.—Ocean View (Fox).

Cape May Interior.—Sea Isle Junction (Fox); S. Seaville (Fox); Clermont (Fox).

MICROCENTRUM Scudd.

M. rhombifolium Sauss. (= *laurifolium* Linn.).

M. retinerve Burm.

PTEROPHYLLA Kirby (= *Cyrtophyllus*).

C. perspicillatus Linn.

The three preceding species are the more strictly arboreal forms, which were not studied in connection with the present investigation. The few specimens which I took add practically nothing to the data already published elsewhere.

CONOCEPHALUS Thunberg of authors.

(= **Conocephaloides** Perkins.)

C. robustus Scudder.

General Range.—Coastal New England south near the coast to North Carolina; local in the interior, especially about the region of the Great Lakes.

Local Distribution.—Of common occurrence throughout the Coastal Plain, especially in the Middle and Coastal Districts; rather local apparently in the Pine Barrens. Frequent on the beaches.

Ecological Distribution.—Typical of tall, grassy thickets in both moist and dry situations. Largely limited to campestral stations. Not frequent in salt marshes.

Locality Records.—

Middle District.—Philadelphia Neck (Rehn); Elmwood, in Tinicum meadows (Fox); Essington, in Tinicum meadows (Fox).

Washington Park (Fox); Almonesson (Fox); Clementon (Fox); Jericho (Fox).

Pine Barrens.—Clementon (Fox); Atsion (Rehn); Manumuskin (Fox); Mt. Pleasant (Fox); Jamesburg (N. J. St. Mus. Rep.).

Coastal District.—Hackensack meadows (N. J. St. Mus. Rep.); Spray Beach (Long); Ocean View, frequent on upland and along the edge of the salt marsh; found on salt marsh in the vicinity of artificial embankments (Fox); Sea Isle City (A. N. S., Fox); Avalon, Piermont, Anglesea (Viereck, Fox); Cape May (Fox).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); S. Seaville (Fox).

C. triops Linn.

General Range.—I have been able to get very little data on the general distribution of this species. It is, to my knowledge, recorded from Connecticut, New Jersey, Pennsylvania, North Carolina and Texas. It does not appear to occur west of the Alleghanies.

Local Distribution.—Frequent in the Piedmont Plateau and Coastal Plain, though apparently rather infrequent and local in the Pine Barrens and on the beaches.

Ecological Distribution.—Prefers areas of open grassland, wherever the plant cover is sufficiently dense, in both moist and dry locations. Absent from salt marshes.

Locality Records.—

Piedmont Plateau.—Collegeville (Fox); Mt. Airy (Fox); Germantown (Fox).

Ft. Lee (Beutenmüller); New Brunswick (Grossbeck); Trenton (N. J. St. Mus. Rep.).

Middle District.—Cornwalls (Rehn); Philadelphia (J. B. Smith, Rehn); Tinicum (Rehn and Hebard); Elmwood, in Tinicum meadows (Fox); Newcastle (Fox).

Lahaway (N. J. St. Mus. Rep.); Riverton (Viereck); Washington Park (Fox); Westville (Johnson); Merchantville (Daecke); Lucaston (Daecke); Sewell (Dickerson).

Pine Barrens.—Lakehurst (Davis); Belleplain (Fox).

Coastal District.—Ocean View (Fox); Sea Isle City (Haim); Avalon, scarce (Fox); Cape May (Davis, Fox).

Cape May Interior.—S. Seaville, frequent in old fields (Fox); Clermont (Fox).

C. atlanticus Bruner.

I have not recognized this species in any of my collections and am inclined to think that the name is a synonym of the preceding.

C. ensiger Harris.

General Range.—New England to southern New Jersey and western North Carolina, west to Ontario, northern Indiana, Minnesota and Colorado.

Local Distribution.—Apparently scarce, most frequent northward along the edge of the Appalachian District; rare in extreme southern New Jersey.

Ecological Distribution.—No data on hand for our region, but usually recorded as occurring in grassy meadows and swales.

Locality Records.—

Highlands.—Greenwood Lake (Davis).

Piedmont Plateau.—Honesdale (Pa. St. Dept. Zool.).

Ft. Lee. (Beutenmüller); New Brunswick (N. J. St. Mus. Rep.).

Middle District.—Jamesburg (Davis).

Pine Barrens (?).—Manumuskin (Daecke).

C. exiliscanorus Davis.

General Range.—Is definitely known from Connecticut, Long Island and New Jersey. I am not aware of any records elsewhere, but it doubtless occurs further south.[23]

Local Distribution.—Apparently not very common, most frequent in the Coastal District, occasionally occurring inland in near-by parts of Middle District and Pine Barrens.

Ecological Distribution.—Mr. Davis informs me the species prefers a wet or swampy place. The first specimens were collected from salt marsh, but he has found it in cattail swamps in places far removed from salt marsh.

Locality Records.—

Middle District.—Farmingdale (Davis); Freneau (Davis).

Pine Barrens.—Lakehurst (Davis in personal letter).

Coastal District.—Hackensack meadows (Beutenmüller); Staten Island, in salt meadows on "Spartina" (Davis, N. J. St. Mus. Rep.); Dennisville (Davis).

C. lyristes Rehn and Hebard.

General Range.—New Jersey to Florida near the coast.

Local Distribution.—Moderately frequent in the Coastal District; occasional inland in the near-by parts of the Pine Barrens and Cape May District.

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[23] In a personal letter Mr. Davis informs me that "southward the insect gets larger and the female was in consequence described as *C. bruneri* by Mr. Blatchley." If the latter is a synonym of this species it would extend its known range as far west as Indiana at least. *C. bruneri* has also been recorded from North Carolina (Sherman and Brimley).

Ecological Distribution.—Along the coast occurs both in true salt marsh and in the marginal (Submaritime) zones, though in my experience it is most frequent in true salt marsh, where it chiefly inhabits the tall, reedy growths of *Spartina glabra* along the tidal streams and ditches. Mr. Davis writes that he found it at Lakehurst about cranberry bogs.

Locality Records.—

Pine Barrens.—Lakehurst (Davis); Speedwell (Stone); Staffords Forge (Hebard).

Coastal District.—Snake Hill (Davis); Staten Island (Davis); Tuckerton (Davis); Barnegat Bay District (N. J. St. Mus Rep.); Ocean View (Fox); Sea Isle City (Fox); Avalon (Fox); opposite Anglesea (Fox); Cold Spring (Davis, personal communication); Cape May (N. J. St. Mus. Rep.); Goshen (Fox); Dennisville (Davis).

Cape May Interior.—In a personal letter Mr. Davis does not specify any locality, but states that he has collected the species "about as far away from the salt water as it was possible for it to get on the rather narrow strip of land."

C. nebrascensis Bruner.

General Range.—Records known to me include parts of southern New Jersey, southeastern Pennsylvania, Ontario, Indiana, Minnesota and Nebraska.

Local Distribution.—Rather infrequent and local, in my experience most frequent in the Delaware Valley, occasional in the Coastal District.

Ecological Distribution.—In swamps, frequenting rather dense, reedy growths of grasses and sedges.

Locality Records.—

Middle District.—Elmwood, in Tinicum meadows, in a swamp containing an almost pure growth of rice cut-grass (*Homalocenchrus oryzoides*) (Fox).

Washington Park (Fox).

Coastal District.—Sea Isle City (Haim, in N. J. St. Mus. Rep.); Cold Spring (Long); Cape May Point, in *Scirpus americanus* marsh along edge of salt marsh (Fox).[24]

C. caudellianus Davis.

General Range.—I do not know of any records of the occurrence of this species outside of New Jersey.

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[24] Mr. Davis writes me that the Lakehurst record credited to him in the State Museum Report refers to *C. lyristes* and not to *C. nebrascensis*. Its inclusion under the latter was an error.

Local Distribution.—According to Davis, this species is frequent in the Coastal District. It appears to occur inland occasionally in the Pine Barrens.[25]

Ecological Distribution.—According to a personal communication from Mr. Davis, this species occurs in the same kind of situations as *C. lyristes.* On one occasion he adds that he took a considerable number in a rather dry field (Tuckerton).

Locality Records.—

Pine Barrens.—Jamesburg (Davis); Lakehurst (Davis).

Coastal District.—Tuckerton (Davis); (? Ocean View, Fox); Cold Spring (Davis).

C. palustris Blatchley.

General Range.—Probably an Austral species, recorded, to my knowledge, from New Jersey, southeastern Pennsylvania, North Carolina and Indiana.

Local Distribution.—Not common; Middle and Coastal Districts, seemingly more frequent in the former.

Ecological Distribution.—Occurs in open fresh-water swamps in locations similar to those frequented by *C. nebrascensis.*

Locality Records.—

Middle District.—New Brunswick (N. J. St. Mus. Rep.); Trenton, in Delaware River swamp (Davis, in personal letter).

Philadelphia Neck (Wenzel, A. N. S); Elmwood, in Tinicum meadow, in a soggy spot covered with dense growth of cut rice-grass (Fox); Tinicum (Rehn).

Coastal District.—Dennisville (Davis), edge of salt marsh (personal letter).

C. fuscostriatus.

General Range.—Extreme southern New Jersey to North Carolina, Georgia and Texas.

Local Distribution.—One individual taken by Henry W. Fowler, Oct. 24th, 1909 at Town Bank, Cape May Co. (A. N. S.).

ORCHELIMUM Serv.

O. vulgare Harris (= *Agile* De Geer).

General Range.—Canada to Florida and Texas, west to the Great Plains.

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[25] After examining some specimens of this species kindly sent me by Mr. Davis, I am almost certain that I have taken the same species at Ocean View in Cape May County. At the time I received Mr. Davis' specimens I had already donated my own collections to the Philadelphia Academy and removed to Indiana, and was therefore unable to directly verify my suspicions by comparing my material with determined specimens sent by Mr. Davis. Some of the specimens in my collection which I have labelled *lyristes* will, I think, prove to be *caudellianus.*

Local Distribution.—Abundant throughout except in the Pine Barrens, where it appears to be rather local.

Ecological Distribution.—Typical of open, moist grassland where there is an abundance of succulent grasses; not infrequent in grassy and weedy uplands. Exceptional in sphagnum bogs and absent from salt marsh.

Locality Records.—

Appalachian District.—Blairsville (Pa. St. Dept. Zool.).

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Perkasie (Fox); Collegeville (Fox); Ft. Washington (Fox); Mt. Airy (Fox); Germantown (Fox); Fern Hill (Rehn and Hebard); Castle Rock (Rehn and Hebard); Pink Hill (Fox).

Delaware Valley.—Cornwalls (Rehn); Elmwood (Fox); Paschalville (Fox); Essington (Fox).

Delair (Daecke); Lucaston (Daecke); Washington Park (Fox); Westville (Viereck); Clementon (Fox); Jericho (Fox); Canton (Fox).

Pine Barrens.—Atsion (Hebard); near West Creek (Rehn); Belleplain (Fox).

Coastal District.—Ocean View, common in sandy uplands in denser grasses and grassy thickets, also in boggy depressions and in low grounds adjoining the salt marsh (Fox); Sea Isle City (Haim); Avalon, marshy hollows in the dune areas (Fox); Piermont (Fox); Cape May Court House (Fox); Anglesea (N. J. St. Mus. Rep., Fox); Cape May (N. J. St. Mus. Rep., Fox); Goshen (Fox); Dennisville (Davis).

Cape May Interior.—Sea Isle Junction (Fox); Ocean View Cemetery (Fox); Swain (Fox); Bennett (Fox).

O. glaberrimum Burm.

General Range.—Apparently co-extensive with the preceding.

Local Distribution.—Appears to be rather rare. Probably local, associated more or less with the preceding of which it may be a mere variety (see Blatchley, Orth. of Ind., p. 385).

Ecological Distribution.—The only specimens I have taken were found in a peat bog where they frequented chain-fern (*Woodwardia virginica*) areas.

Locality Records.—

Appalachian District.—Rockville (Pa. St. Dept. Zool.).

Piedmont Plateau.—Ft. Lee (Beutenmüller).

Pine Barrens.—Between Winslow and Folsom (Fox); Parkdale (Rehn and Hebard).

Coastal District.—Anglesea (Wenzel, from N. J. St. Mus. Rep.).

O. erythrocephalum Davis.

General Range.—New Jersey to eastern North Carolina.

Local Distribution.—Frequent in the Pine Barrens, possibly extending a little into the Middle and Coastal Districts.

Ecological Distribution.—Apparently restricted to sphagnum bogs, where it frequents the dense growth of chain fern, tall sedges, rushes and associated plants.

Locality Records.—

Pine Barrens.—Helmetta (Davis); Jamesburg (Davis); Lakehurst (Davis); New Lisbon (Smith); Lahaway (Smith); Browns Mills Junction (Daecke); Atsion (Hebard); Parkdale (Rehn and Hebard); Manumuskin (Fox); Belleplain (Fox); Great Cedar Swamp near Sea Isle Junction (Fox); Great Cedar Swamp near Dennisville (Fox).

? Coastal District.—Toms River (Davis); Tuckerton (Davis).

O. herbaceum Serv.[26]

General Range.—Massachusetts to Texas, along the coast.

Local Distribution.—Common along the edges of the salt marshes in the Coastal District; occasionally occurring inland in the Pine Barrens.

Ecological Distribution.—Characteristic of the zone of *Scirpus americanus* along the edges of the salt marshes; much less frequent in other parts of the Submaritime area. I have no information concerning its Pine Barren habitats.

Locality Records.—

Middle District.—Newcastle, in *Scirpus americanus* (Fox).

Canton (Fox).

Pine Barrens.—Brookville (Davis acc. N. J. St. Mus. Rep.); Da Costa (Daecke acc. N. J. St. Mus. Rep.); Speedwell (Stone acc. N. J. St. Mus. Rep.).

Coastal District.—Spray Beach (Long); Atlantic City (Rehn); Sea Isle City (Haim, Fox); Townsend Inlet (Fox); Ocean View (Fox); Avalon (Fox); Piermont (Fox); Anglesea (Wenzel, Fox); Cold Spring (Fox); Cape May (Fox); Goshen (Fox); Dennisville (Davis, Fox).

O. pulchellum Davis.

General Range.—New Jersey to eastern North Carolina.

Local Distribution.—Apparently scarce, probably local throughout the Middle and Coastal districts and in the Pine Barrens.

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[26] I am inclined to think that all N. J. specimens referred to *indianense* really belong to this species, at least, so far as coastal material is concerned.

Ecological Distribution.—The only individuals taken by me were found in a sphagnum bog in an open spot bordering dense woods. Some of the locality records would, however, indicate that it occurs in other types of swamps as well.

Locality Records.—

Middle District.—Trenton (Grossbeck); Tinicum (Hebard).

Pine Barrens.—Clementon (Rehn); Helmetta (Davis); Great Cedar Swamp near Sea Isle Junction (Fox); Dennisville (Davis).

O. spinulosum Redt.[27] (= ? *validum* Wlk.) (= ? *gracile* auct. non. Harris).

General Range.—Uncertain; has been recorded from North Carolina.

Local Distribution.—Frequent locally throughout, except in the Pine Barrens, which it barely enters.

Ecological Distribution.—In open grassy or sedgy swamps; especially frequent in swamps dominated by *Homalocenchrus oryzoides.*

Locality Records.—

Piedmont Plateau.—Collegeville, frequent in moist depressions in meadows (Fox); Castle Rock (Rehn and Hebard); Chestnut Hill (Hebard).

Middle District.—Cornwalls (Rehn and Hebard); Tinicum (Hebard); Elmwood, abundant in *Homalocenchrus oryzoides* at edge of Tinicum marshes (Fox); Paschalville, in Tinicum meadows (Fox).

Riverton (N. J. St. Mus. Rep.); Lucaston (Daecke); Gloucester (Hardenberg); Clementon (Greene); Jericho, in stream meadow (Fox); Canton (Fox); Dorchester, tidal swamps along Maurice River (Fox).

? Pine Barrens.—Belleplain (Daecke, Fox), frequent in the wettest parts of an extensive bog, in a tall species of *Juncus*, apparently *canadensis* (Fox).

Coastal District.—West Creek (Rehn); Ocean View, local in fresh meadows and in the Submaritime zone (Fox); Sea Isle City (Haim, Fox); Avalon (Fox); Piermont, in swampy depressions in the dune

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[27] It is possible that there may be two or three species included under this name. Typical specimens from Tinicum agree closely with some in the A. N. S. marked *spinulosum;* others again differ slightly in coloration, and some of these were tentatively referred to the little understood *gracile* as used by authors, not the *gracile* of Harris, which is a synonym of *Xiph. fasciatum.* At Belleplain I captured specimens resembling my Tinicum *spinulosum*, but with a less distinct ruddy tinge on the tegmina. These are probably the species called *validum* in the N. J. St. Mus. Rep. They all come close to *O. nigripes* Scudder, but differ from it in lacking the characteristic black tibiæ of the latter.

area, frequenting *Scirpus americanus* and associated plants (Fox); Anglesea (Fox); Cape May (Fox); Goshen (Fox).

O. campestre Blatchley.

General Range.—Rather uncertain; described from Indiana and since reported, to my knowledge, from Minnesota and New Jersey.

Local Distribution.—Probably scarce, reported, so far as I am aware, only from the Coastal District.

Ecological Distribution.—Have no local data. In Indiana, according to Blatchley, it occurs "in the tall grasses of low prairie meadows."

Locality Records. -

Coastal District.—Tuckerton (N. J. St. Mus. Rep.); Cape May (N. J. St. Mus. Rep.).

O. minor Bruner.

General Range.—Occurs, so far as I have been able to find records, in New Jersey, North Carolina and Georgia.

Local Distribution.—Apparently rather uncommon; most regular in the Pine Barrens, occasional in the Middle District.

Ecological Distribution.—An arboreal species, reported as occurring on pine (N. J. St. Mus. Rep.).

Locality Records.

Middle District.—Delair (N. J. St. Mus. Rep.).

Pine Barrens.—Helmetta (Davis); Jamesburg (Davis); Lakehurst (Davis); Browns Mills Junction (Daecke); Atsion (Hebard); Staffords Forge (Hebard).

O. fidicinium Rehn and Hebard.

General Range.—So far as known, includes from New Jersey to Florida along the coast.

Local Distribution. Common in suitable locations in the Coastal District.

Ecological Distribution.—Characteristic of the tall, reedy growths of *Spartina glabra* along watercourses in the salt marshes. Apparently a purely halophilous species.

Locality Records.—

Coastal District.—Staten Island (Davis); Tuckerton (Davis); Chestnut Neck, Atlantic Co. (Rehn); Ocean View (Fox); Sea Isle City (Fox); Townsend Inlet (Fox); Avalon (Fox); Piermont (Fox); Anglesea (Rehn); Goshen (Fox).

XIPHIDIUM Serville (= *Conocephalus* Thunb.).

X. fasciatum De Geer.

General Range.—Very widely distributed from Canada to the Gulf, and, according to Redtenbacher, as cited by Blatchley, through South America to Argentina.

Local Distribution.—Abundant in suitable locations in the Middle and Coastal Districts; frequent, but rather local, in the Piedmont Region. In my experience it is uncommon in the Pine Barrens.

Ecological Distribution.—Most typical of low, moist areas overgrown with low, succulent grasses, sedges and rushes; especially plentiful in the *Juncus gerardii* zone along the edges of the salt marsh, but not normally found on true salt marsh. Occasionally found in quite dry situations, as in hillside pastures where there is a good growth of the low rush, *Juncus tenuis.*

Locality Records.—

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Rockville (Pa. St. Dept. Zool.); Camphill (Pa. St. Dept. Zool.); Rock Hill (Fox); Perkasie, on pastured hillside in *Juncus tenuis* (Fox); Collegeville, in stream meadows (Fox); Mt. Airy, in small grassy bog (Fox); Pink Hill (Fox); Swarthmore (A. N. S.).

Middle District.—Cornwalls (Rehn and Hebard); Elmwood, in Tinicum meadows (Fox); Paschalville, in Tinicum meadows (Fox); Essington (Fox); Newcastle (Fox).

Washington Park (Fox); Blackwood (Fox); Medford (Stone); Clementon (Fox); Jericho, in stream meadow (Fox); Canton (Fox); Dorchester (Fox).

Pine Barrens.—Taunton (Stone); Penbryn, rare on cranberry bog (Fox); Atsion (Fox).

Coastal District.—West Creek (Rehn); Chestnut Neck, Atlantic Co. (Rehn); Petersburg (Fox); Tuckahoe, low lands along river (Fox); Ocean View (Fox); Sea Isle City (Fox); Townsend Inlet (Fox); Avalon (Fox); Piermont (Fox); Cape May (Fox); Cape May Point (Fox); Goshen (Fox); Dennisville, edge of salt marsh (Fox).

Cape May Interior.—Sea Isle Junction, edge of Great Cedar Swamp, scarce (Fox).

X. brevipenne Scudder.[28]

General Range.—Canada to the Gulf of Mexico, east of the Plains.

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[28] Includes *X. ensiferum* Scudd.

Local Distribution.—Common in suitable locations in the Appalachian and Piedmont Districts; frequent, but rather more local in the Middle and Coastal Districts. Relatively infrequent or local in the Pine Barrens. Apparently absent from the beaches.

Ecological Distribution.—Most typical of wet or humid areas covered with dense, succulent grasses; less frequent on dry ground in dense, grassy thickets. Does not normally occur in salt marshes, nor in *Juncus gerardi* and *Scirpus americanus* zones of the Submaritime areas, but inhabits the more succulent, grassy tracts at places where the Submaritime area merges into the upland.

Locality Records.—

Appalachian District.—Rockville (Pa. St. Dept. Zool.).

Piedmont District.—Harrisburg (Pa. St. Dept. Zool.); Marysville (Pa. St. Dept. Zool.); Dauphin (Pa. St. Dept. Zool.); Collegeville, in damp meadows, ditches, pond borders, etc. (Fox); Valley Forge (Fox); Ashbourne (Long); Mt. Airy (Fox); Germantown (Fox); Fern Hill (Rehn and Hebard); Castle Rock (Rehn and Hebard); Pink Hill, in stream meadow (Fox).

Middle District.—Cornwalls (Rehn and Hebard); West Philadelphia (Long); Elmwood, in Tinicum meadows (Fox); Paschalville (Fox).

Riverton (Viereck); Washington Park (Fox); Woodbury (Viereck); Jericho, in grasses along narrow gutter in sandy barrens (Fox); Canton (Fox); Manumuskin, on *Zizania* on tidal flats (Fox); Medford (Rehn).

Pine Barrens.—Taunton (Rehn); Atsion (Rehn); Staffords Forge (Rehn); Belleplain, in small cranberry bog, not common (Fox); Mt. Pleasant, occasional in undergrowth of oak and pine woods (Fox); Formosa Bog (Fox).

Coastal District.—West Creek (Rehn); Petersburg, tract of succulent grass above tidal meadows (Fox); Ocean View, local, in succulent, grassy spots just above the salt marsh (Fox); Goshen, tall grass, lowlands just above salt marsh (Fox); Dennisville, grassy thickets, edge of the woods (Fox); Cold Spring, in low, grassy tangles bordering *Scirpus americanus* swamp (Fox); Cape May Point, lake margin (Fox).

X. nemorale Scudder.

General Range.—Appears to be largely northern, extending from New York to Minnesota and Nebraska, south to central Pennsylvania and the Ohio River, in the mountains to North Carolina.

Local Distribution.—Apparently rare and very local, occurring only in the extreme northern part of New Jersey and not extending much south of the lower limits of the Appalachian Region of Pennsylvania.

Ecological Distribution.—I know of no record of its habitats in our region. According to Lugger, it prefers the borders of forests, frequenting the low bushes in such locations. In Indiana I have found it in similar situations.

Locality Records.—

Piedmont Plateau.—Highspire (Pa. St. Dept. Zool.); Middletown (Pa. St. Dept. Zool.).

Eastern slope of the Palisades (Beutenmüller).

X. strictum Scudder.

General Range.—Largely Austral in range, extending from New Jersey to Texas, north in the interior to Illinois, Minnesota and Nebraska.

Local Distribution.—Locally not infrequent in the Piedmont Plateau; quite common in the lower half of the Middle District and the Coastal Strip, rare or accidental on the beaches. Apparently very local in cultivated sections of the Pine Barrens.

Ecological Distribution.—A xerophilous species, characteristic of dry, open grasslands.

Locality Records.—

Piedmont Plateau.—Harrisburg (Pa. St. Dept. Zool.); Valley Forge (Fox); Mt. Airy (Daecke); Ashbourne (Long); Fern Hill (Rehn and Hebard); Castle Rock (Rehn and Hebard); Pink Hill, in grass on dry hillsides (Fox).

Middle District.—Cornwalls (Rehn and Hebard); Elmwood, in Tinicum meadows, frequenting dry, grassy areas (Fox); Paschalville (Fox); Essington (Fox).

Washington Park, sandy areas in bunch grasses, etc. (Fox); Almonesson, in open, sandy field, frequenting grassy thickets (Fox); Canton, dry, grassy uplands near salt marsh (Fox).

Pine Barrens.—Taunton (Stone); Atsion (Hebard); head of Tuckahoe River (Fox).

Coastal District.—Staten Island (Davis); Petersburg (Fox); Ocean View, common in upland situations in coarse grasses and weeds (Fox); Avalon, 1 female, no others observed (Fox); Cape May, scarce, noted only one individual (Fox); Cape May Point (Fox); Goshen (Fox).

Cape May Interior.—Sea Isle Junction, in grassy scrub (Fox); Ocean View Cemetery (Fox); S. Seaville, mostly in old fields and in roadside vegetation (Fox); near Dennisville (Fox); Clermont (Fox).

X. saltans Scudder.

General Range.—Canadian Provinces to the Gulf States, west to Minnesota, Nebraska and Kansas.

Local Distribution.—Apparently quite rare and local; has been taken locally in all districts, except Appalachian and Highlands. I know of no records of its occurrence on the beaches.

Ecological Distribution.—On the single occasion when I encountered this species I found it on dry uplands in grassy tangles like those frequented by the preceding species.

Locality Records.—

Piedmont Plateau.—Fern Hill (Rehn and Hebard).

Middle District.—Cornwalls (Rehn and Hebard). Riverton (Viereck).

Pine Barrens.—Browns Mills Junction (Daecke); Atsion (Hebard).

Coastal District.—Ocean View, rare (Fox).

X. spartinæ Fox.

General Range.—Southern Massachusetts to New Jersey and probably to Florida along the coast.

Local Distribution.—Abundant in the Coastal District on salt marshes; occasional inland along tidal streams.

Ecological Distribution.—Characteristic of salt marshes, where it frequents the short variety of *Spartina glabra* that covers the tidal flats between the watercourses. Less frequent in the Submaritime zone. Doubtless extends inland in small numbers along tide-water streams as one was taken in the rice grass (*Zizania*) on tidal flats of Manumuskin Creek.

Locality Records.—

Middle District.—Canton, edge of salt marsh (Fox); Manumuskin, in *Zizania* (Fox).

Coastal District.—Atlantic City, salt marsh (Rehn, originally reported as "*nemorale*" and later as "*brevipenne*," see Ent. News, 1902 and 1904); Palermo (Fox) in salt marsh; Ocean View, salt marsh (Fox); Sea Isle City (Fox); Avalon (Fox); Piermont (Fox); Anglesea (Fox); Cape May (Fox); Dennisville, salt marsh (Fox).

X. nigropleuroides Fox.

General Range.—New Jersey to Florida along the coast.

LOCAL DISTRIBUTION.—Frequent in salt marshes, to which it is apparently restricted.

ECOLOGICAL DISTRIBUTION.—Characteristic of the reed-like fringes of *Spartina glabra* along the watercourses, in which it is associated with *Orchelimum fidicinium.*

LOCALITY RECORDS.—

Coastal District.—Ocean View (Fox); Townsend Inlet (Fox); Avalon (Fox); Piermont (Fox); Goshen (Fox); between Goshen and Dennisville (Fox).

ATLANTICUS Scudder.

A. dorsalis Burm.

A. pachymerus Burm.

GENERAL RANGE.—New England to the Gulf States, west to Minnesota.

LOCAL DISTRIBUTION.—Moderately frequent in suitable locations in all districts, except the Cape May Peninsula and the beaches, in which it is either rare or lacking.

ECOLOGICAL DISTRIBUTION.—Sylvan, frequenting the undergrowth of open woodlands.

LOCALITY RECORDS.—

Highlands.—Greenwood Lake (Beutenmüller); Newfoundland (Davis).

Piedmont Plateau.—Ashbourne (Long); Guthriesville (Rehn and Hebard); Newtown Square (Rehn and Hebard).

Middle District.—Woodbridge (Davis); Jericho (Fox).

Pine Barrens.—Lakehurst (N. J. St. Mus. Rep.); Lahaway (N. J. St. Mus. Rep.); Browns Mills Junction (Daecke;) Staffords Forge (N. J. St. Mus. Rep).

Coastal District.—Tuckerton (Davis); Dennisville (Davis).

CERTAIN FEATURES OF SOLENOGASTRE DEVELOPMENT.

BY HAROLD HEATH.

The solenogastres comprise a group of worm-like organisms which for a full half-century have held an unsettled systematic position in zoological literature. Certain features of their organization remind one strongly of the mollusks; others apparently relate them to the worms; and accordingly their classification has depended upon the relative importance given to these resemblances. Numerous works have appeared treating of their anatomy, but up to the present time our knowledge of their development has been confined to two brief papers by Pruvot ('90, '92). The observations therein recorded are so unique in several respects that they have influenced the problem in a negative way only, making it appear that in the development of these organisms we have to deal with matters not closely related to other animals. It has been my good fortune to be able to study a small collection of solenogastre embryos, and I shall endeavor to show that as a matter of fact the development is very clearly molluscan.

In a report on the solenogastres of the North Pacific (Heath, '11), a species, *Halomenia gravida*, was described which carried about twenty-five embryos, in various stages of development, between the branchial folds in the cloacal chamber. These were discovered only after the adult was sectioned, but a careful study of sections and reconstructions has rendered the course of development fairly clear from the one cell stage to the point where the mid-gut, stomodæum, foot and nervous system are distinctly outlined.

At the outset it is well to state that one of the most striking features of solenogastre development is the presence of a vast test, or coat of ciliated cells, which envelops the larva until the metamorphosis, masks the internal structures and so distorts certain details of the development that it may well have appeared to Pruvot and other authors that these animals are unique. I am decidedly of the opinion that Drew ('99) was correct in regarding the test as a modified velum. It is enormous assuredly, but in its relations to other organs and the fact that in several other animals it is shed at the time of the metamorphosis certainly points to more than a superficial resemblance. In *Yoldia, Teredo* and *Ischnochiton,* for example, the velum is ultimately discarded, and a study of the diagrams (fig. 1) will serve to show that the differences between the development of the solenogastres and the chitons are in large measure due to the size of the test or velum. Whether or not this is a fundamental fact depends upon the history of the early blastomeres, which is lacking at the present time; nevertheless, there are many indications that the two classes of animals have descended from a common ancestor.

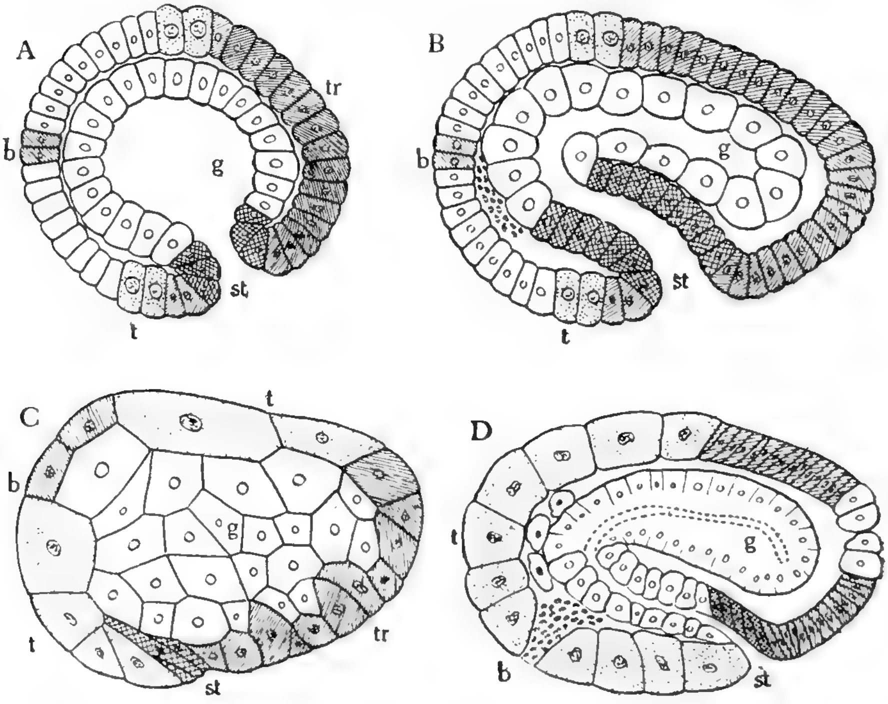

Fig. 1.—Diagrams illustrating the development of the primary germ layers in the chitons (A, B) and solenogastres (C, D). *b*, cells producing the cerebral ganglia; *g*, archenteron; *st*, stomodæum; *t*, test cells. Such devices as stippling, cross-hatching and parallel diagonal lines indicate homologous regions.

The egg of *Halomenia gravida* is a spherical body, densely and uniformly packed with yolk, and is surrounded before it leaves the ovotestis with a distinct vitelline membrane. In the earliest stage represented at least one polar body is distinctly visible, and immediately beneath it the female pronucleus is clearly defined. Close to the equator of the egg another nucleus, probably the male pronucleus, appears with equal distinctness.

In the next stage segmentation has commenced, resulting in 28 cells of approximately equal size. There is no sign of a blastocele or any signs of differentiation. In the succeeding stage fully 100 cells are present and size differences are apparent, but while a slight elongation defines the antero-posterior axis of the larva, the absence of blastocele and stomodæum renders it difficult to accurately define the ventral and dorsal surfaces.

In the following stage the differentiation of the test has commenced and, judging from two larvæ where the polar bodies remain attached, it extends over the greater portion of the dorsal surface and to a considerable extent of the ventral as well (fig. 1, C). The remaining cells, those destined to form the future animal, are thus in large measure enclosed. The cells not included in the test but bordering upon the surface are, generally speaking, of smaller size than those upon the interior (in one specimen this is more marked than in the one figured), but there is up to this time no clear differentiation into ectoderm and endoderm. In the mid-ventral line, in immediate contact with the border of the test, are slender elements (*st*) that represent the first stages in the formation of the stomodæum. The comparatively thin cells (C, *b*) in the neighborhood of the polar body (not represented) are a constant feature and evidently furnish the material for the development of the cerebral ganglia.

In later stages (as in D) the various regions of the body are distinctly outlined, and to some extent the digestive and nervous systems have been sketched in. The stomodæum is clearly differentiated and the mid-gut is outlined, though its constituent cells and cavity are not as yet in an advanced state of development. The cerebral ganglia comprise large masses of cells forming a group anterior to the stomodæum. Posteriorly, these divide, encircle the stomodæum and extend along the ventral surface to the posterior end of the body. At various points in the trunk region between the gut and body wall or test there are a few scattered cells, yolk-laden and accordingly distinguishable from the ganglionic products. They probably are mesoblastic elements.

At the posterior end of the body is a ring of cells, ciliated in *Myzomenia,* that enclose a depressed area bordered in the earliest recognizable stage by relatively slender cells. These last-named elements appear to divide repeatedly and become transformed into a group of cells bordering upon the surface and on the other hand passing without a sharp line of demarcation into the ganglionic cords. In the oldest stage represented the nerve cord appears to be completely cut off from, though in contact with, a fairly distinct group of cells bordering the surface of the body. It thus appears that the cells enclosed by the ring of larger cells become transformed into a sense organ, perhaps the dorso-terminal sense organ known to occur in many solenogastres.

In the latest stages the test becomes considerably reduced in size and the trunk gains proportionately in prominence. This increase in the extent of the trunk appears to be wholly due to the division of definite ectoderm trunk cells and not to any products supplied by the test. Measurements show conclusively that the test cells gradually shrink in bulk, probably due to the absorption of their nutritive products, and karyokinetic spindles indicate activity on the part of the trunk ectoderm. To what extent this proceeds it is impossible to state. In early stages there is one, possibly two cells situated immediately beneath the cells (fig. 1, C, *b*) that I believe furnish the material for the cerebral ganglia. In later stages there are indications that this deeper seated cell has undergone a few divisions, and the resulting products occupy the space (fig. 1, D) between the alimentary canal, cerebral ganglia and test cells of the head region. They may possibly represent mesoblastic products, but their relatively large size (for the sake of clearness, they are smaller in the diagram than in reality) and their position suggests that they may supply the material for the head epidermis as the test recedes.

Turning now to the development of the species described by Pruvot, we find that especially in *Proneomenia aglaopheniæ* the early development follows essentially the same path as in *Halomenia*. In the other species, *Myzomenia banyulensis*, there is a decided difference in the size of the cells during the early cleavages, but in both cases the close of segmentation finds the larvæ constructed upon the same plan. The test is evidently of greater size than in *Halomenia* and more completely envelops the remaining cells so that they are hidden in lateral view, but the arrangement of the cells is evidently quite similar to that shown in diagram C. The enclosed elements are supposed to be endodermal in character, and the region (depressed in the species studied by Pruvot) bordered by the test is termed the blastopore. I believe both of these statements are incorrect as I shall now attempt to demonstrate.

Generally speaking, the velum of the trochozoa forms only an insignificant portion of the ectoderm. In the solenogastres it has expanded to such an extent that it comes in contact with the cells destined to form the cerebral ganglia, and posteriorly it forms a considerable portion of the trunk as well. But the important fact remains that in *Halomenia* the position of the stomodæum, which marks the position of the blastopore, is unmistakable and, as the diagrams show, it is located immediately behind the border of the test on the ventral surface. Furthermore, the diagrams illustrate the fact that there remain many other exposed cells bounded by the test, and these become directly transformed into the trunk ectoderm. In other words, diagram C is a gastrula stage just as certainly as diagram A, the main differences in the solenogastres being correlated with an epibolic type of gastrulation and the enormous size of the velum. The accurate details of the process are lacking and close comparisons are not possible at present, but the important fact is certainly clear that the cells enclosed by the test are not all endoderm and the blastopore is small and typically situated.

In later stages certain developmental processes are described that rest in part upon the assumption that all of the region bounded by the test represents the blastopore. In this depressed area the cells are stated to form, by a species of delamination, the future definitive ectoderm and endoderm. The outer layer, circumscribed by the test, now represents the trunk ectoderm, and in it three invaginations soon appear. One of these remains open and becomes the proctodæum, while the other two soon close and are transformed into mesoblastic bands. Still later the borders of the proctodæum (evidently the large terminal cells of the trunk that form a ring as in D) are said to develop into a sort of caudal button (bouton caudal) that at first projects into the blastocele. Finally the button becomes evaginated and with the trunk ectoderm protrudes beyond the borders of the test.

In commenting upon these observations it is to be noted that a depression exists in *Halomenia* within the terminal ring-like group of large cells, but it is in no way connected with the endoderm. No sign of a proctodæum is evident at this time nor has it put in an appearance in a stage considerably beyond the one represented in diagram D. The caudal button is evidently the group of cells that in *Halomenia* develops from the cells enclosed by the large cells of the terminal ring. As already noted, these at first project into the blastocele, then flatten out, and exposed to the surface are connected with the ventral ganglionic cords. The mesoblast bands are evidently these same cords, as will appear more clearly in connection with the cerebral ganglia.

In the anterior half of the embryo three invaginations now appear in the test cells on the ventral side. The median one, of a transitory character, is said to represent the stomodæum, but as a stomodæum exists in *Halomenia* in the normal position I am strongly of the opinion that Pruvot is in error regarding this point. The lateral invaginations unite, forming a transverse band, and posteriorly are prolonged to meet the mesoblastic bands of the trunk. Some of the more dorsal elements constitute the cerebral ganglia. In addition, the ectoderm of the head appears to arise wholly from these same lateral invaginations. Such an origin of mesoblast elements is certainly unique, and I have only to state that I believe this entire group is ganglionic. Its posterior union with the ventral cords certainly indicates its nervous character. The anterior enlargements, the future cerebral ganglia, are of unusual size in *Halomenia*, but there is nothing whatever to indicate that they comprise any mesoblastic elements. Furthermore, there is nothing in *Halomenia* to suggest the development of head ectoderm from any of these cells; and the counter theory, that at least in part it may arise from one or two large cells located beneath the cells responsible for the development of the cerebral ganglia, has been noted in a preceding paragraph.[1]

If on the basis of comparative anatomy it is impossible at the present time to definitely place the solenogastres in their proper systematic position, it is obvious that this is more emphatically true where scanty embryological data are the sole criterion. However, it is evident that their development is more in accord with what we find among the mollusks than with any other phylum. The resemblance of the embryo shortly before its metamorphosis is strikingly similar, in several important details, to *Yoldia* or *Dentalium* or to the chitons if we neglect size differences with respect to the test. Plate ('92) has shown that there are good reasons for the belief, long ago expressed by Blainville ('25), that the scaphopods are most closely related to the prosobranchs rather than to the lamellibranchs. The excessively developed tests encountered in certain species of the first- and last-named classes are therefore not of fundamental importance, and furthermore its small size in the chitons is accordingly not a serious obstacle to the theory expressed by several authors that the solenogastres and the chitons are derivatives of a common ancestor. Such a conclusion has been based almost entirely on

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[1] A full account of the development of *Halomenia* will appear in connection with a report on the solenogastres from the eastern coast of the United States, but as considerable time must elapse before its completion it has seemed desirable to publish this preliminary account.

anatomical evidence. Whether it will stand the test from the standpoint of embryology can only be decided when our knowledge is more complete.

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THE SCENT-PRODUCING ORGAN OF THE HONEY BEE.

BY N. E. McINDOO, PH.D.

INTRODUCTION.

Bee keepers well know that bees have an odor, but they do not know how the odor is produced, nor do they know the rôle played by the various odors of the honey bee. It is reported that Nassonoff first described the morphology of the scent-producing organ of the honey bee. His original work in Russian cannot be had here, but, according to Zoubareff (1883), Nassonoff did not describe the structure of this organ as seen by the writer, and he suggested that the gland cells of the organ produce perspiration. Sladen (1902) called this organ a "scent-producing organ," but did nothing more than to describe the articular membrane between the fifth and sixth abdominal terga of worker bees.

This paper deals entirely with the morphology of the scent-producing organ. The work dealing with the odors produced by this organ and the significance of these odors will be reported separately.

Fresh material was stained slightly with a weak solution of methylin green, and the cells were studied while still alive. Material was also fixed in Carnoy's fluid (equal parts of absolute alcohol, chloroform, and glacial acetic acid, with corrosive sublimate to excess). The double method of embedding in paraffin and celloidin was employed. Sections were cut 10 micra thick and they were stained with Ehrlich's hämatoxylin and eosin, and with safranin and gentian violet.

1. STRUCTURE.

Sometimes when a worker honey bee, that is fanning, is carefully observed, a transverse white stripe near the end of the abdomen may be seen. This white stripe (fig. 1, *ArtM*) is the articular membrane between the fifth and sixth abdominal terga (propodeum not counted). It is visible only when the last abdominal segment is bent downward. The anterior half of this membrane is folded under the posterior edge of the fifth abdominal tergum, making a pouch or canal (fig. 1, *Can*). The canal encircles about one half of the abdomen and terminates on either side of the abdomen just above the articulation of the tergum and sternum (fig. 1, *ECan*). The diameter of the canal is greatest at the median line of the abdomen and gradually diminishes to zero at each end.

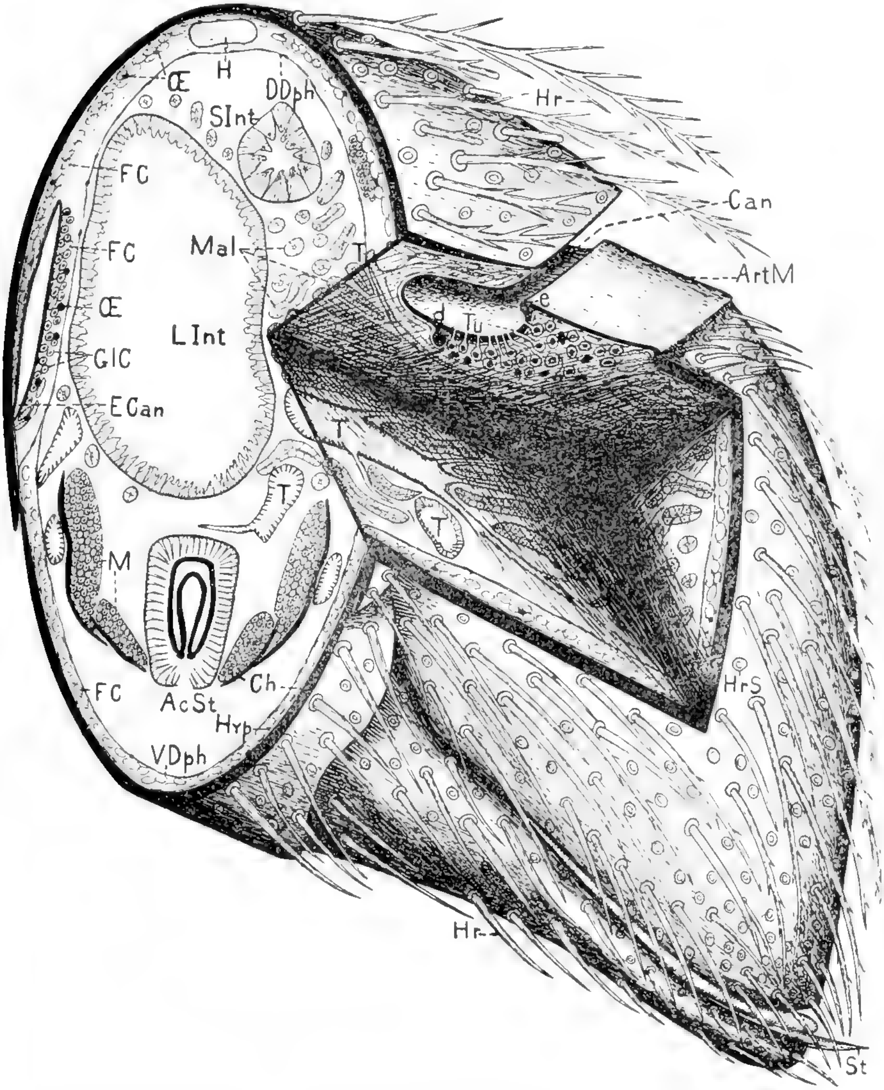

Fig. 1.—Diagram of a transverse-longitudinal view of end of abdomen of a worker honey bee, showing the internal anatomy of the fifth and sixth segments, and also the scent-producing organ composed of the articular membrane (*ArtM*), the canal (*Can*), chitinous tubes (*Tu*) and gland cells (*GlC*). The last segment is bent downward more than ever seen in the living bee. That is, in the living bee only the part marked *ArtM* is seen externally and the canal (*Can*) is never seen.

Fig. 2 is a diagram of the articular membrane, removed from the abdomen and spread out flat under a low-power lens. This membrane in the living bee is shiny and appears to be covered with a transparent liquid. The anterior margin of the membrane is bordered by small barbed hairs (fig. 2, *a*) on the fifth tergum, and the posterior margin is bordered by smaller spinelike hairs (fig. 2, *b*) on the sixth tergum. The chitin of the posterior portion (fig. 2, *PostP*) of this membrance is thinner than is the chitin of the tergum, but it is strengthened near its centre by a narrow and heavy vein (figs. 1 and 2, *e*), and at its anterior margin there is a heavier and much wider vein (figs. 1 and 2, *d*).

The chitin of the anterior portion (fig. 2, *AntP*) of the membrane is much thinner than is that of the posterior portion. It is quite flexible and for this reason may be easily folded to form the canal. Instead of it being perfectly smooth, as is the posterior portion of the membrane, its surface is covered with innumerable minute, narrow, groovelike indentations. These may be comparatively long or short, bent, tortuous, or straight and seemingly extend half way through the chitin. The small lines in fig. 2, *c*, represent their arrangement and fig. 3 represents a few of them seen under a high magnification. Of course, they are not slits passing entirely through the chitin, but they are grooves and pass about one half through the membrane.

Looking through the chitin of the posterior portion (fig. 2, *PostP*) of the articular membrane, at a deeper focus, may be seen many round cells, each of which has a tube that runs to the surface of the membrane. In fig. 2, 115 of these tubes with cells are shown, but in all there are from 500 to 600. The majority of the tubes have exits in the chitin between the two heavy veins (figs. 1, Plate XIX, and 2, *d* and *e*), but none of them has an exit in the chitin of the anterior portion (*AntP*) of the membrane. The place where these tubes empty is best seen in fig. 1, *Tu*. It is thus seen that the tubes unite with the posterior wall of the canal which is formed by the heavy chitin between *d* and *e* in figs. 1 and 2. The bottom and anterior wall of the canal are formed by the anterior portion of the articular membrane.

Fig. 4 represents four of the cells and several of the tubes seen under a high-power lens. *a* represents comparatively thin and almost transparent chitin; *b* is a narrow, thick, and yellow band of chitin; *c* is a thick, semitransparent band of chitin; *d* is a wide, thick, and opaque band of chitin; *e* is thick, semitransparent chitin. It is thus seen that the cells lie beneath the thinnest portion of the chitin belonging to the posterior part of the articular membrane, and that their exits lie in the thickest portion of this chitin. A transparent area (Plate XIX, fig. 4, *Amp*) was seen in many of the cells, and a tube (fig. 4, *Tu*) runs into each of these areas.

In order to study these cells in a living state more carefully, the articular membranes including the tissues adhering to them were removed from worker bees. This material was placed on a slide in a weak solution of methylin green. The cells adhering to the chitin were teased apart and a few of them with their tubes were separated from the mass of cells and chitin. Such a treatment, however, almost always pulls the internal ends of the tubes out of the cells, whereupon the transparent areas disappear immediately. The tubes are then attached only at their peripheral ends.

The cells vary considerably in size. They are either spherical or ovoid in shape. Fig. 5 represents one of the largest ovoid cells. It is typical and was drawn with the aid of a camera lucida while still alive, being stained very slightly with methylin green. The large nucleus has a heavy wall, and it stands out conspicuously. The nucleoli with heavy walls stain green. The cytoplasm in the centre of the nucleus has a faint green color, while that near the periphery of the nucleus is semitransparent. The wall of the cell is thin. The cytoplasm of the cell is more or less transparent. It is granular and appears to have innumerable minute clear spots (*ClS*). In the broader end of the cell lies the ovoid, transparent area, which may be called the ampulla (*Amp*). The tube (*Tu*) terminates at the centre of the ampulla. The ampulla seems to have many lines or streaks which radiate from the periphery toward the centre, and these radial streaks (*RadStr*) stop short of the centre and leave a perfectly transparent, ovoid area (*TrA*) at the centre of the ampulla.

Judging from the structure of these cells, we must call them gland cells, but when observed hurriedly they may be mistaken for œnocytes. As a rule, the œnocytes are smaller than the gland cells, but nevertheless many of them are as large as many of the gland cells. Only a few œnocytes may be found among the mass of gland cells, but they are quite abundant on all sides of the gland cells. Fig. 6 represents a typical large œnocyte, still alive and stained slightly with a weak solution of methylin green. The following may be used to distinguish a gland cell from an œnocyte. An œnocyte is never connected with a tube. It never has an ampulla.

Its cytoplasm is less granular. It is always partially, and sometimes almost totally, filled with globules (*Glo*).

Chiefly on account of its size, a fat cell should never be mistaken for a gland cell. Fat cells are always larger, and sometimes several times larger, than these gland cells. They are found on all sides of the mass of gland cells, but seldom among them. Their structure is similar to that of œnocytes, but the globules are much larger, more conspicuous and are so abundant that the nucleus is scarcely visible. Fig. 7 represents a small fat cell, still alive and stained slightly with a weak solution of methylin green.

To ascertain if the tubes connecting the gland cells with the chitin are composed of chitin, articular membranes removed from the abdomens of workers were placed a few hours into a saturated solution of caustic potash. When all the adhering tissues had disintegrated, the membranes were cleaned with water and a pencil brush. In all cases the tubes were left attached to the membranes. This proves that they are chitinous. To determine how they terminate in the articular membrane, one of the membranes treated with caustic potash was sectioned. The sections show that the canal of the tube opens freely to the exterior (fig. 8, *CanTu*).

Judged by the morphology, we may reasonably conclude that the gland cells secrete a volatile substance throughout their cytoplasm. This substance collects in the ampulla which serves as a reservoir, and from the ampulla it passes through the chitinous tube to the exterior where it runs into the canal. The groovelike indentations in the chitin forming the canal may serve two purposes—(1) to give more flexibility to the chitin, and (2) to retain the volatile secretion and help prevent a too rapid evaporation of it. As long as the abdomen is straight, the canal is well protected and the liquid cannot evaporate rapidly, but when the abdomen is considerably bent, the entire canal is more or less exposed to the outside air.

2. Origin of Gland Cells.

The scent-producing organs of several 15-day-old worker pupæ (counting from the time the eggs were laid) were sectioned. At this stage the chitin (fig. 9, *Ch*) is just beginning to be formed, and the hypodermis (fig. 9, *Hyp*) is very thick. The fat cells (fig. 9, *FC*) are also not yet completely differentiated. The hypodermal cells (fig. 9, *HypC*) are long and slender. Most of them near the place where the wide and heavy vein (figs. 2, *d*, and 9, *v*) is later formed, break loose from the hypodermal layer and migrate backward till the majority of them lie posterior to the heavy vein. In fig. 9, *a*, a row of them has broken loose from the hypodermal layer and they are assuming the ovoid shape. At fig. 9, *b*, they are a little farther advanced. In the 16-day-old stage the gland cells (fig. 10, *GlC*) are much larger and lie just back of the heavy vein (fig. 10, *v*). Now the chitinous tubes (fig. 10, *Tu*) are formed and they are connected with the gland cells.

3. Origin of Chitinous Tubes.

In the 15-day-old stage may occasionally be seen hypodermal cells having processes. Such cells lie at the place where the chitinous tubes later appear. One of these cells (fig. 11*a*) has a large and conspicuous nucleus. The growing point of the process appears to have no cell wall. Twelve hours later the hypodermal cells (fig. 11*b*) forming the tubes have become much smaller, no doubt because of the formation of long processes. It seems that the more the processes grow in length, the more the cells diminish in size. Each hypodermal cell, therefore, must serve as a storehouse for building a tube. When the process is far advanced, its cytoplasm probably begins secreting a substance which in a short time is transformed into the chitinous tube. In fig. 11*b* the tube is developed and it is connected with the exterior, but the cytoplasm surrounding the tube has not yet disappeared. In a little later stage (fig. 11*c*), the cytoplasm surrounding the tube has all disappeared except a small process of the cell. The tube is now connected with a gland cell.

4. Development of Gland Cells.

As already stated, the gland cells were originally hypodermal cells (fig. 9, *a* and *b*) which migrated from the hypodermal layer. This migration occurs in worker pupæ 15 days old. In 16-day-old worker pupæ these cells (fig. 10, *GlC*) are three or four times as large as they are in the 15-day-old stage and they begin to resemble true gland cells. In the 17-day-old stage they are still larger (fig. 12, *GlC*). Their nuclei are extremely large and stain less densely than does the cytoplasm with Ehrlich's hämatoxylin and eosin. By the ninteenth day the gland cells (fig. 13, *GlC*) have enlarged but little since the 17-day-old stage. In 21-day-old worker pupæ (age at which they emerge from their cells) the gland cells (fig. 14, *GlC*) seem to be perfectly developed in all respects, except they are only about two-thirds the size of the gland cells (fig. 15, *GlC*) in old worker bees.

It is quite possible that the gland cells never function until the bee has emerged. It seems reasonable, therefore, to regard the rapid growth which takes place in these cells after the bees have emerged to the fact that the gland cells suddenly begin to function.

5. Scent-producing Organ of Queen.

The articular membrane between the fifth and sixth abdominal terga of a queen honey bee is never visible externally, except at the instant when she bends her abdomen to sting an object beneath her. Several of these articular membranes of queens were excised and were examined in the same manner as already related for those of workers. Gland cells and chitinous tubes are present in the same position and arrangement as they are in workers.

All the other articular membranes between the abdominal terga in queens and workers were examined, but no chitinous tubes nor gland cells were found.

The gland cells (fig. 16*a*) in adult queens are at least one-third larger than are those in adult workers (fig. 15, *GlC*) and in fixed and stained sections they have the same structure. The gland cells (fig. 16*b*) in pupæ of queens also have the same structure as those in pupæ of workers.

6. Does a Drone have a Scent-producing Organ?

All the articular membranes between the abdominal terga of several drones were excised and carefully examined. At no time did the writer ever find chitinous tubes attached to any one of these membranes and he never saw any cells adhering to the membranes which resemble the gland cells already described. This does not mean that drones do not have any scent-producing organs, because other parts of the body and all the appendages were not examined for glandular structures. Scent-producing organs in males of several other insects have been described, so that such an organ may still be found in drones.

Sometimes when the abdomens of young drones are slightly squeezed, a very thin and whitish liquid may be seen on the abdominal articular membranes. At other times a clear liquid may be observed on the articular membranes, particularly on those between the fourth and fifth, and fifth and sixth abdominal terga. This clear liquid has a saline taste, and in this respect resembles the blood of drones.

7. Discussion.

A discussion of all the literature available pertaining to the scent-producing organs of insects has been prepared, but since such a long discussion cannot be presented here, only a brief outline will be given.

A review of the literature shows that the substance produced by any scent-producing organ is secreted by unicellular glands which as far as known are modified hypodermal cells. For description, scent-producing organs may be divided into five types based on their devices for disseminating the odor and for storing the secretion as follows: (1) No special device for disseminating the odor or storing the secretion; (2) gland cells associated with hairs and scales as a means of scattering the odor more effectively; (3) "evaginable" sacs lined with hairs connected with gland cells as a device for storing and distributing the odor; (4) articular membranes serving as pouches for storing and preventing a too rapid evaporation of the secretion; (5) specialized tubes and sacs acting as reservoirs for storing and discharging the secretion.

The first type is the simplest of all five types. It is best represented as unicellular glands uniformly distributed over the entire body surface as found in some beetles (Tower, 1903). In the beetles *Dytiscus* and *Acilius* unicellular glands lie just beneath the hypodermis between the head and tergite of the prothorax (Plateau, 1876). In the blister beetle, *Meloe*, are found unicellular glands beneath the hypodermis on both sides of the femoro-tibial articulations (Berlese, 1909). These gland cells are similar in structure to those of the honey bee. Beneath the femoro-tibial articulation in *Camponotus* and the tibio-tarsal articulation in *Formica*, Schön (1911) found unicellular glands. Beneath the hypodermis of the caruncles of the Indian roach, *Corydia*, lie unicellular glands, also similar to those of the bee (Klemensiewicz, 1882). In this type of scent-producing organ the secretion passes through the chitinous tubes to the exterior where it spreads over the surface of the chitin surrounding the exits of the tubes.

In regard to spreading the secretion over a wider area, the second type is much more highly developed than is the first type. This is accomplished in most cases by the secretion spreading over the surfaces of many large hairs arranged in tufts which may be expanded into a fan-shaped figure. The hind tibiæ of the male moth *Hepialus hecta* are greatly swollen and are almost filled with large unicellular glands, each of which communicates with a spatula-shaped hair (Bertkau, 1882). In the male moth *Phassus schamyl* the hairs are scalelike with the distal end of each scale divided into two or three lobes (Deegener, 1905). The same kind of organ is found in the male moths *Syrichthus malvæ* and *Pechipogon barbalis* (Illig, 1902). In the latter species, instead of there being a tuft of hairs on each hind tibia, each front tibia bears three tufts. In the male moth *Sphinx convolvuli* a pair of lateral tufts of scalelike hairs is found at the proximal end of the abdomen (Tozzetti, 1870). In the female moths *Taumatopoca pinivora* and *Stilpnotia salicis* the scent-producing organ is a large paired tuft of hairs on both sides and above the anus (Freiling, 1909). In many male butterflies, the scent scales on the wings serve as scent-producing organs (Müller, 1877). Each scale is connected with a unicellular gland (Thomas, 1893; Illig, 1902). In the second type of scent-producing organ, the secretion from the gland cells passes into the hairs and scales and then spreads over their surfaces, whereby the odor from the secretion is more effectively disseminated.

In regard to storing the odor in an "evaginable" sac, the third type is a little farther advanced than the second type. In the male butterflies *Danais* and *Euplœa* the scent-producing organ consists of two large chitinous invaginated sacs, lined with scalelike hairs. One of these sacs lies on either side of the abdomen and opens between the seventh and eighth sterna (Illig, 1902). In the female butterfly *Gonopteryx rhamni* this organ is a single invaginated sac, but in the female of *Euplœa* it consists of a circle of scalelike hairs around the anus and of a pair of invaginated sacs, lined with hairs as usual (Freiling, 1909). Each hair is connected with a unicellular gland. The sacs are evaginated by blood pressure and retracted by muscles. It is thus seen that the odorous substance may be more or less retained in the invaginated sacs, but when the sacs are evaginated, like the fingers of a glove, all the odor escapes.

In regard to storing the secretion, the fourth type is more highly organized than any one of the preceding types of scent-producing organs. In the roach *Periplaneta orientalis* this organ consists of a pair of shallow pouches in the articular membrane between the fifth and sixth abdominal terga. The pouches are covered by the fifth tergum, but open to the exterior by a pair of slit-shaped openings. They are lined with hairs, each of which connects with a unicellular gland (Minchin, 1888). In the sexually matured male roach *Phyllodromia germanica* there are two double pouches, one of which is located in the articular membrane between the fifth and sixth and the other between the sixth and seventh abdominal terga. These pouches are not lined with hairs. The tubes from the unicellular glands carry the secretion directly to the pouch where it is forced to the exterior by muscles constricting the lumen of the pouch (Oettinger, 1906). In the female moth *Orgyia antiqua* the scent-producing organ is a shallow pouch in the articular membrane between the eighth and ninth abdominal terga. The unicellular glands lie in groups like several bunches of grapes just beneath the thin membrane. Freiling (1909) saw no tubes connecting the gland cells with this membrane. He thinks that the secretion passes through the membrane by infiltration. In the petiole of the worker ant of *Myrmica rubra*, Janet (1898) found an invaginated chamber. At the bottom of the chamber may be seen the exits of the tubes which lead to the bunch of unicellular glands. He also found in the same ant two small groups of unicellular glands beneath the articular membrane between the ninth and tenth abdominal terga. These glands are also connected with tubes which run to the exterior. Both of these organs may possibly be scent-producing organs. The wax glands of young worker bees may also have such a function. Each of these unicellular glands is nothing more than a hypodermal cell modified for secreting a substance which passes through many minute pores in the thick chitin of the abdominal segment. After coming in contact with the external air the substance changes to wax. In *Apis* these glands lie beneath the second, third, fourth, and fifth abdominal sterna, in *Melipona* beneath the last four abdominal terga, in *Trigona* beneath the last five abdominal terga, but in *Bombus* beneath both the abdominal sterna and terga (Dreyling, 1906).

The scent-producing organ of the honey bee belongs to the fourth type, and it is probably the most highly developed organ of this type. Nassonoff thought that the chitinous tubes ran into the bottom of the canal, chiefly formed by the anterior portion of the articular membrane, instead of them uniting with the posterior wall of the canal. If they united with the bottom of the canal, they would materially affect the flexibility of the membrane. Zoubareff (1883) imagines that the gland cells in this organ of the bee secrete the little drops of liquid which bees are said to let fall when flying. He thinks that these drops represent the excess of water contained in freshly gathered nectar over that in ripened honey.

In regard to storing and discharging the secretion as a means of defence, the fifth type of scent-producing organ is the most highly organized of all five types. For storing the secretion, the ear-wig has two pairs of reservoirs in the third and fourth abdominal terga (Vossler, 1890). Both sexes of walking-sticks have two straight, ribbonlike blind sacs which lie in the thorax (Scudder, 1876). The electric-light bug has two long cœcal tubes in the metathorax (Leidy, 1847). In another bug, *Pyrrhocoris apterus,* the scent-producing organ is quite complicated. It has a specialized reservoir with a valve to prevent the escape of the secretion (Mayer, 1874). The male roaches *Periplaneta orientalis* and *P. americana* have, besides the scent-producing organ in the articular membrane already mentioned, anal glands which are highly organized (Bordas, 1901). The unicellular glands belonging to the anal glands of a beetle, *Blaps mortisaga,* are very similar in structure to those of the bee (Gilson, 1889). Many species of Carabidæ and Dytiscidæ have been studied by Dierckx (1899). He finds that all their anal glands are highly organized and that the secretion is produced by many unicellular glands which lie either in the tubes leading to the reservoir or lie a short distance from these tubes. All of the gland cells are quite similar in structure to those of the bee. A highly organized anal gland has also been found in a few ants (Forel, 1878).

From this brief outline, it is seen that scent-producing organs have already been found in many insects belonging to five orders. There is a wide variation in organization between the lowest type and the highest type. All of those organs belonging to the first four types are used in all probability for alluring purposes and as a means for recognition, while those of the fifth type are perhaps used only as a means of defence. Of the scent-producing organs used for recognition, that of the honey bee is probably the most highly organized.

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EXPLANATION OF PLATES XIX AND XX.

All figures, except diagrams Nos. 1 and 2, are from camera lucida drawings, made at the base of the microscope. Figures 5 to 16*b* were made by using a V and S4 ocular and a $\frac{1}{12}$ oil immersion. Each one of these drawings is enlarged 875 diameters.

ABBREVIATIONS.

AcSt	accessory parts of sting.
Amp	ampulla of gland cell.
AntP	anterior portion of articular membrane.
ArtM	articular membrane.
Can	canal.
CanTu	canal of chitinous tube.
Ch	chitin.
ClS	clear spot in cytoplasm of cell.
DDph	dorsal diaphragm.
ECan	end of canal.
FC	fat cell.
GlC	gland cell.
Glo	globule of cell.
Gr	groovelike indentation in chitin forming canal.
H	heart.
Hr	hair.
HrS	hair socket.
Hyp	hypodermis.
HypC	hypodermal cell.
LInt	large intestine.
M	muscle to move sting.
Mal	Malpighian tubules.
Œ	œnocyte.
PostP	posterior portion of articular membrane.
RadStr	radial streak of ampulla.
SInt	small intestine.
St	sting.
T	trachea.
Tu	chitinous tubes of gland cells.
TrA	transparent area in ampulla.
VDph	ventral diaphragm.

a to *f* of figure 2.—*a*, small barbed hairs; *b*, small spinelike hairs; *c*, groovelike indentations on anterior portion of articular membrane; *d*, heavy and wide vein of chitin between anterior and posterior portions of articular membrane; *e*, heavy and narrow vein of chitin in posterior portion of articular membrane; *f*, location of gland cells.

a to *e* of figure 4.—*a*, comparatively thin and almost transparent chitin; *b*, narrow, thick and yellow band of chitin; *c*, thick, semitransparent band of chitin; *d*, wide, thick and opaque band of chitin; *e*, thick semitransparent chitin.

a to *b* of figure 9.—*a*, hypodermal cells, which later become gland cells, now broken loose from hypodermal layer; *b*, a later stage of same.

v, the heavy and wide vein of chitin shown in figure 2, *d*.

Fig. 1 has been placed in the text.

PLATE XIX. Fig. 2.—Diagram of articular membrane spread out flat under a low-power lens, showing its superficial appearance, and looking through the posterior part (*PostP*) of membrane at a deeper focus may be seen gland cells and tubes as shown at *f*. The material used for figs. 2 to 7 inclusive was fresh and was stained slightly with a weak solution of methylin green.

Fig. 3.—A small portion of anterior part (*AntP*) of membrane from fig. 2, showing the groovelike indentations (*Gr*). × 700.

Fig. 4.—A small portion of posterior part (*PostP*) of membrane from fig. 2, looking at inner side of chitin with strong transmitted light. Four gland cells (*GlC*) and many tubes (*Tu*) are shown. The tubes are twice too wide. × 275.

Fig. 5.—Large live gland cell, showing its structure.

Fig. 6.—Large live œnocyte, showing its structure.

Fig. 7.—Small live fat cell, showing its structure.

Fig. 8.—Cross section of a small portion of posterior part (*PostP*) of membrane from fig. 2 at *f*, after treatment with caustic potash, showing that tubes (*Tu*) are chitinous.

Plate XX.—Fig. 9.—Sagittal section through articular membrane of a 15-day-old worker pupa (counting from the time the egg was laid), showing origin of gland cells from hypodermal cells (*HypC*). All material used for figs. 9 to 16*b* was fixed and stained.

Fig. 10.—Same kind of section as fig. 9, from a 16-day-old worker pupa, showing (1) great increase in size of gland cells (*GlC*) within one day's time; (2) presence of tubes (*Tu*); (3) thin hypodermis (*Hyp*); and (4) presence of chitin (*Ch*).

Fig. 11*a–c*.—Origin of chitinous tube from a hypodermal cell. 11*a* is from a 15-day-old worker pupa, and 11*b* and 11*c* are from a 15½-day-old worker pupa.

Fig. 12.—Same kind of section as fig. 9, from a 17-day-old worker pupa, showing, as compared with fig. 10, (1) a slight increase in size of gland cells; (2) a thinner hypodermis; and (3) thicker chitin.

Fig. 13.—Same as fig. 12, but from a 19-day-old worker pupa, showing no noticeable change in size of gland cells.

Fig. 14.—Same as figs. 12 and 13, but from a 21-day-old worker pupa (now emerged as an imago insect), showing; (1) a considerable increase in size of gland cells, and (2) thicker chitin.

Fig. 15.—Same as fig. 14, but from an old worker bee, showing a still greater increase in size of gland cells. Compare this large gland cell, which was fixed and stained, with the large live gland cell in fig. 5.

Fig. 16*a*.—Large gland cell from an old queen.

Fig. 16*b*.—Large gland cell from a middle-aged pupal queen. Compare fig. 16*a* with gland cell in fig. 15.

FURTHER NOTES ON METEOR CRATER, ARIZONA.

BY DANIEL MOREAU BARRINGER.

I present this as a supplement to my paper, entitled "Coon Mountain and Its Crater," published in the PROCEEDINGS of The Academy of Natural Sciences of Philadelphia in December, 1905, and to my more comprehensive and necessarily more accurate paper (owing to the amount of exploration work which has been done), read before the National Academy of Sciences at its autumn meeting at Princeton University, November 16, 1909, with a few additional and apparently conclusive arguments with regard to the correctness of the impact theory of origin of what is now known as the Meteor Crater of Arizona.

One of the most significant minor facts in connection with this remarkable crater is the discovery by those who have conducted the extensive exploratory work there of quite large quantities of quartz glass, which is undoubtedly fused sandstone and has been so described by Merrill.[1] An examination of the specimens now on exhibition at the American Museum of Natural History, New York, will immediately convince the most skeptical that this is nothing but fused sandstone.

It does not appear that those who have written on the interesting subject of the origin of this crater in Arizona, myself included, have used this fact, and the circumstance that the material is abundantly stained with nickel-iron oxide, as a conclusive argument—for such it is—in favor of the impact theory rather than the volcanic theory of origin. I am assured by Dr. Merrill and others that there is no record of a sudden outburst of volcanic action wherein the heat generated was sufficient to fuse crystalline quartz. The only case of quartz being fused by a sudden rise in temperature to the necessary degree of heat to effect a result comparable to that produced here is that of the more or less familiar action of the lightning striking sandstone or sand and altering it to what is known as fulgurite glass. No volcanic action, however violent or however long con-

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[1] *Proc. U. S. National Museum*, Vol. XXXII, pp. 547–550, June 15, 1907, and *Smithsonian Misc. Collections* (Quarterly Issue), Vol. 50, Part 4, pp. 461–498, pls. 61–75, January 27, 1908. See also the description of this metamorphosed sandstone in my National Academy paper.

tinued, has been known to produce such an effect. The only comparison which occurs to me and which will at all fit the facts is that of the striking of a heavy armor-piercing projectile upon armor plate. There, I understand, a very high heat is generated momentarily, as was certainly the case at the Arizona crater. There also the heat of impact is sufficient to not only fuse a small portion of the target, but a small portion of the projectile, since momentarily iron-and-nickel vapor is produced. That this vapor of iron and nickel was also produced at the crater, being derived from the impacting body, is evidenced by the fact that this particular variety of fused sandstone, referred to by me as "Variety B" of metamorphosed sandstone in my National Academy paper, is nearly always more or less abundantly stained by iron and nickel oxide. The fact that this stain is often found in places where the metamorphosed sandstone has gaped open under the influence of intense heat and then closed again upon cooling, is most significant.

Now it must not be forgotten that the white or gray saccharoidal sandstone, small portions of which have been fused in this way, does not outcrop anywhere nearer than the Grand Canyon of the Colorado, seventy miles distant, where it is known as the White Wall or Cross-bedded sandstone and overlies, as at Meteor Crater, the Red Wall or Red Beds sandstone. At the crater the upper portion of this sandstone occupies a position about 350 feet below the surface of the plain, being overlaid by about 300 feet of the Aubrey limestone and 40 or 50 feet of the purplish-red sandstone, which, in the form of small buttes, is found all over the surrounding otherwise almost level plain. It must be remembered also that all the strata in this locality are horizontal. Clearly, nickeliferous iron had penetrated into and, as we now have strong reason to believe, through this bed of white or gray sandstone, and we know that nothing terrestrial in this vicinity contains nickel in any form. The only possible source of this stain is, therefore, the meteoric iron, the occurrence of which has been very fully described in my previous papers. (See Plate XXIII, showing the distribution of meteoric iron around the crater.) It seems to me, therefore, that this peculiar vesicular form of metamorphosed sandstone, which was certainly produced by sudden and intense heat and which is so abundantly stained with nickel and iron oxide, in itself furnishes an incontrovertible proof of the impact theory of origin, the opinion of certain members of the United States Geological Survey to the contrary notwithstanding.

Professor Elihu Thomson has given me permission to quote a statement which he made to me in a letter written a few days after he visited the crater some years ago, as follows: "This Arizona crater bears all the evidences of impact and the evidences of nothing else." This is the complete story told in a few words. It will be in the interest of science if scientific men, and especially those of the United States Geological Survey who deny this theory of origin, will present their reasons for maintaining the hypothesis that the crater was due to some manifestation of volcanic activity. I believe that it will be easy to refute any argument they may advance. No examination of the crater since the exploratory work was done has been made by any members of the Survey, to the best of my knowledge and belief. Therefore, unless they can satisfactorily account for the facts which I have stated in this and in my previous papers on the subject on some other theory than that of impact by a great mass of meteoric iron, it would seem that I can fairly claim to have proved the theory that the crater was formed by this agency.

There is good reason to believe that the meteoric mass was a dense cluster of iron meteorites and possibly was the head of a small comet which was not moving at very high speed, astronomically considered, since there is no evidence, beyond the very slight evidence referred to above, of the volatilization of any portion of the mass. Moreover, it is certain that the siliceous limestone bed, which it encountered after passing through the 40 to 50 feet of overlying purplish-red sandstone, would have been readily fused had the impact been such as we can reasonably suppose it to have been had there been a head-on collision between this small cluster of iron meteorites or cometary body and the earth. Besides this, as anyone who knows anything about ballistics will at once acknowledge, there would have been no such penetration as we now know took place: nearly, if not fully, 1,200 feet into solid limestone and sandstone strata. It has been inferred, therefore, that the cluster of iron meteorites may have followed after the earth and that the blow delivered was not such as it would have been if there had been a direct head-on collision. We now know that the mass, probably weighing as much as 10,000,000 tons, if not more, penetrated through the white or gray sandstone and as far down as the top of the Red Beds sandstone (Red Wall sandstone of the Grand Canyon section). Several cores from this sandstone bed, showing it to be undisturbed and lying in a horizontal position, have been brought up by the drill directly under the centre of the floor of the crater and at a depth of from 900 feet to over 1,000 feet below the floor of the crater. They are to be seen at the American Museum of Natural History, New York.

Only a small and unfortunately the central portion of the crater has been explored by the drill, not more than $\frac{1}{19}$ of the total area of the crater, but undoubted meteoric material (small pieces of "iron shale" or magnetic nickel-iron oxide) have been brought up by the drill, as stated in my previous papers, from a depth of between 700 and 800 feet below the level of the floor of the crater, which is about 440 feet, on an average, below the level of the surrounding plain. The drill holes were located there because we did not at the time this drilling was done appreciate the direction from which the meteoric mass approached or properly interpret the evidence which now causes us to believe that it lies under the southern wall of the crater, some *2,000 feet* distant from where the drilling was done. We did not take into consideration certain facts now very plain to us and to anyone who may visit the crater or carefully study the maps, once his attention is called to these facts, which should have shown us that it approached at quite an angle from the north, perhaps as much as 30° from the vertical.

In the first place, the greatest amount of iron meteorites and especially those of the "shale ball" variety, described in my previous papers, have been found on the northern slope of the crater and on the plain beyond—accurately, slightly to the east of a north and south line passing through the centre of the crater. In this connection it may be of some interest to know that there was found about a mile and a half from the crater in a north-northeast direction three years ago the largest Canyon Diablo iron meteorite which has ever been found. The following are the dimensions of this meteorite, which is of the ordinary Canyon Diablo type, with characteristic pittings, etc.:

Length	3′ 2″
Width	2′ 5″
Height	1′ 3½″
Greatest circumference	8′ 3½″
Least circumference	5′ 7″
Estimated weight	Between 1,700 and 2,000 pounds.

It is to be seen at the museum[2] which has been built at the crater.

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[2] The collection of meteorites, metamorphosed sandstone, specimens of all the strata penetrated, etc., in this museum and in the collection at the American Museum of Natural History, in New York City, which has been loaned to it by Princeton University, should be seen by all those who are interested in the subject.

Secondly, vastly more of the fragmentary material, including that which came from its greatest depths, which has been expelled from the crater by the force of the impact, lies on the southern rim than anywhere else.

Other proofs that the meteoric mass which produced the crater by its impact with the earth approached from this direction are that in the south wall of the crater, composed of great limestone and sandstone cliffs, the fact is clearly discernible that this sandstone and limestone have been lifted vertically some 105 feet out of position for a total length of nearly one-half mile. On either side of this great uplift the formations are tilted violently backward, a fault separating them from the central uplifted mass (see Plates XXI and XXII). Moreover, a distinct bending or arch can be seen in the lines of stratification of the rocks composing this central mass which has been vertically uplifted and which probably weighs in the neighborhood of 50,000,000 tons. The highest point of this curvature is in the exact centre or midway between the point where the strata have been turned backward, as described. This would seem to indicate that something was wedged or intruded underneath this great mass of rock and lifted it vertically upward. The central portion of this mass of rock so uplifted is almost due south of the centre of the crater or nearly opposite to that portion of the crater's rim and the plain beyond on which the greatest number of ordinary Canyon Diablo meteorites and the so-called "shale ball" meteorites have been found. Also beginning at the north the strata exposed in the circular wall of the crater increase in the dip representing their backward tilting on each side of the crater right around to the faults which mark the east and west sides of this uplifted mass (see Plates XXI and XXII). When these facts are considered in connection with that of the great fragmentary masses of limestone being collected together in what I have heretofore referred to as "fields of limestone boulders," which lie to the east and west of a north and south line passing through the crater, conviction is forced upon the mind that the mass which made the crater, and which according to our present knowledge of physics and chemistry must lie somewhere in its depths, approached the earth from a northerly direction and held to its course as a rifle bullet would until perhaps it came to the top of the hard Red Beds sandstone stratum, when possibly it may have been deflected somewhat. Apparently, however, it advanced sufficiently far underneath the white or gray sandstone and the overlying limestone to uplift the portion of the wall of the crater referred to above more than 100 feet out of its proper position. What could be more natural under these conditions than that we would have found nothing in the centre of the crater except some little pieces of iron oxide representing largely sparks or bits of metal which were literally torn off the projectile as it advanced through the rock target? By far the greater portion of it must have held together, as a charge of shot holds together for a short distance after it leaves the muzzle of a shotgun. It is considered extremely likely that the major portion of the mass lies under the southern wall of the crater and particularly under that portion of it which has been uplifted in the manner that I have attempted to describe.

The theory has been advanced that this great crater was partially formed by the heating of the water in the moist sandstone converting it almost instantly into steam. I have no doubt that this action contributed in a measure to excavate the crater, but I do not think that it contributed very largely to the general effect. It seems to me that it is hardly necessary to call in any other agency to account for the observed facts than the excavating effect of such a projectile. In short I believe the crater would have been practically as large as it is to-day if there had been no water in the sandstone. We well know from repeated borings by the Atchison, Topeka & Santa Fe R. R. Company that these strata contain very little water to-day and all the evidence is in favor of the crater's being of recent origin, the Indians of that section having a legend connected with the fall.

Having once been convinced of the correctness of the impact theory of origin, the size of the meteoric mass which formed the projectile becomes of interest. It is hardly conceivable that its weight was less than five million tons. It may have been 10,000,000 tons, or twice that weight. Admitting that it was a cluster that produced the result, the wonder is that it was as small as we now realize it must have been. These masses of meteoric material we know to be flying through space in the vicinity of our solar system. They possibly represent the small remaining portions of the nebula out of which our system was made. Most of them have probably long since been gathered into the sun or into some of the planetary bodies. Saturn's rings, I believe, are largely composed of meteorites. They probably present an early stage of moon-making. The craters on the moon's surface are much more thinkable in size than the Arizona crater. Most of the craters on the moon's surface, which I firmly believe to be impact craters, are vastly larger than our Arizona crater, and one of them is even 150 miles in diameter. When one who is familiar with the Arizona crater examines the lunar craters through a good telescope they are at once seen to show the main features of the former. The relation of width to depth is the same. Most of the ejected material lies close around the lunar craters and forms the so-called rim, as in the case of the Arizona crater. There are spurts or tongues of ejected material in the Arizona crater and presumably in the lunar craters. Even the peculiar conical central hill or mountain which is observed in most of them and which I confidently assert cannot be explained on any theory of volcanic action, has its counterpart in our own Silica Hill at Meteor Crater (see Plates XXI and XXII). It probably exists in all of the lunar craters, but in the very small ones it is not easily discernible on account of the smallness of the crater and because, as in our crater, the effect has been somewhat masked. This hill in the Arizona crater is now somewhat masked by the overlying lacustrine sediments and by fine material deposited by the action of wind over it. For a long time its origin puzzled us greatly. It now seems to have been a necessary feature of the impact. These central conical hills or veritable mountains in the larger lunar craters would seem to be due to the same physical law which we see in operation when we drop a stone into water or soft mud, with which solid rock can be compared if the projectile strikes it at sufficient speed. A raindrop falling on still water produces for a moment the same small conical-shape in the centre of the cavity caused by the impact. In the case of water, of course, it soon mingles with the surrounding water; in the case of rock fragments or rather stiff mud it remains. In this connection one should read *A Study of Splashes*, by Professor W. A. Worthington, of Devonport, England, in which the author has introduced some quite wonderful photographs and arrived at certain conclusions with regard to the behavior and flow of solid substances under great pressure, suddenly applied, being analogous to the motion set up in liquids or viscous material upon impact. These conclusions seem to be fully warranted and also seem to go far toward explaining the presence of the conical-shaped hills in nearly all of the lunar craters. Anyone who will make a careful study of our Arizona crater and will then read Worthington's book, studying the diagrams he has made, and will then turn his attention to the lunar craters, cannot escape the conviction that the lunar craters are impact craters. Why the moon should have been so abundantly bombarded and the earth so seldom bombarded during recent geological history is seemingly difficult to explain, but one must not forget that the moon has been without an atmosphere for perhaps a great many million years and all the bombardment to which it has been subjected during this vast period of time is clearly and permanently recorded.

May it not be possible that when one holds in his hands one of the meteorites that occasionally reach this earth and which reached it on its present surface in far greater numbers at and around Meteor Crater in Arizona than any other locality known to us, he is holding in his hands something older than our sun or any of the planets which revolve about it; in fact, that he is holding in his hands something which has literally formed part of the nebula out of which our whole solar system has been built up? If this be in accordance with the facts it would help to confirm the more recent theories of the building up of the planetary systems as put forward by Chamberlin and Moulton.

It seems to me to be not inappropriate to bring this paper to a close by quoting in substance an argument which I recently heard used by Dean W. F. Magie, Professor of Physics at Princeton University, in favor of the impact theory of origin of the Arizona crater and as against the steam explosion theory of origin, which has been advanced and persisted in notwithstanding all the evidence presented in the many papers which have been written on the subject since the publication of my first paper read before The Academy of Natural Sciences of Philadelphia. Dean Magie spent a fortnight at Meteor Crater several years ago studying the various phenomena in connection with the crater and carefully checking the statements of fact made by me in the National Academy paper above referred to. The argument is as follows:

First, on the doctrine of probabilities, the chances are one in many millions that the greatest known shower of iron meteorites should have fallen on the exact spot, with the Arizona crater as the centre of its distribution (by consulting Plate XXIII it will be noticed that the meteorites increase in number as one approaches the crater), at which a single, unprecedented steam explosion on a rapidly revolving earth occurred.

Secondly, that the chances are one in many more millions that this shower should have fallen on the exact site chosen for such an unprecedented steam explosion at the same instant of time that the steam explosion occurred.

Thirdly, that the chances are again one in millions that the steam explosion should have produced not only such a peculiarly symmetrical crater as has been described in the various papers which have been recently written concerning it, but should have produced one which furnishes so much other evidence strongly confirming the theory of impact as against the theory of steam explosion.

Consequently, it is perfectly fair mathematically to multiply these three and for one to say, on the theory of probabilities, that the chances are one in the product of all these millions that the crater was formed by a steam explosion. This of course is negligible.

EXPLANATION OF PLATES XXI–XXIII.

PLATE XXI.—Map of Meteor Crater, Arizona (six miles south of Sunshine Station, Atchison, Topeka & Santa Fe R. R., Coconino County, and in Sections 13 and 24, T. 19, N. R., $12\frac{1}{2}$ E.).

PLATE XXII.—Rough sketch map showing distribution of major portion of fragmentary material ejected from Meteor Crater, Arizona.

Some rock fragments have been thrown as far as two miles from the crater. This map merely shows manner of distribution and relative quantity of material near the crater. Very much more material has been thrown to the south (generally speaking) than elsewhere, *i.e.*, the mass of rock fragments is much thicker there than elsewhere and the rock has been more finely crushed. The rock fragments seem to have been thrown furthest to the northeast by east, where they thinly cover a large area.

LEGEND.—

▬ Crater Rim.

······ Lower limit of *bulk* of ejected material which forms to a large extent the so-called mountain. This line necessarily approximate.

▤ Limestone fragments, the most coherent rock thrown out of the crater.

▨ Fields of big limestone boulders on the east and west slopes of the mountain.

▭ White or gray saccharoidal sandstone fragments. These frequently show cross bedding.

■ Brown sandstone fragments and brown sand due to their disintegration. Much of this sand has been drifted to the eastward by the prevailing winds.

▧ Thin sheets or individual masses of ejected limestone far out on the plain. These scattered fragments are found $1\frac{1}{2}$ miles from the crater rim to northeast, $1\frac{3}{4}$ to 2 miles east and about 1 mile southeast. Map too small to show their distribution except in a general way.

PLATE XXIII.—Map showing distribution of meteoric material around Meteor Crater, Coconino County, Arizona.

LEGEND.

⊛ Meteoric irons (ordinary Canyon Diablo siderites) from 10 pounds to 547 pounds, discovered by Standard Iron Company.

✧ Meteoric irons, from 10 pounds to 1000 pounds, discovered by Mexicans employed by F. A. Volz *et al.* previous to acquisition of property by S. I. Co.

✦ Meteoric irons. Small. Discovered by S. I. Co. Thousands of the small irons found. Hence distribution only approximated. (These are generally only a few grains or ounces in weight, irons weighing from 1 to 10 pounds found only occasionally.)

◈ Large irregular masses of meteoric iron oxide or large "shale balls," from 100 pounds to 300 pounds in weight, due to oxidation of meteoric iron rich in chlorine and sulphur, or shale-ball iron.

○ Small broken fragments of meteoric iron oxide or "iron shale" (a few grains or ounces, rarely a pound in weight). Thousands of such pieces found, hence distribution only approximated.

OCTOBER 6.

MR. CHARLES MORRIS in the Chair.

Fifteen persons present.

Reports on the work performed during the summer vacation were made by the Curators, the Librarian, and the Secretaries.

The deaths of William N. Whelen, a member, and of Eduard Suess, a correspondent, were announced.

The reception of papers under the following titles was reported:

"Further notes on Meteor Crater, Arizona," by Daniel M. Barringer (July 2).

"Morphologic sequences in the canaliculate Fulgurs," by Burnett Smith (July 7).

"Observations sur la théorie générale des phénomènes glaciaires et sur les Galets stries," par Stanislas Meunier (July 27).

"New and little-known Craneflies from the United States and Canada (Tipullidæ, Diptera)," by Charles P. Alexander (August 24).

"New neuropteroid Insects, native and foreign," by Nathan Banks (September 29).

The following were ordered to be published:

MORPHOLOGIC SEQUENCES IN THE CANALICULATE FULGURS.

BY BURNETT SMITH.

The Tertiary and Recent gastropods which are usually assigned to the genus *Fulgur* or to the genera *Fulgur* and *Sycotypus* have been studied on several occasions in the endeavor to clear up the phylogenetic relationships of the different species. Inexact methods of collecting, poorly preserved material, and uncertainty of stratigraphic relations have perhaps contributed in no small degree to the conflicting interpretations which have resulted. In spite of the attention which these forms have attracted, no detailed morphologic work has, so far, been attempted in the group. The purpose of the present paper is to record some of the changes exhibited by the canaliculate division of the genus when traced throughout its geological and geographical range.

The following notes have been prepared after an examination of well-preserved specimens whose localities and horizons are in most cases known to have been determined with considerable accuracy. Museum sets of individuals falling well within a single specific diagnosis have been omitted whenever there was a suspicion that they were derived from more than one locality or from more than one horizon. It is recognized, however, that the amount of collecting necessary for a final settlement of these problems of phylogeny is far beyond the resources and the time of any one individual. Conclusions reached in these notes are therefore submitted with the full realization that they are preliminary in character and limited in scope.

In even so simple a structure as the gastropod shell there are too many features to be taken in and appreciated at a single glance, and when a number of gradational forms are viewed together it is seldom possible to retain any definite mental image in passing from one extreme to the other of a morphologic sequence. True, it can be seen by the most casual inspection that many species are closely allied, but to say *how* they are allied is by no means an easy matter. The chief obstacles encountered in such work are those presented (1) by multiplicity of morphologic characters, (2) by the inadequacy of words to express the requisite shades of meaning, and (3) by the difficulty of representing a transitional ontogenetic stage in a diagram.

In spite of their shortcomings it is believed that diagrams give a closer approximation to the truth than verbal descriptions and can be employed to greater advantage if their limitations are understood.

Though fully appreciating the necessity for the correct use of systematic terms, the author wishes to emphasize the point that the present study has not for its object the comparison of species as ordinarily understood, but the comparison and correlation of the morphologic combinations exhibited by the majority of individuals of communities or races.

Wherever practicable, the forms examined have been compared with type specimens. When this could not be done satisfactorily it has been the policy to refer, if possible, to some good figure of a specimen whose horizon and locality are known. Though this latter method may perhaps increase the chances of confusion among names, it is believed that it lessens the chances of confusing morphologic units.

In the group of gastropods under discussion the shell characters most available for comparison are the sutural canal, the nodes on the shoulder angle, and the shoulder-angle keel. The appearance and disappearance, strength or weakness, persistence or the reverse of these characters have been used in comparing one race or species with another. Decortication in many fossils and mechanical abrasion in most recent specimens have usually obscured the minute details of the first and second whorls. It is therefore not possible to compare here every ontogenetic stage, but it can be stated that the sequence of ontogenetic stages for the group appears to be (1) a smooth and rounded stage, (2) a short cancellated and rounded stage, (3) an angulated and noded stage, (4) an angulated and keeled stage without nodes, and (5) a final rounded stage in which only the faintest spiral striæ remain.

In the present study, as mentioned above, the last three stages are, together with the canal, the most useful for comparative purposes. It is unfortunate that it is not practicable to extend the comparisons in detail to the first and second whorls, but the nodes are usually much obscured on the second whorl, while the cancellated stage is known to the author in only one fossil race. Its presence, though not proved, is suspected nevertheless for the entire group of canaliculate Fulgurs.

In order to restrict, as far as possible, the verbal description of each feature in each whorl of each race, it is deemed advisable to present the diagrams first and allow them to serve as a guide to the explanations that may follow. The purpose of the diagram is to picture the persistence or the reverse of the different characters in passing from the early to the late whorls, that is, throughout the ontogeny of the average individual[1] of a race. The heavy horizontal line of the diagram represents the ontogeny. It might be described as a linear representation of that which in the shell is spiral:—the spiral shell unwound, if we may use such an expression. Above this line the ontogenetic stages are marked off as follows:

A. The smooth and rounded stage.[2]
N. The noded stage.
K. The keeled stage without well defined nodes.
R. The final rounded stage.

The ontogenetic range of the sutural canal is shown below the heavy line mentioned. The vertical dotted lines delimit the different whorls and the spaces between them are numbered accordingly.

It has been found by measurement that (due to ventricose coiling) the length of the shoulder on any one whorl is about twice as great as that on the preceding whorl. This, though not mathematically correct, is believed to be so close an approximation to the truth that the diagrams can be constructed in this manner. Whorl seven is accordingly shown as twice as long as whorl six, and this proportion is maintained down to the third whorl. (See tables on p. 570.)

THE CORONATUM-PYRUM SEQUENCE.

The sutural canal or channel which is such a prominent character in our two Recent species of canaliculate Fulgurs and which is usually selected as the chief diagnostic feature of the genus or subgenus *Sycotypus* had its beginnings at least as early as the Ballast Point Oligocene. It is here, as pointed out by Dall[3], more of an individual than a racial or specific character, but it is none the less present, and in any account of the canaliculate Fulgurs one must not fail to mention those Florida specimens which are provided with the shell structure in question. They are usually assigned (see A. N. S. P., No. 10,514) to *Fulgur spiniger* (Conrad), but their rather wide divergence from the type of that species is made evident by a com-

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[1] It cannot be too strongly emphasized that the tabulated results are intended to apply only to those specimens which are regarded as *average*. In every race or species individuals may be selected which exhibit either more or less acceleration of shell characters than does the average example.

[2] In the diagrams the cancellated stage when known to be present is included with stage A.

[3] *Trans. Wagner Free Institute of Science of Phila.*, vol. III, pt. 1, p. 111.

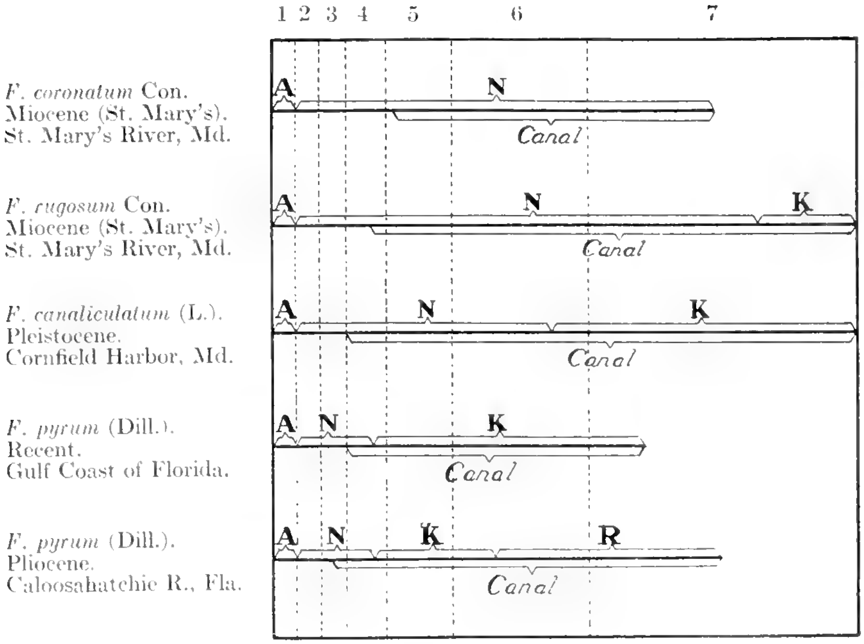

TABLE I. The *coronatum-pyrum* Sequence.

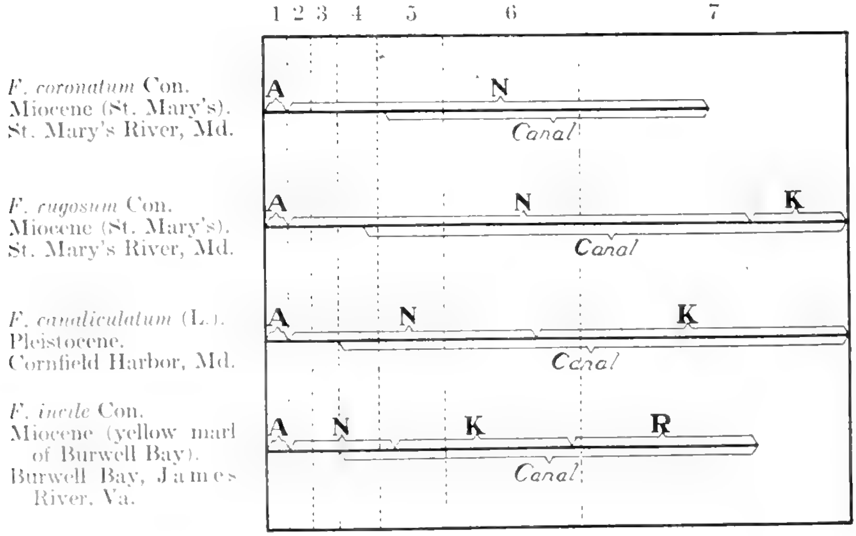

TABLE II.—The *coronatum-incile* Sequence.

parison with the figure which accompanies the original description.[4] They are without doubt a very primitive expression of the canaliculate type, but entire individuals of the series are all of small size, and the suspicion that they are not fully grown has prevented the author from including them in the tables with mature examples of other species. It is therefore considered better to begin the discussion of morphologic sequences with a later though perhaps equally primitive form—*Fulgur coronatum* Conrad[5]—from the St. Mary's Miocene.

The most striking sequence starting with this species terminates with a form from the Caloosahatchie Pliocene of Florida, which is usually included in *Fulgur pyrum* (Dillwyn). The steps in the sequence are *F. coronatum* Conrad (St. Mary's Miocene), *F. rugosum* Conrad[6] (St. Mary's Miocene), *F. canaliculatum* (L.)[7] (Maryland Pleistocene), *F. pyrum* (Dillwyn)[8] (Recent Florida), and *F. pyrum* (Dillwyn) (Florida Pliocene). These are all shown in Table I. Pleistocene specimens of *F. canaliculatum* have been selected because their preservation is superior to that of the available Recent specimens. It should also be noted that the ontogeny line which has been introduced for the Recent *F. pyrum* cannot be used to represent all individuals of the species.[9]

On consulting the table it will be seen that the sequence consists (1) in the progressively earlier appearance of the canal in passing from *F. coronatum* to the Caloosahatchie *F. pyrum*, (2) the progressive shortening of the noded stage through compression of the stage and acceleration of its later part, (3) the introduction and progressive acceleration of the keeled stage and its final compression in the terminal member of the sequence, and (4) the introduction of a final rounded stage in the Caloosahatchie *F. pyrum*[10] accompanied by compression and acceleration of the noded and keeled stages.

However little this arrangement may conform to geologic order or to one's ideas of phylogenetic relationship, it must be admitted that

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[4] *J. Acad. Nat. Sci. Phila.*, vol. 1, 2d ser., p. 117, pl. XI, fig. 32, 1848.

[5] "Fossils of the Medial Tertiary," pl. XLVI, fig. 1.
See also Md. Geol. Surv., Miocene, pl. XLVI, figs. 1*a*, 1*b*.

[6] "Fossils of the Medial Tertiary," pl. XLVI, fig. 4.
See also Md. Geol. Surv., Miocene, pl. XLVI, figs. 2*a*, 2*b*.

[7] See Md. Geol. Surv., Pliocene and Pleistocene, pls. XLVI, XLVII, XLVIII.

[8] "A Descriptive Catalogue of Recent Shells," L. W. Dillwyn, London, 1817, p. 485.
Martini Lister Syn. Method. Conch., 3d ed., 877, 1.
See also *Manual of Conchology*, G. W. Tryon, 1 ser., vol. III, pl. 58, figs. 402, 403.

[9] The suspicion is entertained that the Recent *F. pyrum* will eventually prove divisible into two species or at least races.

[10] This stage is also seen in many specimens of the Recent *F. pyrum*.

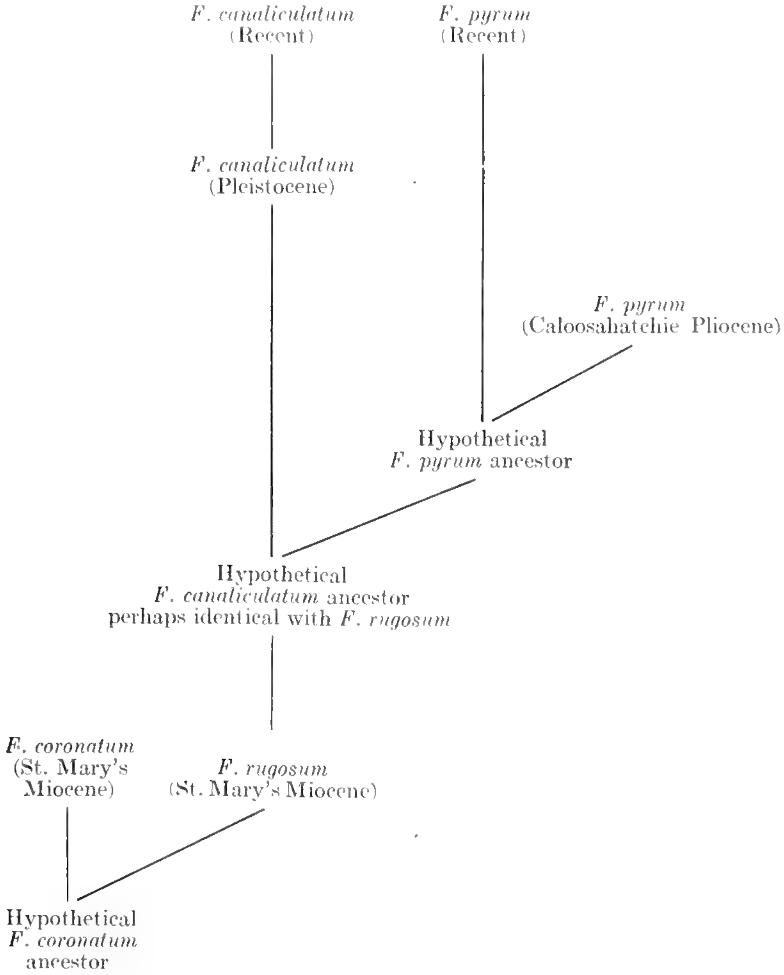
these forms just enumerated exhibit actual morphologic gradations. Any one feature is just a little stronger or more accelerated or perhaps just a little weaker in passing from *F. coronatum* to the Pliocene *F. pyrum*—in other words, the sequence is morphologic.

That the actual specimens from which these tabulated results were obtained could constitute part of a phylogenetic sequence is, of course, inadmissible. The specimens of *F. coronatum* and *F. rugosum* were contemporaries in the Miocene sea and the two lots of *F. pyrum* have their morphologic sequence the reverse of their geologic order. Again, *F. canaliculatum* and *F. pyrum* are contemporaries in the Recent seas and were probably even so in the Pliocene.

To interpret such data in terms of the phylogeny, one must decide between two quite diverse courses. In the first the worker may accept the geologic sequence as indicating the phylogeny and modify his ideas about organic evolution. The other course lies in choosing the morphologic sequence as portraying the phylogeny and introducing hypothetical species into the final scheme. In this latter case forms which are morphologically discordant but geologically intermediate must be regarded as intercalated migrants which have attained a high degree of specialization.

As an illustration of the difficulties presented by the first method of interpretation, attention is called to the Recent and Pliocene examples of *F. pyrum*. Those from the Pliocene are according to the morphology at the very limit of the sequence. If the Recent Florida individuals of this species are derived from the Caloosahatchie form, then the canal must have gone through a process the reverse of acceleration, and the disappearance or non-appearance of a final rounded stage must be accounted for in what is probably a majority of Recent examples. When the second method of interpretation is applied to these two assemblages, it is found necessary to derive both Recent and Pliocene examples from a hypothetical *F. pyrum* ancestor less specialized than the Pliocene form and not more specialized than the Recent form here tabulated. On this basis the Caloosahatchie *F. pyrum* is a terminal offshot which is extinct and not the ancestor of the less specialized Recent forms which are regarded as post-pliocene invaders from some other region.

At first glance it would appear that the method of interpreting by geologic position alone presents fewer difficulties. The study of these closely related species in this as well as in other groups of gastropods has, however, led the author to favor not the first, but the second method of interpreting. The reasons for choosing such a course will be more fully discussed later and at present it is sufficient to say that the morphologic sequence displayed by *F. coronatum*, *F. rugosum*, *F. canaliculatum*, and the two assemblages of *F. pyrum* is believed to be best interpreted in terms of the phylogeny as follows:



F. rugosum has been reported from the Calvert and Choptank formations.[11] Both are older than the St. Mary's. As far as the

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[11] Md. Geol. Surv. Miocene, p. 182.

writer has been able to learn, *F. coronatum* has not been found in these earlier beds. Those favoring purely stratigraphic methods will probably argue that, in any phylogenetic scheme, *F. coronatum* should be represented as derived from *F. rugosum.* This, however, would require an explanation of the absence of a keeled stage in *F. coronatum* and the acceptance of a theory that ontogenetic stages do sometimes go through a process the reverse of acceleration. The author inclines to the morphologic method in this case. It is believed that the derivation of *F. rugosum* from *F. coronatum* or something very close to it is amply justified, in spite of the fact that the latter form has not yet been proved to extend farther back than the St. Mary's Miocene.

In passing it may be said that the *F. pyrum*-like forms from the Duplin Miocene have been omitted purposely from the scheme, because of the suspicion, as yet unverified, that most museum sets are made up of specimens from more than one horizon in the Duplin beds.

THE CORONATUM-INCILE SEQUENCE.

The second morphologic sequence which commands our attention starts, as before, with *F. coronatum,* but ends with the late Miocene *F. incile* Conrad.[12] The gradations in this sequence, though not as complete as in the *F. coronatum-F. pyrum* sequence, are perhaps no less striking. Its members comprise *F. coronatum* Conrad (St. Mary's Miocene), *F. rugosum* Conrad (St. Mary's Miocene), *F. canaliculatum* (L.) (Pleistocene and Recent), and *F. incile* Conrad (Burwell Bay Miocene). These are shown in Table II. As before, the sequence consists (1) in the progressively earlier appearance of the canal in passing from *F. coronatum* to *F. incile;* (2) the progressive shortening of the noded stage through compression of the stage and acceleration of its later part; (3) the introduction and progressive acceleration of the keeled stage and its final compression in the terminal member, and (4) the introduction of a final rounded stage in *F. incile.*

In the succession of its ontogenetic stages, *F. incile* parallels *F. pyrum,* but in other respects it is quite different. In *F. pyrum* the tendency is for a shortening of the spire and a lengthening of the anterior canal. For *F. incile,* on the other hand, the reverse is true;

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[12] "Descriptions of Miocene Shells of the Atlantic Slope," T. A. Conrad, *Am. J. Conch.*, p. 64, pl. 6, fig. 2, 1868.
See also *Am. J. Sci.*, vol. XXIII, p. 343.

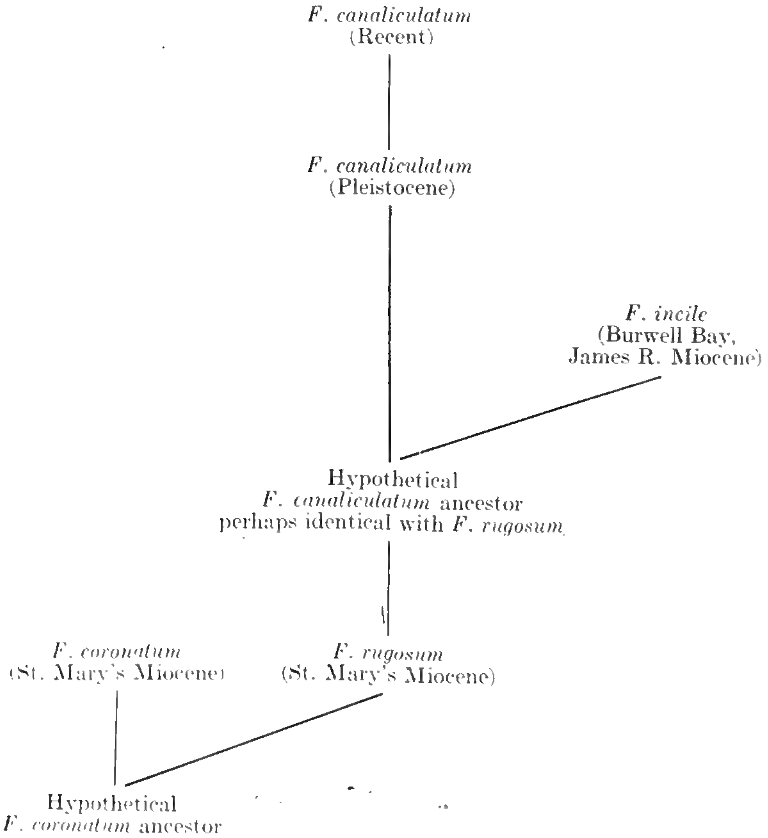
the canal shortening and the spire becoming more scalar during individual growth. Again the shell of *F. pyrum* tends to become light and thin, that of *F. incile* thick and heavy with the progress of the ontogeny.

The sequential relations presented by *F. canaliculatum* and *F. incile* are by no means apparent unless one is dealing with well-preserved specimens of the latter species. The average museum specimen of *F. incile* fails completely in this respect. If, however, the material is illustrative of the entire ontogeny, the similarity in the immature stages of these two species is very striking, and even the late whorls and short anterior siphon of *F. incile* are occasionally approached in very old and perhaps slightly abnormal individuals of *F. canaliculatum.*

When the geologic order of these species is considered in relation to their morphologic sequence, we are confronted with the fact that the Pleistocene and Recent (perhaps also Pliocene) *F. canaliculatum* is morphologically intermediate between *F. rugosum* of the St. Mary's Miocene and *F. incile* of the Burwell Bay (James River) Miocene. The descent of *F. incile* from any known race of *F. canaliculatum* is manifestly impossible, but the derivation of *F. canaliculatum* from *F. incile* could only be accomplished by the loss or non-development of acquired characters and a resumption of primitive features only slightly less marked than in *F. rugosum.*

Again, a decision must be made on what course to follow in interpreting the facts. We must either make the phylogeny agree with the stratigraphic order and modify our conception of the laws of evolution or else introduce a hypothetical common ancestor for both *F. canaliculatum* and *F. incile.* On this basis *F. incile* would be in no sense ancestral, but a terminal radiation of the late Miocene, which left no descendants.

In the case of the present sequence the author again favors the second method of interpretation and believes that the fewer difficulties are presented by the following phylogenetic scheme:



GEOLOGICAL RANGE AND CLASSIFICATORY VALUE OF SHELL STRUCTURES AND ONTOGENETIC STAGES.

Studies in evolution may be undertaken with the object of determining either the phylogeny of biologic groups, such as families, genera, species, or the phylogeny of organic structures. Though these two lines of research can never be regarded as entirely separate, they nevertheless constitute rather widely different aspects of the problem. Therefore, the results obtained in these present studies will be summarized with the view of emphasizing the phylogeny of structures.

The Sutural Canal:

(*a*) Oligocene to Recent.

(*b*) An ascendant character, becoming stronger and accelerating with the progress of time.

(*c*) Appearing in primitive forms of the Miocene after the beginning of the fifth whorl (*F. coronatum*).

(*d*) Appearing in a very specialized Pliocene form as early as the middle of the third whorl (*F. pyrum* Caloosahatchie Race).

(*e*) Though showing acceleration, its most notable changes are due to exaggeration of its depth or of its width.

(*f*) Its changes (variations or mutations) serve in part as a basis for the species of systematists. Its persistence is of generic or group value and serves to differentiate the canaliculate from the non-canaliculate Fulgurs.

The Noded Stage:

(*a*) Oligocene to Recent in this group.

(*b*) A declining character for this group, becoming weaker with the progress of time. Accelerating more by compression than by the dropping out of nodes.

(*c*) Appearing in all forms at about the beginning of whorl two. Closing the ontogeny of primitive forms of the Miocene (*F. coronatum*).

(*d*) Disappearing in very specialized forms before the completion of the fourth whorl (*F. pyrum*).

(*e*) Though its termination may show widely different degrees of acceleration, its most notable changes are due to its degeneration.

(*f*) Its changes through acceleration and degeneration serve in part as a basis for the species of systematists. Its persistence is of no higher classificatory value, for it is a primitive feature widely distributed among very diverse groups of marine gastropods.

The Keeled Stage:

(*a*) Miocene to Recent in this group.

(*b*) An ascendant character in the fairly primitive species (*F. rugosum*, *F. canaliculatum*). A declining character in the most specialized (*F. pyrum*, *F. incile*).

(*c*) Appearing in more primitive forms toward the end of the seventh whorl, in the most specialized toward the end of the fourth whorl.

(*d*) Terminating the ontogeny in fairly primitive forms (*F. rugosum*, *F. canaliculatum*). Ending early in the sixth whorl of the most specialized (*F. pyrum* Caloosahatchie Pliocene).

(*e*) Changes due to compression, acceleration, degeneration, and exaggeration are all well marked.

(*f*) Its changes through compression, acceleration, degeneration, and exaggeration serve as a basis for the species of systematists. It has no higher classificatory value.

The Final Rounded Stage:

(*a*) Late Miocene to Recent in this group.

(*b*) An ascendant character appearing only in the most specialized species (*F. pyrum, F. incile*). Never a declining character, though it may perhaps be indicative of decadence.

(*c*) Never appearing in primitive forms. Appearing early in the sixth whorl of the most specialized form (*F. pyrum* Caloosahatchie Pliocene). Never, in this group, followed by any other ontogenetic stage.

(*e*) Its chief changes are due to its degree of exaggeration.

(*f*) Its changes through exaggeration help to serve as a basis for the species of systematists. It has no higher classificatory value.

In the preparation of these notes the collections most extensively studied were those of The Academy of Natural Sciences of Philadelphia and of the Wagner Free Institute of Science of Philadelphia. Acknowledgments are due to the officers of these institutions for many courtesies and to Mrs. Ethel Ostrander Smith for the careful execution of the drawings.

Explanation of Plate XXIV.

Fig. 1.—*Fulgur coronatum* Conrad. Miocene (St. Mary's). St. Mary's River, Md. Apical view of an adult individual of about 6½ whorls. Illustrates a rather primitive type of the sutural canal and a vigorous noded stage which persists to the end of the ontogeny. Diameter of last whorl at shoulder = 79 mm.

Fig. 1*a*.—Side view of specimen shown in fig. 1.

Fig. 2.—*Fulgur rugosum* Conrad. Miocene (St. Mary's). St. Mary's River, Md. Apical view of an adult individual of about 7 whorls. Shows a well-developed sutural canal and a degenerating noded stage with its gradual transition into a keeled stage toward the end of the seventh whorl. Diameter of last whorl at shoulder = 100 mm.

Fig. 2*a*.—Side view of specimen shown in fig. 2.

Fig. 3.—*Fulgur canaliculatum* (L.). Recent. Apical view of an immature individual of about 6¾ whorls. Shows a well-developed sutural canal and an accelerated and degenerate noded stage, which passes into a keeled stage toward the end of the sixth whorl. Diameter of last whorl at shoulder = 67 mm.

Fig. 3*a*.—Side view of specimen shown in fig. 3.

Fig. 4.—*Fulgur incile* Conrad. Late Miocene. Yellow marl of Burwell Bay, James River, Va. Apical view of nearly mature individual of 6¾ whorls. Shows a highly developed sutural canal, a much accelerated and compressed noded stage, and an accelerated and compressed keeled stage which passes into a final rounded stage toward the end of the sixth whorl. Diameter of last whorl = 81 mm.

Fig. 4*a*.—Side view of specimen shown in fig. 4.

NEW OR LITTLE-KNOWN CRANEFLIES FROM THE UNITED STATES AND CANADA. TIPULIDÆ, DIPTERA.

BY CHARLES P. ALEXANDER.

During the past few years the various collections of craneflies in the Eastern United States have been examined by the author and observations made upon the more uncommon and less-known species. The following paper deals with the new species discovered, the corrections in synonomy and the geographical distribution of insufficiently known forms. The collections examined are those of the United States National Museum through the kindness of Mr. Knab, The Academy of Natural Sciences of Philadelphia through Mr. Cresson, the Museum of Comparative Zoology at Cambridge through Mr. Henshaw, the Boston Society of Natural History through Mr. Johnson and the private collections of Dr. W. G. Dietz, Mr. C. W. Johnson, and Mr. M. C. Van Duzee.

The Loew and Osten Sacken types are in the Museum of Comparative Zoology (excepting *Triogma exculpta* Osten Sacken, which is in The Academy of Natural Sciences of Philadelphia). Coquillett's types and the Limnobinæ described by Doane in his first paper are in the National Museum. The species described by Mr. Johnson are in The Academy of Natural Sciences of Philadelphia, the Boston Society of Natural History or in the private collection of the describer.

Family **TIPULIDÆ**.

Subfamily LIMNOBINÆ.

Tribe **Limnobini**.

Genus **DICRANOMYIA** Stephens.

1829. *Dicranomyia* Stephens; Cat. Brit. Ins., vol. 2, p. 243.

Dicranomyia nelliana sp. n.

Color gray; wings with vein *Sc* short; membrane hyaline with abundant brown spots and dots.

Male, length, 5.5 mm.; wing, 7.5 mm.

Rostrum, palpi and antennæ dark brown, the segments of the antennal flagellum rounded oval. Head gray.

Thoracic dorsum gray, the præscutum with a large dark brown spot in front whose exact limits behind are uncertain, due to the injury done to the thorax by the pin; scutum gray medially, the lobes yellow outwardly, black on the inner part of the lobe; scutellum gray medially, black on the sides; postnotum blackish gray. Pleuræ gray. Halteres yellow, the knob darker. Legs, coxæ and trochanters dull yellow, femora yellowish brown, the tip broadly dark brown, tibiæ light brown, the tip narrowly dark brown, tarsal segments 1 and 2 light brown, the tips of the segments brown, segments 3 to 5 brown. Wings hyaline with abundant brown markings in all the cells including a series of four large marks along the costa, the third at the origin of *Rs* and the fourth at the stigma; venation (Pl. XXVII, fig. 22): *Sc* short ending opposite the origin of *Rs*, basal deflection of Cu_1 before the fork of *M*.

Abdomen with the basal tergites dull brownish yellow, dark brown laterally, segments 6 to 8 dark brown, the hypopygium yellow; sternites dull light yellow, the lateral margin of the sclerites brown, segments 6 to 8 uniformly darker.

Holotype, ♂, Colorado, in the U. S. National Museum.

This is the only North American species with the short subcosta that has the wings so spotted; superficially this insect resembles *simulans* Walker which has a long subcosta, but in the details it is quite a different fly.

Dicranomyia reticulata Alexander.

1912. *Furcomyia reticulata* Alexander; Canadian Entomologist, vol. 44, pp. 334, 335, pl. 11, fig. p.

One female from Biscayne Bay, Dade Co., Fla., taken by Mrs. Slosson, constitutes the first record for the United States.

Genus **RHIPIDIA** Meigen

1818. *Rhipidia* Meigen; Syst. Beschr., vol. 1, p. 153.

Rhipidia (Rhipidia) bryanti Johnson.

1909. *Rhipidia bryanti* Johnson; Proceedings of the Boston Society of Natural History, vol. 34, pp. 123, 124, pl. 16, fig. 20.

This showy *Rhipidia* has been bred from decaying wood underneath bark by Mr. R. C. Shannon at Washington, D. C. The male has never been described, but has been found several times; the antennæ in this sex are bipectinate. The collections of Dr. Dietz, Mr. VanDuzee and the National Museum indicate a wide range for this species. Orono, Penobscot Co., Me., June 30, 1913 (Alexander). East Aurora, Erie Co., N. Y., June 15, 1912 (VanDuzee). Plummers Island, Md., September 4, 1904. Potomac Park, Washington, D. C., May 11, 1913 (Shannon). Black Mts., Buncombe Co., N. Car., June 16, 1912 (Beutenmuller). Braidentown, Manatee Co., Fla., March (Van Duzee). Clear Creek, Clear Creek Co., Col., June 10, 1912 (Osler). Kirbyville, Jasper Co., Tex., March 21, 1908 (E. S. Tucker).

Rhipidia (Arhipidia) schwarzi Alexander.

1912. *Rhipidia schwarzi* Alexander; Bulletin of the Brooklyn Entomological Society, vol. 8, pp. 13, 14, pl. 1, fig. e.

One female from Biscayne Bay, Dade Co., Fla., taken by Mrs. Slosson. Three females from Braidentown, Manatee Co., Fla., taken in March, 1913, by Mr. M. C. Van Duzee.

Rhipidia (Arhipidia) shannoni sp. n

Antennæ subpectinate, black; thoracic dorsum without a broad pale margin in front; postnotum velvety black; wings with a few dark brown spots and with abundant gray dots in all the cells.

Male, length, 4.9-5.1 mm.; wing, 6.7-6.8 mm.

Female, length, 5.4-5.6 mm.; wing, 5.8-7.2 mm.

Rostrum, palpi and antennæ black. Head gray.

Mesonotal præscutum yellowish brown without distinct markings except behind near the suture where there are two brown spots on either side of the median line, narrowly separated from one another, a more linear mark on either side; scutum very light yellow medially, darker on the lobes with a dark brown ring on each lobe; scutellum light yellow with a dusky mark on either side of the middle line; postnotum with a deep velvety black triangle with its point behind, the sclerite pale on the sides. Pleuræ brown with a gray bloom with two narrow brown stripes, the more dorsal less clean-cut, the ventral one narrow, well-defined, beginning on the fore coxa, traversing the bases of the other coxæ. Halteres brownish yellow. Legs, coxæ yellow, brown at the base on the outer face, trochanters dull yellow, femora yellowish brown, tibiæ and tarsi yellowish brown, the two apical segments of the latter black. Wings light yellow with a few large brown spots as follows: a large one beyond the middle of vein *Sc*, smaller ones above the arculus, origin of *Rs*, tip of Sc_1 and a large rounded spot at the stigma; paler seams along the cord and outer end of cell *1st* M_2, abundant pale gray dots in all the cells; venation (Pl. XXVII, fig. 23).

Abdomen grayish brown, the pleural line narrowly dark.

Holotype, ♂, Plummers Island, Md., June 14, 1913 (R. C. Shannon).

Allotype, ♀, topotypic, August 18, 1912 (J. R. Malloch).

Paratype, ♂, Cabin John, Md., August 30 (Fred'k Knab); ♀, Gatun, Canal Zone, Panama, December 12, 1912, at light (J. Zetek).

Related to *R. multiguttata* Alexander (Guatemala) and in my key to the species of this genus[1] it would run down to this form. It differs widely in its wing-pattern which resembles that of certain members of the *subpectinata* group (*annulicornis* Enderlein, *schwarzi* Alexander) in the prominent rounded dark spots at the base of the sector and at the stigma. The thoracic pattern, especially the velvety black postnotum, separates this species off from any of the described forms.

This species is named in honor of Mr. Raymond C. Shannon, assistant to Mr. Knab in the Department of Dipterology at Washington, who collected the type and who has reared many interesting craneflies.

Tribe **Antochini.**

Genus **TEUCHOLABIS** Osten Sacken.

1859. *Teucholabis* Osten Sacken; Proc. Acad. Nat. Sci. Phila., p. 222.

Teucholabis rubescens sp. n.

Head and abdomen black; thorax red; wings dark colored; legs brownish black.

Male, length, 6.8–7 mm.; wing, 7.1–7.3 mm.

Rostrum short, dark brown; palpi dark brownish black. Antennæ dark brownish black, the flagellar segments rounded. Head black.

Pronotum dark brown. Mesothorax reddish orange. Halteres brown, the knobs darker. Legs, coxæ and trochanters dark brown, femora brownish yellow at base, darkening to the tip, tibiæ and tarsi dark brownish black. Wings with a decided brown tinge, stigma rather distinct, small; veins dark brown; venation (Pl. XXVII, fig. 24).

Abdomen dark brownish black.

Holotype, ♂, Rio Ruidoso, White Mts., N. Mex., alt. about 5,500 feet, July 25 (hovering around trunks of mountain cotton-wood) (C. H. T. Townsend).

Paratype, ♂, topotypic.

Related to *T. flavithorax* Wiedemann in the bright colored thorax and dark wings; it is a smaller species with the wings much lighter colored, the stigma smaller and more distinct, the femora with the bases brighter colored, not entirely jet-black. In *flavithorax* the legs are stout and covered with long, conspicuous hairs, while in *rubescens* the hairs are not conspicuous; the basal tarsal segments of *flavithorax* are light yellow, conspicuously lighter colored than the

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[1] *Bulletin of the Brooklyn Entomological Society*, vol. 8, pp. 7, 8; 1912.

tibiæ, but in *rubescens* the tarsi are dark brown, concolorous with the tibiæ.

Tribe **Eriopterini.**

Genus **ERIOPTERA** Meigen.

1803. *Erioptera* Meigen; Illiger's Magaz., vol. 2, p. 262.

Subgenus MESOCYPHONA Osten Sacken

1869. *Mesocyphona* Osten Sacken; Mon. Dipt. N. Am., vol. 4, p. 152.

Erioptera (Mesocyphona) rubia sp. n.

Dark brownish black; wings dark brown with white spots and a white cross-band at the cord.

Female, length, 4 mm.; wing, 4.2 mm.

Rostrum, palpi and antennæ black, flagellar segments rounded oval. Head black.

Thoracic dorsum dark brownish black with a sparse brown bloom, the area darker in front of the pseudosutural foveæ. Pleuræ dark brown with a sparse gray bloom. Halteres yellow, the knobs a little darker. Legs, coxæ and trochanters very dark brown, femora dark brownish black, greatly enlarged at the tip, tibiæ dark brown, the tip darker, tarsi with the basal half of the metatarsi dull brownish yellow, remainder of the feet dark brown. Wings dark brown with white marks as follows: a large rounded spot at Sc_2, a smaller rounded spot near the tip of *2d A*, a broad white band at the cord entirely traversing the wings, tip of the wing white including the ends of cells R_3, R_5 and parts of R_2 and M_1; it is probable that the base of the wing is also white, but this is not certain; veins dark brown except in the white markings, where they are china-white and difficult to detect; venation (Pl. XXVI, fig. 12).

Abdomen dark brownish black, valves of the ovipositor brownish yellow.

Holotype, ♀, Chiricahui Mts., Cochise Co., Ariz., June 24 (H. G. Hubbard).

Erioptera (Mesocyphona) immaculata Alexander.

1913. *Erioptera* (*Mesocyphona*) *immaculata* Alexander; Proceedings of the United States National Museum, vol. 44, pp. 518, 519, pl. 66, fig. 20.

One female from Denison, Grayson Co., Tex., June 22, 1904, taken by Mr. H. S. Barber.

Erioptera (Mesocyphona) eiseni Alexander.

1913. *Erioptera* (*Mesocyphona*) *eiseni* Alexander; Proceedings of the United States National Museum, vol. 44, pp. 516, 517, pl. 67, fig. 26.

One male collected at La Cueva, Organ Mts., Donna Ana Co., N. Mex., alt., 5,300 feet, on September 1, by Prof. C. H. T. Townsend.

Subgenus ERIOPTERA Meigen.

1803. *Erioptera* Meigen; Illiger's Magazine, vol. 2, p. 262.

Erioptera (Erioptera) dorothea sp. n.

Cell *1st* M_2 closed, but without a spur as in *Hoplolabis;* wings spotted.

Female, length, 4.5–4.6 mm.; wing, 5.6–6.8 mm.

Rostrum and palpi dark brown. Antennæ with the basal segments brown, flagellar segments dull yellow, the apical segments brown. Head gray.

Thoracic dorsum light gray, the præscutum narrowly margined with pale in front, area in front of the pseudosutural foveæ pale, tuberculate pits dark brown. Pleuræ light gray. Halteres light yellow, the knob scarsely darker. Legs with the coxæ thinly dusted with gray, trochanters brownish yellow, femora dull yellow, the tip narrowly brown, tibiæ dull brownish yellow, the apex browned, tarsi brown. Wings light gray with brown markings as follows: a series of six large blotches along the costal margin, the second at the origin of *Rs*, third at Sc_2, fourth, largest, at tip of Sc_1 and on cross-vein *r*, fifth at the tip of R_1 and the last at the tip of R_2: brown seams along the cord, outer end of cell *1st* M_2 and at the ends of the longitudinal veins; venation (Pl. XXVI, fig. 13): cross-vein *m* present less than one-half as long as the outer deflection of M_3.

Abdomen grayish brown, the apical tergites and the valves of the ovipositor reddish yellow; the apical margins of the sclerites pale.

Holotype, ♀, South Fork of Eagle Creek, White Mts., N. Mex., alt. 8,000 feet, August 16 (C. H. T. Townsend).

Paratype, ♀, topotypic.

The wing-pattern is very similar to *E.* (*Hoplolabis*) *armata* O. S. of the Eastern States, but the venation is quite different.

Erioptera (Erioptera) lucia sp. n.

Cell *1st* M_2 closed and very small; pleurites of the male hypopygium bearing a triangular flattened lobe at the tip.

Male, length, 4.5 mm.; wing, 6 mm.

Female, length, 4.5 mm.; wing, 6.3 mm.

Rostrum light yellow, palpi brown. Antennæ light yellow, the flagellum broken. Head light gray.

Thoracic dorsum yellow without darker markings. Pleuræ yellow, the ventral sclerites darker and with a sparse grayish bloom. Halteres light yellow. Legs, coxæ and trochanters dull yellow, femora and tibiæ brownish yellow, tarsi brown. Wings hyaline or nearly so, the veins brown; venation (Pl. XXVI, fig. 14, which shows the very similar *microcellula*); basal deflection of Cu_1 just before the fork of M, cell *1st* M_2 small, the outer deflection of M_3 and cross-vein *m* subequal.

Abdomen brownish yellow, sternites yellow. Hypopygium with the pleurites rather long, slender with rather abundant long pale hairs, the dorsal appendage flattened (Pl. XXVI, figs. 19, 20), triangular, the base narrowed, the tip truncate, chitinized along the margin, at the apex finely denticulate; ventral appendage shorter, at the tip bearing a chitinized hook that is directed caudad and outward; gonapophyses sharp-pointed, chitinized, decussate.

Holotype, ♂, Colorado.

Allotype, ♀, Beulah, N. Mex., alt. 8,000 feet, August (T. D. A. Cockerell).

Differs from all of the described American species except *E. microcellula* sp. n., in the small closed cell *1st* M_2. From *microcellula* it can be easily separated by the male genitalia.

Erioptera (Erioptera) microcellula sp. n.

Very similar to *E. lucia* in all general features, but the male genitalia are conspicuously different. The pleurites are stouter and bear an irregular appendage shaped as in the figures (Pl. XXVI, figs. 16, 17 and 18). The ventral pleural appendage is not shown in the drawings; it consists of a cylindrical fleshy lobe, narrower at the base, very densely covered with long pale hairs. The gonapophyses seen from beneath are long chitinized hooks, slightly curved inward but their tips not meeting, along the sides with numerous appressed teeth.

The wing-venation is shown in Pl. XXVI, fig. 14.

Male, length, 4.8 mm.; wing, 6.8 mm.

Holotype, ♂, Colorado.

Subgenus EMPEDA Osten Sacken.

1869. *Empeda* Osten Sacken; Mon. Dipt. N. Am., vol. 4, p. 183.

Erioptera (Empeda) alicia sp. n.

Body coloration light yellow without darker markings; cell *1st* M_2 closed.

Female, length, 3.5 mm.; wing, 4.9 mm.

Rostrum light yellow, palpi brown. Antennæ with the basal segments light yellow, flagellar segments light brown. Head light yellow.

Thorax light yellow without darker markings; the pleuræ of a lighter shade than the dorsum. Halteres light brown. Legs, coxæ and trochanters yellow, femora brown, more yellowish at the base.

tibiæ and tarsi light yellowish brown with abundant yellow hairs. Wings hyaline or nearly so, the veins light yellow; venation (Pl. XXVI, fig. 15) as in *stigmatica* O. S., but the cross-vein *m* is present, closing the cell *1st* M_2.

Abdomen brownish yellow.

Holotype, ♀, Scotia, Cal., May 20, 1903 (H. S. Barber).

This differs from the described American forms, *stigmatica* Osten Sacken and *nigrolineata* Enderlein by its closed cell *1st* M_2 and the uniform pale yellow coloration.

Genus **RHABDOMASTIX** Skuse.

1889. *Rhabdomastix* Skuse; Proc. Linn. Soc. N. S. Wales, series 2, vol. 4, pp. 828, 829.

Subgenus SACANDAGA Alexander.

1911. *Sacandaga* Alexander; Entomological News, vol. 22, pp. 349–351.

Rhabdomastix (Sacandaga) caudata Lundbeck.

1898. *Goniomyia (Empeda) caudata* Lundbeck; Diptera gröenlandica, Vidensk. Meddel. fra den naturh. Foren., p. 267, pl. 6, fig. 18.

This curious fly was described from a single female taken at Permiliarsukfiord, 61°, 30′ N. L., Greenland. It seems to me that the generic reference as given above is more nearly correct. The cross-vein *r* is shown in Dr. Lundbeck's figure and it is indicated in the material before me; it is probable that this species is an intermediate form in the Eriopterine series. The following material was studied: One female, Signuia, Baffin Land, August 2, 1897 (Schuchert and White). Several of both sexes, Kokanee Mt., Brit. Col., alt. 8,000 feet, August 11, 1903 (R. P. Currie).

I am greatly indebted to Dr. Lundbeck for a copy of the description and figure of this interesting fly.

Genus **GONOMYIA** Meigen.

Subgenus GONOMYIA Meigen.

1818. *Gonomyia* Meigen; Syst. Beschr., vol. 1, p. 146.

Gonomyia (Gonomyia) obscura Doane.

1900. *Phyllolabis obscura* Doane; Journal of the New York Entomological Society, vol. 8, p. 192, pl. 8, fig. 7.

The type, a female, is No. 7,034, in the U. S. National Museum Collection; it was taken at Pullman, Wash., June 22, 1898.

Gonomyia (Gonomyia) blanda Osten Sacken.

1859. *Gonomyia blanda* Osten Sacken; Proceedings of the Academy of Natural Sciences of Philadelphia, p. 231.

The following records extend the range of the species: Peachland, B. Col., May 19, 1912. Blue Lake, Humboldt Co., Cal., June 24, 1903 (J. C. Bradley). Tex., one female in the C. V. Riley Collection in the National Museum.

Subgenus LEIPONEURA Skuse.

1889. *Leiponeura* Skuse; Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 4, p. 795.

Gonomyia (Leiponeura) alexanderi Johnson.

1912. *Elliptera alexanderi* Johnson; Psyche, vol. 19, p. 3, fig. 6.

The following additional distribution in the United States: Black Mts., Buncombe Co., N. Car., June 13, 1912 (Beutenmuller). Plano, Collin Co., Tex., August (E. S. Tucker).

Gonomyia (Leiponeura) cinerea Doane.

1900. *Dicranomyia cinerea* Doane; Journal of the New York Entomological Society, vol. 8, pp. 182, 183, pl. 7, fig. 2.

The type, a female, is No. 7,005 in the U. S. National Museum Collection; it was taken at Pullman, Wash., August 10, 1898.

Gonomyia (Leiponeura) manca Osten Sacken.

1869. *Goniomyia manca* Osten Sacken; Monographs of the Diptera of North America, vol. 4, pp. 178, 179.

1908. *Dicranomyia curvivena* Coquillett; Proceedings of the Entomological Society of Washington, vol. 9, p. 144.

Coquillett's types were examined in Washington and proved to belong to this species.

Gonomyia (Leiponeura) puer Alexander.

1913. *Gonomyia (Leiponeura) puer* Alexander; Proceedings of the United States National Museum, vol. 44, p. 506, pl. 66, fig. 14.

Miami, Dade Co., Fla., December 19, 1912 (Fred'k Knab). Billy's Island, Okefenoke Swamp, Charlton Co., Ga., June 25, 1912 (Bradley and Leonard); several specimens of both sexes.

Gonomyia (Leiponeura) sacandaga sp. n.

Coloration yellow and brown; pleuræ striped; wings with the costa strongly yellow, stigma pale brown.

Male, length, 3.2–3.4 mm.; wing, 3.3–3.5 mm.

Rostrum and palpi dark brownish black. Antennæ with the two basal segments light yellow, the flagellum brown. Head light yellow with a dark brown spot in the middle.

Mesonotal præscutum rather dark brown, narrowly edged around with light yellow; scutum pale yellow medially, the lobes brown margined with yellow behind; scutellum brown, broadly margined with yellow behind; postnotum brown. Pleuræ striped brown and yellow; the dorsal pleurites light yellowish brown, limited above by the bright yellow margin of the præscutum, limited below by the dorsal pleural stripe which begins beneath the base of the halteres and goes to above the fore coxa; lower pleural stripe broader, traversing the coxæ, the yellow band between these dark stripes very clear, at the anterior end including most of the fore coxa. Halteres light yellow. Legs, coxæ as described above, trochanters dull yellow, femora brown broadly tipped with dark brown, tibiæ and tarsi dark brown. Wings light gray, the costal margin conspicuously light yellow; cells *C*, *Sc* and R_1 pale, almost hyaline; stigma pale brown, oval; veins brown; venation (Pl. XXVII, fig. 25): *Sc* ending far before the origin of *Rs*, the distance equal to two-thirds the length of the sector.

Abdominal tergites dark brown, the apical third of each sclerite yellow, the lateral margin narrowly yellowish; hypopygium reddish; sternites brown, the extreme apex of each sclerite yellowish. Hypopygium (Pl. XXVI, fig. 21) with the pleurites rather long, slender, with a few rather long hairs on the outer face near the tip, bearing two appendages; of these the more dorsal is stouter, paler and less chitinized on its basal two-thirds, the apex a strong chitinized tooth with numerous pale hairs around its base; this appendage is connected basally with the long, flattened basal appendage, which is a little truncated at its apex, shaped as in the figure. The ventral lobe of the pleura is produced into a short fleshy conical lobe provided with long hairs. The dorsal gonapophyses are short, curved, strongly chitinized beyond the curve, pointed at the tip, with two or three blunt teeth on the cephalic or under face of the hook.

Holotype, ♂, Sport Is., Sacandaga R., Fulton Co., N. Y., August 24, 1910 (Alexander).

Allotype, ♀, topotypic.

Paratypes, 50 ♂ ♀, topotypic, July 5 and July 27, 1909.

? Gonomyia slossonæ sp. n.

Cell *1st* M_2 open by the atrophy of the outer deflection of M_3; cell M_1 absent.

Female, length, 6–7 mm.; wing, 6–6.8 mm.

Rostrum brown at the tip, yellowish at the base; palpi dark brown. Antennæ brown. Head light yellow.

Thoracic pronotum yellow with a brown spot on either side. Præscutum light yellow with dark brown stripes, the median one darker in front, behind somewhat divided by a pale line; the lateral stripes begin behind the pseudosutural foveæ and are entirely confluent with the middle stripe; pseudosutural foveæ chestnut, very far proximad; scutum yellow, the lobes largely dark brown; scutellum dull yellow; postnotum brown, yellowish on the sides in front.

Pleuræ, dorsal pleurites purplish brown, sternum lighter grayish brown, the two enclosing a broad light yellow stripe beginning behind the fore coxa and ending above the hind coxa. Halteres pale brown, the knob a little darker. Legs with the coxæ and trochanters dull yellow, femora and tibiæ yellow, the latter a little darkened at the tip, tarsi dark brown. Wings light brown, stigma small, rather indistinct, veins brown; venation (Pl. XXVII, fig. 26): Sc_2 far removed from the tip of Sc_1; cross-vein *r* rather indistinct at the fork of R_{2+3}; cell M_1 absent; outer deflection of M_3 absent; basal deflection of Cu_1 at the fork of *M*.

Abdomen dark brown, the pleural line and the genital segment yellowish.

The paratype has the two basal segments of the antennæ yellowish, the head behind gray, cross-vein *r* very indistinct, basal deflection of Cu_1 before the fork of *M*.

Holotype, ♀, Biscayne Bay, Dade Co., Fla. (Mrs. A. T. Slosson).

Paratype, ♀, Paraiso, Canal Zone, January 29, 1911 (Aug. Busck).

I was unable to detect tibial spurs on this insect. The general appearance is more like that of a *Limnophila* than any other form known to me and I refer it to *Gonomyia* with considerable doubt. The long *Sc* and cross-vein *r* are not typical of *Gonomyia*.

Genus **CLADURA** Osten Sacken.

1859. *Cladura* Osten Sacken; Proc. Acad. Nat. Sci. Phila., p. 229.

Cladura delicatula sp. n.

From the only described American species, *C. flavo-ferruginea* O. S. (= *indivisa* O. S.), this form differs in its very much smaller size and pale coloration. The specimens of *indivisa* mentioned by Osten Sacken,[2] where he states "some of the specimens, probably recently excluded, were pale and without spots," may have belonged to this form. There are no brown spots on the pleuræ; the extreme lateral margin of the abdominal tergites is dark; the wings are hyaline and lack the dark markings on the cord, origin of the sector and on the outer deflection of cell *1st* M_2. I have compared this insect with the extensive series of *Cladura* studied by Mr. Leonard and myself[3] and have no doubt of its specific distinctness. The wing is figured in Pl. XXVII, fig. 27.

Female, length, 4.6–4.7 mm.; wing, 5.6–5.7 mm.

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[2] Mon. Dipt. N. Am., vol. 4, p. 189.

[3] Venational variation in Cladura, *Journ. N. Y. Entomological Society*, vol. 20, pp. 36–39, 1912.

Holotype, ♀, White Mts., N. Hamp. (H. K. Morrison).
Paratypes, 2 ♀, topotypic.

Tribe **Limnophilini.**

Genus **LIMNOPHILA** Macquart.

1834. *Limnophila* Macquart; Suit. a Buffon, vol. 1, p. 95.

Limnophila albipes Leonard.

1913. *Limnophila albipes* Leonard; Entomological News, vol. 25, pp. 248, 249, fig.

One male of this species was taken by Mr. S. Frost at Tarrytown, Westchester Co., N. Y., June 16, 1913. This constitutes the first record for the State.

Limnophila alleni Johnson.

1909. *Limnophila alleni* Johnson; Proceedings of the Boston Society of Natural History, vol. 34, pp. 126, 127, pl. 16, fig. 18.

This fine species was described from a single male. A male specimen was taken in Coy Glen, Ithaca, N. Y., June 20, 1910, by Miss Anna H. Morgan. Another male in Simmon's woods, Gloversville, N. Y., June 9, 1914, by the author. There is a badly injured female in the Cornell Collection, taken in North Carolina by H. K. Morrison; this specimen has a strong cross-vein in cell R_5 in both wings uniting R_{4+5} with M_1. A second female was taken at Sugar Grove, Fairfield Co., O., May 19, 1901, by Prof. J. S. Hine; the female never having been described, I make this specimen the allotype and characterize this sex as follows:

Allotype, ♀: Head dark brown; abdominal segments 2 to 4 bright orange-yellow, the caudal median portion brown, smallest on segment 2, largest on segment 4; segments 5 to the end of the body brownish yellow with a narrow darker median stripe; sternites yellow with a narrow median brown stripe extending the length of the segment; no black band on the middle of the fore femora.

Female, length, 36 mm.; wing, 22 mm.

Specimen in the author's collection.

Limnophila subcostata Alexander.

1911. *Phylidorea subcostata* Alexander; Canadian Entomologist, vol. 43, pp. 288, 289.

Since this species was first described it was found to be rather common in the bogs, deep woods and gorges in May and early June. The species has not been figured hitherto and I show its venation in Pl. XXV, fig. 1. A male from Fall Creek, Ithaca, N. Y., May 7, 1913; a second male from the same place on May 13, 1913; a male from Bear Creek bog, Freeville, N. Y., May 29, 1913. Several females swept from rank vegetation at Sacandaga Park, Fulton Co., N. Y., June 1, 1914. Three females taken in Simmon's woods, Gloversville, N. Y., June 3, 1914, in company with a cranefly fauna that is quite characteristic of northern woodlands that support a rich Canadian flora. (*Dicranomyia pubipennis, Rhypholophus rubellus, Erioptera stigmatica, Adelphomyia minuta, Limnophila rufibasis, L. areolata, Rhaphidolabis flaveola, Tricyphona calcar*, etc.)

Subgenus EPHELIA Schiner.

1863. *Ephelia* Schiner; Wien. Entomol. Monatschr., vol. 7, p. 222.

Limnophila (Ephelia) johnsoni sp. n.

Color yellow; wings hyaline, unmarked; a supernumerary cross-vein in cell *M*.

Male, length, 4 mm.; wing, 6.1 mm.

Female, length, 7.2 mm.; wing, 8.6 mm.

Rostrum pale brownish yellow; palpi and antennæ very pale yellowish brown. Head yellow with a pale bloom, eyes conspicuously contrasting, black.

Pronotum pale yellow. Mesonotal præscutum pale yellow with four broad indistinct darker stripes, of which the median pair are the longest; scutum, scutellum and postnotum light yellow with a sparse pale gray bloom. Pleuræ yellowish. Halteres pale yellow. Legs yellow, the tibiæ and tarsi a little suffused with brown. Wings pale yellow, the veins pale; venation (Pl. XXV, fig. 2): *Rs* rather long, angulated at base, in a line with the deflection of R_{2+3}; cross-vein *r* not distinct; basal deflection of R_{4+5} and M_{1+2} strongly arcuated and in a line; a strong supernumerary cross-vein in cell *M*.

Abdomen very light brownish yellow.

Holotype, ♂, Mountain Lake, Fulton Co., N. Y., alt. 1,590 feet, June 17, 1914 (C. P. Alexander).

Allotype, ♀, Bretton Woods, N. H., June 23, 1913 (C. W. Johnson).

This interesting new species is named in honor of the well-known dipterologist, Mr. Charles W. Johnson, who collected the allotype. The only other species of *Ephelia* in America are *aprilina* O. S. and *superlineata* Doane which have the wings heavily spotted with brown.

Subgenus DACTYLOLABIS Osten Sacken.

1859. *Dactylolabis* Osten Sacken; Proc. Acad. Nat. Sci. Phila., p. 240.

Limnophila (Dactylolabis) hortensia sp. n.

Wings subhyaline; color gray, hypopygium reddish.

Male, length, about 8 mm.; wing, 8.8 mm.

Female, length, 7.8 8.4 mm.; wing, 8.4–8.8 mm.

Rostrum and palpi brown. Antennæ with the basal segment very elongate, dark brown, flagellum dark brown. Head gray.

Thoracic dorsum light gray, the præscutum with darker markings, a very indistinct stripe on either side of the middle line, a more distinct stripe on either side, narrowest in front. Pleuræ light gray. Halteres pale yellow. Legs, coxæ and trochanters yellow, femora yellow darkened at the tip, tibiæ brownish yellow, brown at the tip, tarsi brown. Wings subhyaline or faintly yellowish, stigma indisstint, veins brown; venation (Pl. XXVII, fig. 29): R_{2+3} about as long as the basal deflection of Cu_1; cross-vein r at about two-thirds the length of R_2.

Abdominal tergites gray, the hypopygium reddish yellow; sternites blackish gray, each segment with more or less yellow at the base.

Holotype, ♂, London Hill Mine, Bear Lake, Brit. Col., alt. 7,000 feet, July 29, 1903 (A. N. Caudell).

Allotype, ♀, topotypic.

Paratypes, 10 ♂ ♀, topotypic.

In the U. S. National Museum Collection this material was determined as *L. cubitalis* Osten Sacken, and by Osten Sacken's key[4] it would run down to that species. The following differences suffice to separate the forms:

1. The extreme base of R_2 is perpendicular to the end of the sector; cell R_2 very long and narrow; wings more tinged with yellow; hypopygium concolorous with the rest of the abdomen; size larger (Eastern United States) .... *cubitalis* Osten Sacken.
   R_2 leaves the end of the sector at an angle; cell R_2 shorter, not so elongated; wings nearly hyaline; hypopygium reddish, conspicuously brighter than the rest of the abdomen; size smaller (British Columbia) .... *hortensia*, sp. n.

Limnophila nigripleura A. and L. sp. n.

Belongs to the *luteipennis* Osten Sacken group; wings clear; pleuræ with a conspicuous dark brown stripe from the cervical sclerites to the postnotum.

Male, length, 4.8–5 mm.; wing, 5.8–6 mm.

Female, length, 6 mm.; wing 7 mm.

Palpi and antennæ dark brownish black. Head light clear gray, provided with numerous hairs.

Pronotum dusted with gray. Mesonotal præscutum and scutum

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[4] Mon. Dipt. N. Am., vol.4, pp. 202, 203.

light brown, rather darker medially; scutellum more yellow medially; postnotum gray. Pleuræ dull light yellow with a broad dark brown stripe extending from the cervical sclerites to the postnotum; mesosternum suffused with brown. Halteres light yellow, the knobs darker. Legs, coxæ and trochanters dull yellow, femora brownish yellow, tibiæ similar, the tip narrowly brown, tarsi brown. Wings subhyaline, stigma indistinct, veins brown; venation (Pl. XXV, fig. 3).

Abdominal tergites dark brown, sternites much paler, yellowish white, hypopygium brown.

Holotype, ♂, Sacandaga Park, Fulton Co., N. Y., June 20, 1910.

Allotype, ♀, topotypic.

Paratypes, 50 ♂ ♀, topotypic; Mountain Lake, Fulton Co., N. Y., alt. 1,580 feet, June 15, 1914; Orono, Penobscot Co., Me., July 29, 1913; Ithaca, Tompkins Co., N. Y., July 7, 1911; Ridgewood, Bergen Co., N. J.

A common and widely distributed species in the Eastern United States; the material has been compared with the types of *contempta* in the Museum of Comparative Zoology, and the form differs as described above. The species has been in the collection of Mr. Leonard and myself for some years.

A key to the species of the *luteipennis* group in the Eastern United States.

1. Cell M_1 absent..*noveboracensis* Alex.[5]
Cell M_1 present..2.
2. Wings with small brown dots on the cross-veins and at the forks, *luteipennis* O. S.[6]
Wings clear, unspotted..3.
3. Thorax clear blue-gray..*inornata* O. S.[7]
Thorax brownish without gray color..4.
4. Larger species with the pleuræ unmarked..*contempta* O. S.[8]
Smaller species; pleuræ with a conspicuous dark brown stripe from the cervical sclerites to the postnotum, *nigripleura* A. & L., sp. n.

The members of the *luteipennis* group have the following characters in common: head narrow and prolonged behind; pronounced pseudosutural or humeral pits; conspicuous tuberculate pits on either side of the middle line of the præscutum in front. Venation

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[5] *noveboracensis* Alexander; *Pysche*, vol. 18, pp. 196 to 198; 1911.
[6] *luteipennis* Osten Sacken; *Proc. Acad. Nat. Sci. Phila.*, p. 236; 1859.
[7] *inornata* Osten Sacken; Mon. Dipt. N. Am., vol. 4, pp. 219, 220; 1869.
[8] *contempta* Osten Sacken; *l.c.*, pp. 218, 219; 1869.

of the wings, cells R_3 and *1st* M_2 longer than cell R_5; radial and medial veins long and slender; second anal vein incurved at the tip.

Limnophila novæ-angliæ sp. n.

Belongs to the *adusta* Osten Sacken group; wings hyaline; body coloration yellowish; abdomen of the male with a black subterminal ring.

Male, length, 6.8–7.5 mm.; wing, 5.8–7.2 mm.

Female, length, 8 mm.; wing, 7.5 mm.

Rostrum yellowish, palpi brown. Antennæ, basal segments brownish yellow, the first four or five flagellar segments with the extreme base yellowish, remainder of the antennæ brown. Head with a broad purplish brown band across the vertex from one eye to the other; occiput rather abruptly reddish yellow.

Thoracic notum reddish yellow without stripes. Pleuræ lighter yellow. Halteres short, rather pale, the knob only a little darker. Legs, coxæ and trochanters yellow, femora and tibæ yellow, the tips narrowly brown; metatarsus dull yellowish basally, tipped with brown, remaining tarsal segments brown. Wings with a faint yellowish tinge, a pale brown, oval stigma, no infuscation at the tip of the wing; venation (Pl. 1, fig. 4).

Abdomen brownish yellow with a conspicuous subapical black ring including segments 8 and 9 and the caudal half of 7; hypopygium reddish yellow.

The female sex is similar, but the abdomen lacks the black subapical ring, and in some specimens the entire head is dark purplish brown.

Holotype, ♂, Ellsworth, Hancock Co., Me., August 10, 1913 (Miss Cordelia J. Stanwood).

Allotype, ♀, topotypic.

Paratypes, 1 ♂, 4 ♀, type-locality, July 9 to August 10, 1913.

A key to the species of the *adusta* group in the eastern United States.

1. Wings more or less clouded with brown apically; often with brown seams on the cross-veins .... 2.
   Wings uniform in coloration, the stigma indistinct .... 3.
2. Yellowish species, the thoracic notum light yellow ..... *adusta* O. S.[9]
   Brown species, the thoracic notum dark brown ..... *similis* Alex.[10]
3. Larger species (wing of male, 9.5 mm.); abdomen without a black subterminal ring in the male .... *lutea* Doane[11]
   Small species (wing of male less than 7.5 mm.); abdomen of the male with a black subterminal ring ..... *novæ-angliæ*, sp. n.

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[9] *adusta* Osten Sacken, *Proc. Acad. Nat. Sci. Phila.*, p. 235; 1859. Mon. Dipt. N. Am., vol. 4, pp. 215–217; 1869.

[10] *similis* Alexander; *Psyche*, vol. 18, pp. 195, 196; 1911.

[11] *lutea* Doane; *Journ. N. Y. Ent. Soc.*, vol. 8, p. 191; 1900.

The members of the *adusta* group are distinguished by the following characters: radial sector short, arcuated; cross-vein *r* situated at about mid-length of R_2 which is quite oblique. The species are yellowish or brown and specimens in a single species vary much in the intensity of their coloration.

The following species have been examined and prove to belong to this group of the genus:

Limnophila fulvocostalis Coquillett,[12] from Bering Islands, type 4,049 U. S. N. M.

Limnophila costata Coquillett,[13] from New Mexico, type 5,318 U. S. N. M.

Limnophila insulana Johnson,[14] from Bermuda, type in the collection of Mr. Johnson.

Limnophila stanwoodæ sp. n.

Belongs to the *quadrata* Osten Sacken group; body-coloration yellow; wings pale yellow; *Rs* long, cell M_1 absent.

Male, length, 6.6–6.9 mm.; wing, 7.5–7.9 mm.

Female, length, 6.8–7.2 mm.; wing, 6.8–7.3 mm.

Rostrum yellowish, palpi with the basal segments light colored, terminal two brown. Antennæ with the scape yellow, flagellum brown, the proximal half of the first two flagellar segments yellowish. Head reddish yellow.

Thorax brownish yellow without distinct dark lines, the postnotum with a narrow indistinct median stripe of brown. Pleuræ, pro-pleuræ darker, the meso- and metapleuræ light yellow. Halteres pale yellow. Legs, coxæ and trochanters light yellow, femora brownish yellow darkening into brown at the tip, tibiæ light brown darker at the tip, tarsi dark brown. Wings with a light yellow tinge, the stigma gray, oval, veins brown, the radial cross-vein mostly obscured by the stigma; venation (Pl. XXV, fig. 5).

Abdomen brownish yellow, the lateral line brownish; sternites a little brighter yellow; segment 8 and the caudal half of the 7th brown; hypopygium yellowish; valves of the ovipositor of the female long, acicular.

Holotype, ♂, Sacandaga Park, Fulton Co., N. Y., June 11, 1914.

Allotype, ♀, topotypic.

Paratypes, 3 ♂, 18 ♀, Ellsworth, Hancock Co., Me., June 21–July 23, 1913.

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[12] Fur Seals and Fur-Seal Islands, vol. 4, p. 342; 1899.

[13] *Psyche*, vol. 9, p. 149; 1901.

[14] The Dipteran Fauna of Bermuda, *Annals of the Entomological Society of America*, vol. 6, pp. 443, 444, fig. 2; 1913.

The paratypes were collected by Miss Cordelia J. Stanwood, the well-known student of bird-life, in whose honor the species is named. Miss Stanwood has done much to discover the craneflies in the vicinity of her home city, and as a result of her careful observations our knowledge of the Hancock Co. Tipulidæ is remarkably complete and constitutes one of the most valuable lists of a restricted locality that has ever been secured.

Limnophila osborni sp. n.

Belongs to the *quadrata* Osten Sacken group; mesonotum rich brown; pleuræ with a conspicuous black dorsal stripe; wings with a brown tinge; cross-vein *r* at the fork of R_{2+3}; *Rs* long, cell M_1 absent.

Male, length, 6.3–6.5 mm.; wing, 7.4–7.5 mm.

Rostrum a little reddish yellow, palpi and antennæ dark brownish black. Head dark brownish black.

Mesonotal præscutum rich yellowish brown with a very narrow black line on either side of the broad median space, a deep black spot on the anterior margin of the præscutum continued foreward onto the pronotal sclerites, lateral stripes not clearly indicated; scutum yellowish brown with a darker brown suffusion on each lobe; scutellum dull yellow; postnotum clear light gray. Pleuræ pale yellowish with a broad deep black stripe extending from the cervical sclerites across the dorsal pleural sclerites to the abdomen; the pleuræ adjoining this broad conspicuous stripe very narrowly gray pruinose; sternal sclerites pale dull yellow. Halteres rather long, pale, the knob elongate, dark. Legs, coxæ and trochanters pale yellow, femora brownish yellow, the tip darker, tibiæ and tarsi dark brown. Wings with a brown tinge, veins dark brown; venation (Pl. XXV, fig. 6): cross-vein *r* at the fork of R_{2+3}.

Abdominal tergites shining black; sternites dark brownish black; basal sternites with some yellow; hypopygium reddish brown.

The paratype from Phair, Me., shows the mesonotal præscutum very dark brown medially, a little lighter behind, lobes of the scutum shiny black.

Holotype, ♂, Phair, Aroostook Co., Me., August 26, 1913 (Herbert Osborn).

Paratypes, 1 ♂ with the type; 2 ♂ from the Bangor Bog, near Orono, Penobscot Co., Me., August 30, 1913 (Herbert Osborn).

This interesting late summer member of the *quadrata* group is named in honor of Dr. Herbert Osborn, who collected the type material.

A key to the species of the *quadrata* group in the eastern United States.

1. Mesonotum and pleuræ yellowish or brownish yellow; wings pale yellow; size small .... *stanwoodæ* sp. n.
   Mesonotum and pleuræ not yellow; size larger .... 2.
2. Pleuræ and mesonotum clear bluish black with a gray bloom, only the coxæ conspicuously light yellow; wings with a yellowish tinge; cross-vein *r* beyond the fork of R_{2+3} on R_2, *quadrata* O. S.[15]
   Pleuræ with a conspicuous black dorsal stripe; mesonotum rich brown; wings with a brown tinge; cross-vein *r* at the fork of R_{2+3} .... *osborni* sp. n.

The members of the *quadrata* group have the radial sector long and in a line with R_{2+3}; cells R_3, R_5 and *1st* M_2 in a line or nearly so; cell M_1 absent.

Limnophila emmelina sp. n.

Brown, abdomen hairy; wings brown; cell R_2 sessile; cell M_1 absent.

Male, length about 7 mm.; wing, 8.9 mm.

Rostrum very short, reddish brown, the palpi brown. Antennæ rather short, dull yellowish brown. Head reddish brown.

Thoracic dorsum yellowish brown without distinct darker markings. Pleuræ dull yellow. Halteres yellow. Legs, coxæ and trochanters dull yellow, femora yellow, broadly tipped with brown, tibiæ dull yellow, rather narrowly tipped with brown, tarsi brown, the base of the metatarsus a little paler. Wings with a slight brownish tinge, no stigmal spot, veins brown; venation (Pl. XXVII, fig. 28): R_2 arising from the sector so that the cell R_2 is sessile; cell M_1 absent.

Abdominal tergites dark brown, sternites lighter colored. Holotype, ♂, Great Falls, Va., April 20, 1913 (Fred'k Knab).

From other members of the genus in which cell M_1 is lacking this species is readily distinguished by the sessile cell R_2.

Tribe **Pedicini.**

Genus **ORNITHODES** Coquillett.

1900. *Ornithodes* Coquillett; Proc. Wash. Acad. Sci., vol. 2, p. 400.

Ornithodes harrimani Coquillett.

1900. *Ornithodes harrimani* Coquillett; Proceedings of the Washington Academy of Science, vol. 2, p. 400.

The type is No. 5,203 in the U. S. National Museum. It is a male from Virgin's Bay, Alaska, June 26, 1899. This insect is very similar to *Tricyphona* in venation, but distinct in the curious

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[15] *quadrata* Osten Sacken; *Proc. Acad. Nat. Sci. Phila.*, p. 241; 1859; Mon. Dipt. N. Am., vol. 4, p. 230; 1869.

elongate rostrum, from which character Coquillett evidently derived the generic name.

Genus **TRICYPHONA** Zetterstedt.

1838. *Tricyphona* Zetterstedt: Ins. Lapponica, Dipt., p. 851.

Tricyphona katahdin sp. n.

Color light brown; wings light yellow with sparse brown seams and spots; cross-vein *m–cu* lacking.

Male, length, 6–7.6 mm.; wing, 6–6.9 mm.

Female, length, 8.8–9.5 mm.; wing, 7.5–9 mm.

Palpi dark brownish black, rostrum and head brownish gray, clearer gray on the vertex adjoining the eyes; first segment of the antennæ pale yellow, remainder of the antennæ dark brown.

Mesonotal præscutum light fawn-brown with an indistinct brownish stripe on either side of the middle line and shorter lateral pale brown stripes, these latter continued caudad onto the lobes of the scutum; scutellum grayish; postnotum light yellowish brown with a whitish bloom. Pleuræ light yellow. Halteres pale, the knob a little darker. Legs yellow, coxæ and trochanters brownish yellow, femora yellow darkening into brown on the apical half or more, tibiæ and tarsi dark brown. Wings light yellow, the veins yellow; small brown markings as follows: a rounded spot on Sc_2 continued up into the costal cell; an oval spot at Sc_1; brown seams at the base of *Rs*, base of R_{2+3}, cross-vein *r*, tip of R_{2+3}, fork of R_{4+5}, cross-vein *r–m;* venation (Pl. XXV, fig. 7): cell R_4 much shorter than cell R_3, usually one-half as long; cell M_1 very short usually about equal to its petiole beyond cross-vein *m* or a little longer; cell *1st* M_2 very long, narrow; Cu_1 and M_3 fused for a distance obliterating cross-vein *m–cu*.

Abdominal tergites with the basal two-thirds brown, apical third yellowish; sternites dull brownish yellow, margined laterally with brown, the apical segments with the margin reduced or lacking; hypopygium pale.

The female is similar to the male, but larger, especially the abdomen; brown tips to the femora narrower; abdomen usually with more yellow color, often with a broad median patch of yellowish on the tergites.

In some of the males the scapal segments of the antennæ are dark brown, concolorous with the rest of the antennæ.

There is some variation in venation in the series, the fusion of M_3 and Cu_1 is sometimes lacking, the cross-vein *m–cu* being present as in *vernalis* Osten Sacken; one female lacks cross-vein *m* in both wings.

Holotype, ♂, at the foot of Mt. Katahdin, Piscataquis Co., Me., along the Abol trail; altitude about 1,000 feet, August 22, 1913 (Alexander).

Allotype, ♀, topotypic.

Paratypes, 9 ♂, 5 ♀, topotypic (Morse and Alexander). 1 ♂, 1 ♀, Ellsworth, Hancock Co., Me., August 26 and September 1, 1913 (C. J. Stanwood).

Paratypes have been deposited in the Museum of Comparative Zoölogy (through Prof. Morse); Boston Society of Natural History, Maine Experiment Station, American Museum of Natural History, The Academy of Natural Sciences of Philadelphia, and the U. S. National Museum.

Related to *Tricyphona vernalis* Osten Sacken (Pl. XXV, fig. 8), but is a very different species. The size, sex for sex, is smaller; no sign of the gray coloration so characteristic of *vernalis;* wings much paler, yellowish, and the markings are reduced to mere spots and narrow seams as described above, not conspicuous rounded clouds. In normal individuals of both species, *vernalis* has cross-vein *m-cu* present and cell M_3 consequently very long; *katahdin* has Cu_1 and M_3 fused for a greater or less length; the forks of cell M_1 and R_4 are much shorter in *katahdin* than in *vernalis.*

Genus **POLYANGÆUS** Doane.

1900. *Polyangæus* Doane; Journ. N. Y. Ent. Soc., vol. 8, p. 196.

Polyangæus maculatus Doane.

1900. *Polyangæus maculatus* Doane; Journal of the New York Entomological Society, vol. 8, p. 197, pl. 8, fig. 20.

The type is apparently not in the collection of the U. S. National Museum with the remaining Doane types. There are a few specimens from Eureka, Humboldt Co., Cal., May 22, 1903, taken by Mr. H. S. Barber.

Genus **DICRANOTA** Zetterstedt.

1838. *Dicranota* Zetterstedt; Ins. Lapponica, Dipt., p. 851.

Dicranota pallida sp. n.

Size large, wing over 7 mm.; body coloration light yellow; cell M_1 present, deep; cross-vein *m* present.

Female, length, 8 mm.; wing, 8.1 mm.

Rostrum and palpi pale yellow. Antennæ with the two basal segments pale yellow, the flagellum broken. Head yellow.

Thoracic dorsum light yellow, lobes of the scutum, basal portion of the scutellum and the postnotum more brownish. Pleuræ dull yellow. Halteres broken. Legs, coxæ and trochanters dull yellow, femora yellow, a little darker at the tip, tibiæ and tarsi dull yellow, the tips of the individual segments a little darkened. Wings broad, hyaline, highly iridescent, veins brown; venation (Pl. XXVII, fig. 31): *Rs* long, angled and spurred near its origin; cell *1st* M_2 closed; cell M_1 present and very deep, its petiole very short so that the cell is almost sessile.

Abdomen dull yellow.

Holotype, ♀, White Mts., N. H. (H. K. Morrison).

This insect agrees with *argentea* Doane and *noveboracensis* sp. n., in the presence of cell M_1 of the wings. The pale coloration and the closed cell *1st* M_2 readily separate it from these species. The related *Rhaphidolabis flaveola* O. S. has the petiole of cell M_1 long, the radial sector short, no supernumerary cross-vein in cell R_1, etc.

Dicranota noveboracensis sp. n.

Body coloration gray; size small (length about 6 mm.); wings with cell M_1 present.

Male, length, 5.5–6.3 mm.; wing, 6.6–7.5 mm.

Female, length, 6–6.5 mm.; wing, 7.8–8 mm.

Rostrum, palpi and antennæ dark brown, the flagellar segments short, oval. Head brownish gray, paler around the eyes, a very narrow dark brown median stripe.

Thoracic dorsum gray with three dark brown stripes on the dorsum, the middle stripe broadest, extending the length of the præscutum, faintly bisected by a narrow pale median line; lateral stripes short, beginning at about midlength of the præscutum, extending back onto the scutum where they suffuse the lobes; scutellum and postnotum light gray. Pleuræ light gray. Halteres pale. Legs, coxæ brown with a sparse gray bloom on the outer face, trochanters yellowish brown, remainder of the legs brown. Wings light gray, the stigmal spot pale brown, not completely filling the space between the cross-veins in the radial cells, veins dark brown; venation: *Rs* rather elongate, oblique; cell M_1 present. The venation is figured in Needham's paper, 23d Report of the N. Y. State Entomologist for 1907, pl. 19, fig. 1 (as *rivularis* Osten Sacken).

Abdomen light brownish gray.

Holotype, ♂, Fall Creek, Ithaca, N. Y., May 8, 1914.

Allotype, ♀, topotypic.

Paratypes, 4 ♂, 1 ♀, topotypic, 1 ♂, 1 ♀, Dolgeville, Fulton Co. N. Y., May 16, 1914.

The American species of *Dicranota* may be separated by the following key.

1. Cell M_1 absent .... 2.
Cell M_1 present .... 3.
2. Halteres with the knob darkened; antennæ of the male much longer than the thorax (eastern United States) .... *eucera* O. S.[16]
Halteres pale; antennæ of the male short (eastern United States), *rivularis* O. S.[17]
3. Cell *1st* M_2 present; body-coloration yellowish (eastern United States) .... *pallida* sp. n.
Cell *1st* M_2 absent; body-coloration grayish .... 4.
4. Size large (length of female 9 mm.) (western United States), *argentea* Doane[18]
Size small (length of the female 6 mm.) (eastern United States), *noveboracensis* sp. n.

Genus **RHAPHIDOLABIS** Osten Sacken.

1869. *Rhaphidolabis* Osten Sacken; Mon. Dipt. N. Am., vol. 4, p. 284.

Rhaphidolabis polymeroides sp. n.

Antennæ elongated, much longer than the head and thorax together, the segments of the flagellum with abundant outstretched hairs; wings with a brown suffusion.

Male, length about 6–6.5 mm.; wing, 7.4 mm.

Rostrum brown, palpi dark brownish black. Antennæ elongated, if bent backward they would extend to the middle of the abdomen; flagellar segments very long, cylindrical, with abundant outstretched hairs. Head gray.

Thoracic dorsum brown with three dark brown stripes, the median one longest and broadest, the lateral stripes short, narrowed in front, broader behind; scutum with the lobes dark brown these being continuations of the lateral præscutal stripes; scutellum and postnotum brown with a sparse gray bloom. Pleuræ brownish gray. Halteres long, pale at the extreme base, knob dark brown. Legs, coxæ brown, more yellowish at the tips, trochanters yellow, femora yellow darkening into brown beyond the base, tibiæ and tarsi brown. Wings with a dark brown suffusion, stigma indistinct, veins dark brown with conspicuous hairs; venation (Pl. XXVII, fig. 30).

Abdominal tergites dark brown, the hypopygium lighter brown; sternites more yellowish.

Holotype, ♂, Eureka, Cal., May 22, 1903 (H. S. Barber).

This insect is conspicuously different from any of the described

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[16] *eucera* Osten Sacken; Mon. Dipt. N. Am., vol. 4, pp. 281, 282; 1869.
[17] *rivularis* Osten Sacken; *Proc. Acad. Nat. Sci. Phila.*, p. 249, pl. 2, fig. 16; 1859.
[18] *argentea* Doane; *Journ. N. Y. Ent. Soc.*, vol. 8, p. 196, pl. 8, fig. 19; 1900.

Dicranotæ. The resemblance of this insect to species of *Polymera* is remarkable.

Tribe **Hexatomini.**

Genus **ERIOCERA** Macquart.

1838. *Eriocera* Macquart; Dipt. exot., vol. 1, No. 1, p. 74.

Eriocera tristis sp. n.

Abdomen shining black; wings with a blackish suffusion; cross-vein *r* at the fork of R_{2+3}.

Female, length, 12 mm.; wing, 10–10.8 mm.

Rostrum and palpi brown. Antennæ reddish brown. Head dark brownish black, much paler, yellowish, along the margin of the eye and a pale spot behind the frontal tubercle. Frontal tubercle conspicuous, shiny, without hairs, deep chestnut-brown with a V-shaped notch in front.

Thorax with the pronotum dark brownish black; mesonotum very dark brown with four indistinct blackish stripes, the middle pair longest, divergent in front, the lateral pair abbreviated; scutum and scutellum brown, the latter with a sparse gray bloom; postnotum black. Pleuræ dark brown. Halteres dark brownish black. Legs, coxæ brown, trochanters dull yellow, femora full yellow at base, darkening into brown at the swollen tips; tibiæ reddish brown, tarsi brown. Wings blackish brown, stigma oval, dark brown; venation: cross-vein *r* at the fork of R_{2+3}; cell *1st* M_2 small, almost square; basal deflection of Cu_1 beyond the fork of *M*. (The venation is figured in *Psyche*, vol. 19, pl. 13, fig. 8; 1912.)

Abdominal tergites dark shiny black, the terminal segment and the ovipositor reddish brown; sternites yellowish, apices of the segments dark brownish black, sometimes the yellow color indistinct.

Holotype, ♂, Fall Creek, Ithaca, N. Y., August 1, 1912 (Alexander).

Allotype, ♀, topotypic.

Paratypes, 1 ♀, topotypic, (Carl Ilg). 2 ♀, topotypic (Carl Ilg.).

I examined the types of *fuliginosa* O. S. on September 11, 1913. The wing is suffused with rather light brown; stigma small, rounded, brown; cross-vein *r* just beyond the fork of R_{2+3}. *E. tristis* may be told by the very dark color of the wings and the deep black abdomen; this is the species mentioned by me in *Psyche*, December, 1912, p. 169, under the account of E. *fultonensis*.

Subfamily CYLINDROTOMINÆ.

Genus **CYLINDROTOMA** Macquart.

1834. *Cylindrotoma* Macquart; Suit. a Buffon, vol. 1, p. 107.

Cylindrotoma splendens Doane.

1900. *Cylindrotoma splendens* Doane; Journal of the New York Entomological Society, vol. 8, p. 197, pl. 8, fig. 21.
1900. *Cylindrotoma juncta* Coquillett; Proceedings of the Washington Academy of Sciences, vol. 2, p. 401.

Doane's type (No. 7,051 U. S. N. M., from Unalaska, August 24, 1897) was described three months before Coquillett's *juncta* (No. 5,204 U. S. N. M., Virgin's Bay, Alaska, June 26, 1899) appeared in press.

Cylindrotoma tarsalis Johnson.

1912. *Cylindrotoma tarsalis* Johnson; Psyche, vol. 19, p. 2, fig. 4.
1912. *Cylindrotoma* (?) *anomala* Johnson; Psyche, vol. 19, pp. 2, 3, fig. 3.

The two names given above represent one and the same species. I have found this insect commonly in various parts of Fulton County, N. Y.

Genus **PHALACROCERA** Schiner.

1863. *Phalacrocera* Schiner; Wien. Ent. Monatschr., vol. 7, p. 224.

Phalacrocera neoxena sp. n.

Wings dark-colored; vein R_1 persistent at the tip as in *replicata* Linnæus.

Male, length, 11.8–12 mm.; wing, 10.4–11 mm.

Female, length, 11.8 mm.; wing, 10.9–11.9 mm.

Rostrum and palpi dark brownish black. Antennæ dark brownish black. Head broad, black with a sparse grayish bloom.

Pronotum black with a gray bloom which is most intense on the sides of the sclerites. Mesonotal præscutum with a pale yellowish gray bloom; four indistinct darker stripes, the median pair long, the lateral pair short and broad; scutum, scutellum and postnotum with a pale grayish white bloom. Pleuræ black with a gray bloom which leaves patches of the ground color at intervals. Halteres long, brown. Legs, coxæ grey, trochanters and femora yellowish brown, brown at the tip, tibiæ light brown, darker brown at the tip, tarsi dark brown. Wings with a brown suffusion; stigma prominent, oval, brown; veins dark brown; venation (Pl. XXV, fig. 10): *Rs* very long, almost straight; cross-vein *r* short; R_1 beyond *r* persistent as in *replicata*, not atrophied as in *tipulina;* cross-vein *r–m* present as a short vein or else lost by the slight fusion of R_{4+5} on M_{1+2}; cell *1st* M_2 large, arcuated at the base.

Abdominal tergites brown with a dark brownish black median line; lateral margins of the sclerites narrowly dark brownish black; sternites dark brown. Hypopygial sternites bright yellowish chestnut, tergites brown.

Holotype, ♂, Nipigon, Algona District, Ontario, June 17, 1913 (Dr. E. M. Walker).

Allotype, ♀, topotypic.

Paratype, No. 1, ♂, topotypic; No. 2, ♂, type locality, June 18, 1913; No. 3, ♀, North Fairhaven, Cayuga Co., N. Y., May 17, 1913, found dead in lake drift (Dr. J. G. Needham and Miss Emmeline Moore).

The type and paratype No. 1 is in the collection of the University of Toronto.

This insect is closest to *P. replicata* Linnæus of Europe, but the wings are darker colored, much more tinged with brown; the venation, although similar in the persistence of the tip of R_1, shows a tendency to the reduction of the radio-median cross-vein, the base of cell *1st* M_2 more arcuated and other details. Grünberg's figure of the male hypopygium of *replicata*[19] shows differences in the shape of the 9th tergite and the conspicuous appendages of the 9th sternite. The wing venation of the three known species of the genus are figured on Pl. XXV, *replicata*, fig. 9, *neoxena*, fig. 10, *tipulina*, fig. 11.

At this point it may be mentioned that there is a great difference in the interpretation of the venation of the radial field of the wing in this tribe of craneflies. Most authors have considered the vein R_2 of the Cylindrotominæ to represent a combined fusion of R_{1+2+3} from the tip of the wing backward. From a study of the venation of the known species of this tribe, about a dozen in all, it is seen that the above interpretation of a long backward fusion of R_{1+2+3} is impossible and two other possible explanations are here presented. Looking over the series of wings before me, it seems that the vein hitherto considered as R_{1+2+3} is, in reality, R_3 or R_{2+3} alone, R_1 becoming atrophied beyond the radial cross-vein rather than obliterating this cross-vein and fusing with R_3. This is proved by the wings of *Phalacrocera* shown in the plate, in *replicata* and *neoxena*, R_1 being separated from R_{2+3}, whereas in *tipulina* the tip of R_1 is atrophied beyond cross-vein *r*. A second possible interpretation is that of considering the small cross-vein mentioned by Osten Sacken as occurring in the costal cell beyond the tip of *Sc* and present as a very indistinct vein in many specimens (*Liogma*) as being the

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[19] Süsswasserfauna Deutschlands, vol. 2A, pt. 1, p. 33; 1910.

tip of R_1. In this case R_1 is quite short, extending only a slight distance beyond the fork of the radial sector, and the cross-vein *r* is very long and simulates a section of vein *R*, ending at the outer part of the stigma; according to this interpretation, R_1 would be separate, but usually very indistinct or lacking, R_2 is atrophied at its tip except in two species of *Phalacrocera* (*replicata* and *neoxena*), whereas the vein hitherto considered as being R_{1+2+3} is really R_3 alone. This latter explanation of these veins of the radial field is probably the correct one.

Subfamily TIPULINÆ.

Tribe **Tipulini.**

Genus **LONGURIO** Loew.

1869. *Longurio* Loew; Berl. Ent. Zeitschr., vol. 13, p. 3.

Longurio minimus sp. n.]

Size small (wing under 18 mm.); wings with cell M_1 long-petiolate.

Male, length, 21 mm.; wing, 14.6 mm.; abdomen, 17.6 mm.

Female, length, 27 mm.; wing, 16.4 mm.; abdomen, 22 mm.

Frontal prolongation of the head very short, yellowish, the nasus elongate, prominent. Palpi and mouth parts brown. Antennæ short, light yellow, the flagellar segments gradually decreasing in size from the base outward. Eyes rather large, metallic, the front between them narrowed. Head yellowish brown.

Thoracic dorsum brownish yellow, the stripes indistinct in alcoholic material. Pleuræ dull yellow. Halteres yellow, the knob a little darker. Legs, coxæ and trochanters dull light yellow, femora and tibiæ brownish yellow broadly brown at the tip, tarsi brown. Wings with a pale brown suffusion, stigma prominent, a narrow brown seam along the cord; venation (Pl. XXVII, fig. 32): petiole of cell M_1 nearly as long as the cell itself.

Abdominal tergites dull yellow, 7 to 9 dark brown, sternites light yellow, each segment with an elongate brown subterminal median mark, on the 6th and 7th segments covering the caudal end of the segment, 8th sternite dark brown, paler caudally, hypopygium brown.

Holotype, ♂, Tallulah Falls, Rabun Co., Ga., June 17, 1910 (J. C. Bradley).

Allotype, ♀, topotypic.

Paratype, ♂, topotypic.

I am referring this insect to *Longurio*, although it does not agree with *Longurio testaceus* Loew, the genotype, in some respects. *L.*

testaceus[20] is a much larger insect (male, wing 25.5 mm., abdomen 36 mm.), the cell *1st* M_2 is much larger and the petiole of cell M_1 is very short. *Æschnosoma rivertonensis* Johnson,[21] a paratype of which is in my collection through the kindness of Mr. Johnson, is a large fly (male, wing 22 mm., abdomen 30 mm.) with cell M_1 entirely sessile.

EXPLANATION OF PLATES XXV, XXVI, XXVII.

PLATE XXV.—Fig. 1.—Wing of *Limnophila subcostata* Alexander.
Fig. 2.—Wing of *L.* (*Ephelia*) *johnsoni* sp. n.
Fig. 3.—Wing of *L. nigripleura* A. & L. sp. n.
Fig. 4.—Wing of *L. novæ-angliæ* sp. n.
Fig. 5.—Wing of *L. stanwoodæ* sp. n.
Fig. 6.—Wing of *L. osborni* sp. n.
Fig. 7.—Wing of *Tricyphona katahdin* sp. n.
Fig. 8.—Wing of *T. vernalis* Osten Sacken.
Fig. 9.—Wing of *Phalacrocera replicata* Linnæus.
Fig. 10.—Wing of *P. neoxena* sp. n.
Fig. 11.—Wing of *P. tipulina* Osten Sacken.

PLATE XXVI.—Fig. 12.—Wing of *Erioptera* (*Mesocyphona*) *rubia* sp. n.
Fig. 13.—Wing of *E.* (*Erioptera*) *dorothea* sp. n.
Fig. 14.—Wing of *E.* (*Erioptera*) *microcellula* sp. n.
Fig. 15.—Wing of *E.* (*Empeda*) *alicia* sp. n.
Fig. 16.—Hypopygium of *E.* (*E.*) *microcellula;* dorsal aspect of the pleurite and appendages. *d* = dorsal appendage.
Fig. 17.—Hypopygium of *E.* (*E.*) *microcellula;* ventral aspect of the dorsal apical appendage.
Fig. 18.—Hypopygium of *E.* (*E.*) *microcellula;* ventral aspect of the ventral gonapophyses.
Fig. 19.—Hypopygium of *E.* (*E.*) *lucia;* lateral aspect of the pleurite.
Fig. 20.—Hypopygium of *E.* (*E.*) *lucia;* dorsal aspect of the pleurite.
Fig. 21.—Hypopygium of *Gonomyia* (*Leiponeura*) *sacandaga;* dorsal aspect.

PLATE XXVII.—Fig. 22.—Wing of *Dicranomyia nelliana* sp. n.
Fig. 23.—Wing of *Rhipidia* (*Arhipidia*) *shannoni* sp. n.
Fig. 24.—Wing of *Teucholabis rubescens* sp. n.
Fig. 25.—Wing of *Gonomyia* (*Leiponeura*) *sacandaga* sp. n.
Fig. 26.—Wing of ? *Gonomyia slossonæ* sp. n.
Fig. 27.—Wing of *Cladura delicatula* sp. n.
Fig. 28.—Wing of *Limnophila emmelina* sp. n.
Fig. 29.—Wing of *L.* (*Dactylolabis*) *hortensia* sp. n.
Fig. 30.—Wing of *Rhaphidolabis polymeroides* sp. n.
Fig. 31.—Wing of *Dicranota pallida* sp. n.
Fig. 32.—Wing of *Longurio minimus* sp. n.

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[20] *Berlin. Entomol. Zeitschr.*, vol. 13, p. 3; 1869.

[21] *Proceedings of the Boston Society of Natural History*, vol. 34, p. 116, pl. 16, figs. 13–15; 1909.

November 17.

Mr. Charles Morris in the Chair.

Fourteen persons present.

The Publication Committee reported that a paper under the following title had been presented for publication:

"A biological reconnaissance of the Okefenokee Swamp in Georgia" (November 16).

The death of J. Ronaldson Magee, a member, November 4, 1914, was announced.

A. H. Gottschall was elected a member.

Alfred Werner of Zurich, and Frank Lawson Adams of Montreal, were elected correspondents.

November 24.

The President, Dr. Samuel G. Dixon, in the Chair.

Special meeting.

The President announced that the object of the meeting was the presentation of the gold medal of the Hayden Memorial Geological Award to Henry Fairfield Osborn, Sc.D., LL.D., in recognition of his brilliant paleontological studies.

The presentation address was made by the President.

The address was responded to by Dr. Osborn.

The following was ordered to be printed:

NEW NEUROPTEROID INSECTS, NATIVE AND EXOTIC.

BY NATHAN BANKS.

The descriptions of the following new species have accumulated during the past year, based mostly on accessions to my collection, but the types of some (indicated in text) are in other collections. I have included a table to the genera of Myrmeleonidæ known from the Indo-Australian region.

PERLIDÆ.

Perlodes slossonæ n. sp. Pl. XXVIII, fig. 17.

Marked much as in *P. signata*, the pale between ocelli runs back to pronotum; basal joint of antennæ dark; pronotum dark, a broad pale median stripe; thorax black; abdomen brown; setæ pale, tips of joints dark. Legs pale brownish. Wings faintly fumose, venation brownish. Ocelli as in *P. signata;* pronotum a little broader than long. Wings about as in *P. signata*, the apical cross-veins confined to subcosta, radius or its branches, the costal margin concave at humeral cross-vein. Female ventral plate with a median excision, and a curved tooth each side. Expanse 28 mm.

From Mt. Washington (Mrs. Slosson).

Perlodes tibialis n. sp. Pl. XXVIII, fig. 19.

Yellowish, head with faint dark mark back of each posterior ocellus, and dark on clypeus; pronotum dark on sides, and each side of the narrow pale median line, the disk each side mostly pale; thorax dark on sides, pale in middle; legs pale, the femora dark at tips, the base of tibiæ black, stopping suddenly and beyond very pale, but dark near tip; abdomen dull black, setæ pale. Wings with brownish venation. Posterior ocelli rather nearer to eyes than to each other; pronotum broader than long, much broader in front than behind. Wings long, the apical part with cross-veins all over from costa to hind margin; costal area with eight or more cross-veins. Expanse 37 mm.

From Olympia Mts., Wash. (Kincaid).

Perla georgiana n. sp. Pl. XXVIII, fig. 16.

Mostly pale yellowish throughout; bases of the hind femora infuscated; abdomen brown, discolored. Ocellar triangle broader than long, posterior ocelli much nearer to each other than to the eyes, and the bosses are much nearer to posterior ocelli than to the eyes; the anterior bosses are elongate, oblique, and together form a V. Setæ short, the joints for some distance out are broader than long. Pronotum much broader in front than behind, anterior corners sharp, posterior corners rounded, sides much rugose. In fore wings there are four cross-veins beyond the end of the subcosta; eight or nine costal cross-veins; radial sector with four branches; about seven median and five cubital cross-veins. Expanse 32 mm.

From Clayton, Ga., 2,000 to 3,000 feet, June (Davis).

Perla xenocia n. sp. Pl. XXVIII, figs. 5, 12.

Head yellow, a large dark brown spot over the ocelli, pointed behind, truncate in front; antennæ and palpi black, pronotum dull black, anterior lobe of mesonotum, and two spots on the metanotum black; abdomen pale yellow; setæ black; legs black, femora (except tips) pale yellow; sternum yellow. Wings dark brown, veins dark, except the yellow costa. Posterior ocelli fully three diameters apart, a little further from the anterior ocellus, and not one diameter from the lateral bosses, latter about their length from the eyes. Pronotum about one and one-fifth broader than long, barely narrowed behind, the corners nearly square, surface rugose. Wings rather long, about 17 costals, not far apart, three or four cross-veins beyond end of subcosta, three branches of the radial sector, and a minute apical fork, about 7 or 8 median and cubital cross-veins, in hind wings 8 or 9 cubital cross-veins, and the anal fork has three branches; in both wings the radial cross-vein is oblique. Last joint of the maxillary palpi about twice as long as the preceding joint; the third nearly twice as long as the fourth; last tarsal joint twice as long as others together. Expanse 42–45 mm.

From Singla, Darjiling, India, 1,500 feet, April (type in Indian Museum, cotype in author's collection).

Neoperla phantoma n. sp.

Body pale yellowish; margin of pronotum faintly brown, palpi dark brown or black, antennæ slightly brown, basal part pale; black mark above on tip of femur, and on tip of last tarsal joint. Wings faintly brownish, veins (except costal) brown, hind wings all pale, except brown radial cross-vein. Ocelli not diameter apart, about twice as far from the eyes, ocelli very close to the bosses, latter scarcely their length from the eyes; third joint of maxillary palpi barely longer than the fourth; last tarsal joint hardly twice as long as others together, tibia I almost as broad as the femur. Pronotum only slightly rugose, broader in front than behind, much wider than long. Fore wings with about 8 costals, and two or three beyond subcosta, two branches of radial sector, three median and three cubital cross-veins; in hind wings the anal fork has only one branch. Expanse 20 mm.

From Mallali, British Guiana, March (Parish).

Neoperla plutonis n. sp. Pl. XXVIII, fig. 10.

Large black species. Head yellow, a large, broad, blackish spot over ocelli extending to the anterior bosses, and reaching laterally toward eyes. Antennæ and palpi blackish; pronotum black on sides, pale in middle; thorax brown; abdomen pale on base, dark at tip, setæ yellow brown; legs brown, basal tarsal joints pale, blackish at tips of femora and on bases and tips of tibiæ. Wings blackish, veins (except costal) dark. Ocelli a little more than their diameter apart, not one-half their diameter from the bosses, which are larger, transverse, and not their length from the eyes; third joint of maxillary palpi much longer than the fourth; last tarsal joint fully three times as long as the others together, tibia I not one-half as wide as the femur. Pronotum much broader than long, sides rounded, surface rugose. Wings large, about 15 costal cross-veins, four beyond end of subcosta; three or four branches of radial sector; 10 median and 7 cubital cross-veins; in the hind wings the anal fork has four branches; anal plate of female broad, emarginate behind. Expanse 56 mm.

From La Trinidad, Turricares, and Orosi, Costa Rica (Garlepp).

Neoperla nigriceps n. sp.

Head and pronotum nearly shining black, sides of pronotum very narrowly pale, thorax and abdomen brown, antennæ and setæ pale yellowish, basal joint of the antennæ partly dark; wings brown, veins scarcely darker; legs pale, tibia and apex of femur II brown. Last joint of palpus long and slender. Head bent down, eyes very prominent, ocelli very small, about three diameters apart, twice as far from the eyes, lateral bosses no larger than ocelli, much lower down, and fully their length from the eyes and twice as far from ocelli. Pronotum fully one and a half times as broad as long, much broader in front, corners rounded, surface rugose; last joint of tarsi three times as long as others together. Wings slender, costals few and weak, radial sector forked once (nearer anastomosis than to tip), 7 median and 7 cubital cross-veins. Expanse 15 mm.

From Belgaum, India, 2,000 feet, April. Its small size and black head and pronotum distinguish it.

Neoperla bolivari n. sp. Pl. XXVIII, fig. 1.

Yellowish; margin of pronotum brown; abdomen brown on base; a brown spot each side on mesonotum; antennæ pale brownish; last joint of tarsus, tip of tibia, and mark at tip of femur above black or dark brown. Wings faintly brownish, veins pale, except radial cross-vein is black. Ocelli about one and a-half times their diameter apart, only half as far from the bosses, the latter about their length from the eyes; pronotum about one and a fourth times broader than long, hardly narrowed behind, anterior corners sharp, posterior ones rounded, surface rugose, three ridges near middle. Third joint of maxillary palpi much longer than the fourth; legs stout, femur I twice as broad as the tibia, last tarsal joint more than twice as long as others together. Female ventral plate very large, emarginate in the middle behind. Wings long; about 15 costal cross-veins, four cross-veins beyond end of subcosta; three branches to radial sector beyond anastomosis, 8 to 10 median cross-veins, 6 or 7 cubital cross-veins, in hind wings the anal fork has five branches. Expanse 54 mm.

From Monte Soccoro, Colombia, 3,600 m. (Fassl).

Isoperla texana n. sp. Pl. XXVIII, fig. 3.

Yellowish; a faint dark V-mark connecting the ocelli; palpi yellowish brown, antennæ pale on basal fourth, dark beyond; pronotum brown on the sides; abdomen yellow above and below, setæ pale yellow, the tips dark; legs yellow, a black streak on outer side of femora and on basal outer part of tibæ, and the tips of tarsi dark; wings brownish, veins dark brown, costal area yellowish. Posterior ocelli a little nearer to eyes than to each other, bosses about half way from ocelli to bases of antennæ; pronotum one and a half times as broad as long, hardly broader in front, sides straight, corners right-angled, sides coarsely rugulose; fore wings with two or three cross-veins beyond the end of the subcosta; radial sector forked twice beyond the anastomosis, about six median and five cubital cross-veins. Expanse 23 mm.

From Kerrville, 19 June; Dallas, 20 May; Victoria, 26 May; and Devils River, 3 May, all Texas. Type in U. S. Natl. Museum.

PSOCIDÆ.

Psocus stigmosalis n. sp. Pl. XXVIII, fig. 18.

In general similar to *P. semistriatus*, but the stigma is more slender and marked with black, mostly behind. Nasus lineated with black, a black spot in front of the ocelli, and the vertex mostly dark in the middle; antennæ minutely hairy, the second joint about as long as the distance between the eyes. Thorax black, a yellow Y-mark in front; legs brownish yellow; wings hyaline, veins dark, vein closing the cell and base of radial fork whitish hyaline, a dark dot at base of the stigma, the stigma very long, much longer than the longest side of the cell, very low and evenly rounded behind, almost wholly blackish, dark dot at end of anal vein. The cell about once and a-half longer than broad at base, four-sided, tip about one-half of base. Length 4 mm.

From Cambridge, Mass., September, Franconia, N. H., Bear Mt., Salisbury, and East River, Conn. (Ely).

Cæcilius posticus n. sp. Pl. XXVIII, fig. 15.

Body dark, perhaps discolored; legs and antennæ pale yellowish. Wings hyaline; fore wings mostly dark on basal part, but some pale near base, and on costal area, and behind. A streak runs down the cubitus to the areola postica; the upper branch of the radial sector is also margined with dark brown, and the three marginal cells also dark brown, the brown extending into the areola postica. The upper branch of the radial sector runs more vertical than usual, ending just beyond the stigma; the latter long and slender, unmarked. Hind wings are hyaline. Length 2.7 mm.

From Sea Cliff, N. Y., in August.

Cæcilius umbrosus n. sp.

Yellowish; nasus and clypeus dark brown, a brown, median streak on face and vertex; the antennæ pale; legs pale; thoracic notum dark brown; abdomen mostly pale, dark at tip. Wings pale brown, rather darker near veins and toward tip, stigma also darker; venation brown, the vein at base of anal cell hyaline white. Second joint of antennæ not as long as vertex width in female, in male one and a fourth longer, third joint two-thirds as long as the second. Wings rather long, stigma large, about three times as long as wide, nearly angulate behind, the two parts of the pedicel of radial fork subequal in length, anal cell plainly longer than high. Length 3 mm.

From Hillside, Fulton Co., N. Y. (Alexander), and Sea Cliff, L. I., N. Y.

EPHEMERIDÆ.

Anagenesia greeni n. sp

Grayish yellow; abdomen blackish above, thoracic notum dark; front legs mostly gray, others pale yellowish, setæ white, with extremely long white hair. Wings gray, veins yellowish, the subcosta and radius dark. Vein 8 emits two branches from above near base, and then forks below, the branch running to middle of hind margin; between this fork and vein 8 are four longitudinal veins, the third a branch of the second, the fourth a branch of third (in this respect nearer typical *Palingenia*). Vein 9 connected several times to fork of 8; vein 9^1 unconnected. Vein 6 forked plainly before middle of wing, one long intercalary in this fork. Expanse 28 mm.

From Peradeniya, Ceylon, 17 March (Green).

Hexagenia callineura n. sp. Pl. XXVIII, fig. 13.

♀. Yellowish; a broad black band on face from eye to eye through ocelli, facial carina with a black spot; pronotum and thorax with a black stripe each side; a black stripe on each upper side of abdomen, on the tip of each segment the stripe is broader than on base. Leg I rather reddish, last tarsal joint blackish; other legs paler, tips of femora and tibiæ dark. Wings hyaline; most of veins yellowish, subcosta and radius dark, cross-veins dark, some in base of fore wings narrowly bordered; in hind wings the veins pale, cross-veins dark, in discal part are about 16 or 18 cross-veins black, narrowly bordered with white or hyaline, and outside of this a blackish fusiform mark, giving these veins a strikingly beautiful appearance. Setæ pale, some joints dark at tip. Expanse 44 mm.

From Cali, Colombia, 1,000 m. (Fassl.).

Rhœnanthus posticus n. sp.

♂. Yellowish, much marked with dark brown. A dark mark between eyes; pronotum broadly dark each side, thorax with a faint brown median streak, a dark brown line each side to base of fore wings, below this a large dark spot, a spot on pleura under fore wings. Abdomen yellow, base brown, each segment, beyond second, with a long dark U-mark each side, leaving a narrow median yellow stripe, last segment pale above; venter pale, each segment with a dark streak or spot; tip of forceps dark; setæ pale, tips of joints dark; legs pale, claws dark; leg I more reddish, tip of tibia dark. Tibia I of male almost twice as long as femur, tarsal joints one and two subequal, third three-fourths of second, fourth about one-third of third. Wings hardly hyaline, veins brown, apical costal area red-brown, and the subcostal area to base also red-brown; the costals in basal part of wing are margined; beyond middle of wing are four dark spots, the outer three in a transverse row, the other, larger, is on the forking of vein 6. Hind wings with tip and veins brown, and a brown spot near outer third on the first fork. Expanse 27 mm.

From Kandy, 4 November, Ceylon (Green).

Leptophlebia assimilis n. sp. Pl. XXVIII, fig. 8.

Very close to *L. præpedita*, but in male the basal joints of forceps seen from below are widely divergent, and this basal piece does not extend so far out below the next piece as in *L. præpedita* (in *L. præpedita* the basal pieces seen from beneath are close together). Marked much as *L. præpedita*, but no trace of color in the costal area of wings, middle segments of the abdomen bordered behind with dark, ventral segments with a blotch on each side. Leg I of male with about same proportions as in *L. præpedita*, but whole leg shorter; no costals in apical part of wing crossed. Expanse 14 mm.

From Black Mt., north fork Swannanoa River, N. C., May.

Ephemerella vernalis n. sp. Pl. XXVIII, fig. 11.

♂. Size and appearance of *E. excrucians*, but in leg I of ♂ the tarsi are fully one-fourth longer, the third joint being over three-fourths as long as second (in *E. excrucians* much shorter). Markings of body, legs and setæ as in *E. excrucians*, venter shows no marks, the last two segments being dark. Venation about the same, the costals in apical part are crossed. In the male forceps the next to last joint is plainly swollen. Expanse 22 mm.

From Black Mt., north fork Swannanoa River, N. C., May.

Habrophlebia jocosa n. sp. Pl. XXVIII, fig. 14.

♂. Head and thorax dark brown; abdomen dark on base and tip, segments 3 to 6 each with a very large median triangular pale mark occupying most of these segments, segment 7 with a pale basal band. Venter mostly pale, dark at base and tip; setæ white, legs whitish, femur I nearly black, tip of tibia I dark; in tarsus I the first joint is nearly one-half of the tibia, second joint almost as long as first, third fully one-half of second; mid and hind legs very slender. Wings hyaline, unmarked, veins pale, indistinct, five costals in the swollen apical part; hind wings about twice as long as broad, angulate on the middle of costa. Expanse 10 mm.

From Asheville and Black Mt., north fork of the Swannanoa River, N. C., in May. *H. americana* has hind femora banded twice, and dorsum of the abdomen darker.

Callibætis semicostata n. sp. Pl. XXVIII, fig. 7.

♂. Brownish; many parts, especially venter, finely dotted, some of the thoracic sutures are whitish; legs pale, darker on tips of the tarsi, setæ white. Wings hyaline, veins pale, a light brown or reddish brown streak extending from middle of base one-half way out to tip, it is bounded in front by the subcosta and behind by the fourth vein, it contains two or three pale dots, sometimes a few dark marks in costal area. Two rows of cross-veins, the outer not much more than their length from the margin; marginal intercalaries in pairs. Hind wings fully twice as long as broad, angulate in front. Expanse 17 mm.

From Stony Mt., Manitoba, 16 September (Wallis).

Callibætis pretiosa n. sp.

Brown; thoracic notum with two narrow white stripes above; abdomen with darker spots on sides; legs pale, tips of tibiæ and tarsal joints dark; setæ white, the joinings dark. Wings hyaline, veins and cross-veins mostly white, except where there are dark marks; five or six faint irregular clouds along the hind border, a fairly broad, brown stripe from base to tip on costa, its hind border sinuate with four projections, four hyaline spots in the subcostal area before middle, about five pale spots on costal area before middle, and several more or less connected beyond. Outer row of cross-veins not twice their length from margin. Marginal intercalaries single, except toward tip of wing. Expanse 14 mm.

From Great Falls, Va., 11 September.

Heptagenia coxalis n. sp.

♂. Pale yellowish, carina of face dark each side above, antennæ pale, thoracic notum with indistinct median darker streak, base of abdomen dark above, beyond pale, segments not plainly marked, but last two are dark; legs pale, a black line, wider at each end, at base of the hind coxa, femora faintly dark at tips, and tip of tibia I dark; claspers pale; setæ pale, dark at tips of joints. Wings hyaline, veins brown, apical costal area brownish yellow, some of the costals faintly margined; 8 costals before bulla, 14 beyond, all simple. Tarsus I of male has first joint about one-third of second, the third equal second, fourth twice as long as first, fifth fully as long as first.

♀. Mostly yellow throughout, black line on hind coxa as in ♂; some costals margined. Expanse 21 mm.

From Clear Creek, Colo. (Oslar).

Heptagenia subæqualis n. sp.

♂. Head and thorax rather reddish yellow, a shining black ring at base of each ocellus, antennæ pale, thoracic notum rather dark behind, abdomen pale, segments dark on apical one-third or one-half above, last three segments brownish, claspers pale, setæ faintly dark; legs pale, a black dot at tip of femur and tibia I; wings hyaline, veins and cross-veins mostly brown, apical costal portion brownish yellow, no costals nor radial cross-veins margined; hind wings not dark at tip, in fore wing about five costals before bulla, fourteen beyond, a few near the middle are crossed. In the tarsus I of male the first joint is fully two-thirds of second, the third equals second, the fourth scarcely longer than first, the fifth not one-third of first. Expanse 17 mm.

From Black Mt., north fork Swannanoa River, N. C., May.

Heptagenia carolina n. sp.

♂. Head and thorax pale yellowish or reddish yellow, no distinct marks on either head or thorax, basal joints of antennæ pale, rest black. Abdomen pale, more grayish, each segment with a narrow apical dark ring of even width all around, penultimate segment rather darker, claspers brown, setæ brownish. Legs pale, femora I and II with median and apical dark bands, hind femur dark near tip, tibia and the tarsal joints narrowly dark at tips. Wings hyaline, rather brownish yellow in apical costal part and extending around to the tip, venation brown; the costals, or most of them, with a dark spot at costal end, the first three or four radial cross-veins narrowly margined, then one or two broadly margined with dark; tip of hind wings slightly fumose. In fore wing only about six costals before bulla, about ten beyond. Tarsus I of male has the first joint a little more than one-half of second, third equal second, fourth longer than first, fifth not one-half of first. Expanse 24 mm.

♀. Yellow or reddish yellow throughout, the abdominal segments narrowly dark at tips above, setæ faintly dark, darker at tips of the joints, femora faintly dark in middle and tip, apical part of tarsi dark. Wings as in the male, two or three radial cross-veins broadly margined. Expanse 30 mm.

From Black Mt., north fork Swannanoa River, N. C., in May.

ASCALAPHIDÆ.

Phalascusa cruciger n. sp.

Yellowish; tips of lateral fringe of face gray; vertex with gray and black hair; antennæ black; thorax yellow above; a brown mark near base of fore wings, a brown median line on anterior lobe and behind this is a brown cross; metascutellum with median brown mark. Abdomen of female short, swollen in middle, white-haired at base, above with two rows of yellow spots, separated by black line as in *P. hildebrandti;* pleuræ pale, with a brown stripe which is furcate in front; legs pale yellow, tarsi faintly brown. Wings hyaline, much more slender than in *P. hildebrandti*, each wing with two brown spots, one at base, another larger over origin of radial sector and obliquely back to margin, some cross-veins between spots are margined, and some costals also with yellowish brown. Expanse 58 mm.

From River Errer, Abyssinia, Africa (Kristensen).

Suhpalasca orsedice n. sp.

Blackish; face below yellowish, gray hair below antennæ, above darker or even black, club of antennæ wholly dark, antennæ reaching about four cells from stigma; thorax hardly paler in the middle; abdomen of female dark, in male rather yellowish above, black streak on sides, venter pale; legs black, femora yellowish, at least near base. Wings hyaline, venation dark, stigma nearly black, in fore wing scarcely longer above than high, with four veinlets, in hind wings a little longer, with five veinlets, two rows of cells beyond stigma. In fore wing the radial sector arises much beyond the cubital fork, four cross-veins before it, in hind wing only two cross-veins before radial sector, in both wings five branches to the radial sector. Expanse 58 mm.

From Singla, Dargiling, India (Type in Indian Museum; cotype in author's collection).

MYRMELEONIDÆ.

Dendroleon javanus n. sp.

Head pale, a large black band between eyes extending above and below the antennæ, vertex darker, darker across posterior part; palpi wholly pale; pronotum dark in middle, and irregularly on the sides, thoracic notum dark, with a few pale spots on sides; abdomen dark, paler on base; legs pale, tips of femora and tibia dark, tibiæ I and II with broad dark band before middle, femur I with a dark streak above, coxæ I with dark spot in front. Wings hyaline, veins pale and dark, subcosta with dark dots, the radius and cubitus with long dark streaks, many cross-veins entirely dark, an oblique line up from end of anal vein in fore wings, a recurved line (extending toward the first one) from middle of hind margin, another dark line or streak on cross-veins up from union of median and cubitus, a short dark streak and spot just before the tip of wing, and outer margin with many dark patches; in hind wings the apical and outer marginal marks are present as in the fore wings. Pronotum longer than broad, narrowed in front; legs very long and slender, the tarsi very long, the basal joint as long as the apical, and each as long as other three together, spurs long and slender, nearly straight, except at tip, covering two joints; tibia as long as femur. Wings rather broad at stigma, the hind pair plainly longer than front pair, and narrower; a few costals forked before stigma, in fore wings three cross-veins before radial sector, one in hind wings, in both the anal stops soon after cubital fork, ten branches of radial sector, about 25 radial cross-veins before the black-margined one. Expanse, fore wings, 75 mm.

From Java (Berlin Museum).

Acanthaclisis hesperus n. sp.

Similar to *A. fallax* Rbr. The pronotum shows a dark median stripe, forked in front, lateral margins black, and between is a dark stripe reaching to the transverse groove. Abdomen above distinctly striped with pale; male appendages yellowish; venter black. Wings with many small spots by veins, dark spots between subcosta and radius, but not between median and cubitus; hind wings without marks; forks of axillary vein of fore wings connected by several cross-veins. Larger than any *A. fallax* I have seen. From Eureka, Utah, 15 July, and Jemez Mts., N. Mex., 28 July and 4 August (Spaldings, Woodgate). Separated from *A. fallax* by black venter. *A. texana* Hagen, I take to be *A. fallax*. I have this latter species from Phœnix, Ariz., as well as Mexico. From *A. americana* these forms may be separated thus:

1. Forks of axillary vein in fore wings not connected by cross-veins; a spot in apical part of hind wings; dark between median and cubital vein of fore wings; male genitalia black; venter black, the abdomen not striped above .... *americana*.
   Forks of axillary vein of fore wings connected by one to three cross-veins; no spot in hind wings; abdomen more or less plainly striped with pale above; male appendages mostly yellowish .... 2.
2. Venter yellowish .... *fallax*.
   Venter black .... *hesperus*.

Myrmeleon agriope n. sp.

Very similar to *M. crudelis* Walk., but the vertex shows a transverse row of four large pale spots, the submedian pair being longitudinal, the lateral ones transverse and extending to the eyes; behind on the vertex are pale spaces in middle and on the sides. The pronotum shows pale mark in middle of anterior part, the sides largely pale, with a narrow dark stripe reaching as far as the transverse furrow. The wings are similar to that species, with dotted veins, and longer dark spaces on subcosta, radius and cubitus. In fore wings are about seven cross-veins before radial sector, in the hind wings about four such cross-veins, in both pairs eight branches to the radial sector. Expanse 53 to 55 mm.

From Claremont, Calif., and Nogales and Phœnix, Ariz.

Myrmeleon heriocles n. sp.

Face shining black, in front with two submedian projections, mouth and cheeks pale, tips of palpi dark; vertex black, with transverse row of more or less shining rufous spots; antennæ black, basal joints pale; pronotum dull black, but lateral half of anterior part pale, and the margin of posterior part also pale; thorax dull black, with pale yellow stripe through the bases of the wings, continuous with the pale margin of pronotum; abdomen dull black; legs pale, broad dark bands on middle of the femora, narrow bands near base and at tip of tibiæ I and II, most of tarsi black, hind tibia with black stripe within; wings hyaline, veins dotted with dark, the subcosta, radius, and cubitus with longer dark spaces, stigma dark. In fore wings about nine cross-veins before radial sector, in hind wings six or eight such cross-veins, ten branches to radial sector in each wing, in fore wings three cross-veins between anal and cubital fork, in both pairs the tips are acute. Expanse 70 to 73 mm.

From Southern Pines, N. C., in May; also occurs in Florida. I had considered this as probably the *M. tectus* of Walker, but a view of the type shows that it is a different species.

Macronemurus darwini n. sp.

Face pale yellowish, with a median vertical dark mark, a dark spot below each antenna, vertex mostly dark, but usually pale each side near eye; antennæ pale, darker at tip; palpi pale; pronotum pale, with a pair of submedian brown marks, sometimes faint; thorax yellowish brown, indistinctly marked, but usually with a pale median line; abdomen dark, often pale at base and some segments pale at base above, legs pale, unmarked, spines black, spurs equal two tarsal joints on front legs. Wings with the longitudinal veins spotted with dark, and most of the cross-veins dark at one or both ends; in both wings is a long dark brown streak from near end of median and cubitus out toward tip, and usually a series of spots beyond the stigma to near the tip. In fore wings six cross-veins before the radial sector, eight or nine branches to the radial sector in each wing; in fore wings the anal is connected three or four times to cubital fork. Expanse 40–46 mm.

From Port Darwin, N. Australia.

Acratoleon n. gen.

Similar to *Paraglenurus*, but claws not as long and more curved; spurs about as long as four tarsal joints. Legs slender, the tibia about as long as the femur. Antennæ long, hardly diameter apart at base; palpi very short. Wings moderately broad at stigma, outer margin not sinuate, hind wings a little longer than front pair, one cross-vein in hind wings before the radial sector, about seven such cross-veins in the fore wings; the radial sector arises much before the cubital fork.

Acratoleon flavum n. sp. Pl. XXVIII, fig. 6.

Pale yellowish; a dark mark each side under antennæ, a dark spot each side on vertex; palpi all pale; antennæ pale yellow, tip dark; pronotum pale, a dark interrupted stripe near each margin, broader behind; thorax pale, dark streak over bases of wings, pleuræ with large dark spot under fore wings, a smaller spot under hind wings. Abdomen pale, tips of segments dark. Wings hyaline; veins pale yellow, those behind radius marked with dark at ends of the cross-veins, cross-veins nearly all dark and mostly margined with dark, a dark mark above in front of stigma, outer margin to the outer forkings mostly faintly dark, and dark cloud over end of anal; in hind wing venation similar to fore wing, and with two dark streaks near tip of wing, one on the anterior margin. Legs pale yellow, with black bristles, spurs and claws pale. Pronotum one and one-half times as long as broad, a little narrowed in front; legs slender, spurs very long and nearly straight, almost reaching to last joint, basal joint much shorter than the fifth; hind wings longer than fore wings and a little more narrow; fore wings broad at stigma and rather short beyond, costals mostly simple, seven cross-veins before radial sector, about eight branches of radial sector, 28 radial cross-veins, anal connected four times to cubital fork in fore wings, only twice in hind wings. Expanse, fore wings, 65 mm.

From Salamo Archipel., Shortlands Island (C. Ribbe). Type in Berlin Museum.

This new genus is placed in the following table of the genera of the Indo-Australasian region. In this table a hitherto unused character, the condition of the anal veins in the fore wings, is considered of prime importance. (Pl. XXVIII, figs. 20, 21, 22, 23, 24.)

1. Four separate anal veins in the fore wing; in hind wings the anal is not connected directly to the hind margin, but to the second anal by a series of cross-veins .... (Palparini) 2.
   Two or three anal veins in fore wing; in hind wings the anal is connected by cross-veins directly to the margin .... 4.
2. Two or more series of costal cells near to base of wing .... Stenares.
   But one series of costal cells until near the stigma .... 3.
3. Antennæ not their diameter apart at base; the basal joint with long bristles .... Palpares.
   Antennæ more than their diameter apart at base .... Tomatares.
4. In the fore wings the second and third anal veins are separate, but connected by a short cross-vein; a line in apex of the fore wings .... (Dendroleonini) 5.
   In the fore wings the second and third anal veins are united for at least one point .... 11.
5. In the hind wings the anal vein runs parallel to the cubitus for a long distance, finally curving to the margin beyond the middle of wing .... Echthomyrmex.
   In hind wings the anal runs to margin in a normal manner .... 6.
6. Legs very slender, spurs very long and nearly straight, the first tarsal joint about as long as the last .... Dendroleon.
   Spurs and legs shorter; first tarsal joint much shorter than the last .... 7.
7. Outer margin of wings barely sinuate .... 9.
   Outer margin of wings sinuate or excised .... 8.
8. Many radial cross-veins are crossed; the venation very dense; outer margin of wings sinuate .... Episalus.
   Radial cross-veins not crossed; outer margin of wings excised, Periclystus.
9. Many of the costals crossed; abdomen about as long as wings; cubito-anal cross-veins longer than anal cross-veins, Epicanthaclisis.
   Few of costals crossed; abdomen much shorter than wings .... 10.
10. Cubito-anal cross-veins shorter than anal cross-veins; venation irregular .... Layahima.
    Cubito-anal cross-veins longer than anal cross-veins; venation fairly regular .... Glenoleon.
11. One cross-vein before radial sector in the hind wings, (Macronemurini) 12.
    Three or more cross-veins before the radial sector in the hind wings; antennæ wide apart at base .... (Myrmeleonini) 20.
12. No spurs to tibiæ 13.
    Spurs distinct .... 14.
13. Many costals forked; two series of anal cells for part of the way .... Chrysoleon.
    Costals simple; one series of anal cells; wings rather narrow, Compsoleon.

14. In fore wings the anal vein runs parallel to the cubitus for a long distance 15.
In fore wings the anal vein does not parallel the cubitus; a divergent cubital fork present 16.
15. First tarsal joint much shorter than the fifth CREAGRIS.
First tarsal joint about as long as the fifth PROTOPLECTRON.
16. Legs rather short and stout 17.
Legs very slender, tibia about as long as the femur; no line in apex of fore wings 18.
17. Spurs about as long as first two joints of tarsus together, MACRONEMURUS.
Spurs as long as three or four tarsal joints together DISTOLEON.
18. Radial sector arises much before the cubital fork; spurs as long as three or four tarsal joints ACRATOLEON.
Radial sector arises much beyond the cubital fork; spurs hardly more than two tarsal joints 19.
19. Claws very long, little curved, half as long as last tarsal joint; pronotum rather short PARAGLENURUS.
Claws not one-half as long as last tarsal joint; pronotum long and slender INDOLEON.
20. Legs short and stout; spurs much longer than basal joint of tarsus, which is short 21.
Legs more slender; spurs but little longer than basal joint of tarsus 24.
21. Larger species; legs very stout and hairy; spurs much curved or even bent 22.
Smaller species; legs not very stout; spurs but little curved; costal area with but one series of cells MYRMECÆLURUS.
22. Hind wings with a double series of costal cells; antennæ very long; veinlets before origin of radial sector in fore wing are crossed STIPHRONEURA.
Hind wings with but one series of costal cells 23.
23. Second and third anal veins in fore wing form a closed cell, ONCLUS.
Second and third anal do not form a closed cell ACANTHACLISIS.
24. Branches of radial sector are bent to form a line or groove in apical part of the wing NESOLEON.
No such line of bent veins in apical part of wing 25.
25. Fore wings with a double series of costal cells in middle of length; a single series at each end WEELIUS.
A double series of costal cells only near the stigma 26.
26. A series of connecting veinlets just before the stigma; wings very broad at stigma HAGENOMYIA.
No such series, perhaps one or two veinlets connected to others, several may be forked 27.
27. Some cross-veins before radial sector crossed; wings broad at stigma CALLISTOLEON.
No cross-veins before radial sector crossed; wings narrow throughout MYRMELEON.

CHRYSOPIDÆ.

Allochrysa boliviana n. sp.

Yellowish green; palpi unmarked; basal joint of antennæ with a red stripe on outer side; pronotum unmarked, longer than broad, narrowed in front; thorax and legs pale; abdomen marked with reddish on the middle of some segments towards tip. Wings hyaline, venation green; stigma not distinct in fore wings; in hind wings is a dark spot; no dark spots on union of cubitus and median near margin of wing; in fore wings the outer gradates are brown, outer ends of costals, middle of first few radials, origin of radial sector, and one or more cross-veins behind it dark. Wings rather long, fore ones not acute, hind ones plainly acute, in fore wings 9 outer and 14 or 15 inner gradates, reaching far up toward the base (as in *A. colombia*); in hind wings 7 outer and 11 inner gradates. Expanse 38 mm.

From Rio Longo, Bolivia, 750 m. (Fassl).

Allochrysa nigrilabris n. sp.

Yellowish green; labrum jet black, a black V-mark between and above the bases of the antennæ, basal joint of antennæ with a red spot outside; pronotum pale, hardly longer than broad; thorax above with large black spots as in *A. colombia* and *A. varia* and black spots above on some segments of the abdomen toward the tip; legs pale. Wings hyaline, venation green, gradates dark, a dark spot in stigma, and in fore wings one on the union of median and cubitus near margin, many radials at each end, the origin of radial sector, several anals, the lower part of end of second cubital cell, and the upper part of end of third cubital cell dark. In fore wings 7 outer and 10 inner gradates; in hind wings 7 outer and 8 inner gradates. Expanse 38 mm.

From St. Antonio, Colombia, 1,800 m., December (Fassl).

Allochrysa riveti Navas.

Described from Ecuador, occurs in Colombia and Panama.

Allochrysa titan n. sp.

Body large and heavy. Pale yellowish or greenish, palpi mostly black, a faint red spot each side at base of clypeus, vertex with a red triangle, red stripe on outer side of basal joint of antennæ, joints beyond for about one-third way out blackish on outer side. Pronotum with two red marks each side, almost making a stripe, rest of thorax, abdomen, legs, and wings unmarked, latter with some black veinlets, some of the radial cross-vein partly black, and some of the gradates near end of the series black; stigma indistinct. Antennæ but little longer than wings, pronotum much broader than long, but little narrowed in front; abdomen short, the tip of the last ventral segment roundedly produced in the middle. Wings long, barely acute, costal area not very wide; about 18 radial cross-veins before stigma; radial sector arises nearer base than usual, the second cubital cell is fully as high, as long on upper side, the third oblique, and very obliquely divided, about 13 gradates in each series, wide apart, the inner series curving up and getting near the radial sector, in the fore wings between the two series are two or three gradates of an intermediate series; many of the outer forks fully four or five times as long as wide. Expanse 65 mm.

From Limon, Costa Rica, 24 May, Schaus. The largest species of the genus. Type in U. S. National Museum.

Allochrysa torquatus Navas.

Similar to *A. nigriceps*, but larger, and the pronotum pale, and longer, and narrowed in front. Head, basal joints of antennæ, and thoracic notum black. Wings marked as in *A. nigriceps*, but the stigmal spot does not extend so far inward, and that at the end of the cubitus is larger and does not extend out along the gradates; in hind wings there is no spot at end of the cubitus. Expanse 45 mm.

From Alajuela, 9 April, Trinidad River, 2 May, Panama (Busck). In U. S. National Museum. Navas has lately described this species from Guatemala under the name "*Goñzaga torquatus.*" There is not the slightest need of a generic name for this section of the genus *Allochrysa*, which also includes *A. nigriceps* and *A. palliceps.*

Leucochrysa cinctipes n. sp.

Rather grayish yellow; last joint of palpi black, faint marks on face, faint line on the outer side of basal joint of antennæ; legs with faint dark bands on tips of femora, near base and tip of tibia, and the extreme tip of tarsi black. Wings hyaline, with gradates gray, many cross-veins brown at ends; stigma whitish, with dark spot at each end, in hind wings there is a faint cloud over the end of cubitus, near the margin, ends of veins on all of margin brown; fore wings with gradates 6–7; in fore wings the radial sector has no connecting cross-vein near its base to the third cubital cell, but there is a cross-vein before the radial sector to the third cubital cell. Expanse 30 mm.

From Corazal, Canal Zone, Panama, 11 June (Busck), Type in

U. S. National Museum. A very remarkable species on account of venation, and will go in the genus *Berchmansus* of Navas.

Leucochrysa apicalis n. sp.

Pale yellowish, a brown dot under each eye; palpi with dark on penultimate joint; antennæ very long, pale, basal joint with a large brown spot above at tip; pronotum much narrower in front, with a dark reddish side line; mesonotum with a dusky spot each side above the fore wings; abdomen and legs pale. Wings with green venation; stigma with dark spot in hind wings, in fore wings indistinct; in hind wings the radial sector is dark for a short distance before stigma, not in the fore wings. In fore wings the gradates, most of the cross-veins in part, origin of the radial sector, divisory veinlet in part, and vein at base of the third cubital cell dark. In hind wings the gradates and some radial cross-veins near stigma dark. Gradates 6 and 7 in fore wing, 4 and 5 in hind wing; the inner series as near to radial sector as to outer series. The third cubital cell very much longer than the second; marginal forks two and a half to three times longer than broad. Expanse 28 mm.

From Rio Pacaya, Peru, August.

Leucochrysa marginalis n. sp.

Similar to *L. azevedoi* Navas, but the gradates all pale, no dark marginal forks, the hind margin of hind wing is dark for most of length, the radial sectors are black for a short distance in both wings and the veinlets above the black portion are also black, the stigma with black basal spot, outer ends of costals, some radial cross-veins, and others in basal part of wing are black, also the origin of the radial sector. Head with a red band under antennæ, red stripe on basal joint, and red spot each side on the vertex, basal part of antennæ with black line on lower side, pronotum with red band near base, and spots each side, two red spots on front of mesothorax, and two on the scutellum, metathorax marked in the same way, abdomen with red spots on most of the segments above. Venation about as in *L. azevedoi,* 13–14 gradates, the inner series as near to radial sector as to outer series, and extending basally, the median vein running into the outer series; in hind wings 10–10 gradates. Expanse 50 mm.

From Rio Longo, Bolivia (Fassl). Several of the species placed by Navas in his table of South American *Leucochrysa* belong to *Allochrysa;* such are *nigriceps, palliceps,* and *internata. Allochrysa vigoi* appears to be the same as *A. palliceps.*

Leucochrysa submacula n. sp.

Pale yellowish, face with a dark or reddish spot each side under antennæ and close to the eyes, second and third joints of the maxillary palpi with black spots, antennæ pale, basal joint with a dark streak on the outer side, vertex rather reddish in front part of the elevation; pronotum narrowed in front, and with a reddish spot near each anterior corner, thorax with a dark spot over base of the wings; abdomen pale, with dark spot near base and another beyond the middle. Wings hyaline, stigma short, black, many cross-veins black at ends, gradates (5–6 fore wings, 4–4 hind wings) black, eight radial cross-veins before stigma, inner gradates nearer to radial sector than to outer series. Expanse 27 mm.

From Bartica, British Guiana (Parish).

Leucochrysa callota n. sp.

Pale yellowish; a dark spot each side at base of the clypeus near the eyes, two dark dots on front of vertex above the antennæ, basal joint of antennæ with dark dot near tip; pronotum with a red-brown spot each side near middle of the side margin; thorax with a large spot each side above base of wings, second segment of abdomen and some other segments marked with dark. Wings hyaline; veins pale, many cross-veins dark at ends, gradates dark, stigma dark in both wings. Pronotum hardly longer than broad, narrowed in front, 14 radial cross-veins, 7 inner, 8 outer gradates in fore wings, outer series as near inner as to margin, outer forks fully four times as long as broad; hind wings with six gradates in each series. Expanse 33 mm.

From Austin, Texas (McClendon).

Chrysopa chacranella n. sp.

Similar to *C. nosina* Navas. Black mark on cheek, reddish divergent mark on vertex, and sides of thorax with two blackish stripes, but here they are practically connected and not widely separated as in *C. nosina*. The antennæ are wholly pale, no mark on basal joint, there are no spots on the face under antennæ, and the venation is not black at juncture of veins, the entire venation being pale. Gradates 6–6 in both wings, the outer series as near to margin as to inner series. Expanse 26 mm.

From Chacra di Coria, Argentine, 26 February (Jensen-Haarup).

Chrysopa figuralis n. sp.

Green; face with a rather broad red streak across it, palpi and antennæ pale, basal joint of latter more yellowish, vertex with two broad red stripes near middle, narrowed in front and united just above antennæ, a red line each side near eyes; pronotum a little broader than long, with a very broad reddish stripe, containing a darker red median line, the red extending back on the anterior lobe of mesothorax. Venation green, costals, gradates, radials, and divisory all black, other veins and branches dark in part; in hind wing the gradates and costals, and endings of veins on radial sector black; 18 costals, 3–6 gradates in each wing, inner series much nearer outer than to radial sector; marginal forks hardly twice as long as broad; divisory ends beyond the cross-vein, the third cubital cell barely broader at tip. Expanse 29 mm.

From Chosica, Peru, 2,800 feet, 10 June (Parish).

Chrysopa incalis n. sp.

Deep green; palpi and antennæ pale, unmarked, no marks on head or rest of body except that the pronotum has a faint yellowish stripe on each side a little distance from margin. Pronotum about as broad as long. Venation green, gradates, costals, except at costal end, radials on middle and a few other veins near base in part black; in hind wings some costals and the gradates scarcely dark. Wings rather broad, hind pair acute at tips, 21 costals, 5–7 gradates in fore wing, 3–7 in hind wing, the series parallel, inner series twice as near outer as to the radial sector, divisory ends beyond cross-vein, marginal forks about three times as long as broad. Expanse 30 mm.

From Matucana, Peru, 7,780 feet, 14 June, and Chosica, Peru, 2,800 feet, 10 June, both from Mr. Parish.

Chrysopa asoralis n. sp.

Green, a pale yellow median stripe on thorax and abdomen, face with red stripe each side on cheeks, sometimes a red dot on vertex each side near eyes, otherwise unmarked, palpi and antennæ pale. Pronotum much broader than long. Wings with green venation, gradates and origin of radial sector dark, costals, radials and a few other veins dark at ends; in hind wings gradates, ends of costals, and some radials dark; 22 costals, 6–8 gradates in fore wing 5–7 in hind wing, the series parallel, inner one-half way from radial sector to outer series, many marginals two or more times longer than broad, the divisory ends at or just before the cross-vein. Expanse 28 mm.

From Chosica, Peru, 2,800 feet, 7 June, Matucana, Peru, 7,780 feet, 14 June, and La Cumbre, Colombia, 6,600 feet, May, all taken by Mr. Parish.

It is related to *Ch. læva* Navas, which I have from Monte del Eden, Ibaque, Colombia, 9,000 feet (Fassl), but the inner gradates do not extend basally.

Chrysopa hesperina n. sp.

Pale greenish; thorax with a pale median stripe; head with red stripe on cheeks, an oblique spot under each antenna, and vertex with a line each side near eyes, red; last joint of palpi black; antennæ pale, unmarked, rest of body also unmarked. Pronotum about as broad as long. Wings scarcely acute at tips, with green venation; costals, radials, cubital and median cross-veins wholly dark, as also the gradates, branches of radial sector, and forkings of marginals dark in part, origin of radial sector, and tip of divisory vein dark; 14 costals, third cubital cell not very long, divisory ends beyond cross-vein, gradates 5–6, inner series scarcely nearer to outer than to radial sector, marginal forks not twice as long as broad. In hind wings costals and gradates black, and also the ends of veins ending in middle portion of radial sector black; gradates 4–6. Expanse 22 mm.

From Caldras, Colombia, May, 4,400 feet (Parish), and Cali, Colombia, May, 500 feet (Parish).

Chrysopa breviata n. sp.

Pale greenish or yellowish, head unmarked, palpi marked with black, antennæ pale, more yellowish on base; pronotum about twice as broad as long, a large red spot on each anterior side; rest of body and the legs pale, unmarked. Wings with green venation, costals, radials, gradates, some other cross-veins, bases of radial branches, origin of radial sector, part of divisorius, and marginal forks black. In hind wings a few costals and the gradates black. Wings short, almost rounded at tip, about 16 costals, third cubital cell one-half as wide at base as at tip, divisory ending a little beyond cross-vein; in fore wing 3 to 5 outer, and 2 or 3 inner gradates; in hind wing 4 to 6 outer, and 1 or 2 inner gradates; the inner nearly twice as close to outer as to the radial sector; marginal forks not twice as long as broad. Expanse 18 to 20 mm.

From Guayaquil (Parish) and Quevedo, Ecuador.

Chrysopa azygota n. sp.

Pale yellowish or greenish, a blackish stripe on each cheek, a dot on middle of face, and second and third joints of antennæ blackish, a dark stripe on outer side of basal joint, and tips of palpi dark; rest of body and legs pale, unmarked. Wings with pale venation, much marked by brown, at ends of costals, radials, and other cross-veins, origin and branches of radial sector in part dark; gradates, lower base of third cubital and several basal cross-veins wholly dark; hind wings with gradates wholly and some costal and radial cross-veins partly dark, stigma not distinct. Wings narrow, acute at tips, gradates subparallel, nearer to each other than to outer margin or radial sector; 5 to 7 in fore wing, 2 to 4 in hind wings, each much farther than its length from the next; 15 costals in fore wing; divisory ends beyond cross-vein, third cubital cell twice as wide at tip as at base, the marginal forks little more than twice as long as wide. Pronotum plainly broader than long. Expanse 21 mm.

From Mt. Makiling, Philippines (Baker).

Chrysopa ilota n. sp.

Pale yellowish or greenish; a dark stripe on each cheek; palpi lightly marked with dark, no other marks except sides of pronotum rather darker; pronotum a little longer than broad and narrowed in front. Wings moderately broad, acute at tips; venation pale, gradates and some basal cross-veins wholly dark, costals dark at lower end, radials at upper end, a few other cross-veins partly dark; in hind wings gradates, costals, and radials marked with dark. Gradates subparallel, inner series as near radial sector as to outer series, latter nearer to margin than to inner series, 5 to 7 gradates in fore wing, 3 to 5 in hind wings, each more than their length apart, 20 costals in the fore wings before the stigma, latter long, faintly dark; marginal forks scarcely twice as long as broad; divisory ends much before cross-vein, third cubital about one-half as wide at base as at tip. Expanse 25 mm.

From Mt. Makiling, Philippines (Baker).

Chrysopa morota n. sp.

Pale yellowish or greenish, unmarked; palpi and antennæ unmarked, margins of pronotum more greenish; wings long, acute at tips, venation green throughout, unmarked, the stigma long, brownish; gradates subparallel, but inner series is nearer to the radial sector than to outer, and latter nearer to margin than to inner series; 6 to 7 gradates in fore wings; 4 to 7 in the hind wings, each hardly a length apart; 17 costals before stigma in fore wing; the divisory ends just before the cross-vein, the third cubital cell at base not one-half as wide as at tip; marginal forks little more than twice as long as broad; pronotum a little broader than long, much narrowed in front. Expanse 23 mm.

From Mt. Makiling, Philippines (Baker).

The species of *Chrysopa* now known from the Philippine Islands can be tabulated as below:

PHILIPPINE CHRYSOPÆ.

1. Wings with some dark clouds .... *faccta* Navas.
   Wings not clouded .... 2.
2. Second joint of the antennæ dark, a dark median spot on face below antennæ .... *azygota.*
   Second joint of antennæ pale .... 3.
3. Venation partly dark, gradates dark .... *ilota.*
   Venation pale, gradates pale .... 4.
4. Gradates divergent; inner series at upper end very close to the radial sector .... *tagalica.*
   Gradates subparallel .... 5.
5. Inner gradates few (3 or 4), each much more than its length from the next one; divisory veinlet ends beyond the cross-vein, *isolata.*
   Inner gradates (6 or 7) scarcely their length apart; divisory veinlet ends before the cross-vein .... *morota.*

HEMEROBIIDÆ.

Sympherobius intervenalis n. sp.

Yellowish, head without definite spots except one each side on vertex near the eyes; antennæ pale, with three or four dark segments about one-third way out; palpi brown. Pronotum brown, thorax with lobes at base of wings dark; abdomen brownish; legs pale. Wings yellowish hyaline, with pale venation; the forkings of veins, costals at base, and some anal veins dark brown, the four gradates dark and bordered with dark brown, the two posterior disjointed from the two anterior by more than their length; a large dark brown spot in the subcostal area between subcosta and radius near base of wings; behind it the cubital cross-vein is heavily dark, and the median and radial cross-veins near base are also dark. The costal area is quite broad, about four times as broad as the subcostal area. In the hind wings the stigma at tip and some of the outer forkings are dark; the entire margin of both wings with dots between veins. Expanse 11 mm.

From Cali, Colombia, 500 feet (Parish).

Sympherobius modestus var. **connexus** n. var.

This is similar to the typical form, with the same markings more heavily developed; the four dark spots across the face are connected into a streak each side; the spots on upper and lower clypeus are connected; the front tibiæ are plainly banded near base and at tip; the head and thorax with pale median stripe; the wings very heavily marked with dark on plan of *S. modestus*, but the wings are about one-fourth longer than in that species, making the cells more elongate; the four outer gradates in pairs. Expanse 14 mm.

From Chosica, Peru, 2,800 feet, 9 June (Parish). I have received *S. modestus* from Matucana, Peru (Parish Coll.).

TRICHOPTERA.

Œcetina parishi n. sp.

Yellowish, with yellow and gray hair; palpi densely gray-haired; antennæ with tips of joints plainly blackish. Wings yellowish gray, darker at tip, black along the outer margin, but here interrupted three times with pale, a tuft of black hair on anal margin toward base, surface with about ten black spots or marks; two near base, one above the tuft on anal margin, one on fork of radial sector, two or three at anastomosis, one beyond, one at end of radius, one at end of subcosta and one near arculus. Hind wings with gray fringe, much longer than width of the wings. In fore wings the discal cell is nearly as long as its pedicel, strongly convex above, fork 1 twice as long as its pedicel; both wings acute at tips. Expanse 12 mm.

From Mallâli and Bartica, British Guiana (Parish).

Macronema fragilis n. sp.

Face yellowish, with whitish hair; antennæ pale, faintly marked at tips of the joints; vertex brown; thoracic notum brown, abdomen pale on base, dark at tip; legs pale yellowish, hind tarsi darker; fore wings a nearly uniform brown, veins darker, an elongate pale spot over stigmal area, broader on basal part, reaching to discal cell, apical part usually containing a dark spot, beyond this and half way to tip is a yellowish white spot extending from costa to fork 2, in base of second apical cell, just beyond discal cell, is a pale spot; hind wings gray, fringe black. In structure extremely similar to *M. parvum*, and venation practically the same. Expanse 14 mm.

From Bartica, British Guiana, December (Parish).

Macronema picteti n. sp. Pl. XXVIII, fig. 9.

Similar to *M. lineatum* and *M. argentilineatum*, and probably the species referred to by Ulmer (Selys, Trich. pt. 2, p. 69) under *M. argentilineatum* from British Guiana in Leyden Museum. It differs from *M. lineatum* in small eyes, and longer, more pointed wings, and the apical marks are a little different. It differs from *M. argentilineatum*, in having fork 1 to hind wings, and in the position of the costal cross-vein in fore wings, and the apical marks of fore wings. The wings are long, dark brown; there is a transverse band of white in stigmal region, a crescentic white mark over tip of wing, and pale spots on outer margin in the cells. Between the apical and stigmal marks is a large patch of golden hair, which when rubbed shows hyaline streaks in the bases of several apical cells. Expanse 26 mm.

From Mallali, British Guiana, March (Parish).

Phylloicus brevior n. sp. Pl. XXVIII, figs. 2, 4.

Body yellowish, with yellow hairs; anterior part of the thorax blackish, and tip of abdomen dark; antennæ black-haired, and sometimes a black spot over base of each antenna; a row of black hairs each side of face under the antennæ; legs pale, most of fore and mid tarsi, all of hind tarsi and part of tibia black, three spurs on hind tibia, four on mid tibia. Wings nearly evenly dark reddish brown, darker on costal area and on apex; hind wings also dark, more blackish. Fore wings with venation much like that of *P. abdominalis*—that is, the first fork extends one-half way back on discal cell; in the hind wings, however, the apical forks are longer, and there is no closed median cell; the male genitalia are exposed. Expanse 19 mm.

From Bartica, British Guiana, December (Parish).

EXPLANATION OF PLATE XXVIII.

Fig. 1.—*Neoperla bolivari*, ventral plate.
Fig. 2.—*Phylloicus brevior*, genitalia of male.
Fig. 3.—*Isoperla texana*, ventral plate.
Fig. 4.—*Phylloicus brevior*, tip of hind wing.
Fig. 5.—*Perla xenocia*, side and dorsal view ♂ genitalia.
Fig. 6.—*Acratoleon flavum*, tarsus I.
Fig. 7.—*Callibætis semicostata*, clasper.
Fig. 8.—*Leptophlebia assimilis*, clasper and last dorsal segment.
Fig. 9.—*Macronema picteti*, tip of fore wing.
Fig. 10.—*Neoperla plutonis*, ventral plate.
Fig. 11.—*Ephemerella vernalis*, clasper.
Fig. 12.—*Perla xenocia*, ventral plate.
Fig. 13.—*Hexagenia callineura*, part of wing.
Fig. 14.—*Habrophlebia jocosa*, clasper.
Fig. 15.—*Cæcilius posticus*, fore wing.
Fig. 16.—*Perla georgiana*, ventral plate.
Fig. 17.—*Perlodes slossonæ*, ventral plate.
Fig. 18.—*Psocus stigmosalis*, fore wing.
Fig. 19.—*Perlodes tibialis*, ventral plate.
Fig. 20.—*Periclystus*, anal area fore wing.
Fig. 21.—*Indoleon*, anal area fore wing.
Fig. 22.—*Glenoleon*, anal area fore wing.
Fig. 23.—*Distoleon*, anal area fore wing.
Fig. 24.—*Myrmeleon*, anal area fore wing.
Fig. 25.—*Paraglenurus*, tarsus I.
Fig. 26.—*Perlodes signata* Hagen, venter.

DECEMBER 15.

The President, DR. SAMUEL G. DIXON, in the Chair.

Twenty-nine persons present.

The Publication Committee reported the receipt of a paper entitled "Miocene fossil insects," by T. D. A. Cockerell (November 30).

The deaths of the following members were announced: Horace Magee, January 10, 1912; George L. Knowles, October 27, 1914; William Redwood Wright, December 3, 1914.

The following was ordered to be printed:

MIOCENE FOSSIL INSECTS.

BY T. D. A. COCKERELL.

The miocene insect beds at Florissant, Colorado, continue to furnish numerous undescribed species, and the time is still distant when it will be appropriate to bring all the data together in a single monograph. To illustrate the wonderful richness of the Florissant shales, it is sufficient to mention Professor H. F. Wickham's collection made in 1912 at the Wilson Ranch. In an excavation about 20 feet long and 6 feet deep he obtained over 90 species of Coleoptera, of which at least 40 were new. In addition to this, Professor Wickham, my wife, and I secured various species of other groups in this same excavation, so that probably there will be in all not less than 60 new species. This particular spot had been looked over several times in previous years by University of Colorado expeditions, but had yielded nothing of particular value, because only the surface was examined. On digging into the hill, the remarkable collection just mentioned was secured. There can be no doubt that the Florissant shales are practically inexhaustible; but it is unfortunately true that many good fossils, some doubtless of species which will never be found again, have been collected and lost or placed where they are unlikely to fall into the hands of competent students. Even in the larger museums there are still many undescribed Florissant species, and it will be some years before we have a complete account of the materials already gathered and in safe custody.

In Europe, the locality which we naturally compare with Florissant is Œningen in Baden. The beds, which I have examined so far as their present condition permits, are not, strictly speaking, at Œningen, but above the village of Wangen, on the Rhine. They are doubtless extensive, and would yield much of value if reëxcavated, but they have been neglected for many years. Various European museums contain Œningen insects, but by far the richest collection is that of Heer at Zürich. Heer estimated that he knew 844 species of fossil insects from Œningen, but only 464 ever received published scientific names. Of these no less than 250 were Coleoptera, but Professor Wickham records 494 described beetles from Florissant. Eighty

Hemiptera are from Œningen, but Florissant has about 230. The Hymenoptera from Œningen number 60, but those of Florissant are about 220, with only one of the many ants as yet published. Thirty Diptera come from Œningen, over 100 from Florissant. Œningen has only one recorded Trichopteron, Florissant 29. The Œningen list could be considerably increased if we added a number of species cited by their generic names or even less exactly, but not described or given specific names. Experience shows that such records are too unreliable to be of much value. Œningen has more species than Florissant in each of the following groups, as the lists stand at present. (O. = Œningen; F. = Florissant.)

Odonata—Libellulidæ: O. 9, F. none. However, the Œningen species are simply a lot of nymphs; one, *L. perse,* is doubtfully from Œningen. Specimens of *L. eurynome* and *L. doris* are in the University of Colorado Museum.

Thysanoptera—Thripidæ: O. 2, F. none.

Orthoptera—Gryllotalpinæ: O. 1, F. none. The Œningen species is stated to be long and narrow, but we have no other details.

Coleoptera—Carabidæ: O. 35, F. 33. Dytiscidæ: O. 9, F. 8. Gyrinidæ: O. 2, F. none. Scaphidiidæ: O. 2, F. none. Histeridæ: O. 9, F. none. Elateridæ: O. 10, F. 4 (but many more Florissant species await description). Buprestidæ: O. 31, F. 15. Hydrophilidæ: O. 17, F. 8. Trogositidæ: O. 7, F. 1. Coccinellidæ: O. 7, F. 3. Scarabæidæ: O. 34, F. 28. Florissant especially outranks Œningen in Curculionidæ (O. 24, F. 95) and Staphylinidæ (O. 7, F. 45). The most striking feature is the absence of Histeridæ at Florissant. It is curious that the lists contain no Cicindelidæ.

Hymenoptera—Cephidæ: O. 2, F. 1. Sphecidæ: O. 4, F. 2. Œningen has 34 described species of ants, Florissant only one, but very numerous ants from the latter place await description by Dr. Wheeler.

Lepidoptera—Psychidæ: O. 1 (a case), F. none.

Diptera—Bibionidæ: O. 14, F. 4. Chinonomidæ: O. 3, F. none good enough to describe. Tachinidæ: O. 1, F. none.

Hemiptera—Reduviidæ: O. 11, F. 3. Naucoridæ: O. 2, F. none. Belostomatidæ: O. 2, F. 1. Nepidæ: O. 1, F. none.

This enumeration is of interest mainly as a statement of the present condition of our knowledge, but some of the features indicated probably will be confirmed or amplified by fuller data.

The new species described below have, with few exceptions, been collected by Professor Wickham.

ORTHOPTERA.

Amblycorypha (?) perdita n. sp. (Locustidæ).

Tegmen 30.5 mm. long, 12 mm. broad, the broadest part about 11 mm. from the very broadly rounded and obtuse apex; costal region not enlarged, the subcostal nervure about equally distant from costa and stem of radius until 5 or 6 mm. from base, where it is nearer costa than radius, and so continues; radius straight, the radial sector coming off at a rather wide angle near the middle of the tegmen; apical field irregularly reticulated throughout. The lower margin of the tegmen can be distinctly followed to near the base, and there appears to be no anal lobe, but it seems exceedingly probable that this is illusory, the apparent margin near the base being the sharp line of demarcation found in the modern species, limiting the anal area above.

Amblycorypha (?) *perdita.*

Miocene shales of Florissant, Wilson Ranch (*Wickham*). I have wondered whether this could be Scudder's *Orchelimum placidum*, but it is certainly not an *Orchelimum*, and beyond a general similarity, there is nothing definite to indicate its identity with Scudder's species. It is provisionally placed in *Amblycorypha*, to which it is presumably allied, and from which, without better preserved materials, it does not seem worth while to separate it. Mr. J. A. G. Rehn kindly examined my sketch of the venation, and reported that it was not quite like any modern genus; as he observed, if the anal area is truly absent, the tegmen is quite peculiar; but if it is present, the insect is not very remarkable. Except for the shape of the tegmen, there is a rather close resemblance in structure to *Pycnophlebia speciosa* (Germar) from the lithographic stone of Solenhofen.

HEMIPTERA.

PSYLLITES n. gen. (Psyllidæ).

The distinctive characters are in the venation, as follows:

(1) The radius leaves the radial sector a little before the middle of the wing, and passes obliquely to the costa, where it ends, as in *Psylla astigmata*.

(2) The stem of the radius is in a straight line with the radial

sector, which is nearly straight, with only a slight curvature, practically as in *Psylla caudata.*

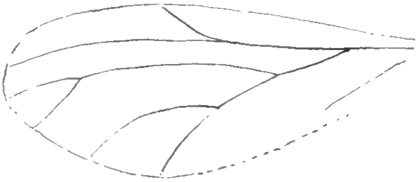
(3) The mediocubital fork is some distance basad of the separation of the radius from its sector, as in *Psylla.*

(4) The separation of the radius from the radial sector is at practically the same level as the separation of the branches of the cubitus, the cell between the cubital branches being long, the arrangement herein practically as in *Pachypsylla venusta.* The cell in the forks of the media is, however, as in *Psylla.*

Except for the shape of the cell in the forks of the cubitus, the insect could go in *Psylla;* herein it is less specialized than *Psylla.* The outline of the wing, as figured, is only approximate.

Psyllites crawfordi n. sp.

Length about 2 mm., anterior wing less than 1.5 mm.; wings clear, without markings. The following measurements are in microns: length of upper wing, about 1,440; radial fork to base of wing, about 690; radial fork to end of radial sector, about 752; medio-cubital fork to branching of cubitus, 224; medio-cubital fork to branching of media, 624; cell between cubital branches on wing-margin, 320; fork of media to level of radial and cubital forks, about 416; fork of media to nearest point on anterior branch of cubitus, 208.



Psyllites crawfordi, wing.

Miocene shales of Florissant, Wilson Ranch (*Wickham*). On the same piece of shale as the type of *Heteromyiella miocenica* and very close to it. Dedicated to Mr. David L. Crawford, whose monograph of the Psyllidæ of the New World has been of great use in the study of the fossil species.

HYMENOPTERA.

PALÆOTELEIA n. gen. (Scelionidæ).

Elongate, with the same form as *Chromoteleia semicyanea* Ashmead, except that the abdomen is broader, fully twice as broad at base, broadest about the end of the second segment, and with the apical 1 mm. or more conspicuously narrower than the part before. Antennæ inserted very close to the middle (vertical) line of face, perhaps on a frontal prominence; scape apparently short; flagellum rather long and of uniform width, not at all moniliform. Head broad, eyes prominent. Thorax long and narrow, the parts indistinct, but there is a cordiform metathoracic area or depression, and just in front of this a transverse series of little ridges or pleats, presumably on the postscutellum (compare *Macroteleia*). Hind femora unusually stout. Wings with a very well developed submarginal vein, but no marginal at all; stigmal vein short but distinct, ending in a round knob; postmarginal vein long; a shadowy oblique vein going from the postmarginal toward the stigmal knob, as in *Chromoteleia*.

Palæoteleia oxyura n. sp.

Length nearly 7 mm.; anterior wing nearly 4 mm.; the stigmatal knob 2.25 from base. Elongate, narrow, black, antennæ and legs ferruginous; thorax narrow, about .75 mm. in length anterior to wings; abdomen narrow and tapering, sessile, rather broad at base, its length a little over 4.5 mm., its width a very little over 1 mm.; thorax same width as abdomen. Wings ample, clear, faintly reddish, with a small ferruginous cloud in stigmatal region.

The following measurements are in microns: length of postmarginal vein, about 640; length of stigmal vein, including knob, 256, without knob, 192; diameter of flagellum, 128; width of hind femur, 352; length of hind tibia, about 1,120.

Miocene shales of Florissant, Wilson Ranch (*Wickham*).

This is fully as specialized as the modern genera.

Polistes kirbyanus n. sp.

Osmia kirbyana Heer MS.

Stout bodied, with rather short abdomen, the basal two segments of which are pallid and the other parts dark brown. Wings ample, dusky. Length of body 13 mm., of wings about 11 mm.; first discoidal cell almost 5.5 mm. long. Most of the venation of the anterior wings can be made out, showing that it is nearly normal for *Polistes*, except that the first t.c., instead of being straight, has a double curve like the second. The third s.m. is much broader above than the second. As in *Polistes*, the b.n. goes basad of t.m.; the second s.m. receives both recurrent nervures (the cell is very broad, broader than in modern *Polistes*); the first discoidal cell is very oblique at end; the marginal cell has an elongated triangular form. The great width of the second s.m. and the long very oblique apical end of the first discoidal agree better with *Monobia* (*M. quadridens* L., Rito de los Frijoles, New Mexico, *W. W. Robbins;* det. Rohwer) than with *Polistes*. On the other hand, the third s.m. agrees with *Polistes*, not with *Monobia*.

Miocene of Wangen, Baden; described from Heer's type specimen in the University Museum at Zürich. Heer named a *Polistes primitiva* from Œningen (Wangen), but as no description appeared, it cannot be recognized.

It may be useful to add that Heer's *Vespa atavina* from Moudon is not the same species as his much earlier *Vespa attavina* from Parschlug; Handlirsch treats them as identical, spelling the name *atavina.*

Odynerus percontusus n. sp.

Length about 8 mm.; black, including legs; wings hyaline, the nervures pallid, darker basally; length of anterior wing about 5 mm., reaching at least to end of third abdominal segment; head and thorax strongly but irregularly punctured; abdomen very broad at base, second segment large, about 1.65 mm. long and 2.40 broad; apex of stigma broad and obtuse, only moderately oblique; end of marginal cell squarely (not obliquely) truncate; second s.m. not narrowed to a point above.

The following measurements are in microns: basal nervure on first discoidal, 1,472; first submarginal (s.m.) on first discoidal, 928; first s.m. on marginal, 528; second s.m. on marginal, 128; third s.m. on marginal, 368; width of truncate end of marginal, about 128; second s.m. on first discoidal, 192; distance between ends of recurrent nervures on second s.m., 272; end of second r.n. to lower end of second t.c., 80; lower side of third s.m., 448.

The general structure is essentially as in the living *O. tuberculocephalus* Sauss. (Boulder, Colo., *W. P. Cockerell;* det. Rohwer); but the abdomen is more as in *O. capra* Sauss. (Colorado Springs, Colo., *T. and W. Cockerell*, at flowers of *Ribes aureum:* det. Rohwer). The measurements readily distinguish this from the other species fossil at Florissant.

Miocene shales of Florissant, Wilson Ranch (*Wickham*).

Odynerus wilmattæ n. sp. (Eumenidæ).

Black, apparently with light bands on abdomen; length of head and thorax 3 mm., of abdomen about 4.5 mm. in bent position, but would be about 6.5 straightened out, of anterior wings 4.5 mm.; first abdominal segment rather small, in lateral profile only about 1 mm. deep, whereas the abdomen in middle is fully 2 mm.; wings dusky reddish, venation ordinary, marginal cell very narrowly obliquely truncate at end; third t.c. arched inward; second s.m. greatly narrowed above, receiving first r.n. a little before middle and second very near end (very much nearer end than in the living *O. tuberculiceps*, *O. capra* and *O. parietum*); second r.n. at right angles to lower side of third s.m.

The following measurements are in microns: second s.m. on marginal cell, 64; third s.m. on marginal, 256; lower side of marginal beyond third s.m., 384; lower side of third s.m., 384; end of first r.n. to end of second, 176.

Station 14, Miocene shales of Florissant (*Wilmatte P. Cockerell*). Very easily known from other fossil (as well as living) species by the remarkably short wings. It has also been examined by Mr. S. A. Rohwer, who cannot find any reason for regarding it as a distinct genus, notwithstanding its peculiar appearance. The anterior wings reach only a little beyond end of second abdominal segment. The wings, as preserved, are not longitudinally folded.

Palæovespa wilsoni n. sp. (Vespidæ).

♀. Length about 15 mm., anterior wing about or hardly 9 mm., first discoidal cell 4 mm.; robust, head and thorax black, abdomen paler, probably yellow in life, as also the legs; wings clear, veins nearly colorless (costo-apical region lost); first discoidal cell slightly oblique at end; second recurrent nervure ending more than twice as far from first as from end of second s.m.

The following measurements are in microns: basal nervure on first discoidal cell, 2,550; first discoidal on first submarginal cell, 1,760; first discoidal on second submarginal, 144; third discoidal on second submarginal, 480; lower side of second s.m. beyond third discoidal, 192; lower side of third discoidal 1,840; lower side of third submarginal, 640; third discoidal on second discoidal, 512; outer side of second discoidal below third discoidal, 288.

Wilson Ranch, Miocene shales of Florissant (*H. F. Wickham*). Named after the owner of the ranch where the fossils were collected, who did everything in his power to aid the work. Nearest to *P. gillettei* Ckll., but differing in the venation too much to be regarded as a variation.

Andrena percontusa n. sp. (Andrenidæ).

♀. Length 12 mm., anterior wing about 8 mm.; head and thorax black, abdomen pale; antennæ ferruginous; wings clear, venation ferruginous; basal nervure falling short of the very oblique transversomedial; stigma large; first r.n. joining second s.m. near end.

The following measurements are in microns: depth of stigma, 320; first s.m. on basal nervure, 368; lower side of first s.m., 1,040; second s.m. on first discoidal cell, 480; second s.m. on third discoidal, 64; lower side of third s.m., about 800; distance between lower end of b.n. and upper end of t.m., 64.

Wilson Ranch, Miocene shales of Florissant (*H. F. Wickham*). Apparently a quite typical *Andrena*. It is easily known from *A. grandipes* Ckll. and *A. hypolitha* Ckll. by the venation. The venation is like that of *A. sepulta* Ckll. and *A. clavula* Ckll., but these are much smaller species, and *clavula* is also separated by the form of the abdomen.

Cladius petrinus n. sp. (Tenthredinidæ).

♀. Length 7.5 mm., robust; antennæ 3.65 mm. long, simple, rather slender; width of head 1.85 mm.; head and posterior half of thorax apparently black, rest of thorax and abdomen probably reddish in life; wings clear, with very pale nervures; 4.25 mm. from base of wing to middle of stigma. The end of the best wing is lost, so that it is impossible to determine from it whether the marginal cell has a cross-vein. The other wing is over the body and it is hard to see the details, but the marginal nervure is sufficiently plain, and I am confident that there is no cross-nervure. This accords with *Cladius*, with which the rest of the wing closely agrees. The insect runs in Rohwer's table (*Bull. Amer. Mus. N. Hist.*, XXIV, p. 521) to 20, and runs out on account of the character of the lanceolate cell. If it had a marginal cross-nervure, it would run to *Hemichroa cophila* Ckll., which is larger and otherwise different. There is no particular resemblance to any more recently described species. Compared with MacGillivray's figure of *Cladius pectinicornis*, the anterior wing differs as follows: first s.m. longer; second t.c. bowed inward; t.m. much beyond middle of second part of lanceolate cell; end of second r.n. only a very short distance beyond second t.c. It agrees in the sides of the first discoidal cell being not at all parallel, the long and narrow second discoidal, the very short upper side of first discoidal, etc. The separation of the two parts of the lanceolate cell by a single (coalesced) nervure is very short indeed, only 128 microns.

The following measurements are in microns: length of first submarginal cell (s.m.), 240; second s.m. on marginal, 928; first discoidal on first s.m., 288 (the thickness of the nervures explains the difference from the inside measurement of first s.m.); second s.m. on first discoidal, 432; second s.m. on third discoidal (not allowing for the strong curve), 1,040; third s.m. on third discoidal, 96; third s.m. from second r.n. to end (apparently, from the obscurely preserved wing), 656; first discoidal on basal nervure, 1,200; lower end of basal nervure to upper end of the very oblique t.m., 640; first discoidal on second discoidal, 704; first discoidal on third discoidal, 368; length of t.m., 480; submedian cell on second part (beyond the interruption) of lanceolate cell, 1,280; second discoidal on lanceolate (anal) cell, 768; lower side of second discoidal beyond lanceolate cell, 400.

Miocene shales of Florissant, Wilson Ranch (*Wickham*).

Eriocampa celata n. sp. (Tenthredinidæ).

Length 8 mm., abdomen 4, anterior wing 6 mm.; ferruginous, with the head, posterior half of thorax and apex of abdomen apparently black; legs ferruginous; anterior wings reddish hyaline, nervures pallid; antennæ ordinary, not clavate, width at about 1,600 microns from base 208 microns; insect, as preserved, so like *Cladius petrinus* that I assumed it to be the same until I examined the venation. The venation appears to agree well with *Eriocampa*. In Rohwer's table the insect does not agree with *Eriocampa* because the first r.n. is not parallel with the b.n., the upper end of the r.n. being about 208 microns too far apicad; but nearly the same thing is true of *E. ovata*, as figured by MacGillivray (*Nortonella* has the same feature, but is otherwise quite different). Characteristic features of *E. celata* are the oblique, gently arched cross-vein of marginal cell, which joins the stigma 208 microns below the costa; the produced lower apical corner of first s.m.; the two sides of first discoidal cell (on basal and recurrent nervures) nearly equal; the second s.m. receiving only one r.n.; the very narrow (112 microns) top of first discoidal cell. The lanceolate cell is contracted; but not closed; the cross-nervure, which ought to be present, is obliterated, but I think I can see the stump of the upper end (this, however, is not positive).

The following measurements are in microns: first s.m. on marginal, 288; second s.m. on marginal (not allowing for curve), 800; end of second t.c. to lower end of marginal cross-vein, 608; lower end of marginal cross-vein to upper end of third t.c., 368; first s.m. diagonally, 448; first discoidal on first s.m., 480; first discoidal on second s.m., 416; basal on first discoidal, 832; first discoidal on third, 800; lower end of b.n. to upper end of t.m., 288 on one side, but 208 on opposite wing; upper end of t.m. to lower end of first r.n., 512. Known from the Florissant species of *Eriocampa* by the colors and the venation—*e.g.*, from *E. synthetica*, *pristina* and *wheeleri* by the measurements of the first discoidal cell; from *scudderi* and *bruesi* by the comparative measurements of the first two submarginals.

Miocene shales of Florissant, Wilson Ranch (*Wickham*).

DIPTERA.

Protolomatia antiqua Cockerell (Bombyliidæ).

The reverse of the type has been found and shows some of the details of the venation better than the original specimen. It shows, in particular, that the upper basal corner of second submarginal cell has a short accessory nervure pointing directly basad; consequently, in my table in *Bull. Amer. Mus. Nat. Hist.*, XXXIII, p. 233, the genus runs straight to *Alepidophora.* The insect is, however, very distinct from *Alepidophora pealei* in a variety of ways, such as the more widely open first posterior cell, the quite different shape of the second posterior, and the shape of the end of the marginal cell. The end of the marginal cell in *A. pealei* is like that of *Paracosmus morrisoni*, whereas in *P. antiqua* it is as in *Paracosmus insolens.* In the original account of *A. pealei*, it appears that the præfurca is practically obsolete, but a new study of the type shows that this is an error of interpretation, owing to the condition of preservation; the præfurca is actually 880 microns long in *A. pealei*, while the first basal cell on the first submarginal is 2,240 microns.

In the reverse of *P. antiqua* the abdomen appears reddish, conspicuously lighter than the thorax; it is not banded like that of *A. pealei.*

A new and much more complete set of measurements (in microns) of *P. antiqua* is offered. Length of præfurca, 592; width (depth) of marginal cell near end, 480; first submarginal on wing margin (not allowing for curve), 850; squared basal end of second submarginal, 272; second submarginal on first posterior, 1,184; first basal on first submarginal, 1,472; first posterior on first submarginal, 1,280; length of anterior cross-vein, 288; discal cell on first basal, 1,360; discal on first posterior, 608; width (depth) of discal cell at level of anterior cross-vein, 304; discal cell on second basal, 224; first posterior on wing-margin, 304; second posterior on discal, 280; second posterior on wing-margin, 800; second posterior on third, 992; third posterior on wing-margin, 720; fourth posterior on second basal, 128; greatest width of anal cell, 352; anal on wing-margin, 400.

Geron (?) platysoma n. sp. (Bombyliidæ).

Length about 10.5 mm.; thorax about 3 mm., the dorsum in lateral profile flat for about 2 mm.; length of wing, 7.5 mm.; abdomen with dorsal region alternately banded dark and light, the dark twice as broad as the light (as Becker figures for *Heterotropus glaucus*).

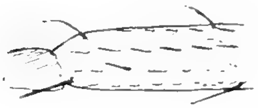
Wings clear, with light ferruginous nervures; venation as in *Geron gibbosus,* with anal cell closed well before wing-margin, but the discal cell is produced apically above and the anterior cross-vein is oblique; all the venational characters agree exactly with a *Geron* from Colorado.

The following measurements are in microns: first submarginal cell on wing margin, 608; length of præfurca, 400; first submarginal cell on first posterior, 1,664; first submarginal on first basal, 1,456; second submarginal on first posterior, about 1,920; first basal on discal, 1,184; first posterior on discal, 960; lower side of discal cell (on third posterior), 1,392; discal on second basal, 192; third posterior on second basal, 288.

Miocene shales of Florissant, Wilson Ranch (*Wickham*). The venation absolutely agrees with that of certain species of *Geron,* but the long, flattened thorax (perhaps partly distorted by pressure?) is very unlike that genus. The antennæ and proboscis cannot be made out. I suppose that the ancestors of *Geron* got the venation of the modern flies before they got the abbreviated form and humped thorax. The fossil should probably constitute a distinct genus, but it may provisionally remain in *Geron,* pending the discovery of better preserved material.

Heteromyiella miocenica n. sp. (Helomyzidæ).

Length 5 mm., wing 4.5 mm.; head, thorax and legs black; abdomen reddish, with scattered coarse bristles; wings reddish hyaline, without markings. Oral vibrissæ very large; anterior (or middle?) tibia with straight spur and curved preapical bristle. Venation normal; costa with many very short black bristles (practically as in *Heteromyiella senilis* = *Heteromyza senilis* Scudder), but no long ones; auxiliary vein distinct, complete and separate; anterior cross-vein below end of first vein; first posterior cell broadened in middle, the third vein distinctly arched upward (as in *Helomyza limbata*); second basal cell minute but distinct, anal cell also distinct.



Heteromyiella miocenica. End of tibia.

The following measurements are in microns: humeral cross-vein to end of first vein, 1,520; end of auxiliary vein to end of first vein, 400; second vein from point below end of first vein to wing-margin, 1,920; submarginal cell on wing margin (not allowing for curve), 592; submarginal cell on first posterior, 2,080; width of first posterior cell at level of end of discal, 448; first posterior on discal, 800; first posterior on second posterior, 1,120; discal cell on second posterior, 544; second posterior on third posterior, 320; first basal on discal, 1,250; second basal on discal, 112; anal on third posterior, 208.

Miocene shales of Florissant, Wilson Ranch (*Wickham*). It is rather remarkable that the *Heteromyiella* type, with only short bristles on the costa, should apparently (as shown by fossils from two or three localities) have been prevalent in North America in Tertiary times, whereas in the modern fauna it has given way to the genera with long as well as short bristles.

Empis miocenica n. sp. (Empididæ).

Length 5.5 mm., wing a little over 5.5, middle leg about 5; head about 1 mm. long, beak evident, but its length cannot be ascertained. Whole insect, as preserved, light ferruginous, the abdomen with dusky bands; wings reddish, with a very dilute stigmatal cloud. Only the upper part of the wing shows the venation clearly, but this appears to be quite normal for the genus.

The following measurements are in microns: end of first vein from base of wing, about 3,440; end of first vein to second (vertically) at same level, 144; end of first vein to end of second, about 1,600; separation of second and third veins from base of wing, about 1,120; the two branches of third vein are about equally long (1,120), the upper branch almost straight, with a very faint downward curve. The auxiliary vein can be seen very close to the first, but extremely weak and not reaching costa. The hind femora are large and stout, with a row of short, stiff, black spiniform bristles on the lower side. The anterior legs are lost.

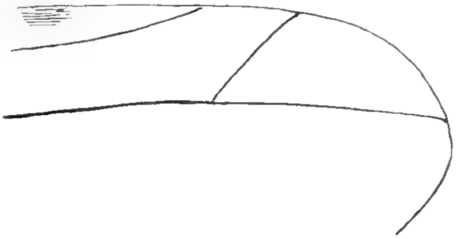
Wilson Ranch, Miocene shales of Florissant (*H. F. Wickham*). Considerably larger and more robust than *E. florissantana*, with the head much smaller in proportion to the thorax.

Empis florissantana n. sp. (Empididæ).

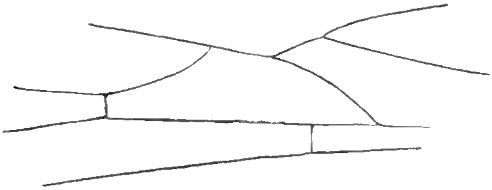
♀. Length about 4.50 mm.; wings 3.25, hyaline, except for a brown stigmatic cloud; middle legs about 4 mm. Face not hairy; head in lateral profile broad-oval; proboscis stout and stiff, much longer than head; thoracic dorsum dark; venation ordinary; hind femur reaching end of fifth abdominal segment.

The following measurements are in microns: length of head, about 640; length of proboscis, about 1,040; anterior femur, about 1,040, its tibia about the same; end of second vein to end of anterior branch of third, 272; length of anterior branch of third, 320; length of posterior or inferior branch of third, 672; apical width of first posterior cell, about 336; apical width of second posterior, about 320.

Wilson Ranch, Miocene shales of Florissant (*H. F. Wickham*). This appears to be a quite ordinary species of *Empis*. These are the first Empididæ to be described from Florissant.



Empis florissantana. Costo-apical region of wing.



Empis florissantana. Discal cell and adjacent parts.

Plecia axeliana n. sp. (Bibionidæ).

♀. Length about 8.5 mm., wing 9 mm.; thorax black with the mesothorax apparently red; abdomen banded dark and light, the light bands wider than the dark; wings reddish hyaline, suffusedly darker in costal region; head small, about 1.25 mm. diameter; venation normal.

The following measurements are in microns: depth of marginal cell at level of anterior cross-vein, 480; depth of submarginal cell at level of end of second vein (so-called anterior branch of third), 480; distance from end of second vein to end of third, about 1,760; distance in a straight line from base of marginal cell to separation of second vein from third, 2,880; length of the rather oblique anterior cross-vein, 272; lower end of anterior cross-vein to fork of fourth, 752.

Wilson Ranch, Miocene shales of Florissant (*H. F. Wickham*). Much larger than *P. melanderi* Ckll. (♂), with the abdomen quite differently marked; but in view of the sexual dimorphism in this family, it may be the female of *melanderi*. I have given it a name derived from Professor Melander's given name, to serve as an indication of this probability. It seems inadvisable to assume identity, as it is improbable that it can be proved, and since the insects appear different, it is desirable to know which is referred to in any particular citation. When describing *P. melanderi* I remarked on the lengthening of the stem of the fourth vein, between the anterior cross-vein and the fork. In *P. plagiata* Wied. (det. Knab) from Quirigua, Guatemala (*W. P. Cockerell*), it is exactly as long (752 microns) as in *P. axeliana*. *P. plagiata*, however, differs radically from *P. axeliana* and *melanderi* in having the second vein (or upper branch of third) directed vertically upward, so that it looks like a cross-vein.

Bibio wickhami n. sp. (Bibionidæ).

♀. Length about 12 mm.; wing 6.75; proboscis 2 mm.; hind femur 3 mm.; second posterior cell slightly over 2.5 mm. long. Head, thorax and legs black; abdomen dark brown, the sutures colorless; wings clear, the costal region slightly brownish, veins pale reddish. The stem of third vein, before the cross-vein (following the usual interpretation), is 576 microns long, while the cross-vein is only about 80. The cross-vein leaves the fourth at a slight angle, and is in a straight line with the part of the third (2 + 3) beyond it, the third being abruptly bent at the cross-vein. This is nearly as in the living *Bibio albipennis*, but is very different from the Florissant fossil *B. atavus*, in which the stem of fourth before the cross-vein is only about 320 microns, while the oblique cross-vein is about 1,040, being almost as long as the stem of fourth vein between the cross-vein and the fork (basal corner of second posterior cell).

Miocene shales of Florissant, Wilson Ranch (*Wickham*).

Mycomya lithomendax n. sp. (Mycetophilidæ).

Length nearly 5.5 mm., abdomen 4, wing 4 mm.; anterior tibia about 1.5 mm., its tarsus 2.5; microscopical measurements give the following in microns: anterior tibia, 1,392; its basitarsus, 1,120; length of antennæ, 1,920. Dorsum of thorax and abdomen dark brown, the abdominal sutures rather broadly pallid; tibiæ and tarsi brown, femora pallid; hind femora with a row of short black bristles on under side; wings reddish hyaline, without markings. The thorax (seen in lateral profile) is much more elevated or humped than in *M. cockerelli* Joh. The venation nearly agrees with that of *M. cockerelli*, but differs in some small details. The subcosta (I follow Johannsen's nomenclature) ends on the costa as usual, its upwardly directed end, beyond the cross-vein, is 128 (all measurements in microns) long; the cross-vein to radius is 192 beyond base of the small cell R_1, and is about the middle of that cell, which is quite long, as in *M. obliqua* (Say). The apical end of cell R has its upper face (above separation of lower branch of radius from radio-medial cross-vein) 128 microns long, and the lower face (radio-medial cross-vein) 192 and more oblique; this is almost as in *M. maxima* Joh.

Miocene shales of Florissant, Wilson Ranch (*Wickham*). Larger than the fossil *M. cockerelli,* and differing in coloration, details of the venation, and the proportions of the legs. It appears to be very close to the living *M. mendax* Joh., a species of the Pacific coast region.

Asilus wickhami n. sp. (Asilidæ).

Length 18.5 mm., of which 13.25 is abdomen; wings about 11 mm.; middle femora 3 mm., hind femora 4. Antennæ normal; the head and thorax were apparently black, the abdomen paler, somewhat darker dorsally than ventrally; legs without conspicuous bristles, tarsi thick; wings clear, nervures ferruginous. Bristles on the legs can be seen with the compound microscope, but they are pale or reddish, not black as in most species, and so are easily overlooked.

As in *A. peritulus* Ckll., the veins at the end of the second basal and fourth posterior cells form a cross; but in some other respects the venation differs from that of *A. peritulus* as follows:

(1) Marginal cell not so narrow at end.

(2) Sides of second submarginal beyond base parallel until near apex, when they gradually diverge; in *A. peritulus* the sides have a gentle double curve.

(3) Second posterior cell broader at base.

(4) Anterior cross-vein about middle of discal cell; *i.e.*, 1,440 microns from base and 1,330 from apex.

Wilson Ranch, Miocene shales of Florissant (*H. F. Wickham*).

The following annual reports were referred to the Publication Committee:

REPORT OF THE RECORDING SECRETARY.
1914.

Ten meetings have been held during the year with an average attendance of thirty.

Thirty-three papers have been presented for publication, as follows:

E. G. Vanatta, 4; Henry A. Pilsbry and Amos Brown, 3; Henry W. Fowler, 2; N. E. McIndoo, 2; Howard Crawley, 2; Henry Fox, 1; F. J. Keeley, 1; John H. Lowell, 1; Edward P. Poulton, 1; Witmer Stone, 1; H. Newell Wardle, 1; Henry A. Pilsbry, 1; Charles S. Boyer, 1; Albert M. Reese, 1; Roy Chapman Andrews, 1; Harold Heath, 1; Phil and Nellie Rau, 1; D. N. Barringer, 1; Burnett Smith, 1; Stanislas Meunier, 1; Joseph C. Thompson, 1; Charles P. Alexander, 1; Nathan Banks, 1; T. D. A. Cockerell, 1; James Chester Bradley *et al.*, 1.

Five of these communications were returned to the authors and two await publication. The others have all appeared in the PROCEEDINGS.

Of the PROCEEDINGS 794 pages and 41 plates have been published. 413 pages, illustrated by 16 plates, have appeared of the TRANSACTIONS OF THE AMERICAN ENTOMOLOGICAL SOCIETY (Entomological Section of the Academy). The Section has also issued 480 pages and 18 plates of the ENTOMOLOGICAL NEWS. 357 pages and 36 plates have been added to the MANUAL OF CONCHOLOGY by Dr. Pilsbry. This is an increase of 480 pages and 17 plates over the total output for last year.

Seven members and eleven correspondents have been elected. The deaths of fifteen members and five correspondents have been announced. Resignations of membership have been accepted from William W. Keen, M.D., Edward Anthony Spitzka, M.D., and C. Hartman Kuhn. Four members were dropped for non-payment of dues.

A final report of the Centenary Celebration was read at the meeting of December 2, 1913. A resolution expressive of the Academy's appreciation of the work of the Committee having charge of the celebration was adopted and duly recorded in the published PROCEEDINGS.

George Vaux, Jr., was reappointed by the Council the Solicitor of the Academy; Frank J. Keeley was also reappointed Curator of the William S. Vaux Collections, and Joseph Wilcox Custodian of the Isaac Lea Collections.

By authority of the Council, the securities of the Academy have been transferred from the Trust Company of North America to the Girard Trust Co.

The manuscript history of the Academy, prepared by the Recording Secretary in connection with the Centenary proceedings and accepted for publication in 1912, has been for some time ready for the printer, but awaits the necessary appropriation for its issue in proper form with desirable illustrations. The requisite amount is believed to be $1800 for an edition of, say, 500 copies.

The Hayden Memorial medal was presented to Dr. Henry Fairfield Osborn for his distinguished work in palæontology at a special meeting held November 24. The presentation address was made by the President and responded to by the recipient of the award.

The lectures delivered to the pupils of the Girls' High School, referred to in the last report, were continued with gratifying results until April 15. During the current season so far two lectures of a similar course have been delivered by Dr. Skinner, two by Dr. Pilsbry, and one by Dr. Moore.

The regular course to the public was delivered on Monday evenings from January 5 to April 27 as follows: Three by Dr. Witmer Stone, on local bird life; one by Dr. B. Franklin Royer, on plagues, their transmission and prevention; one by F. Herbert Snow, on dangers of bad water; three by Dr. Henry A. Pilsbry, on the scientific explorers of America; three by Dr. Henry Skinner, on entomology; three by Dr. Spencer Trotter, on anthropology; three by Dr. Witmer Stone, on local wild flowers, substituting for Mr. Stewardson Brown, who was unable because of illness to deliver his appointed course.

The Delaware Valley Naturalists' Union, the Pennsylvania Library Club, the Delaware Valley Ornithological Club, the Philadelphia Botanical Club and the Philadelphia County Medical Society have held meetings in the Academy.

EDWARD J. NOLAN, *Recording Secretary.*

REPORT OF THE CORRESPONDING SECRETARY.

In the foreign relations of the Academy during the past year the most noteworthy circumstance was the marked decrease in the volume of incoming correspondence as a result of the diminished activities of European scientific institutions since the outbreak of the war.

Correspondents reported deceased during the year were Albert Guenther, Carl Chun, Edward Suess, Frederick W. True, Theodore Gill, August Weismann and Charles Sedgwick Minot. Those elected were Edgar A. Mearns, Frank M. Chapman, Charles W. Richmond, Edmund Heller, Gerrit S. Miller, Nathaniel Charles Rothschild, Marie Curie, Charles T. Ramsden, Shibasaburo Kitasato, Frank Dawson Adams and Alfred Werner.

While a large number of scientific congresses in which the Academy was invited to take part had been scheduled for the year, all of those of an international character were either abandoned or postponed. In those cases in which the Academy was asked to express an opinion upon the advisability of so doing, our vote was cast in favor of postponement, as conditions in Europe seemed likely to preclude the attendance of a representative body of foreign delegates. In cases where delegates had been already appointed they were requested to allow their names to stand as the representatives of the Academy until the postponed meetings shall have convened. At the Atlanta meeting of the American Association for the Advancement of Science held in the early part of the fiscal year, Dr. Henry Skinner and Dr. Philip P. Calvert were the Academy's delegates. Dr. John Mason Clarke served as a delegate to the exercises inaugurating John Huston Finley as President of the University of the State of New York, and Professor J. G. Hidalgo was appointed to a like position in connection with 150th anniversary of the National Academy of Sciences and Arts of Barcelona.

As usual, a considerable number of requests for information were replied to by the Corresponding Secretary or referred to other members of the Academy staff. Statistics of the correspondence follow:

Communications received:

Acknowledging receipt of the Academy's publications	154
Transmitting publications to the Academy	67
Requesting exchanges or the supply of deficiencies	6
Invitations to learned gatherings, celebrations, etc	15
Notices of deaths of scientific men	16
Circulars concerning the administration of scientific and educational institutions, etc	21
Photographs and biographies of correspondents	11
Letters from correspondents	18
Miscellaneous letters	90
Total received	398

Communications forwarded:

Acknowledging gifts to the library	1,308
Requesting the supply of deficiencies	134
Acknowledging gifts to the Museum	73
Acknowledging photographs and biographies	6
Letters of sympathy or congratulation, addresses, etc	10
Diplomas and notices of election of correspondents and delegates' credentials	23
Miscellaneous letters	152
Annual reports and circulars sent to correspondents	257
Total forwarded	1,963

Respectfully submitted,

J. Percy Moore, *Corresponding Secretary.*

REPORT OF THE LIBRARIAN.

1914.

The additions to the library since the last annual report amount to 8,325. Of these 7,244 were pamphlets and continuations of periodicals, 929 volumes and 152 maps.

They were received from the following sources:

Exchanges	3,727
I. V. Williamson Fund	1,938
General Appropriation	827
United States Department of Agriculture	596
Pennsylvania State Library	324
Authors	157
Editors	121
J. A. Meigs Fund	111
United States Bureau of Education	48
Connecticut State Library	44
Nebraska State Board of Agriculture	31
Imperial Department of Agriculture, British West Indies	28
T. B. Wilson Fund	23
New York Agricultural Experiment Station	22
Pennsylvania Department of Health	21
Pennsylvania Department of Agriculture	20
Sveriges Geologiska Undersokning	15
University of Nebraska	15
United States Department of the Interior	13
Pan-American Union	12
International Institute of Agriculture	11
American Iron and Steel Institute	11
Government of India	11
Estacion Sismologica de Cartuja	9
United States Department of Commerce and Labor	8
Edward J. Nolan	8
Henry Skinner	8
Publication Committee of the Academy	7
Argentine Government	7
Michigan Fish Commission	7
Thoreau Museum of Natural History	6
Government of Costa Rica	6
Lowell Observatory	6
Caleb J. Milne, Jr	6
University of Tennessee	6
Trustees of the British Museum	6
Commission of Conservation, Canada	5
Topographic and Geological Survey of Pennsylvania	5
Michigan Geological and Biological Survey	5
New Mexico College of Agriculture	4
Geological Survey of India	4
Department of Trade and Customs, Australia	4

Geological Survey of New Jersey	4
United States War Department	3
Danish Government	3
University of Wyoming	3
New York State Board of Charities	3
Illinois State Geological Survey	3
Geological Survey of Alabama	3
Albert I., Prince de Monaco	3
French Government	3
Missouri Bureau of Geology and Mines	2
Rockefeller Sanitary Commission	2
Station Seismique de Ire Calsse d'Irkoutsk	2
K. Danske Videnskabernes Selskabs	2
Charles Hedley	2
J. G. Whiteman	2
Witmer Stone	2
Washington Geological Survey	2
Iowa Geological Survey	2
Family of Dr. Constantine Hering	1
United States Brewers' Association	1
Geological Survey of Victoria	1
Det Kgl. Frederiks Universitet	1
Chester County Historical Society	1
Illinois Bureau of Labor Statistics	1
Pennsylvania Forestry Association	1
Commission Polaire International	1
Government of Formosa	1
Delaware Valley Ornithological Club	1
Joseph Willcox	1
John M. Clarke	1
Cuerpo de Ingenieros del Minas de Peru	1
Pennsylvania Society	1
Ontario Department of Agriculture	1
Delaware County Institute of Science	1
Louisiana State Museum	1
Hawaii Agricultural Experiment Station	1
Geological Survey of Georgia	1
Seismological Station Ier Ordnung, Ekaterinburg	1
Mrs. S. L. Oberholtzer	1
John C. Branner	1
Department of Fisheries, Bengal, Bihar and Orissa	1
Henry A. Pilsbry	1
North Dakota Agricultural Experiment Station	1
James A. G. Rehn	1
Rice Institute of Liberal and Technical Training	1
Wisconsin Geological and Natural History Survey	1
J. G. Vail	1
Trustees of Amherst College	1
George F. Kunz	1
National Academy of Sciences	1
Pennsylvania Water Supply Commission	1

These additions were distributed to the departments of the Library as follows:

Journals	5,748
Agriculture	1,062
Geology	411
Botany	222
Geography	146
General Natural History	108
Entomology	99
Anatomy and Physiology	95
Voyages and Travels	70
Ornithology	59
Anthropology	44
Encyclopedias	40
Conchology	28
Mammalogy	27
Physical Sciences	20
Ichthyology	17
Mineralogy	17
Helminthology	14
Bibliography	13
Chemistry	12
Mathematics	12
Herpetology	8
Medicine	8
Philology	1
Miscellaneous	44

Among the more important general works secured by purchase are:

Falck, Mycologische Untersuchungen und Berichte, Heft 1.
Keibel, Normentafeln z. Entwicklungsgeschichte d. Wirbelthieren, 1911.
Krusenstern, Reise um die Welt, 1803–1806.
Linné, Genera Plantarum, Ed. 5, 1754.

Valmont de Bomaire, Dictionnaire Raisonnee Universel d'Histoire Naturelle, Editions of 1768, 1768–69, 1776, and 1791.
Willkomm et Lange, Prodromus Floræ Hispanicæ, 1861–1893.

The following additions have been made to the collection of Journals and Periodicals:

Académie des Sciences, Paris, Proces-Verbaux, I–IV.
American Breeders' Association, Reports, I, III, IV, VI–VIII.
American Breeders' Magazine, I–IV.
American Journal of Botany, I, 1.
Archivio de Anatomia e de Antropologia, Nos. 1–2.
Art and Archæology, I, 1.
Australian Zoologist, I, 1.
Beiträge zur Krystallographie und Mineralogie, I, 1, 2.
Bios. Rivista di Biologia Sperimentale e Generale, I–II, 1.
Brooklyn Botanical Garden, Bulletin; Circular; Contributions, I–III.
Bulletin des Neuesten und Wissenswürdigsten aus der Naturwissenschaft, I–XV.
Canada Department of the Interior, Bulletin of Forestry Branch, 1912, 1913.
Connecticut State Board of Agriculture, Annual Reports, 1866, 1869, 1871, 1906, 1909, 1912.
Conseil Permanent International pour l'Exploration de la Mer. Rapports et Proces-Verbaux, I–XX.
Contributions a la Faune des Indes Néerlandaises, I, 1.
Copeia, Nos. 1–10.
Department of Agriculture, Trinidad, Circulars, Nos. 1–7, 10–16.
Department of Colonization, Mines and Fisheries, Quebec, Report on Mining Operations, 1910, 1911, 1912. Preliminary Statement on Mineral Production, 1913.
Durban Museum, Annals, I, 1.
Gardens (The) Bulletin, Singapore, I, 6, 7.
Geographisches Jahrbuch, I–XXXVI.
Hastings and East Sussex Naturalist, I, 4, 5, 6; II, 1, 2, 3.
Hastings and St. Leonards Natural History Society, Reports, 1910–1913.
Internationale Zeitschrift f. physikalisch-chemische Biologie, I.
Journal of Heredity, V.
K. Nederlandsch Meteorologisch Institut. Ergebnisse aerologischer Beobachtungen, No. 1.
Meddelelser om Danmarks Antropologi, I, II, 1.
Mueller Botanic Society, Journal and Proceedings, I, 7–11.
Museo Nacional de Arqueologia, Historia y Etnologia, Anales, I, 13; III, 3, 6, 7, 8; IV; V, 1, 3.
Museum des Neuesten und Wissenswürdigsten aus dem Gebiete der Naturwissenschaft, I–XV.
Natural History and Science Society of Western Australia, Journal, III, 1, 2; IV.
Naturwissenschaftliches Museum der Stadt Crefeld, Mitteilungen, 1909, 1910, 1913.
Nebraska Academy of Sciences, Publications, I–VIII.
Nebraska State Board of Agriculture, Transactions, 1879–1891, 1893–1913.
Petrographical Institute "Lithogæa," Publications, III, IV.
Seismological Society of America, Bulletin, I–III, IV, 1, 2, 3.
Seismische Station Ier Ordnung, Ekaterinburg, Wöchentliches Bulletin, I.
Sociedade Portuguesa de Sciencias Naturais, Memorias, I.
Societa di Etnografia Italiana, Lares Bolletin, I, II, 1, 2, 3.
Société Zoologique de Geneve, Bulletin, I, II, 1, 2, 3.
Université de Jassy, Annales Scientifiques, VIII, 1, 2.
University of Michigan, Occasional Papers of the Museum of Zoology, I, 1–4.
University of Minnesota, Contributions from Department of Anatomy, I, II.
Victoria Memorial Museum, Bulletin, I.
Webbia, Raccolta di Scritti Botanici, I–III, IV, 1.
West Australian Natural History Society, Journal, 1–6.

Zeitschrift f. angewandte Entomologie, I, 1, 2.
Zeitschrift f. Oologie, I–XV.
Zeitschrift f. Vulkanologie, I, 1, 2.
Zoologiska Bidrag fran Uppsala, I, II.

The decrease in the number of accessions as compared to the growth of last year is partly owing to a curtailment of appropriations and partly to the interference of the war with the publication and transmission of foreign periodicals.

The issue of German journals, at first interrupted, has now been resumed, and they, just at present, are being received with tolerable regularity. Scarcely anything, except the *Comptes Rendus* of the Academy of Sciences and the Society of Biology reaches us from France, and these curtailed in size. Needless to say, nothing has come from Belgium since the invasion. The fine annual package from the Catholic University of Louvain will probably never be received again.

The amount at the disposal of the Library Committee has permitted of the binding of only 218 volumes.

The Card Catalogue is being thoroughly revised by Mr. Fox and information secured regarding incomplete sets, many of which, it is found, are in their present condition because of the death of the authors or the discontinuance of publication.

A proposition to amend the By-Laws so as to permit of the loaning of books from the Library, on which adverse action had been taken last year, was again referred to the Council and will probably be reported on favorably. Final action on this and other propositions will not be taken by the Academy until the third Tuesday in January. They will be more particularly dealt with in next year's report.

The Librarian was granted leave of absence to attend the International Exposition of Book Industries and the Graphic Arts in Leipzig and subsequently the meeting of the British Library Association at Oxford. On the breaking out of the war all idea of reaching Leipzig had to be abandoned and news of the postponement of the Oxford meeting soon followed. In the intermediate time between the first mobilization of troops and the beginning of actual fighting the journey from Milan to London was made with no disaster and the minimum of inconvenience. Earlier and later efforts to make the passage were much more serious matters.

During the Librarian's absence the routine business of the library was carried on with characteristic efficiency by his assistants, William J. Fox and Furman S. Wilde, to whom he is glad to again make deserved acknowledgment.

EDWARD J. NOLAN, *Librarian.*

IV. REPORT OF THE CURATORS.

The year just completed has been marked by important progress in the arrangement and study of the collections and by the accession of much valuable material.

The Museum has been visited by a large number of persons and there has been a constant increase in the schools and classes which have come, under the guidance of teachers, to study the collections. Classes in sketching from the School of Industrial Art have made use of the Museum every week during the winter months, and students from the natural history department of the Girls' High School have studied the collections regularly throughout the school year. The Department of Health of the Commonwealth of Pennsylvania has continued to occupy the quarters in the building allotted to it by the Academy some years ago.

The movement of the centre of the city westward has been distinctly noticeable in the increased number of visitors to the Museum, and the completion of the Parkway, which will pass the front of the Academy, will have a still greater influence in this direction.

In the building, necessary repairs to the roof and heating plant have been made during the year. The marble wainscoting in the entrance hall has been moved out and backed by brick to form a support for the larger Icthyosaurus fossils which have been mounted thereon, adding greatly to the appearance of the hall.

A number of large palms in tubs, gift of Mrs. Curwin Stoddart, Jr., have been placed in the entrance halls and the mineralogical room.

Seven plate-glass exhibition cases have been purchased during the year, three for the mammal and four for the archæological hall, while plate-glass frames have been provided for covering the large fossils in the entrance hall.

Twenty-six metal-covered storage cases have been purchased for the study series of mammals and shells, as well as 102 insect boxes and 450 trays.

Mr. Clarence B. Moore conducted two explorations among the Indian burial mounds along the Tennessee River, adding some valuable material to the Clarence B. Moore Collection in the Archæological hall. While the results were not so rich as heretofore in the matter of specimens, the information obtained is of the greatest importance.

Leave of absence was granted to several members of the Museum staff during the year for the purpose of conducting collecting expeditions in the field. Dr. Henry Skinner spent the month of February in Cuba as the guest of Mr. Charles T. Ramsden and collected extensively for the Academy, receiving valuable assistance from Mr. Ramsden.

Dr. Witmer Stone spent two weeks in May collecting in central South Carolina, while Mr. Stewardson Brown made another trip to Bermuda. Both secured valuable material. Other members of the staff carried on considerable local field work, which yielded valuable results. Details of museum work and important accessions in the various departments follow.

Mammals.

For the exhibition series the taxidermist, Mr. David McCadden, has devoted considerable time to the mounting of a number of East African Antelopes, a Giraffe and an African Forest Pig, collected by Messrs. A. M. Collins and E. M. Scull. A very fine Buffalo bull, obtained a few years ago from the Zoological Society of Philadelphia, was also mounted for exhibition.

Some time was also devoted to the mounting of the skeleton of the large fin-back Whale obtained at Ocean City, N. J., in 1891. This specimen has been erected in the north hall of the Museum and presents a very fine appearance. Mr. McCadden was assisted in this work by Mr. Edw. W. Stücke, whose services were secured for part of the year.

Seventeen mammals were received from the Zoological Society and have been variously prepared for mounting, skins, or osteological specimens. Most important of these was a skeleton of the Indian Elephant.

The entire mammalian osteological collection has been assembled during the year in the mammal room on the fourth floor, where metal-covered cases have been provided for its reception. As soon as the collection is thoroughly rearranged it is thought that it will offer as good facilities for the study of mammalian osteology as can be found in any museum in America.

Mr. Childs Frick spent considerable time in the department studying the Donaldson Smith collection in connection with his report on the material obtained by him in Africa.

Mr. Vernon Bailey also visited the Museum for the purpose of studying the series of *Thomomys*, and specimens have been loaned for study to Dr. J. A. Allen, Messrs. R. C. Andrews, E. W. Nelson, G. S. Miller, Jr., and W. H. Osgood.

Dr. Witmer Stone made a critical study of the mammals collected by Mr. S. N. Rhoads in Ecuador and prepared a report on them, which has been published in the PROCEEDINGS.

BIRDS.

Additions to the exhibition series consist of several local specimens received from the Delaware Valley Ornithological Club, a group of Swallow-tailed Kites from Texas, presented by Mr. George B. Benners, and a group of Heath Hens from Marthas Vineyard, the gift of Mr. Frederick H. Kennard, which have been recently mounted.

A large series of beautifully mounted birds, mainly from Texas and Pennsylvania, has been presented by Mr. Benners, which will be substituted for less desirable specimens in the general exhibit just as soon as cases can be secured for storing the duplicate material that must be withdrawn from exhibition before this collection can be rearranged.

The renovation of the study collection has continued without interruption. Mr. D. E. Culver, student on the Jessup Fund, has proceeded with the relaxing of the old unmounted specimens and has completed all of the Tanagridæ, Icteridæ, Ploceidæ, Dicruridæ, Oriolidæ and Turdidæ. The fronts of the trays have been painted with white enamel and all the cases and trays have been relabelled and lined with sheet cotton, from the Psittacidæ to the beginning of the Passeres.

Dr. Stone has also rearranged the Pigeons and Birds of Prey and has reidentified the entire collection of Humming-birds.

The type specimens have likewise been relaxed and relabelled. A number of specimens have been identified for the Zoological Society and for correspondents, and a card catalogue of all new species of birds described since 1911 has been compiled for use in the study room.

A valuable series of bird skins from Santa Marta, Colombia, was received by purchase and a small number from West Africa.

Mr. Gregory M. Mathews spent two days at the Academy studying the Gould types in connection with his great work on the birds of Australia, and Prof. W. W. Cooke examined the collection for Texan specimens. Many local students have also made use of the study material, and specimens were loaned to Messrs. E. W. Nelson, Frank M. Chapman, Harry C. Oberholser and Dr. E. A. Mearns.

REPTILES AND BATRACHIANS.

Mr. Henry W. Fowler has looked after this department during the year and has identified and prepared for preservation all the new material received, numbering several hundred specimens, of which about 100 have been catalogued.

The stuffed reptiles of the old collection, as well as the reptilian osteological material, have been gathered together in a room on the fourth floor, where they are readily accessible. Specimens have been loaned to Dr. L. Stejneger for study.

Fishes.

The ichthyological collection has also been under Mr. Fowler's care. He has examined the main alcoholic collection and prepared, identified and labelled all the specimens obtained during the year, cataloguing some 2,600 individuals. Numerous local trips that he has taken have added large series of Pennsylvania and New Jersey fishes to the collection.

He has also studied critically the large group of catfishes and related forms contained in the Museum and has a report on them now in preparation. Papers have been published on Greenland, British Guianan, and local fishes in the Academy's Proceedings.

Mollusks.

Dr. Henry A. Pilsbry, special curator of this department, reports that accessions have been received during the year from 69 persons and institutions. No small part of his time, as well as that of Mr. E. G. Vanatta, has been taken up in determining specimens for correspondents, and while this work is rendered freely by the Academy, as a service it owes to the public, it is abundantly repaid by the gifts of desired specimens.

Although no expeditions have been undertaken during the year for this department, Messrs. Ferriss and Daniels have shared the results of their summer's collecting in Arizona, covering a district not before worked for mollusks, and local collecting trips by members of the Museum staff have added some valuable material.

Considerable progress has been made in determining and labelling the Hawaiian material collected by Dr. Pilsbry in 1913; the assorting of mixed lots having been completed, so that all species not yet determined are available for convenient study. The study and arrangement of the *Achatinellidæ* have been completed.

The series of American land shells and of land operculates have been cleaned and catalogued by Miss Caroline Ziegler, who has also been occupied with assorting material received from various sources.

Dr. Pilsbry has completed the publication of a monograph of the Hawaiian tree snails, *Achatinellidæ*, together with a supplement describing new material collected in 1913. The preparation of a monograph of the family *Tornatellinidæ*, also largely Hawaiian, is well advanced.

INSECTS.

Dr. Henry Skinner, head of the department of Entomology, reports that he and Mr. E. T. Cresson, Jr., have rearranged the families Gyrinidæ, Hydrophilidæ and part of the Scarabæidæ among the Coleoptera and the exotic and American Syntomidæ, Uranidæ and the genus Catagramma among the Lepidoptera. Considerable time has also been devoted to a study of over 8,000 Acalyptrate Diptera.

Dr. Horn's types of Coleoptera in the families Throscidæ, Malachidæ, Cleridæ, Ptinidæ, Lucanidæ and Scarabæidæ have been located and numbered, as well as many of Grote's types of Moths.

The local collection is being entirely rearranged in cabinets in the Entomological rooms, where it is easily accessible and can be added to from time to time. The arrangement of the Odonata, Orthoptera, Lepidoptera, Rhopalocera, and part of the Heterocera and Coleoptera has been completed.

In the Orthoptera Mr. J. A. G. Rehn has rearranged the Blattidæ and Dermaptera, the exotic Mantidæ and a considerable portion of the North American Tettigoniidæ. He has been engaged more or less regularly throughout the year, in conjunction with Mr. Morgan Hebard, in studying the Orthoptera collected by them in the southeastern United States, together with material from the same area loaned by Cornell University, the State of Georgia and individual collectors. In this connection six genera were critically revised, and papers on them are in press or in process of completion.

Mr. Rehn has also made considerable progress in the study of Brazilian Orthoptera received from various sources and has started upon the determination of African collections submitted by the Berlin Museum and German National Entomological Museum, from which the Academy will receive a duplicate series. A collection of Phasmidæ from New Guinea, sent by the Royal Zoological Society of Amsterdam, is to be worked up on the same terms.

Mr. Hebard, who has spent much time studying his private collection, which is deposited at the Academy, has presented many specimens originally in the Bruner collection and has continued to maintain a preparator whose services have been given liberally to the

Academy in connection with the Orthoptera collection. Through his liberality also, Mr. Rehn was enabled to accompany him to Boston and Washington to study type material.

The Entomological department has received many valuable accessions during the year. A series of 5,296 moths and other insects, the collection of the late Charles S. Welles, was presented by Mrs. Welles, while Mr. C. C. Deam presented 892 Lepidoptera from Florida and Guatemala. Dr. Witmer Stone collected 612 insects in central South Carolina, and Dr. Skinner some 1,500 specimens from eastern Cuba, one-third of which were Lepidoptera. Numerous local specimens were also collected or presented.

Many specialists have availed themselves of the opportunity of studying the collections, among whom were Messrs. A. N. Caudell, W. T. Davis, Charles T. Ramsden, W. P. Comstock, F. E. Lutz, R. A. Leussler, C. T. Alexander.

Other Invertebrates.

Dr. H. A. Pilsbry has spent considerable time in the study of the Cirripeds of the Academy and the National Museum Collections, upon which he has prepared a report. With the addition of duplicates from the National Museum received in return for this work, the collection of the Academy is now believed to be the third in the number of species represented.

Mr. Fowler has cared for most of the other alcoholic Crustacea and lower invertebrates received during the year and has been instrumental in securing a large number of local specimens, so that the collection is now fairly representative of the local fauna. He cleansed the entire series of local Arachnida and Myriapoda, placing them in new vials, which were then arranged in large jars and flooded with alcohol.

Invertebrate Fossils.

Mr. E. G. Vanatta has catalogued and labelled the collection of British Crag Fossils. Little has been accomplished in the rearrangement of the palæozoic material which is badly in need of study.

The recent accessions have been studied, identified, and arranged by Dr. Pilsbry, notably the Vickers-Oberholtzer Collection of Oeland fossils and various small lots of tertiary and cretaceous. Dr. Amos P. Brown has also continued, as opportunity arose, to render generous assistance in this department. A fine group of siliceous sponges from the Upper Devonian of New York has been presented by Dr. John M. Clarke.

VERTEBRATE FOSSILS.

Much progress has been made in bringing the collections in this department into order. Mr. J. A. G. Rehn has cleansed and catalogued the entire series of mammalian and avian remains and finished the systematic arrangement of all the smaller specimens in trays under the cases on the gallery of the north wing. Mr. Henry W. Fowler has done the same for the fishes which are arranged in drawer cases on the fourth floor. He has also catalogued the entire series of reptiles. Dr. Stone has temporarily arranged the reptiles and larger mammalian specimens in old cases in the north wing which have been renovated for the purpose. This brings the material all together, but new cases will be required before it can be systematically displayed. Material has been loaned during the year to Drs. R. W. Shufeldt and L. Hussakof.

HERBARIUM.

Mr. Stewardson Brown, who has had charge of the collections of plants, was absent for nearly half the year on account of severe illness, but the department was looked after by Messrs. S. S. Van Pelt and Bayard Long, who have generously devoted almost their whole time to the care and development of the local collection of plants.

The work in the general herbarium has been mainly devoted to caring for the numerous accessions. Miss Ada Allen has continued to do the mounting and Mr. Brown has labelled, catalogued and distributed the sheets as well as identified many specimens for correspondents.

Through an arrangement with the trustees of Lafayette College, the herbarium of the late Dr. Thomas C. Porter has been deposited in the Academy. It is conservatively estimated to contain 30,000 sheets of plants, among which is the series of the Pennsylvania flora which served as the basis of Dr. Porter's State list. The herbarium of the late Charles S. Williamson; containing some 10,000 sheets, has been presented by his sister, Miss Williamson. Through the assistance of Mrs. Beulah M. Rhoads and the Botanical Section, it was possible to purchase the valuable collection of 1900 ferns and fern allies made by Mr. W. A. Poyser, which adds greatly to the completeness of this section of the Academy's herbarium. The Botanical Section also presented 800 sheets of California plants. Dr. Witmer Stone collected 500 sheets in South Carolina and Mr.

Brown 200 in Bermuda; 1,300 others were received from various donors. Messrs. Long and Van Pelt have voluntarily assumed care of the local herbarium, and some 4,000 specimens were added during the year. Mr. Van Pelt has devoted his time to poisoning and mounting the material, while Mr. Long has done much local field work, critically studied the material and identified and labelled it.

Dr. Stone spent some time in arranging and sorting the lower orders in the Porter herbarium preparatory to having the specimens mounted.

Specimens have been loaned for scientific study to Messrs. K. K. McKenzie, J. K. Small, Harold St. John, C. S. Sargent and M. L. Fernald.

Minerals and Rocks.

The Curator of the William S. Vaux Collections, Mr. F. J. Keeley, reports that Mr. Samuel G. Gordon, a student on the Jessup Fund during the year has completed the cataloguing of the minerals. Thirteen additions have been made during the year. The collection now numbers 8,193 specimens. The catalogue of the general Academy collection has also been brought up to date and comprises 8,508 entries. This collection has been rearranged by Mr. Gordon in trays under the cases in the archæological hall, in accordance with Dana's classification (sixth edition), and is thus easily accessible for study or consultation.

The local collection of minerals was thoroughly cleansed and rearranged geographically. While lacking a number of local minerals, it is good representative collection.

All the rocks stored in various parts of the north museum building have been brought together and arranged in temporary cases of drawers by Mr. Gordon, following Rosenbusch's system, so that they may be easily consulted.

Archæology and Ethnology.

In this department the material obtained by Mr. Clarence B. Moore's expeditions has been placed on exhibition under his direction.

Two cases were procured for the display of portions of the Wm. S. Vaux Collections, which have been withdrawn from exhibition for several years, owing to changes in the hall during alterations.

Two other cases were installed for exhibiting portions of the Pueblo pottery and basketry contained in the Gottschall Collection. This collection, comprising about 5,000 specimens, was presented by Mr. A. H. Gottschall, of Harrisburg, Pa., who gathered it together from 1871 to 1892. It forms an exceedingly valuable collection of ethnographic and archæological material, which strengthens the Academy's department where it was weakest. The greater part of the collection is still of necessity preserved in storage; but beside the exhibit mentioned, Miss H. N. Wardle, who superintended the packing and unpacking of the collection, has picked out, labelled and catalogued some 350 pieces of Eskimo and northwest coast material. Miss Wardle has had to rearrange a large part of the ethnographic exhibition to make room for these accessions.

A series of 89 European Stone Age artefacts found among the Pourier Collections of fossils were turned over to Miss Wardle and have been cleansed, catalogued and labelled.

Another valuable addition to the department has been a gift of numerous pieces of basketry, etc., from Mrs. Curwin Stoddart.

WITMER STONE, *Chairman.*
SAMUEL G. DIXON, M.D.
HENRY A. PILSBRY.
HENRY TUCKER.

REPORTS OF THE SECTIONS.

Many of the statements heretofore found in the reports of the Sections are now included in the Curators' Report.

BIOLOGICAL AND MICROSCOPICAL SECTION.—Eight stated meetings have been held during the year.

The following communications were made:

Mr. F. J. Keeley described various species of diatoms, including specimens he had collected in Florida.

Mr. T. C. Palmer, besides other communications, described species of diatoms he had collected in Yellowstone Park.

Mr. Hugo Bilgram exhibited certain varieties of *Myxomycetes*, which appeared to be new.

Mr. C. S. Boyer exhibited a new species of *Chætoceros*, a description of which was published in the PROCEEDINGS.

Dr. T. S. Stewart exhibited various pathological slides.

Other communications were made by Messrs. S. L. Schumo, J. W. Palmer, W. H. Van Sickel, William B. Davis, and several visitors.

The following officers were elected for the ensuing year:

Director	Dr. J. Cheston Morris.
Vice-Director	T. Chalkley Palmer.
Recorder	Charles S. Boyer.
Corresponding Secretary	Silas L. Schumo.
Treasurer	Dr. Thomas S. Stewart.
Curator	F. J. Keeley.

Charles S. Boyer,
Recorder.

Entomological Section.—The regular monthly meetings have been held during the year and communications of interest have been made. The proceedings have been published in Entomological News and are therefore permanently recorded.

At a meeting held December 14th the following persons were elected officers to serve for the coming year:

Director	Philip Laurent.
Vice-Director	Henry W. Wenzel.
Treasurer	Ezra T. Cresson.
Conservator	Henry Skinner.
Secretary	J. A. G. Rehn.
Recorder	Henry Skinner.
Publication Committee	E. T. Cresson and E. T. Cresson, Jr.

Henry Skinner,
Recorder.

Botanical Section.—Satisfactory progress has been made in the mounting and distribution of specimens in the herbarium, notwithstanding the absence of the Conservator, through illness, during the first half of the year. Additions, which are enumerated in detail in the report of the Curators, have agregated approximately 50,000 specimens, of which 2,700 were purchased. At the annual meeting of the Section, held on November 25, the following officers were elected to serve for the ensuing year:

Director	Benjamin H. Smith.
Vice-Director	Joseph Crawford.
Recorder	John W. Eckfeldt, M.D.
Treasurer and Conservator	Stewardson Brown.

Respectfully submitted,

Stewardson Brown,
Conservator.

MINERALOGICAL AND GEOLOGICAL SECTION.—The Section held four meetings this year, with about the usual average attendance.

A communication was made by Dr. Florence Bascom on Kaolin. and other communications on various subjects by different members. At an additional meeting of the Section, in conjunction with the Academy, on March 23, Miss Mary M. Vaux made a communication on British Columbia Glaciers.

There were five field excursions, with an average attendance of over fifteen. The parties visited: (1) The crystalline schists and limestones between Alton and Glen Hall, in Chester County; (2) The crystalline rocks and their minerals between Hockessin, Delaware, and Kennett Square, Chester County, Pa.; (3) The eastern graphite deposits of Chester County; (4) The crystalline rocks and their minerals on the East Branch of the Brandywine, below Downingtown, Chester County; (5) The gneiss and limestone near Kennett Square and Avondale, Chester County.

The following officers of the Section have been elected for the year 1915:

Director	Benjamin Smith Lyman.
Vice-Director	F. J. Keeley.
Recorder and Secretary	S. L. Schumo.
Treasurer	William B. Davis.
Conservator	George Vaux, Jr.

Respectfully submitted by order of the Section.

BENJAMIN SMITH LYMAN,
Director.

ORNITHOLOGICAL SECTION.—The Section has continued to take an active interest in the development of Ornithology at the Academy. The Pennsylvania Audubon Society and Delaware Valley Ornithological Club have been encouraged to hold their meetings at the Academy, and many persons interested in bird study have thus been brought into closer relation with it.

At the annual meeting of the Section the following officers were chosen for the ensuing year:

Director	Spencer Trotter.
Vice-Director	George Spencer Morris.
Recorder	Stewardson Brown.
Secretary	William A. Shryock.
Treasurer and Conservator	Witmer Stone.

Respectfully submitted,

WITMER STONE,
Conservator.

The annual election of Officers, Councillors, and Members of the Committee on Accounts was held December 15, with the following result:

PRESIDENT	Samuel G. Dixon, M.D., LL.D.
VICE-PRESIDENTS	Edwin G. Conklin, Ph.D., Sc.D.,
	John Cadwalader, A.M.
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	Samuel G. Dixon, M.D., LL.D.,
	Henry A. Pilsbry, Sc.D.,
	Witmer Stone, A.M., Sc.D.,
	Henry Tucker, M.D.
COUNCILLORS TO SERVE THREE YEARS	Charles B. Penrose, M.D.,LL.D., Ph.D.
	Charles Morris,
	Spencer Trotter, M.D.,
	William E. Hughes, M.D.
COMMITTEE ON ACCOUNTS	Charles Morris,
	Samuel N. Rhoads,
	John G. Rothermel,
	Thomas S. Stewart, M.D.,
	Walter Horstman.

COUNCIL FOR 1915.

Ex-Officio.—Samuel G. Dixon, M.D., LL.D., Edwin G. Conklin, Ph.D., John Cadwalader, A.M., Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, Sc.D., Witmer Stone, A.M., Sc.D., Henry Tucker, M.D.

To serve three years.—Charles B. Penrose, M.D., LL.D., Ph.D., Charles Morris, Spencer Trotter, M.D., William E. Hughes, M.D.

To serve two years.—Edwin S. Dixon, Henry Skinner, M.D., Sc.D., Robert G. LeConte, M.D., George Spencer Morris.

To serve one year.—Philip P. Calvert, Ph.D., Thomas Biddle, M.D., Frank J. Keeley, Thomas G. Ashton, M.D.

SOLICITOR OF THE ACADEMY	George Vaux, Jr.
CURATOR OF MOLLUSCA	Henry A. Pilsbry, Sc.D.

Curator of William S. Vaux Collections	Frank J. Keeley.
Custodian of Isaac Lea Collection	Joseph Willcox.
Assistant Librarian	William J. Fox.
Assistants to Curators	Henry Skinner, M.D., Sc.D.,
	Stewardson Brown,
	J. Percy Moore, Ph.D.,
	Edward G. Vanatta,
	Henry W. Fowler,
	James A. G. Rehn,
	Ezra T. Cresson, Jr.,
	Harriet Newell Wardle.
Assistant in Library	Furman Sheppard Wilde.
Aid in Herbarium	Ada Allen.
Taxidermist	David M. McCadden.
Janitors	Charles Clappier,
	Daniel Heckler,
	James Tague,
	Jacob Aebley,
	Adam E. Heckler.

STANDING COMMITTEES.

Finance.—John Cadwalader, A.M., Edwin S. Dixon, Effingham B. Morris, William D. Winsor, and the Treasurer.

Publications.—Henry Skinner, M.D., Sc.D., Witmer Stone, A.M., Henry A. Pilsbry, Sc.D., William J. Fox, Edward J. Nolan, M.D.

Library.—George Vaux, Jr., Henry Tucker, M.D., Frank J. Keeley, Thomas Biddle, M.D., Witmer Stone, Sc.D.

Instruction and Lectures.—Henry A. Pilsbry, Sc.D., Charles Morris, Henry Tucker, M.D., George Spencer Morris, and Stewardson Brown.

ELECTIONS IN 1914.

Members.

January 20.—Arthur Howell Napier.

February 17.—Joseph McFarland, M.D.

April 21.—John S. Sharpe, M.D., Arthur W. Sheafer, William T. Davis.

May 19.—Thomas L. Fansler.

November 17.—A. H. Gottschall.

CORRESPONDENTS.

April 21.—Shibasaburo Kitasato, of Tokyo; Charles T. Ramsden, of Guantanamo, Cuba; Marie Curie, of Paris; N. Charles Rothschild, of London; Gerritt S. Miller, of Washington; Edmund Heller, of Washington; Charles W. Richmond, of Washington; Frank M. Chapman, of New York; Edgar A. Mearns, of Washington.

November 17.—Alfred Werner, of Zurich; Frank Dawson Adams, of Montreal.

ADDITIONS TO THE MUSEUM.

1914.

Mammals.

Dr. P. P. Calvert. One Star-nosed Mole (*Condylura cristata*).

Thomas T. Firth. Skeleton of Beaver (*Castor canadensis*).

H. T. Galbraith (on deposit). Mounted skeleton of Manatee (*Trichechus americanus*), Point Isabel, Tex.

Miss Audrey Kane. Skin of American Beaver (*Castor canadensis*).

Henry A. McGraw. Skin of Fox Squirrel (*Sciurus ludovicianus limitis*), Bedford County, Pa.

New York Aquarium. Skeleton of Bottle-nosed Dolphin (*Tursiops truncatus*), Cape Hatteras, N. C.

Purchased. Skeleton of Bottle-nosed Dolphin (*Tursiops truncatus*), Whale Beach, N. J.

Chas. T. Ramsden. Two specimens each of *Capromys pilorides* and *C. melanura*, skins and skulls, Guantanamo, Cuba.

Dr. R. W. Shufeldt. Disarticulated skeletons of *Cynocephalus philippinensis* and *Procyon lotor*.

Zoological Society of Philadelphia. Mounted: Albinistic Porcupine (*Erethizon dorsatum*). Prepared as skin and skull: Toque Macaque (*Macacus pileatus*); two Northwestern Martens (*Mustela atrata caurina*); Wild Cat (*Lynx ruffus* subsp.); Japanese Bear (*Ursus japonicus*); Coney (*Procavia* sp.); Antilopine Kangaroo (*Macropus antilopinus*). Prepared as skin: Young Mahol's Galago (*Galago maholi*); Red Coati (*Nasua rufa*); very young Warthog (*Phacochærus* sp.). Prepared as skeleton: Ocelot (*Felis pardalis*); European Wolf (*Canis lupus*); Cape Hunting Dog (*Lycaon pictus*); Wolverene (*Gulo luscus*); European Badger (*Meles meles*). Prepared as skull: two Barbary Apes (*Macacus innuus*); Ocelot (*Felis pardalis*); Jackal (*Canis* sp.).

Birds.

H. H. Burton. King Rail (*Rallus elegans*), Tullytown, Pa.

George B. Benners. The Benners' collection of mounted birds consisting of 38 groups and 280 individual specimens.

Dr. P. P. Calvert. Two mounted birds.

Edwin J. Carr. Skin of Red-tailed Hawk (*Buteo borealis*), Panther, Pa.

Edw. N. Fox. Least Tern (*Sterna antillarum*), Sea Isle City, N. J.

E. W. Manderson. Mounted Snowy Owl (*Nyctea nyctea*).

Ornithological Section. 150 skins of Colombian birds.

William Pack. Two Little Blue Herons (*Florida cærulea*), Cape May County, N. J.

Roy I. Phillips. Abnormal Chicken (four legs).

PURCHASED. Skull of Great Auk (*Plautus impennis*), skins of eight Geese and two Yellow-billed Magpies, California; 66 skins of West African birds; 500 skins of Colombian birds; skin of *Tetraogallus altaicus*.

J. S. QUICK. Skin of Red-tailed Hawk (*Buteo borealis*), Delaware County, Pa.

MRS. J. SAENZ. Nest of Bolivian Ovenbird (*Furnarius* sp.).

DR. R. W. SHUFELDT. Disarticulated skeleton of *Agriocharis ocellata*.

ARCHICLAUS P. WILLETTS. Nest and eggs of Prairie Warbler (*Dendroica discolor*); skins of Shoveller Duck (*Spatula clypeata*) and Short-eared Owl (*Asio accipitrinus*), Tuckerton, N. J.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Impeyan Pheasant; two Goura Pigeons; one Penguin.

REPTILES AND AMPHIBIANS.

MRS. W. LUDWIG BAKER. Shell of Loggerhead Turtle (*Caretta caretta*); tray of reptile fragments, Osprey, Fla.

O. F. BAYNARD. Collection of reptiles, Clearwater, Fla.

H. H. BURTON. Bottle of Newts (*Diemictylus viridescens*), Somerset County, N. J.

DELOS E. CULVER. Pickerel Frog (*Rana palustris*), Addingham, Pa.; Toad (*Bufo americanus*), Addingham, Pa.

WILLIAM J. FOX. Tiger Salamander (*Ambystoma tigrinum*), Ocean View, N. J.

J. H. FERRISS. Horned Toad (*Phrynosoma*), Clifton, Ariz.

MORGAN HEBARD. Wood Frog (*Rana sylvatica*), New Jersey; Marbled Salamander (*Ambystoma opacum*), Green Spring, N. J.

J. T. HOLMAN. Young *Coluber constrictor*, West Creek, N. J.

PHILIP LAURENT. Two small snakes taken from an American Bittern, Philadelphia "Neck."

CHARLES LEVEY. Red Salamander (*Spelerpes ruber*), Delaware County, Pa.

BAYARD LONG. Two young Mud Turtles (*Sternothœrus odoratus*), Moorestown, N. J.

SAMUEL MASON, JR. Timber Rattler (*Crotalus horridus*), Stoddartsville, Pa.

H. L. MATHER. Two Salamanders, Peters Creek, Pa.; lot of Amphibians, Melbourne, Ont.

E. S. MATTERN. Two Swamp Tree-toads (*Pseudacris triseriatus*), Carbon County, Pa.

PHILADELPHIA AQUARIUM. Shell of Snapping-turtle (*Chelydra serpentina*), Lake Copake, N. Y.; (*Aspidonectes spinifer*), Lake Erie.

C. T. RAMSDEN. Small collection of reptiles and amphibians, Cuba.

DR. J. W. ROSS. Collection of reptiles, north coast of Cuba.

DR. WITMER STONE. Collection of reptiles and amphibians, Manning, S. C.

R. W. WEHRLE. Collection of amphibians, Huntingdon County, Pa.

ZOOLOGICAL DEPARTMENT OF PRINCETON UNIVERSITY. Collection of reptiles. Egypt.

FISHES.

R. M. ABBOTT. Two jars of fishes, Trinidad and St. Vincent, W. I.

C. S. ABBOTT, JR. Jar of fishes, Hamilton, Bermuda.

FRED ADAMS. Lizard Fish (*Synodus fœtens*), Beesley's Point, N. J.

DR. L. H. ADLER. Mounted specimen of Trout.

O. F. BAYNARD. Collection of fishes, Clearwater, Fla.

H. L. Burton. Four lots of fishes, Connecticut and Pennsylvania.

H. H. Burton and H. W. Fowler. Six lots of fishes, Delaware River tributaries in Pennsylvania and New Jersey.

C. F. Derby. Small collection of fishes, Brazil.

William Duncan. Hammer-head Shark (*Sphyrna zygæna*), Sea Isle City, N. J.

C. H. Eigenman. Ten fresh-water fishes, South America.

H. W. Fowler. Jar of fishes, Swan Creek, Md.; jar of fishes, Hackensack River basin, N. J.; bottle of small fishes, Penns Manor, Pa.; three jars of fishes, Perry and Cumberland Counties, Pa.; Larval lamprey (*Petromyzon*), Bristol, Pa.

E. N. Fox. Sea Robin (*Prionotus evolans*), Sea Isle City, N. J.

William J. Fox. Several lots of fishes, comprising individuals of the genera *Echeneis, Bairdiella, Orthopristis* and *Trachinotus*, Sea Isle City, N. J.; Young Crevallé (*Caranx* sp.), File Fish (*Stephanolepis hispidus*) and deformed eel (*Anguilla chrisypa*), Corsons Inlet, N. J.

W. L. Hartshorne. Jar of fishes, Pompton River, N. J.

C. J. Hunt. Three fishes, Lake Wawasee, Ind.

W. T. Innes. Jar of fishes, Atlantic City, N. J.

F. J. Keeley. One bottle of fishes, Hawks Park, Fla.

Bayard Long. Four lots of fishes, New Jersey.

David McCadden. *Ophichthys ocellatus*, Florida; *Alutera schœpfii*, Ocean City, N. J.

H. L. Mather. One stone catfish (*Schilbeodes*), Peter's Creek, Pa.; three bottles of fishes, Montgomery County, Pa.

H. L. Mather and H. W. Fowler. Small collection of fishes, Bohemia River, Md.

Philadelphia Aquarium. Sunapee Trout (*Salvelinus aureolus*); Mud-shad (*Dorosoma cepedianum*), Schuylkill River; Trout (*Salvelinus* sp.).

Dr. R. J. Phillips. Two collections of fishes, Corsons Inlet, N. J.

Dr. R. J. Phillips and H. W. Fowler. Jar of fishes from reservoir at Wilmington, Del.

Julian Potter and Delos E. Culver. Jar of fishes, Delaware County, Pa.

Dr. Benjamin Sharp. Burr fish (*Chilomycterus schœpfi*), Nantucket, Mass.

Dr. Burnett Smith. Two Whitefish (*Leucichthys osmerinus*), Skaneateles Lake, N. Y., and Canadian side of Lake Ontario.

Dr. Witmer Stone. Collection of fishes, Manning, S. C.

R. W. Wehrle. Collection of fishes, Huntingdon County, Pa.

Zoological Department of Princeton University. Can of fishes, Egypt.

Recent Mollusca.

Jacob Aebly. *Chama macerophylla* Gmel. and *Planorbis corneus* L.

Benjamin Albertson. Four marine shells from Nantucket, Mass.

John A. Allen. Eighteen species of mollusks from Tahiti, Oregon, and Ohio.

Dr. Fred Baker. Three species of land shells from Brazil.

Mrs. W. Ludwig Baker. Eight species of marine shells.

E. B. Bartram. One tray of *Ancylus* from Belvidere, Pa.

S. S. Berry. Two species of *Physa* from Bear Lake, Cal.

E. Bethel. *Pisidium huachucanum* P. and F. from Newcomb, Colo.

Caroline Boice. One tray of *Epitonium*.

Dr. Amos P. Brown. Sixty-eight trays of shells from Antigua, W. I.

H. H. Burton. Eighteen species of shells from Canada and Pennsylvania.

H. H. Burton and H. W. Fowler. Three fresh-water shells from Pennsylvania.

H. F. Carpenter. Four species of land and marine shells.

C. E. Claghorn. One species of *Cassis* and *Melania*.

Geo. H. Clapp. Seven land shells from Florida, Georgia, and Pennsylvania.

T. D. A. Cockerell. *Oreohelix cooperi minor* Ckll. from Boulder, Colo.

Dr. C. M. Cooke. Forty-seven trays of Hawaiian land shells.

Ella C. Cornell. Twenty-two trays of land and fresh-water shells from near Wilmington, Del.

Delos E. Culver. Seven species of land and fresh-water shells from Delaware County, Pa.

L. E. Daniels. Seventeen land mollusks from Indiana and Montana.

Jas. M. De Laney. *Valvata tricarinata* Say from Rochester, N. Y.

J. S. Emerson, *Achatinella apexfulva* Dixon from south side of Opaeula, Oahu, H. I.

J. H. Ferriss. Two hundred and five trays of land shells from Arizona.

H. W. Fowler. Sixty-five trays of land and fresh-water mollusks from Pennsylvania, New Jersey, Delaware, and Maryland.

L. S. Frierson. Two species of *Lampsilis* from Cutter, Ark.

Geo. M. Greene. *Gastrodonta suppressa* Say from East Falls Church, Va.

H. A. Greene. *Goniobasis* and *Polygyra* from Tryon, N. C.

John M. Gould. *Solemya borealis* T. from Portland, Me.

L. E. Griffin, *Corbicula manillensis* Ph. from reservoir in Manila, P. I.

E. E. Hand. *Pisidium huachucanum* P. and F. from Evergreen, Colo.

Hawaiian Expedition of 1913. One hundred and twenty-five trays of land shells.

Morgan Hebard. Five land shells from Pennsylvania, New Jersey, and Texas.

H. Hemphill. *Crepidula plana* Say from Sarasota Bay, Fla.

Junius Henderson. Three land and fresh-water shells from Arizona and Colorado.

H. C. Higgins. Four *Unio* from the Blackstone River, Mass.

Purchased. Sixty-one trays of shells from Guatemala. Collection of East Indian shells; small collection from Santa Marta, Colombia.

H. von Ihering. Two species of land and fresh-water shells from South America.

Chas. E. Jenney. Eleven species of shells from California.

F. J. Keeley. *Physa* and *Janthina* from Florida.

Bayard Long. Ninety-eight trays of shells from Massachusetts, New Jersey, and Pennsylvania.

H. N. Lowe. *Ischnochiton acrior* Cpr. from Cedros Island, Cal.

Miss Edith M. Marble. *Actinobolus flammeus* Mich.

J. E. Mason. Two red specimens of *Littorina littorea* L. from Bridgeton, Scotland.

H. L. Mather and H. W. Fowler. Five fresh-water shells from Montgomery County, Pa.

W. G. Mazÿck. Thirty-nine trays of mollusks from the eastern United States.

Dr. D. G. Metheny. *Helix hortensis* Mull. from Yarmouth, N. S.

F. I. Meyer and H. W. Fowler. *Valvata bicarinata normalis* Wkr. from Bethlehem, Pa.

G. W. H. Meyer. Four marine shells.

Dr. H. E. Meyer. Four species of marine mollusks.

Clarence B. Moore. Forty-six trays of shells from the southeastern United States.

A. Olsson. *Polita rhoadsi* Pils., from the foothills South Adirondacks, Fulton County, N. Y.

C. R. Orcutt. Eleven speceis of land and fresh-water shells from Laredo, Tex.

W. H. Over. One hundred and fifty-five trays of shells from South Dakota.

A. F. Pearse. *Littorina littorea* L. from Nahant, Mass.

F. W. Pennell. One *Ancylus* from Chester County, Pa.

Dr. R. J. Phillips and H. W. Fowler. Three species of fresh-water shells from White Clay Creek, Pa.

Chas. T. Ramsden. Eight species of Cuban land shells.

J. Ritchie, Jr. Two specimens of *Callochiton lævis* Mont.

S. Raymond Roberts. *Petricola dactylus* Sby. from New Bedford, Mass.

A. D. Robertson. Sixty-one trays of fresh-water shells from Lake Huron Can.

Miss Ronaldson. Two species of marine shells.

Russell Rosenfelt. *Polynices ampla* Phil.

Dr. J. W. Ross. One hundred and nine trays of land and marine shells from Varadero Park, Cuba.

H. E. Sargent. Nine *Pectens* from Florida.

Mrs. E. S. Sayres. Eight species of marine and fresh-water shells.

Mrs. C. Schaefer. Two marine shells.

Dr. B. Sharp. *Chætopleura* and *Pleurobranchus* from Nantucket, Mass.

Lloyd B. Smith. Thirteen marine shells.

R. K. Smith and W. F. Clapp. Twelve species of fresh-water shells from Massachusetts.

Irwin Spalding. Twenty-seven trays of Hawaiian shells.

E. Stevenson and H. L. Mather. Six fresh-water shells from Melbourne, Can.

Witmer Stone. Thirteen trays of land and fresh-water shells from South Carolina and Pennsylvania.

D. Thaanum. Sixty-nine trays of Hawaiian shells.

University of Wisconsin. Eleven trays of *Partulina* from Molokai, H. I.

E. G. Vanatta. Nine species of mollusks from Bermuda and Pennsylvania.

Bryant Walker. Four trays of land shells from Guadeloupe.

J. B. Walters and Bayard Long. Five species of land shells from Philadelphia, Pa.

W. F. Webb. Twenty-two species of marine shells.

R. W. Wehrle. Eleven trays of land and fresh-water shells from near Indiana, Pa.

R. Wellington. *Oreohelix cooperi* Binn from Big Snowy Mountains, Mont.

Archiclaus P. Willitts. One *Loligo* from Anglesea, N. J.

INSECTS.

AMERICAN MUSEUM OF NATURAL HISTORY. Four earwigs, Mexico; three Orthoptera, Central and South America.

WILLIAM BEUTENMULLER. Four *Rhodites californicus* (paratypes), California.

J. C. BRADLEY. Four *Orchelimum*, two *Conocephalus;* three *Belocephalus;* fourteen *Truxalinæ*, nineteen other Orthoptera, Georgia.

P. P. CALVERT. Eleven micro-slides of insects and Arachnids, North America.

E. R. CASEY. Twelve *Blatta orientalis*, thirty-one *Lachnosterna*, Philadelphia.

HELEN CLELAND. *Hadenœcus puteanus*, Pennsylvania.

DELOS CULVER. Eight insects, Pennsylvania.

V. A. E. DAECKE. Four moths, Pennsylvania; two Coleoptera.

W. T. DAVIS. One hundred and ten Orthoptera, Florida; seven *Orchelimum*, Pennsylvania and Florida; six Orthoptera, Florida and Pennsylvania; *Belocephalus sleighti* (paratypes).

CHARLES C. DEAM. Two hundred and seventy-seven Lepidoptera, United States; six hundred and fifteen Lepidoptera, Guatemala.

H. W. FOWLER. Three *Gryllotalpa*, Maryland; twenty insects, Pennsylvania.

J. M. GEDDES. One hundred Lepidoptera and Odonata, South America and West Indies.

GEORGE M. GREENE. Eighteen Coleoptera, United States.

GEORGIA STATE COLLEGE. Thirty Orthoptera, Georgia; four *Conocephalus*, Georgia; eighteen *Truxalinæ*, Georgia; four *Tettiginæ*, Georgia.

E. N. HARVEY. Three *Ornithoptera aruana*, Torres Strait.

MORGAN HEBARD. Forty-seven Hymenoptera, Kyoto, Japan; twenty-five Lepidoptera, West Indies and Florida; one thousand one hundred and fifteen Orthoptera, South, Central and North America; ninety-five *Conocephalus;* forty-three *Neoconocephalus*, North America; thirty-two *Amblycorypha;* sixty *Tettiginæ*, United States; seven *Truxalinæ*, eastern United States; two *Belocephalus*, Florida; twenty-three Orthoptera, United States; forty-two Orthoptera, Mexico and Central America; fifty-six Orthoptera, North America; one hundred and eighty-nine *Conocephalus*, North America; one hundred and eighty-three *Orchelimum*, Pennsylvania and New Jersey; one hundred and seven *Neoconocephalus*, North America.

MORGAN HEBARD and J. A. G. REHN. Twenty-eight *Tettiginæ*, Pennsylvania; sixty-seven *Orchelimum*, Pennsylvania and New Jersey; one *Neoconocephalus*, New Jersey; sixty-four *Conocephalus*, New Jersey; one *Cicada superba*, Kerrville, Tex.; thirty-six Orthoptera, North America.

HERMAN HORNIG. Five larvæ, Philadelphia.

F. M. JONES. Two Lepidoptera, Pennsylvania.

PHILIP LAURENT. Nine Lepidoptera, Pennsylvania; two *Hemileuca maia*, New Jersey.

R. A. LEUSSLER. Eight butterflies, Nebraska.

CARLOS LIZER. Forty-two Orthoptera, Argentina.

BAYARD LONG. One Orthoptera; five *Conocephalus*, Pennsylvania; nine *Tettiginæ*, Eastern United States; four *Neoconocephalus*, New Jersey.

W. J. MACCRESSON. One *Balaninus*, Philadelphia.

MUSEUM OF COMPARATIVE ZOOLOGY. One *Orchelimum*, New Hampshire.

EDWARD J. NOLAN. One Agrotid moth, Philadelphia.

Pennsylvania State Department of Zoology. Four *Conocephalus*, Pennsylvania; four Orthoptera, North America; four *Tettiginæ*, Pennsylvania.

C. T. Ramsden. Four Sphingidæ; four Lepidoptera, Cuba.

J. A. G. Rehn. Eight Orthoptera, North America; fifteen *Neoconocephalus*, Pennsylvania and New Jersey.

Henry Skinner and C. T. Ramsden. Four hundred and thirty-five Lepidoptera, Cuba.

Henry Skinner. Twenty butterflies, California; nineteen Odonata, Cuba; four *Callosamia angulifera*, Pennsylvania; one thousand insects, Cuba.

E. A. Smith. Three Hymenoptera, one Hemipteron, eleven Coleoptera, Brazil.

Witmer Stone. Four Lepidoptera, seventy Neuroptera, one hundred and fifty Coleoptera, one hundred and thirty-two Diptera, one hundred and fifteen Hemiptera, sixty-four Hymenoptera, eighty-one Orthoptera, South Carolina.

University of Kansas. Eleven *Melanoplus*, Kansas.

F. W. Urich. One *Parutropes phalerata*, Trinidad.

United States National Museum. Eight Orthoptera, North and South America.

Mrs. C. S. Welles. Five thousand two hundred and ninety-six insects, United States.

F. X. Williams. *Hornia gigantea*, Kansas.

R. C. Williams. Two *Pamphila woodgatei*, types, New Mexico.

F. Wintersteiner. Two Coleoptera, New Jersey.

Purchased. Four hundred and eighty-four Orthoptera, British Guiana. Six butterflies.

Other Invertebrates.

C. S. Abbott, Jr. Jar of crustaceans, Hamilton, Bermuda; dozen vials of spiders, Bristol, Pa.

Benjamin Albertson. *Balanus balanoides* L., Nantucket, Mass.

Mrs. W. Ludwig Baker. Five species of Crabs.

Dr. Amos P. Brown. One crab and two corals, Antigua, W. I.

H. L. Burton. Lot of crustaceans, Connecticut; numerous collections of myriapods, spiders and crustaceans, Tullytown, Pa.

H. L. Burton and H. W. Fowler. Lot of crustaceans, Bucks County, Pa.

H. W. Fowler. Collection of invertebrates (crustaceans, arachnids, etc.), Swan Creek, Md.; several crustaceans, Penns Manor, Pa.

E. N. Fox. Crab (*Arenæus cribrarius*), Sea Isle City, N. J.

Morgan Hebard, Small collection of spiders, southern New Jersey.

T. D. Keim. Several crustaceans, Long Island, N. Y.

Bayard Long. Collection of crustaceans, New Jersey.

H. L. Mather, Jr. Jar of lower invertebrates, Melbourne, Ont.

Miss R. M. Pierce. Specimen of *Arbacia punctulata*.

Chas. T. Ramsden. Two jars of crustaceans, Cuba.

Alice Robertson. *Idmonea californica* Orb.

Miss Anna Robinson. One spider (*Epeira marmorea*).

Dr. J. W. Ross. Collection of crustaceans, scorpions and spiders, north coast of Cuba.

Dr. J. W. Ross. Eight species of invertebrates, Varadero, Cuba.

DR. BENJAMIN SHARP. Bottle of crustaceans, Nantucket, Mass.

JOHN M. SHARP. *Gorgonocephalus agassizii* Lyman, from off Cape Cod, Mass.

RICHARD SHEVLIN. *Arbacia punctulata* Lamarch, Ocean City, N. J.

FLORENCE J. SMITH. *Echinarachnias parma* Lamarch, Plymouth, Mass.

DR. WITMER STONE. Lot of crustaceans, Manning, S. C.

H. W. TRUDELL. *Moira atropos* Klein, Smiths Island off Cape Charles, Va.

E. G. VANATTA. *Orbiculina adunca* F. and M., Fairyland, Bermuda.

R. W. WEHRLE. Collection of crustaceans, Huntingdon County, Pa.

VERTEBRATE FOSSILS.

C. E. CLAGHORN. Fossil fish, Green River beds.

INVERTEBRATE FOSSILS.

R. N. ATKINSON. Four species of fossils, Table Cape, New Zealand.

DR. AMOS P. BROWN. Seven species of Oligocene fossils, Antigua, W. I.

MRS. W. LUDWIG BAKER. Four species of Miocene fossils.

BAYARD LONG. Fifty-nine species of Cretaceous fossils, Vincentown and Mullica Hill, N. J.

DR. VICKERS OBERHOLTZER. One hundred and eleven trays of Silurian fossils, Oeland, Sweden; fifty-one trays of Jurassic fossils, several European localities.

LLOYD B. SMITH. Thirteen species of Pleistocene fossils, Leogane, Haiti.

MINERALS.

DR. JUAN ARGERICH. Geode, Paraná River, Argentina.

C. E. CLAGHORN. Collection of minerals.

MRS. EDW. S. SAYRES. One box of minerals.

FRANK M. WELLES. Two specimens of Carnotite, Naturita, Colo.

PURCHASED for the William S. Vaux Collection. Thirteen specimens.

ARCHÆOLOGY AND ETHNOLOGY.

GEORGE APPERLEY. One hundred and fifty-nine stone implements from Pennsylvania, New Jersey, and Michigan.

A. H. GOTTSCHALL. About 5,000 specimens representing the ethnography and archæology of America from Alaska to Mexico.

CLARENCE B. MOORE. Specimens of stone, shell and pottery from aboriginal sites along the Tennessee River, added to the C. B. Moore Collection.

DR. VICKERS OBERHOLZER. Grooved Axe-head, New Jersey (?).

MRS. SAENZ. Basket-covered water-bottle, Cochabamba, Peru.

DR. SIMOENS DA SILVA. Celt—Baetinga County, Bahia, Brazil.

MRS. CURWEN STODDART, JR. Seven Makah and California Indian baskets, and a Japanese jinrikisha.

MISS. E. V. WELT (through the Elsworth Collection). One hundred and thirty-nine stone implements from Kentucky and Wisconsin.

PLANTS.

EDWIN B. BARTRAM. One hundred and nine local plants and two hundred and ninety-two from the eastern and southern United States.

George W. Bassett. *Botrychium dissectum.*

C. C. Bachman. Two local plants.

Miss M. A. Brown. *Polygala ramosa,* Cape May County, N. J.

Stewardson Brown. Collected on Bermuda trip, two hundred sheets of plants.

Botanical Section (Purchased). Four hundred and fifty plants from California; three hundred and thirty-three plants from Nevada.

Botanical Section and Mrs. Beulah M. Rhoads. Poyser Collection of Ferns, one thousand nine hundred and fifteen sheets.

Miss Anna Crossman. Two local plants.

Delos E. Culver. Three plants, Delaware County, Pa.

J. W. Eckfeldt, M.D. Five local species.

C. H. Eckman. Specimen of *Dioyspyros.*

Wm. Findley. Three local plants.

C. D. Fretz. Twenty-five local plants.

H. L. Fisher. *Alopecurus agrestis.*

Wm. J. Fox. Two local plants.

Prof. Kline. Five local species.

Bayard Long. Three hundred and thirty-four local species.

Bayard Long and M. L. Fernald. Six hundred and twenty-two New England plants.

Caleb Milne. Collection of two hundred seaweeds.

C. D. Lippincott. *Cassia occidentalis*?.

Chas. LaWall. One hundred and twenty-two plants, New Jersey.

J. Mumbauer. Four hundred and ninety-two local plants.

F. W. Pennell. Two hundred and eighty-five local plants.

Mary Pollock. *Origanum.*

H. W. Pretz. Two thousand one hundred and seventy-six plants, Lehigh County, Pa.

Harold St. John. Fifty-three New England plants and one local specimen.

Witmer Stone. Five hundred South Carolina plants and six local species.

Benj. H. Smith. Seventeen specimens of *Cratægus* and eight other specimens.

Dr. Max M. Peet. Forty-two plants from Luzerne, Mich.

Chas. S. Williamson. Sixty-two Newfoundland plants.

Miss Mary E. Williamson. Herbarium of the late Chas. S. Williamson, about ten thousand sheets.

J. B. Walter. Three local plants.

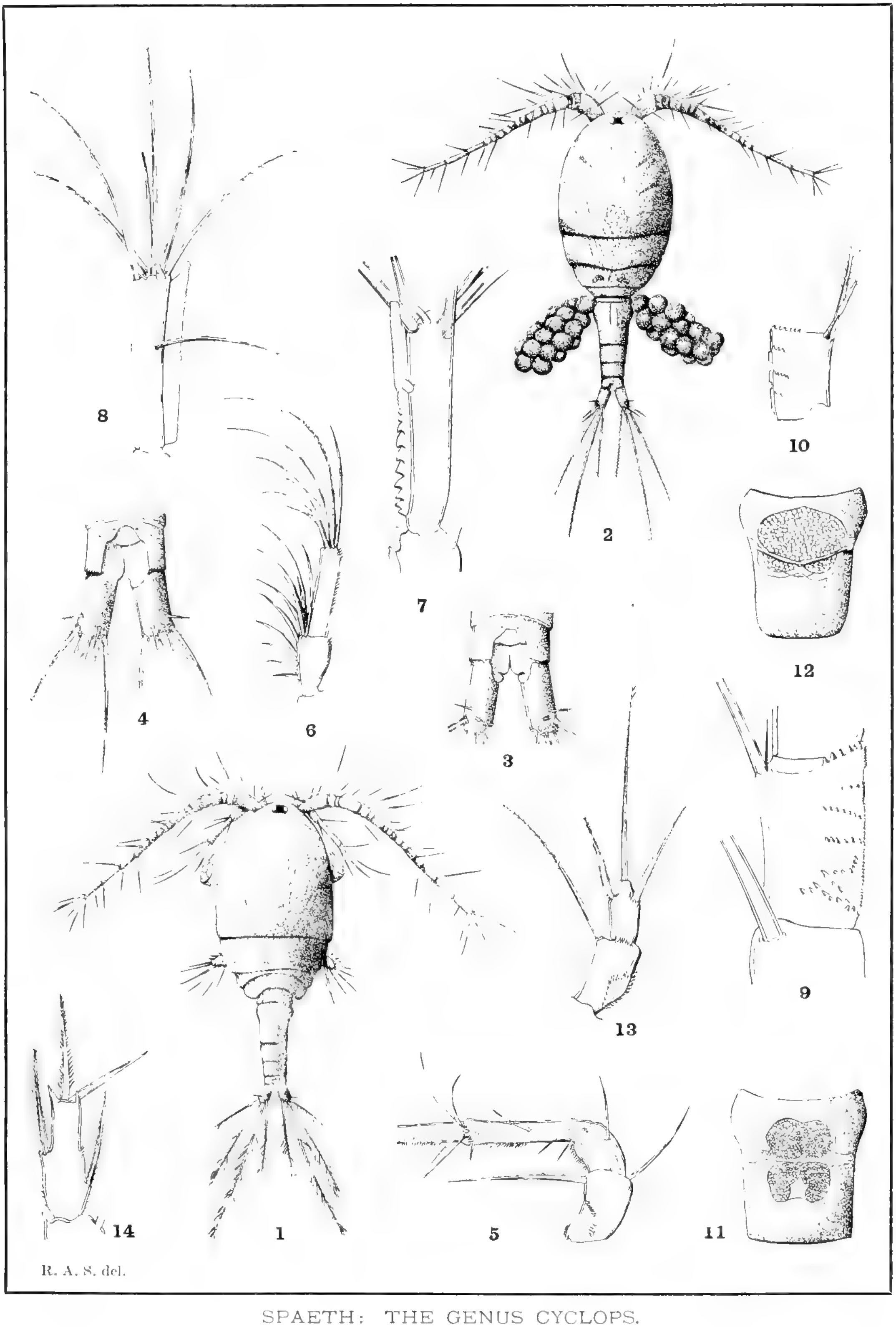
Lafayette College (on deposit). The Thos. C. Porter Herbarium (about thirty thousand sheets).

INDEX TO GENERA, SPECIES, ETC., DESCRIBED AND REFERRED TO IN THE PROCEEDINGS FOR 1914.

Species described as new are indicated by heavy-faced, synonyms by italic numerals.

GENERAL INDEX.

1914.



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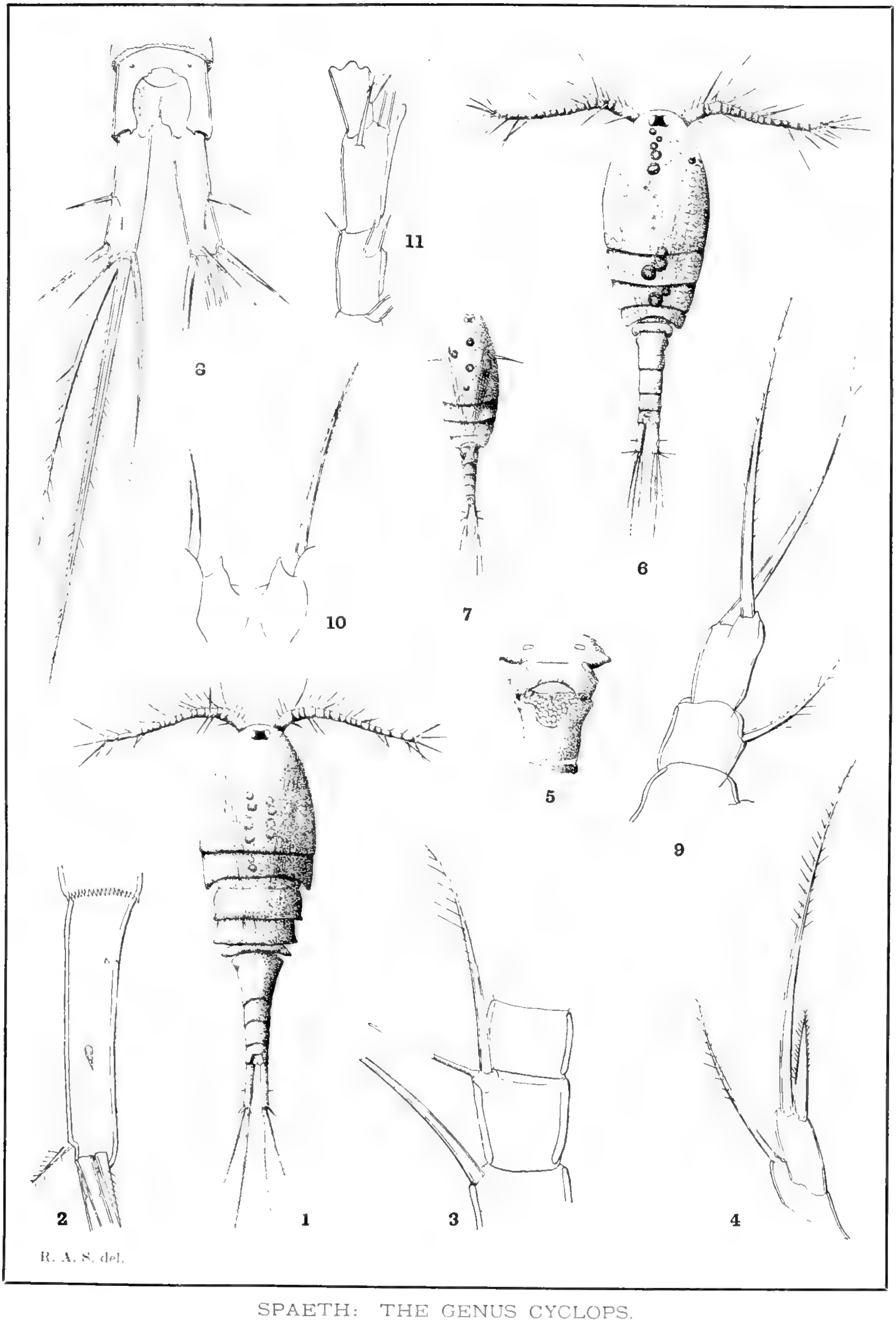

SPAETH: THE GENUS CYCLOPS.

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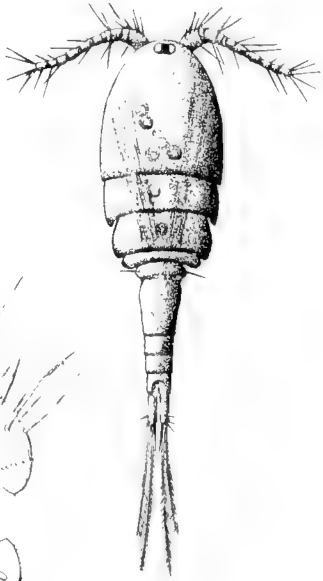

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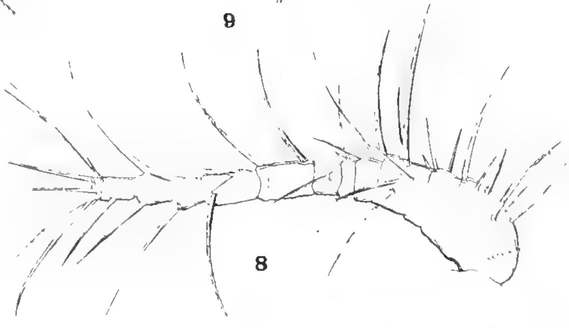

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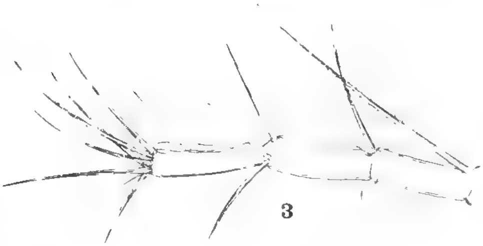

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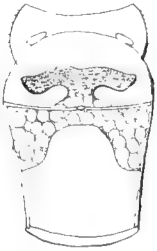

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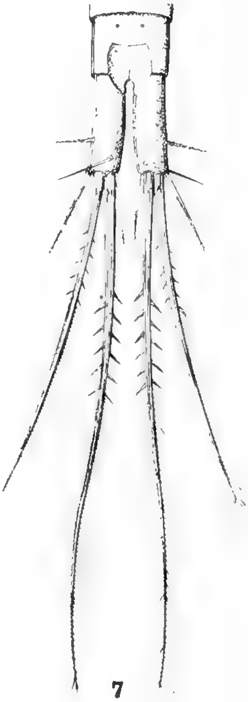

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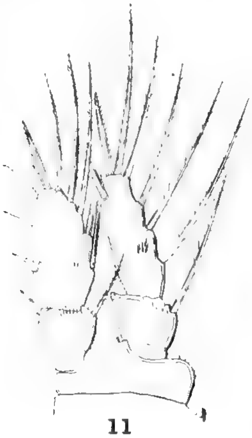

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R. A. S. del.

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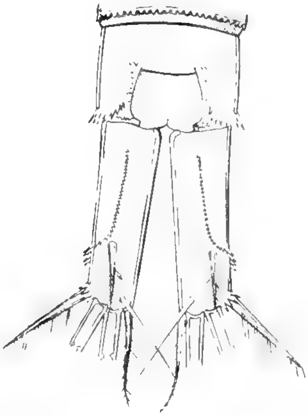

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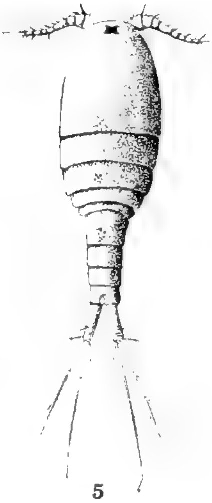

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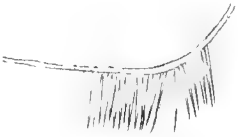

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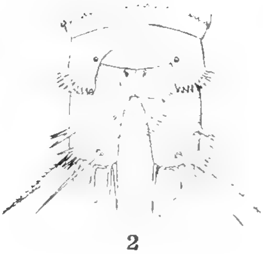

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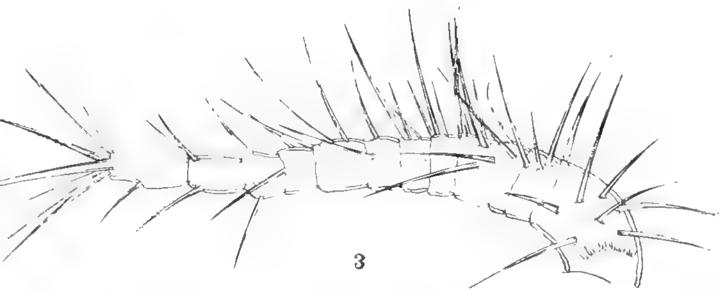

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R. A. S. del.

SPAETH: THE GENUS CYCLOPS.

PLATE V.

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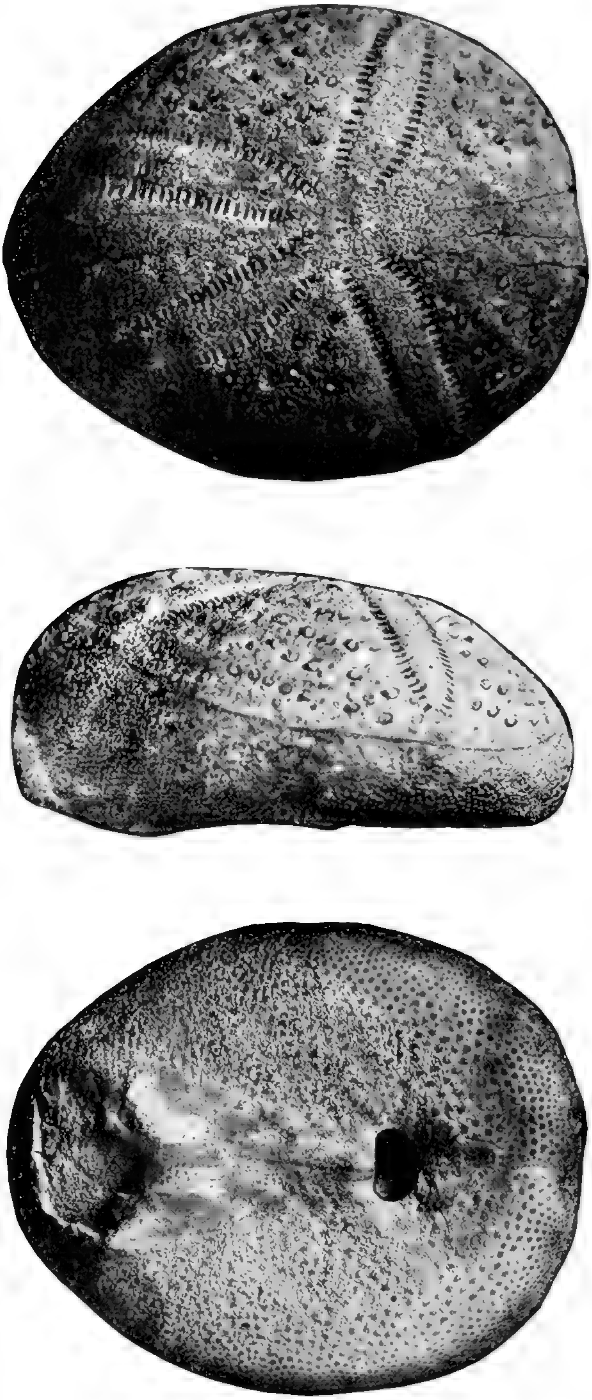
POULTON: MIMICRY IN BUTTERFLIES

WARDLE: TSANTSA

WARDLE: TSANTSA.



EUPATAGUS MOOREANUS PILSBRY

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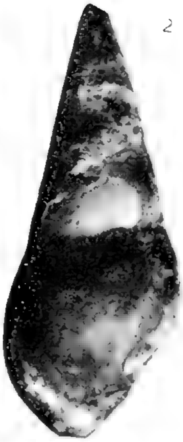

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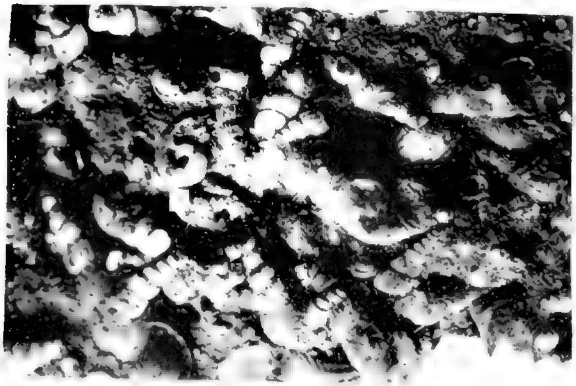

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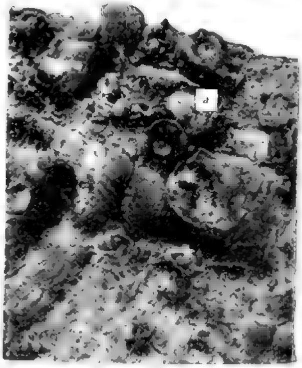

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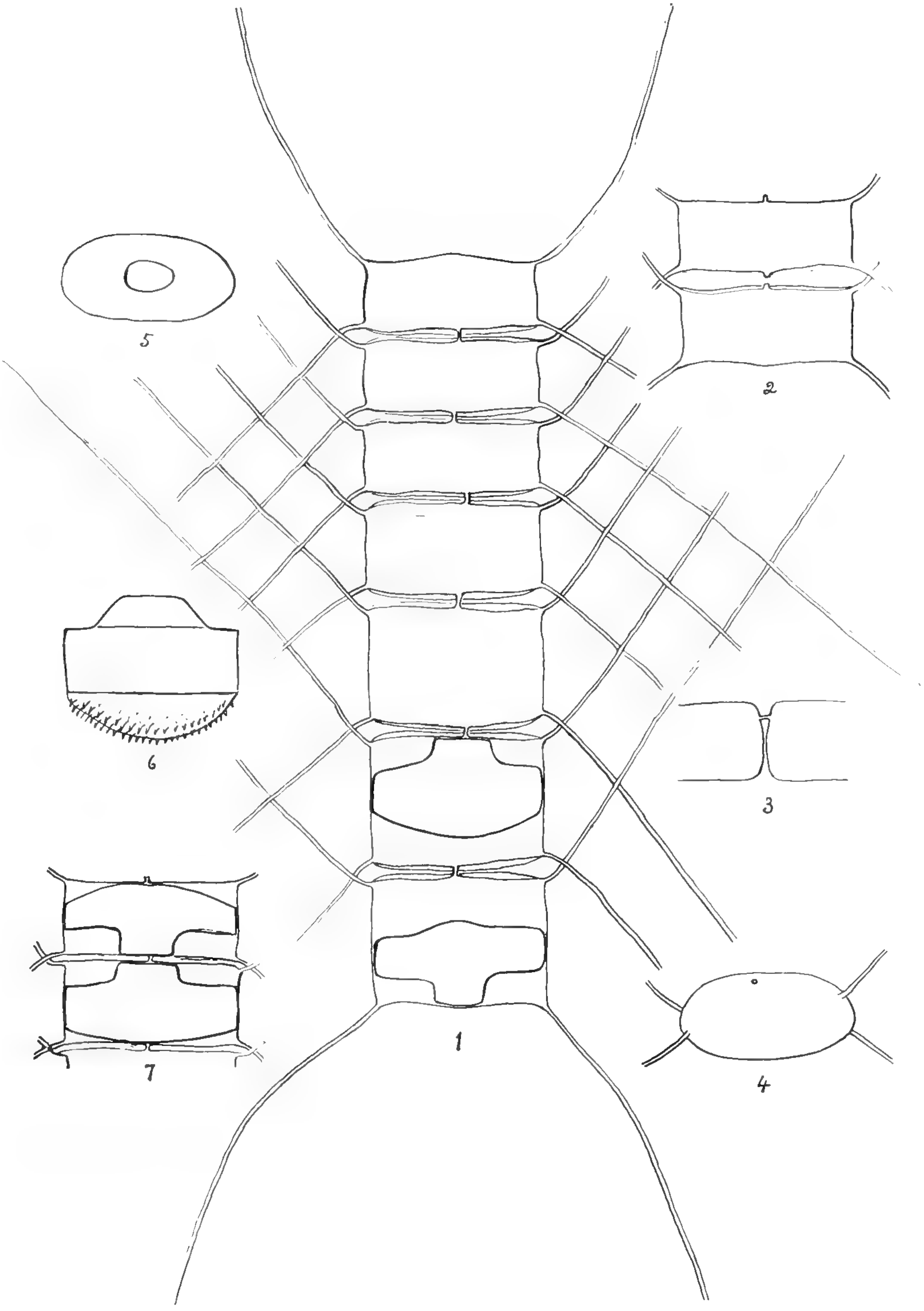
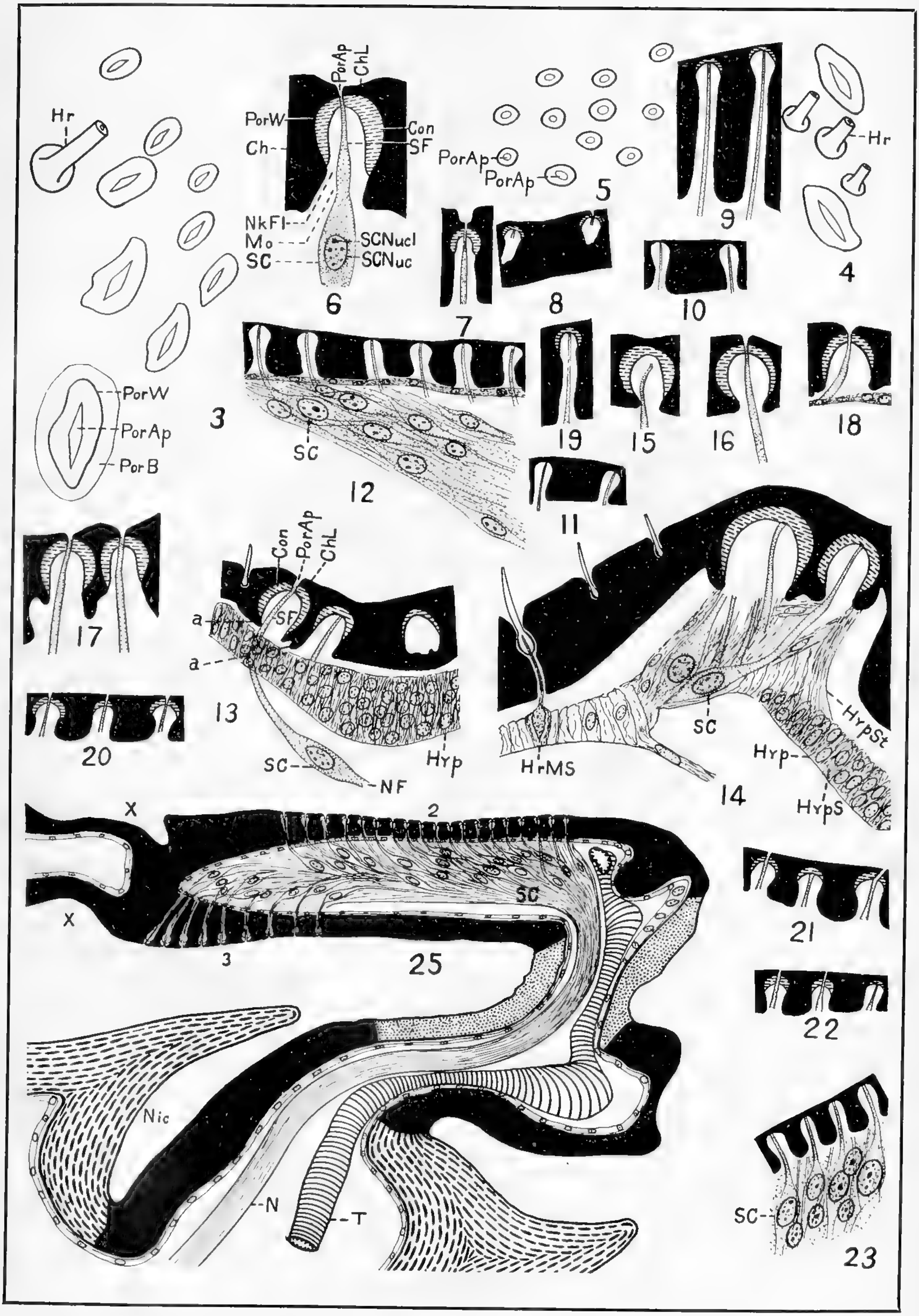
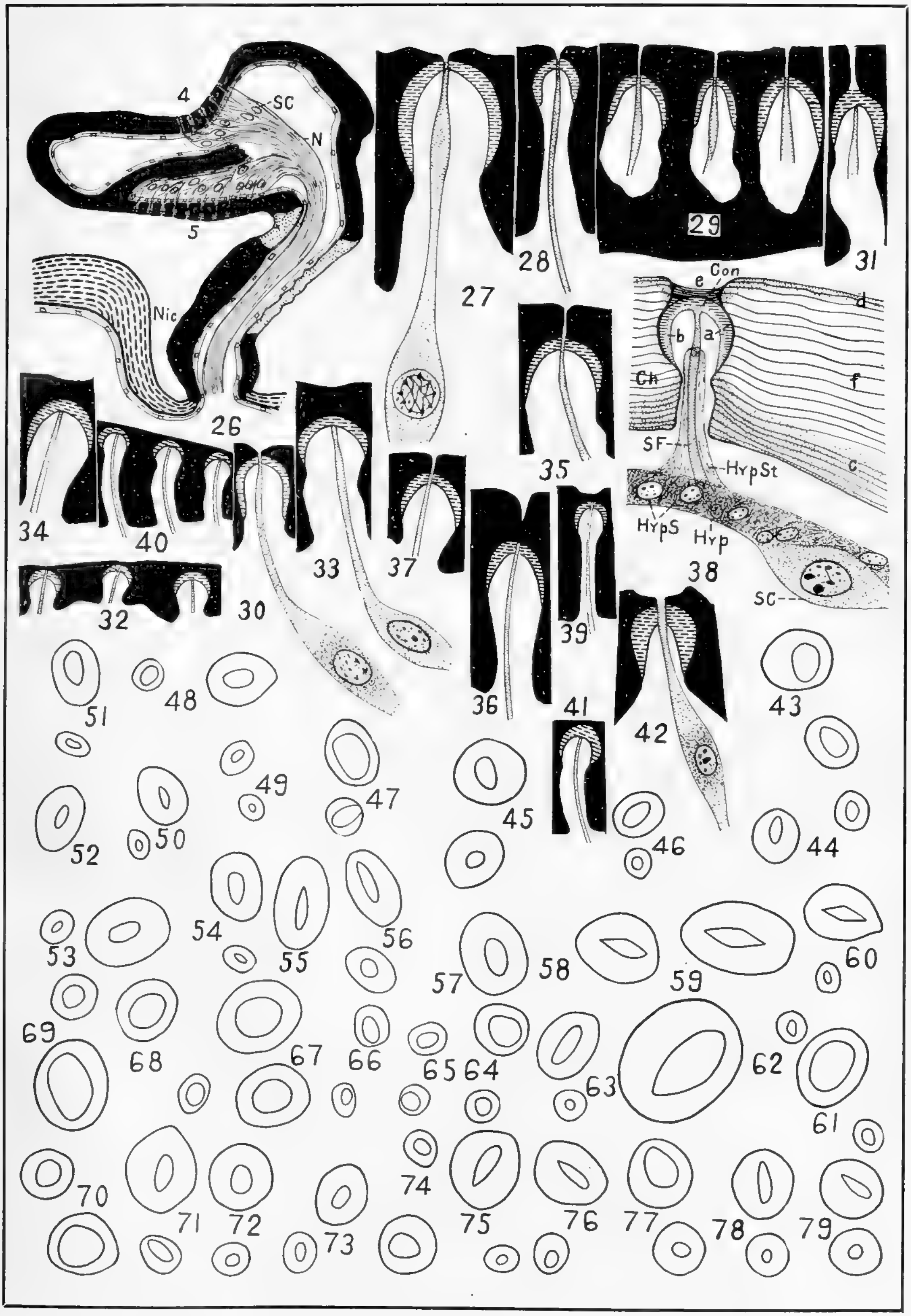
BROWN AND PILSBRY: MOLLUSKS OF ANTIGUA.



CHÆTOCEROS ELMOREI BOYER.



McINDOO: OLFACTORY SENSE OF HYMENOPTERA.



McINDOO: OLFACTORY SENSE OF HYMENOPTERA.

Fig 1

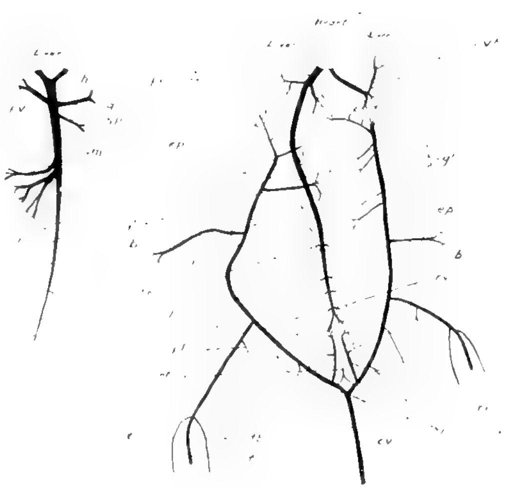


Fig 2

Fig 3

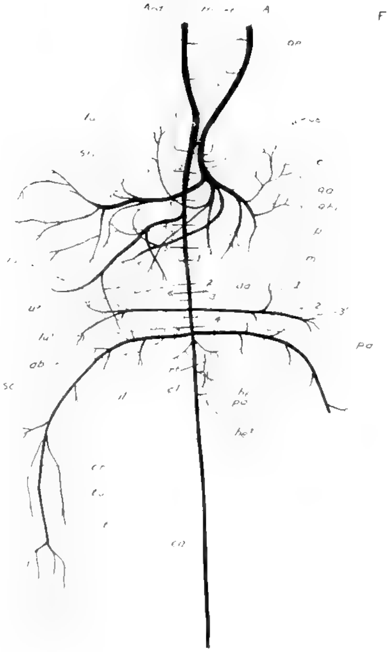
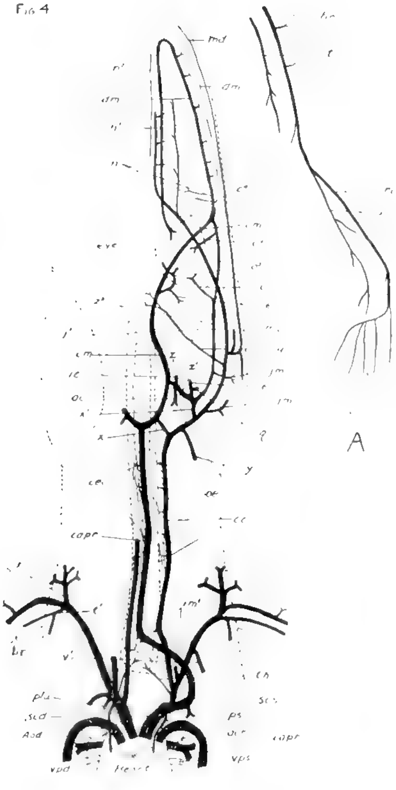
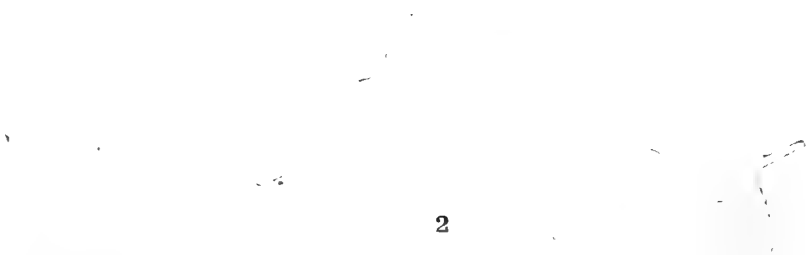


Fig 4



REESE: VASCULAR SYSTEM OF ALLIGATOR.

1



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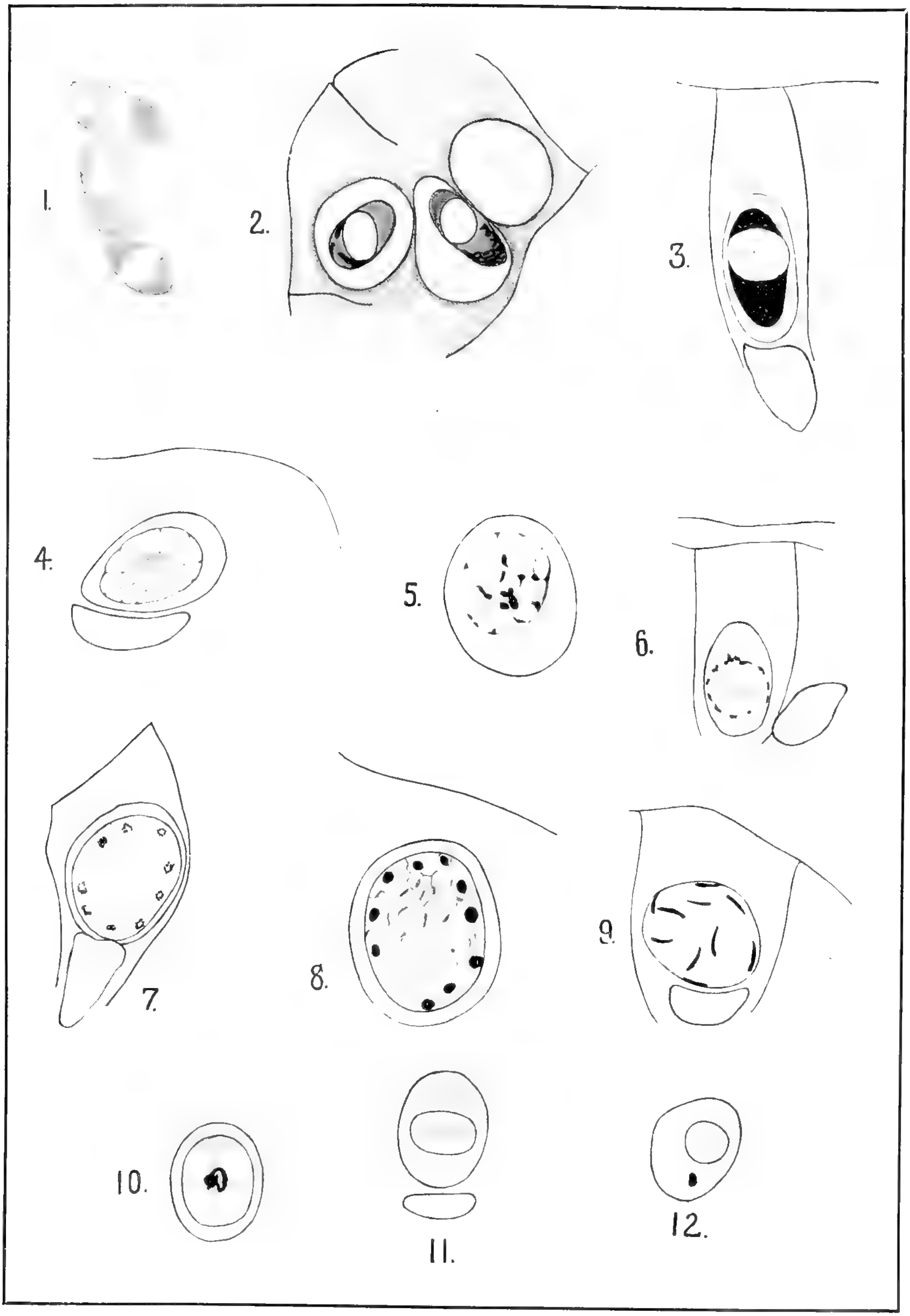
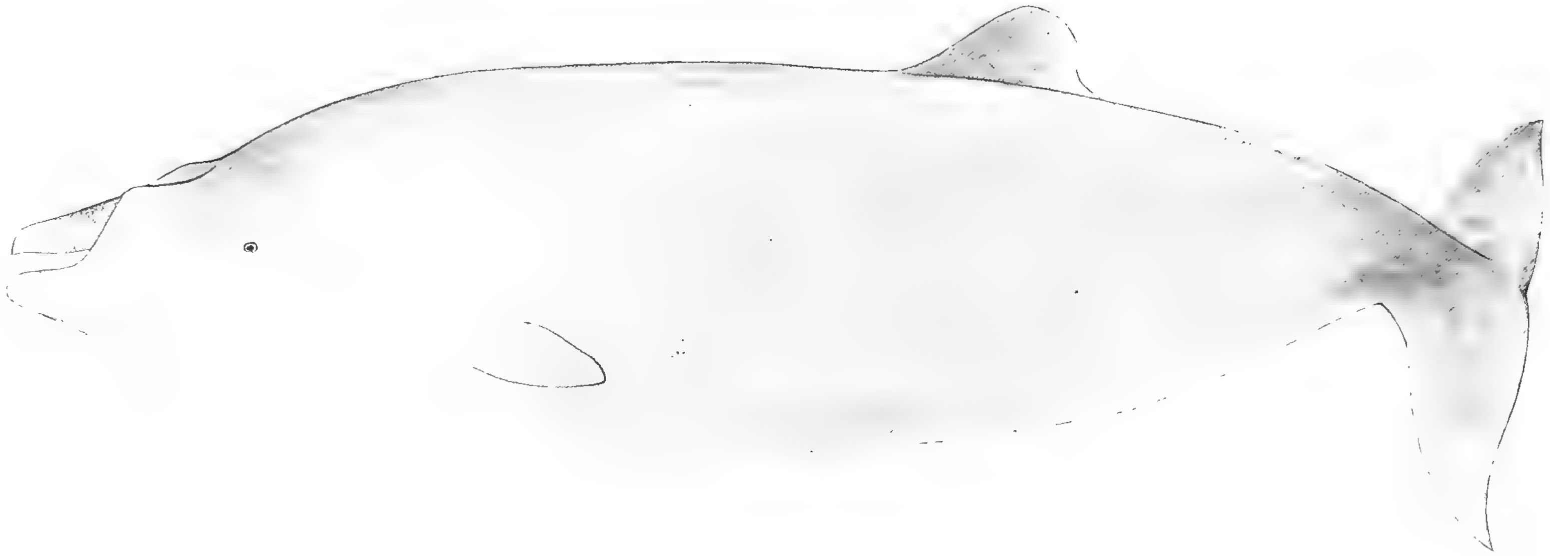
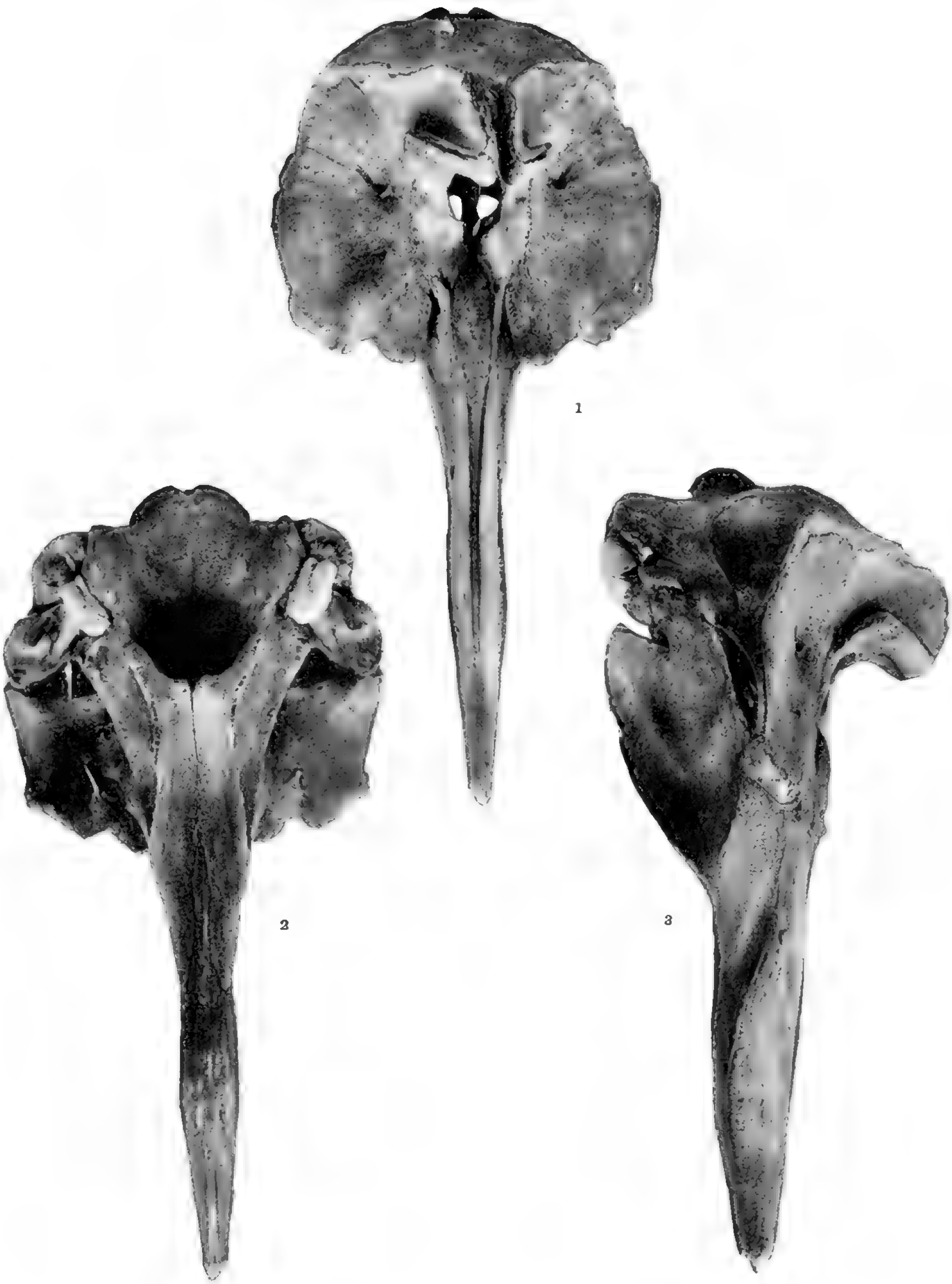
PILSBRY AND BROWN: PROGRESSION OF TRUNCATELLA.



CRAWLEY: EVOLUTION OF SARCOCYSTES MURIS.



ANDREWS: MESOPLODON DENSIROSTRIS.



ANDREWS: MESOPLODON DENSIROSTRIS.

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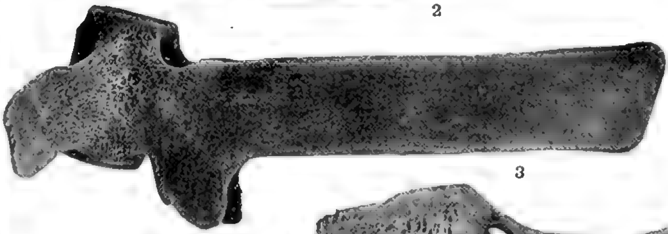

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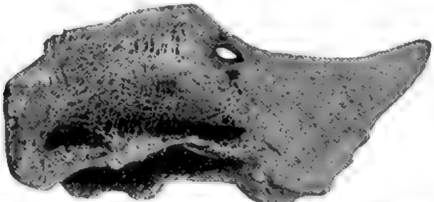

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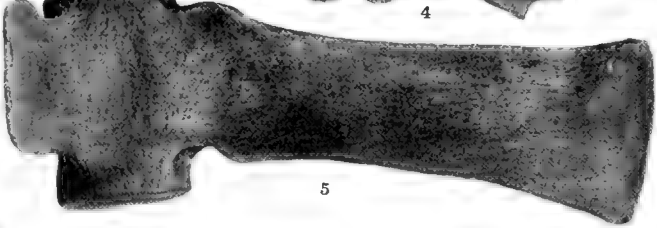

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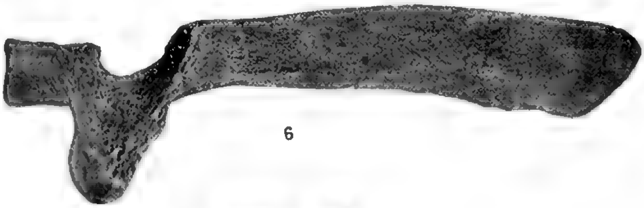

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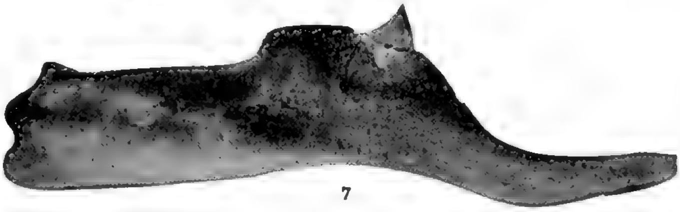

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ANDREWS: MESOPLODON DENSIROSTRIS.

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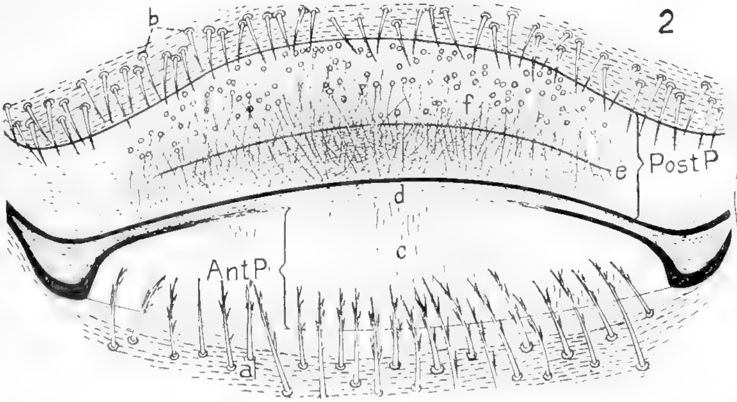

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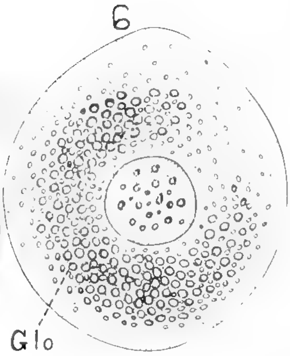

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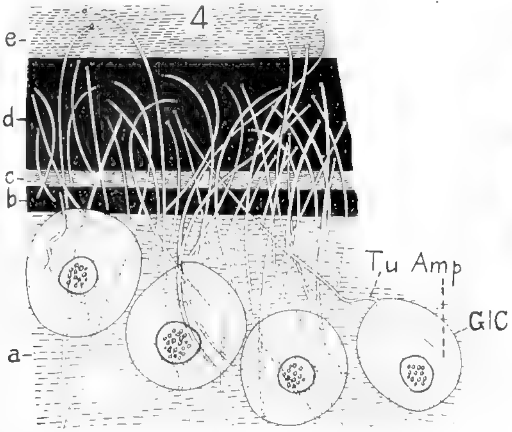

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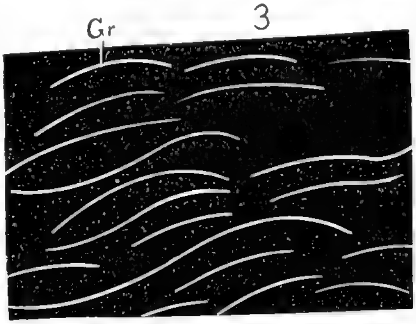

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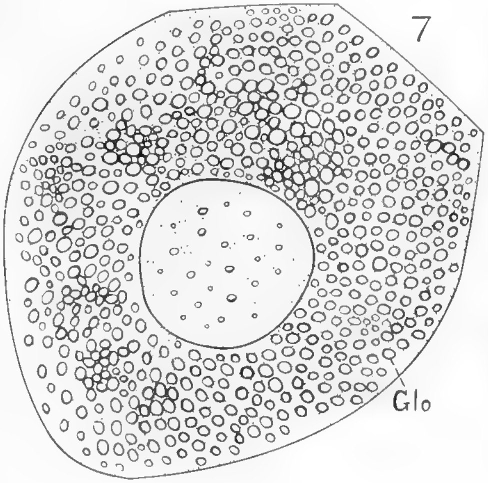

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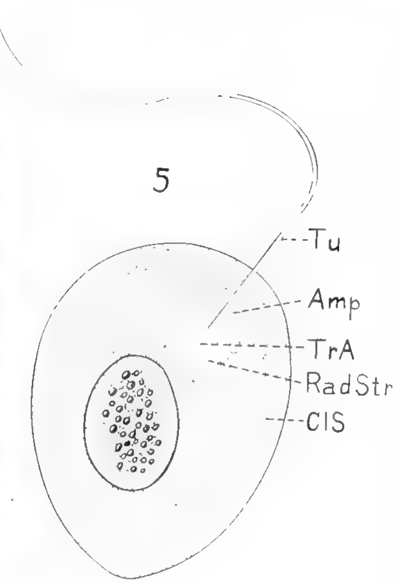
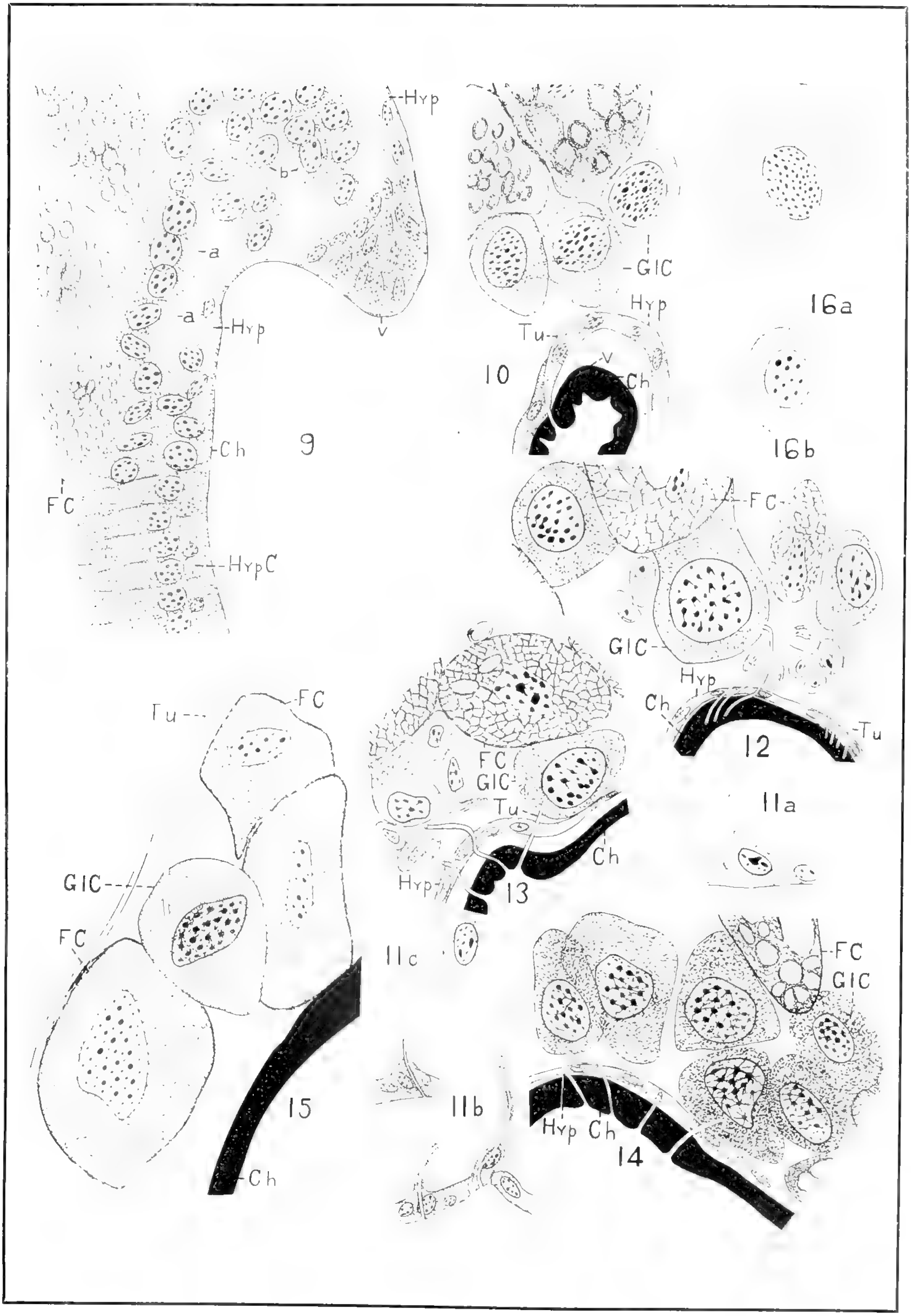
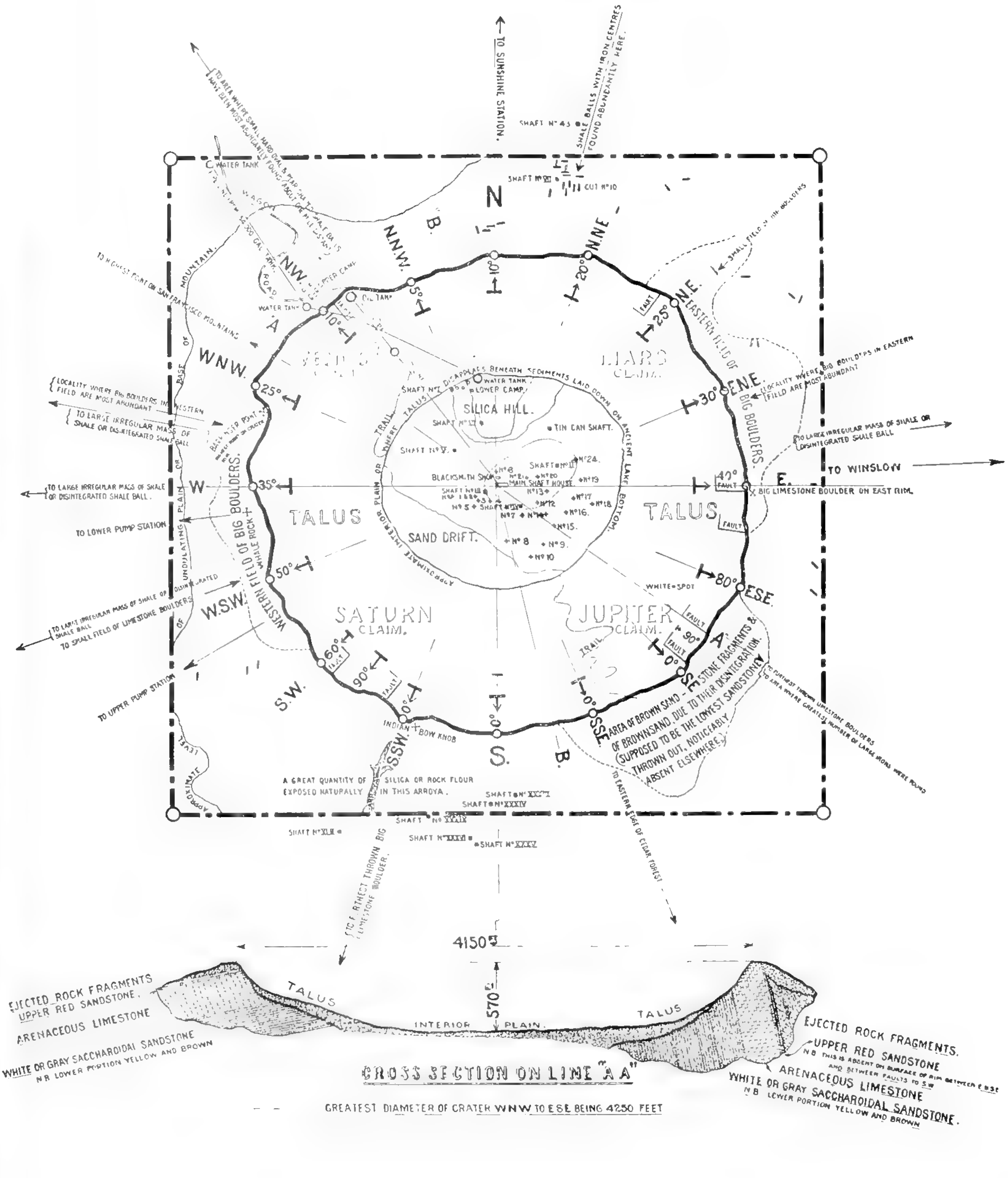


McINDOO: SCENT-PRODUCING ORGANS OF HONEY-BEE



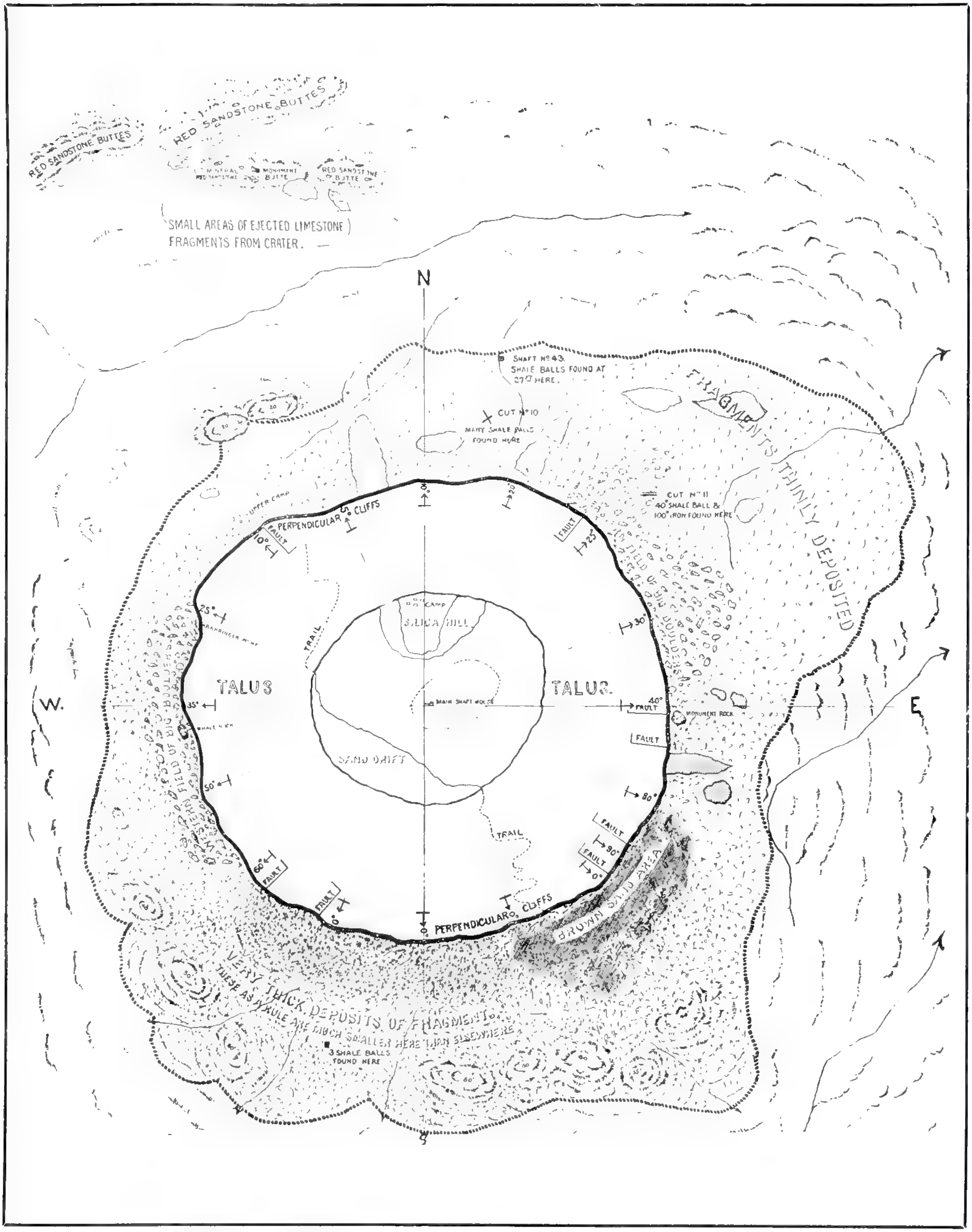
McINDOO: SCENT-PRODUCING ORGANS OF HONEY-BEE



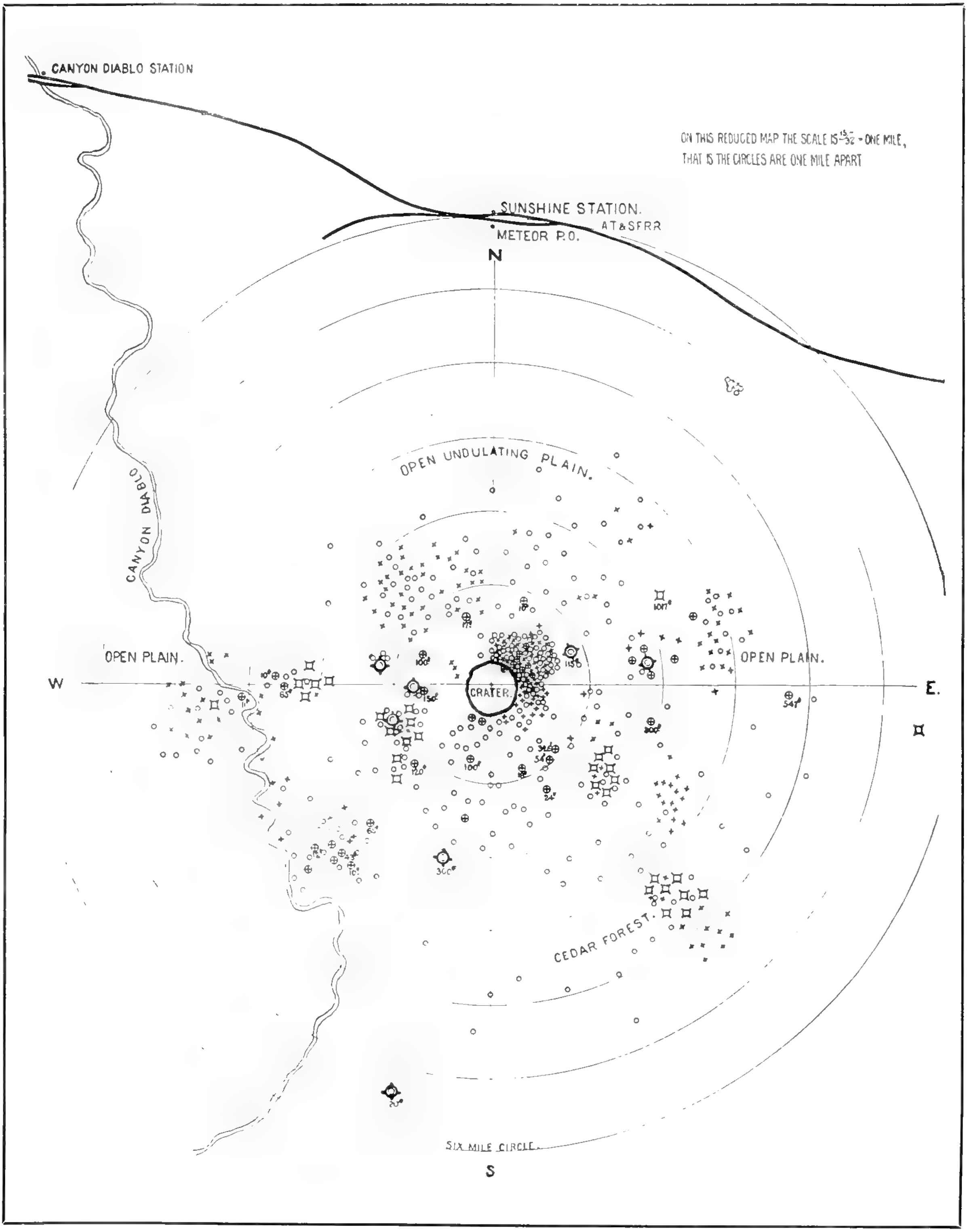
CROSS SECTION ON LINE "A A'"

GREATEST DIAMETER OF CRATER WNW TO ESE BEING 4250 FEET

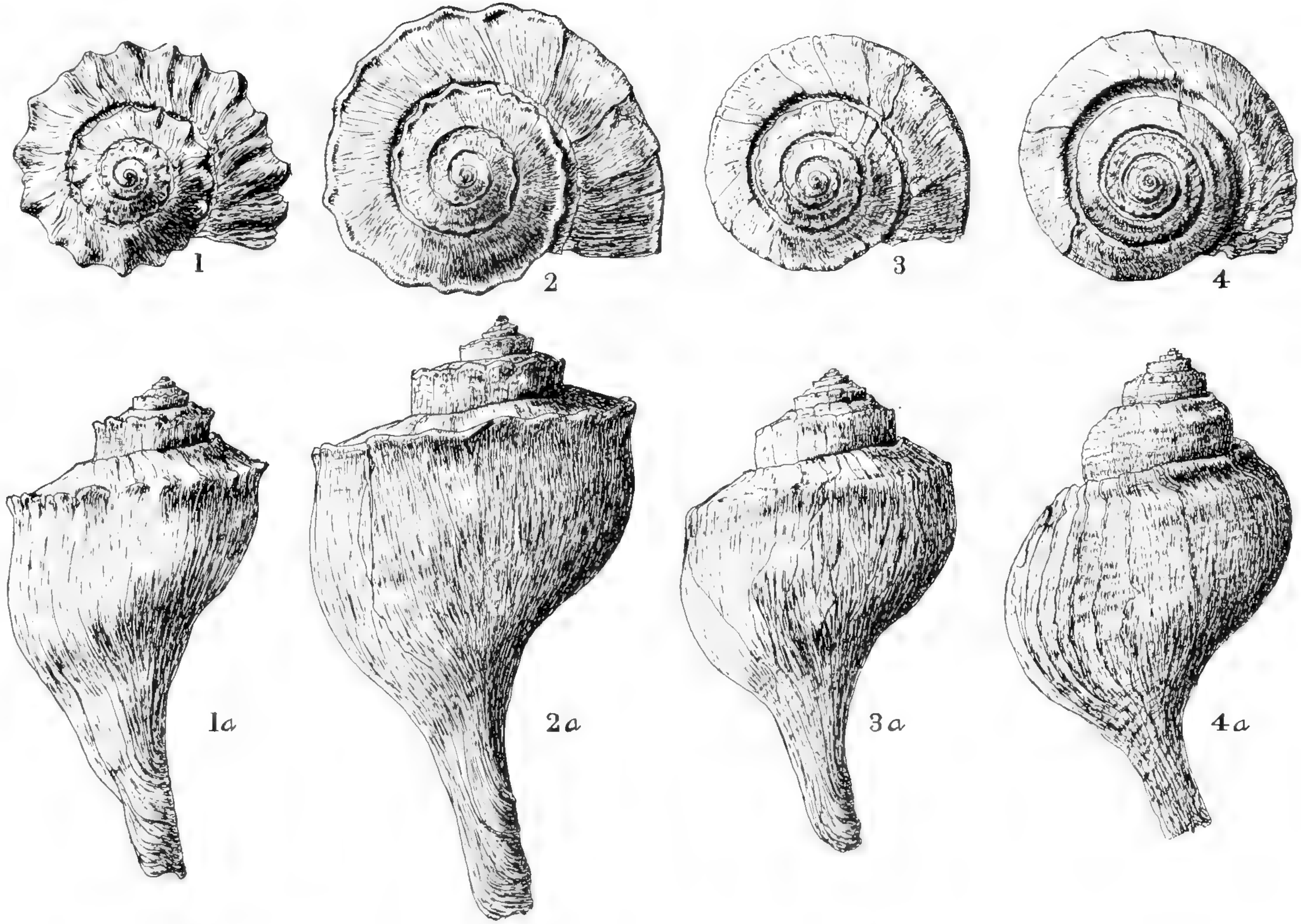
BARRINGER: METEOR CRATER, ARIZONA.
Scale, 1200 feet = 1 inch.



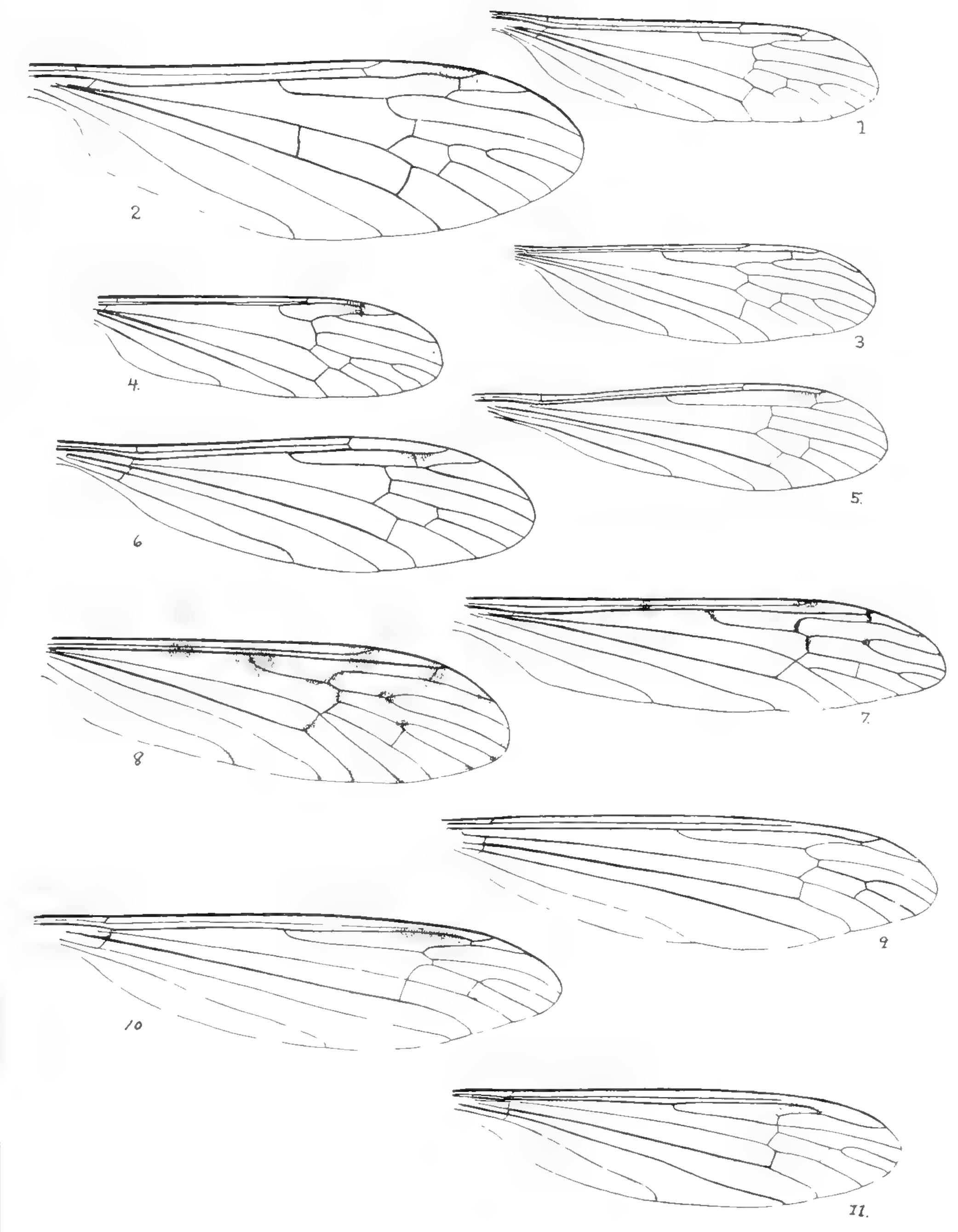
BARRINGER: METEOR CRATER, ARIZONA.
Scale, 1200 feet = 1 inch.



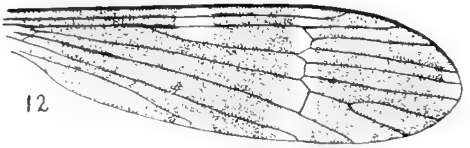
BARRINGER: METEOR CRATER, ARIZONA



BURNETT SMITH: MORPHOLOGIC SEQUENCE IN FULGUR.



ALEXANDER: CRANEFLIES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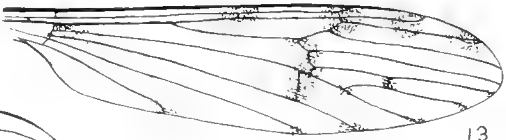
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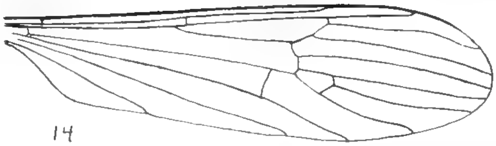
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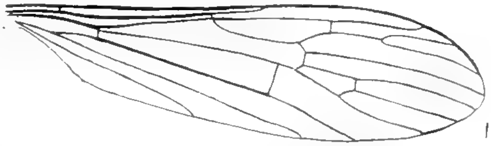
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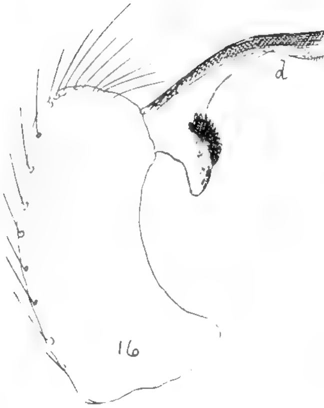

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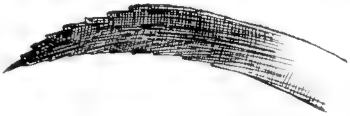
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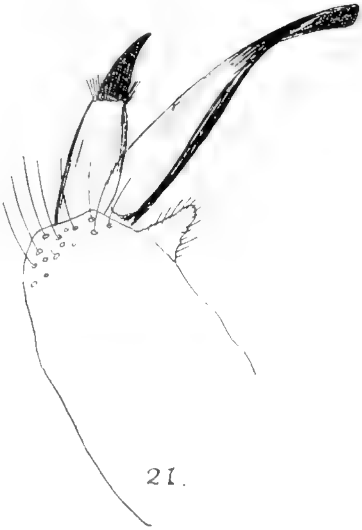
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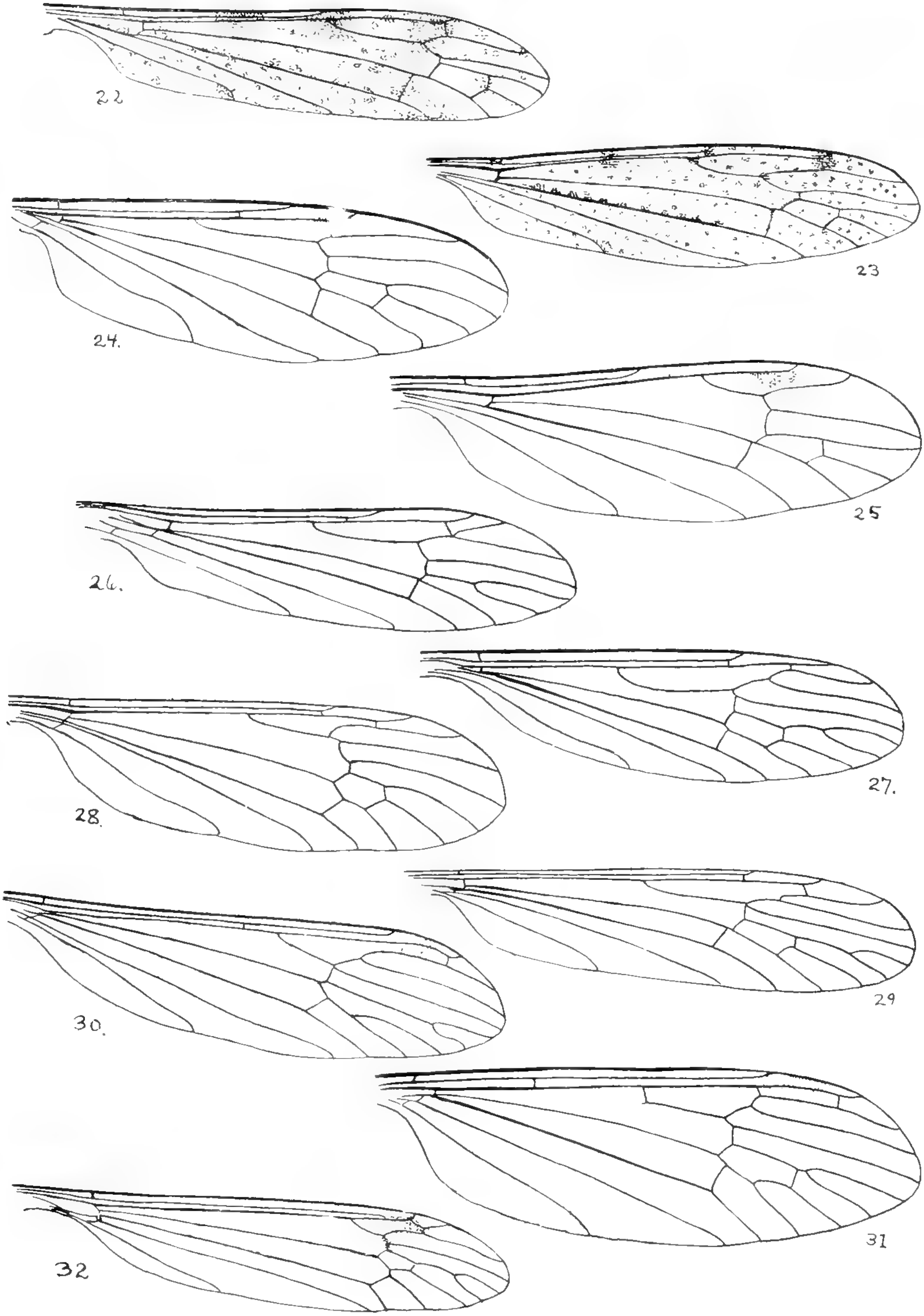
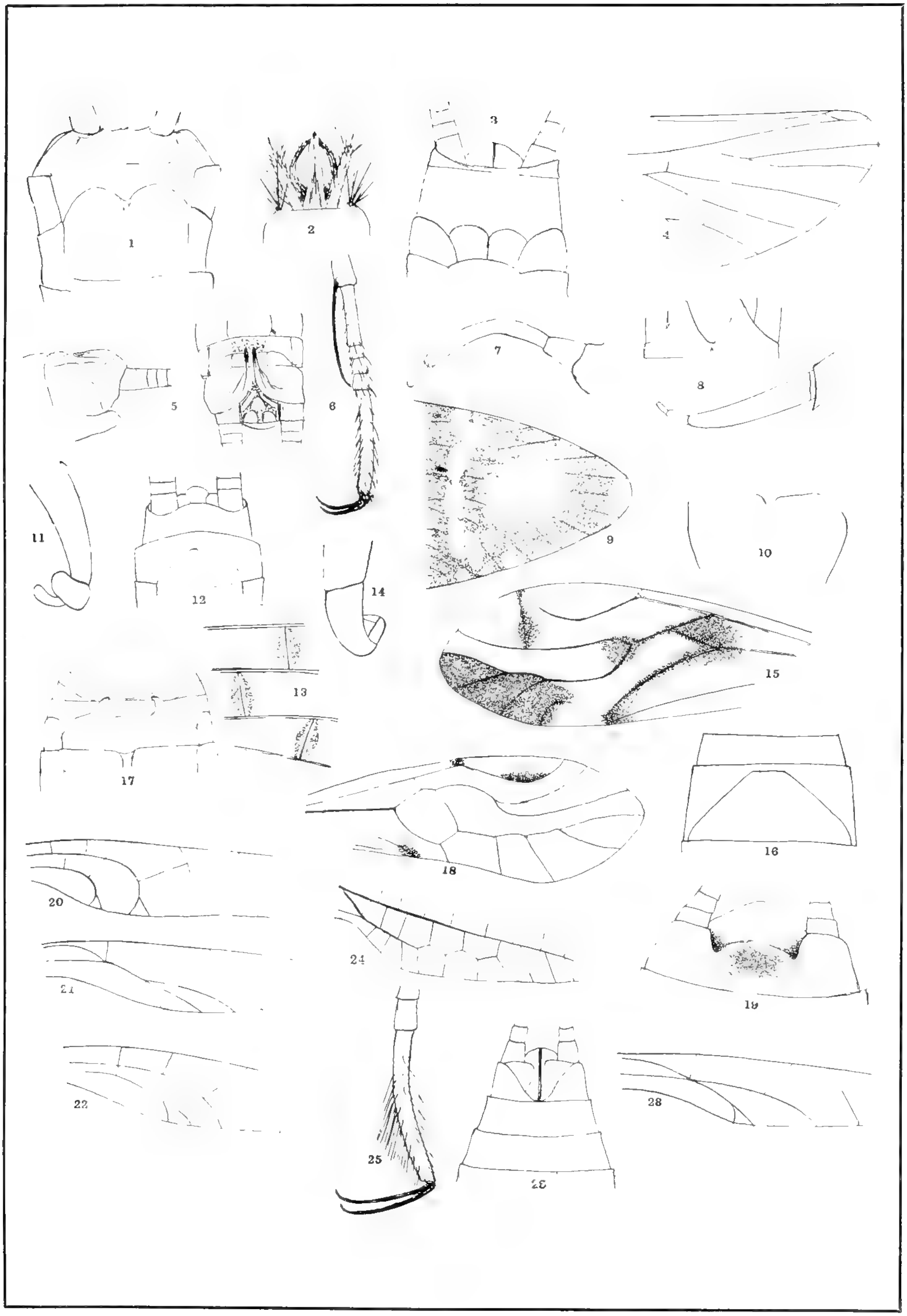
ALEXANDER: CRANEFLIES.



ALEXANDER: CRANEFLIES.



BANKS: NEW NEUROPTEROID INSECTS.