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New Species of Dolichopodidæ from the United States.

BY

WILLIAM MORTON WHEELER.

WITH FOUR PLATES.

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NEW SPECIES OF DOLICHOPODIDÆ FROM THE UNITED STATES.

BY WILLIAM MORTON WHEELER.

PLATES I–IV.

THE species of Dolichopodidæ described as new in the following paper were in great part collected on three different expeditions to the West: one to Wyoming during August and September, 1895, one to Central California (Monterey and vicinity) during July and August, 1896, and another to Southern California (San Diego and vicinity) from December to April, 1897. The seasons available for these expeditions were, unfortunately, not the most favorable—the best months for collecting being July in Wyoming, and April and May in California—so that the species described from my own collecting must represent only an inconsiderable fragment of the Western Dolichopodid fauna. In addition to this material, I have had several interesting species from South Dakota, Idaho and Washington, generously sent me by Professor J. M. Aldrich, and Mr. C. W. Johnson has kindly furnished me with some valuable material from Florida, New Jersey and Pennsylvania.

Only the smaller genera of Dolichopodidæ are considered in the present paper, since the larger genera, like *Dolichopus*, *Gymnopternus* and *Psilopus* deserve special treatment and a more careful and extensive study than I have been able to give them. Only three new genera are added to our North American fauna. One of these, *Teuchophorus*, though known from Europe, has not before been recognized in this country. Two other genera, *Nothosympycnus* and *Parasyntormon* are established for the accommodation of groups of species allied to *Syntormon* and

Sept. 12, 1899.

Sympycnus. Loew's genus, *Synarthrus*, abandoned by more recent students of the Dolichopodidæ, is here reinstated for a further group of species that do not seem to belong to the European genus *Syntormon*. Several new species have been added to well known genera, such as *Pelastoneurus*, *Medeterus*, *Campsicnemus* and *Hydrophorus*.

Hygroceleuthus *Loew*.

Since the publication of Loew's Monograph of the North American Dolichopodidæ, the list of species of the genus *Hygroceleuthus* has received several additions. Loew knew only one North American species, *H. latipes*, which seems to be the only representative of the genus in the states east of the Mississippi. Osten Sacken has added two Californian species, and more recently Aldrich has described two others from Idaho and Dakota, respectively. In the present paper two new species are added, one from California and one from Wyoming and Idaho. The following table will aid in distinguishing the males of the seven species now known:

1.	Middle tarsi compressed laterally........................	2
	Middle tarsi not compressed laterally......................	3
2.	Hind tibiæ tipped with black...............	*Aldrichii*, sp. nov.
	Hind tibiæ yellow throughout....................	*latipes* LOEW.
3.	Wings very broad, narrowed towards the base.............	4
	Wings not very broad, with distinct anal angle.............	5
4.	Cilia of tegulæ small, yellow....................	*crenatus* O. S.
	Cilia of tegulæ long, black............	*consanguineus*, sp. nov.
5.	Sides of second abdominal segment with tufts of yellow hairs.	*afflictus* O. S.
	Sides of second abdominal segment without such tufts......	6
6.	Cilia of tegulæ small, pale....................	*idahoensis* ALD.
	Cilia of tegulæ long, black.	*ciliatus* ALD.

1. Hygroceleuthus latipes *Loew*.

This species is very common in meadows in Wisconsin and Illinois during June, July and August. Aldrich mentions it from South Dakota, Wyoming and Connecticut. He has also sent me a specimen from Moscow, Idaho.

The locality of Loew's specimens is "North Red River." These data show that the species is very widely distributed, especially over the eastern half of the continent.

2. Hygroceleuthus afflictus *O. S.*

I collected both sexes of this species in great numbers in a salt-marsh between Monterey and Del Monte, Calif., in July. Two specimens from Professor Aldrich's collection are marked "G. Zuni R. Arizona."

3. Hygroceleuthus crenatus *O. S.*

PLATE I, FIG. 4.

This species is also widely distributed. Osten Sacken collected his specimens in California. Aldrich mentions it from Washington, and has sent me specimens from Idaho. I have taken it on the wet stones along creeks in Western Wyoming in September.

4. Hygroceleuthus ciliatus *Aldrich.*

Ten specimens of this species were taken at the following localities in Wyoming during August and September: Lusk, Buck Creek, Dinwiddie Creek, Dubois (7,200 ft.), Two-gwo-te-ee Pass, Jackson's Lake. The species occurs in the rank grass along the water courses, in company with *H. crenatus.*

5. Hygroceleuthus Aldrichii, sp. nov.

PLATE I, FIGS. 1-3.

Male. Length 4-5 mm.; length of wing 3.5-4 mm. Bright metallic green with coppery reflections. Palpi yellow, with black hairs; face with silvery white dust below, ochreous above. Antennæ of medium size, black; first and second joints yellow below on the mesial surface. First joint with considerable black hair on its upper surface and a prominent projection on its mesial surface; second joint rather short and but slightly yellow on the mesial surface;

third joint distinctly broader than the basal joints and somewhat pointed; arista moderate, pubescent. Front cupreous metallic green. Postocular cilia delicate, black above, light yellow below. Thorax shining except anteriorly where it is covered with yellow dust. The dust runs back in two broad bands leaving a narrow shining streak in the mid-dorsal line. Abdomen slightly compressed dorsoventrally at its base, covered with short black hairs and with a layer of white dust along the sides. Hypopygium black with bronze green reflections and a layer of white dust. Lamellæ triangular, yellow, bordered with black and with a fringe of delicate black hairs. Pleuræ metallic green covered with a layer of white dust. Coxæ of the same color except the fore pair, which are yellow. These have short white hairs on their anterior surfaces and a few black bristles near their apices. Legs yellow, trochanters with a small black spot on their posterior faces. Tarsi blackened from the tip of the first joint. First joint of middle tarsi rather slender, white; second, third and fourth joints distinctly compressed from side to side and fringed with black hairs. Hind tibiæ somewhat thickened, with black tips. Wings not broadened, grayish hyaline, distinctly yellowish towards the costa, which bears a slight swelling at the junction of the humeral vein. The anal angle is distinctly bilobed and prominent. Distal segment of fourth vein with a decided angle but without traces of a stump-vein. It ends some distance before the apex of the wing. There is a small but distinct notch in the hind margin at the tip of the fifth vein. Halteres and tegulæ yellow, the latter with long black cilia.

Female. Length 4.5–5.5 mm.; length of wing 4.5–5.5 mm. Face broader than that of the male, with grayish yellow dust. Anal angle of wing not bilobed, the costa without the swelling at the junction of the humeral vein. Middle tarsi very slightly compressed. Cilia of the tegulæ black, nearly as long as in the male. Appendages of the ovipositor yellow with black tips.

Numerous specimens, mostly males, collected by J. M. Aldrich at Moscow, Idaho. I have also taken several specimens, mostly females, in sweepings along the water-courses in western Wyoming in September (Dubois, Two-gwo-te-ee Pass).

In having laterally compressed middle tarsi the male of *H. Aldrichii* resembles the male of *H. latipes*, but the compression in the western is not so great as it is in the eastern species. In *latipes* the hind tibiæ are yellow throughout, in *Aldrichii* distinctly tipped with black; the anal angle of the wing in the male of the former species is evenly rounded, in the male of the latter, bilobed and prominent; the base of the second middle tarsal joint is yellow in *latipes*, entirely black in *Aldrichii*. Lastly, the antennæ of *Aldrichii* are blacker and more hairy than those of the eastern species.

6. Hygroceleuthus consanguineus, sp. nov.

PLATE I, FIGS. 5–7.

Male. Length 5.5–6.5 mm.; length of wing 4.5–5.5 mm. Bright metallic green with coppery reflections. Proboscis piceous, palpi yellow with short black hairs. Face covered with thick ochreous dust, the upper two-thirds somewhat olivaceous and more opaque than the lower third. In some specimens two broad ochreous bands run lengthwise of the upper two-thirds. Antennæ deep black, the first and second joints yellow below and on the mesial surface. First joint with abundant black hairs, and a conspicuous smooth swelling on the inner side; second joint nearly as long as the first; third joint scarcely broader than the second, small, with a thick pubescent arista. Front bright metallic green. Postocular cilia black, not very conspicuous above but becoming very thick, flattened and blunt below. Just below the middle of the orbit on either side four to six of the cilia are bright orange. These are very conspicuous when the head is seen from the front. Thorax cupreous on the disc, covered with gray dust anteriorly, and sometimes with a pair of median approximated reddish lines which fade away posteriorly. Abdomen flattened dorsoventrally at its base, laterally compressed and tapering towards the hypopygium. The median dorsal portions of the segments with distinct coppery reflections. Base of the hypopygium metallic green overlaid with white dust, towards the tip opaque black. Lamellæ piceous with black borders and cilia. Internal appendages yellow. Pleuræ bright metallic green with a thin layer of pale dust. Fore coxæ yellow with metallic green posterior surfaces; the anterior surfaces covered with black hairs, long towards the tips. Anterior trochanters yellow with a black spot on the posterior surfaces. Middle and hind coxæ metallic green, opaque with white dust. Legs plain, yellow, with the usual black bristles, blackened from the tip of the first tarsal joint. The hind tibiæ are slightly thickened and have a smooth streak on their inner surfaces. Wings gray, distinctly yellowish towards the costa, very broad, narrowed towards their bases. Veins black. There is a very distinct swelling on the costa at the junction of the humeral vein. The costa ends distinctly before the tip of the wing with the end of the fourth vein. The third vein bends downward at its end, the distal segment of the fourth has an abrupt angle with a stump-vein running from it. The tip of the fifth vein fails to reach a distinct notch in the hind border of the wing. Tegulæ and halteres yellow, the former with strong black cilia.

Female. Length 5–6 mm.; length of wing 5–6 mm. The broader face is covered with yellow, gray or white dust; the antennæ are smaller than those of the male, with narrower first and second joints and less robust arista. Wings of the usual shape, but with the same neuration as the male, except that there is no swelling on the costa. The fore coxæ have black hairs on their anterior surfaces, and the tegulæ are ciliated as in the male. The lower postocular cilia are particolored, but the individual cilia are weaker and less flattened, and the orange colored cilia are more numerous and extend further towards the proboscis, leaving fewer black cilia in this region than there are in the male.

Great numbers of this species were collected in the vicinity of Monterey, Calif., during the entire month of July, 1896. It was particularly abundant in company with *H. afflictus*, in a salt-marsh between Monterey and Del Monte.

At first sight *H. consanguineus* appears to be identical with *H. crenatus*. The more important points of difference are the following: *H. consanguineus* is larger, has stouter infra-ocular cilia, and many of these are deep black, whereas they are all pale in *H. crenatus*. The tegular cilia of the male *consanguineus* are stout and black, those of *H. crenatus* weak and yellow; the anterior surface of the fore coxæ of the former is covered throughout with black hairs, in the latter only a portion of the surface thus is covered. The hypopygium of the male *crenatus* has white lamellæ with a narrow, sharply defined black border, whereas the pale portions of the lamellæ of *consanguineus* are suffused with the black of their borders. The wings have the same neuration in both species, but the short stump on the distal segment of the fourth vein is often lacking in *crenatus*. There are also differences in the antennæ: in *consanguineus* the second joint is proportionally longer than it is in *crenatus*, and the yellow on its mesial surface is more restricted.

Polymedon *Osten Sacken.*

This remarkable genus, first described by Osten Sacken in his "Western Diptera" and based on a single species, *P. flabellifer* O. S., from California, has been extended by Aldrich to include a second species from the West Indies (*P. superbus* Ald.). Among my material I find a single female specimen from Arizona and evidently distinct from the two known forms.

7. **Polymedon castus**, sp. nov.

PLATE I, FIG. 8.

Female. Length 5 mm.; length of wing 7 mm. Proboscis fuscous, fringed with small white hairs and dusted with white along its edge. Palpi and face covered with silvery white dust; the latter, which is convex below and somewhat concave above the transverse suture, extends nearly one-fourth its entire length below the lower corners of the eyes, and terminates in a broad, rounded point. Antennæ rather small; first and second joints yellow, blackened along their dorsal surfaces; third joint wholly black, scarcely longer than the first and bearing a slender, naked, subapical arista. Front concave, metallic green, overlaid with white dust. Postocular cilia black above, below rather long and stiff, yellowish white. Thorax metallic green, more golden on the disc, covered with white dust, which forms three large and conspicuous accumulations on either side, one on the humerus, one in the posthumeral depression and another more elongate accumulation above the insertion of the wing. Anterior fourth of thoracic dorsum covered with very small, thick-set bristles. Acrostichal bristles distinct, in two rows, each of which is bordered by a narrow brown vitta on its outer side as far as the middle of the thorax. Dorsal bristles prominent; six in either inner row. Scutellum metallic green, covered with white dust and bearing two stout mesial and two weak lateral bristles. Abdomen not longer than the thorax, metallic green, overlaid with white dust, which is very thin on the dorsal and very thick on the lateral and ventral portions of the segments. Venter yellowish. Hairs on the abdominal segments short, black. Pleuræ deep, covered with a very thick layer of silvery white dust, so that the ground-color is entirely concealed. Coxæ yellow, middle and hind pairs darker towards the base on their outer sides. All the coxæ are covered with silvery white dust like that on the pleuræ. Fore coxæ with a few black bristles near their bases on their anterior inner surfaces and several larger ones near their tips. Legs yellow, tarsi of fore and middle pairs from the tip of the first joint, hind tarsi entirely and tips of hind tibiæ, black. The separate tarsal joints on all the feet bear one or two strong bristles at the tip on the plantar surface. Wings long and narrow, somewhat pointed, grayish hyaline with yellow veins. The costa is not thickened. Third vein bending down gently at its tip; distal segment of fourth vein turning up from a distinct rounded angle about a third its length from the cross-vein, then describing a slight curve and descending somewhat to terminate a very short distance before the tip of the wing. Attenuated tips of the fifth and sixth veins not reaching the posterior margin. Posterior cross-vein somewhat nearer the apex than the base of the wing and about its own length distant from the posterior margin measured along the distal segment of the fifth vein. Halteres and tegulæ yellow, the latter with long black cilia.

One specimen labelled "Grand Cañon, Arizona," from the collections of the University of Kansas.

The female above described differs from the females of *P. flabellifer* O. S. and *P. superbus* Ald., in having a much longer face. In *P. castus* the face extends below the lower corners of the eyes nearly as far as that of the male *P. superbus*. Aldrich describes the female of his species as having a face "ending in a point below, which reaches fully to the lower edges of the eyes." In *P. flabellifer*, Osten Sacken says that the lower edge of the face is nearly on a level with the lower corner of the eyes. *P. flabellifer* has black legs; *P. superbus* and *P. castus* have yellow legs.

Hercostomus *Loew.*

The two species described below are referred with considerable doubt to this genus, which was not very clearly defined by Loew. *Hercostomus* was to him a general depository for several species which would not fit into the genera *Gymnopternus*, *Pelastoneurus*, *Paraclius* and *Hypophyllus*. *Hercostomus* was regarded as "not ripe as yet for further subdivision on account of the insufficiency of our knowledge of its species." The two species here described differ from *Gymnopternus* in the structure of the hypopygium, and resemble *Hercostomus* in neuration. I have not seen fit to establish new genera on them, although this may yet be necessary. Both the species are from California. A careful sifting of the Dolichopodid fauna of that State may reveal other allied species which will give a clue to the natural affinities of the species here described. Including a Hudson Bay species of *Hercostomus* described by Loew and another described by Aldrich from St. Vincent, West Indies, I append the following provisional table of our North American species:—

1.	Postocular cilia black	2
	Postocular cilia white	3
2.	Legs black	*unicolor* LOEW.
	Legs yellow	*procerus*, sp. nov.
3.	Antennæ red	*latipes* ALD.
	Antennæ black	*impudicus*, sp. nov.

8. Hercostomus procerus, sp. nov.

PLATE I, FIGS. 9 AND 10.

Male. Length 4.5-5.5 mm.; length of wing 4-4.5 mm. Proboscis rather small, piceous, with distinct hairs around its edge. Palpi small, covered with gray dust. Face rather narrow, thickly covered with dull, ochre-yellow dust. Antennæ small, black; first joint with distinct hairs on its upper surface;

second joint broad, covering a considerable portion of the base of the third joint on the inside; third joint not much longer than broad, ending in a blunt but distinct point, and bearing the black arista on its dorsal surface. Pubescence of arista scarcely perceptible. Postocular cilia entirely black. Front, thorax, scutellum and abdomen metallic coppery green, overlaid with rather thick grayish dust. There are two rows of distinct acrostichal bristles and five inner dorsal bristles on either side. Scutellum without hairs, bearing two large mesial and two minute lateral bristles. Abdomen slender, covered with black hairs, which are rather long on the sides of the basal segments. Hypopygium large, subpedunculate, inflected under the abdomen. All the appendages black, the yellow penis and its sheath slender, projecting. Lamellæ small, subtriangular, densely fringed with black hairs; claspers large, broad and flat, with spreading truncated tips. Pleuræ black, thickly dusted with gray. Coxæ of the same color as the pleuræ, fore pair, except at the base, yellow; only the tips of the middle and hind pairs yellow. Anterior surfaces of fore and middle coxæ with prominent black bristles. Legs yellow, with black hairs. Tips of hind femora on their upper surfaces, and all the tarsi from the tip of the first joint, black. All the tibiæ with prominent black bristles. Fore tarsi a little longer than the fore tibiæ; first joint as long as the second, third and fourth joints taken together. Lower surface of the fore tarsi from the tip of the first joint covered with dense short hairs. Middle tarsi considerably longer than the middle tibiæ, with joints diminishing in length successively towards the tip. Hind tibiæ somewhat incrassated at their tips. Hind tarsi longer than the hind tibiæ, first joint distinctly shorter and thicker than the second and without bristles on its upper surface. Wings gray, distinctly broadened towards the middle. Veins black, becoming yellowish brown towards their bases. The tip of the third vein is distinctly bent downwards towards the fourth. The fourth has a slight angle before the middle of its distal segment and rises thence very gradually to end near the tip of the third vein just before the apex of the wing. Posterior cross-vein a little beyond the middle of the wing, about twice its length distant from the posterior margin measured along the distal segment of the fifth vein, which fades away before reaching a notch in the margin. Sixth vein and anal angle of the wing well developed. Halteres and tegulæ yellow, the latter with prominent black cilia.

Female. Length 4–5 mm.; length of wing 4–5 mm. Resembles the male very closely in form and coloration. Proboscis, palpi and antennæ of the same size as in the male; face fully twice as broad, covered with a thick layer of yellowish gray dust and provided with a knot-like swelling at either end of the transverse suture. The wings are distinctly narrower in the middle than they are in the male.

Many specimens of this species were taken in a salt-marsh along the road from Monterey to Del Monte, Calif. The species associates with *Hygroceleuthus afflictus*, H. *consanguineus* and *Dolichopus corax* O. S.

9. Hercostomus impudicus, sp. nov.

PLATE I, FIGS. 11–13.

Male. Length 3 mm.; length of wing 2.5 mm. Proboscis and palpi small, yellowish, the former edged with hairs. Face considerably narrowed below, covered with thick, silvery white dust, and with a groove-like depression running down its middle. Antennæ entirely black; first joint rather slender, distinctly hairy on its upper surface; second joint broad, covering much of the base of the third joint on the inside; third joint large, about twice as long as broad, pointed, with straight dorsal edge bearing the black, scarcely pubescent arista near its middle. Ventral contour convex. Postocular cilia pale. Front very broad, like the thorax and scutellum, thickly covered with grayish brown dust, so that the metallic ground-color is scarcely perceptible. There are two distinct rows of acrostichal bristles and five large bristles in each inner dorsal row. Humeral bristles well developed. Scutellum without hairs, but with a pair of robust mesial and a pair of minute lateral bristles. Abdomen greenish coppery, brighter than the thorax; hairs and posterior edges of the segments black. Hypopygium very large, subsessile, black, dusted with white, inflected under the abdomen, which it nearly equals in volume. Penis and penis-sheath very large and prominent, the latter long and club-shaped, terminating in a prominent black spine anteriorly. Each of the large, pale lamellæ is split into three linear processes fringed with long black bristles. The ventral or uppermost process (in the natural, flexed position of the hypopygium) is curved and broadened at its free end where it is provided with incurved, short black teeth. On its outer surface, for some distance towards the base, it bears long and rather delicate pointed bristles. The bristles on the two other processes of each lamella have truncated broadened tips. Pleuræ and coxæ covered with gray dust; middle and hind coxæ tipped with yellow; fore coxæ yellow except at their bases and bearing some prominent black bristles on their anterior surfaces. Legs plain, yellow. Fore and middle tarsi from the tip of the first joint, tips of hind femora and hind tibiæ and the whole of the hind tarsi, black. All the tibiæ bear prominent black bristles on their outer surfaces. First joint of hind tarsi without bristles, shorter than the succeeding joint. Wings somewhat blackish, slightly narrowed towards the base, with black veins. Third and fourth veins close together and very gradually converging towards their insertion in the costa, the latter ending distinctly before the tip of the wing. Posterior cross-vein before the middle of the wing and about one-third the length of the distal segment of the fifth vein, which reaches the posterior margin. Halteres and tegulæ yellow, the latter with black cilia.

Female. Length 3 mm.; wing 2.5 mm. Face distinctly broader than that of the male, but covered with the same silvery white dust. Third antennal joint of the same shape but much smaller than that of the male. Coloration of body, wings and legs like that of male except that there is much pale dust along the sides of the venter. Ovipositor extruded, terminating in two upturned points, each armed with three black teeth.

One male and one female taken near Monterey, Calif., during July, 1896.

Pelastoneurus *Loew*.

The species of this genus, which is peculiar to America, do not exhibit very prominent plastic characters. Almost the only satisfactory morphological features are to be found in the structure of the hypopygium. On these it seemed possible, at first, to separate the species into two genera, assigning to the one those forms which have long and slender lamellæ, and to the other those with short lamellæ and swollen hypopygial scape, but I abandoned this attempt on failing to find other correlated characters in my specimens. Aldrich has founded a new allied genus, *Metapelastoneurus*, on a peculiar form of hypopygium. Possibly Loew's *Pelastoneurus furcifer* is also to be assigned to this genus. The genus *Pelastoneurus* promises to be a large one when all our species are known. Descriptions of six new species and a dichotomic table of all the known North American forms are given below.

1. Postocular cilia pale.................................... 2
   Postocular cilia black.................................... 9
2. Fore coxæ entirely yellow.................................... 3
   Fore coxæ more or less infuscated.................................... 4
3. Arista short, tapering rapidly....................*cognatus* LOEW.
   Arista long, scarcely tapering..............*neglectus*, sp. nov.
4. Thorax with alternate green and cupreous bands. *alternans* LOEW.
   Thorax with at most one median cupreous band........... 5
5. Hypopygial lamellæ long and narrow.................... 6
   Hypopygial lamellæ short....................*lineatus* ALD.
6. Lamellæ linear, straight, with rounded tips......*vagans* LOEW.
   Lamellæ not linear, nor straight.................... 7
7. Tips only of the fore coxæ yellow.........*occidentalis*, sp. nov.
   Bases only of the fore coxæ infuscated.................... 8
8. Hind tibiæ strongly infuscated..............*argentiferus* ALD.
   Hind tibiæ yellow....................*floridanus*, sp. nov.
9. Wings banded with black................*pictipennis*, sp. nov.
   Wings not banded.................................... 10
10. Wings distinctly blackened....................*lugubris* LOEW.
    Wings grayish hyaline.................................... 11
11. Posterior edge of thorax with a glittering white spot. *longicauda* LOEW.
    No such spot on the thorax.................... 12
12. Hypopygial lamellæ furcate....................*furcifer* LOEW.
    Hypopygial lamellæ not furcate.................... 13

13. Lamellæ long, fore coxæ entirely yellow............*lætus* LOEW.
    Lamellæ short, fore coxæ more or less infuscated......... 14
14. Third antennal joint entirely deep black...*dissimilipes*, sp. nov.
    Third antennal joint more or less yellow.................. 15
15. Abdomen of male metallic violet..............*cyaneus*, sp. nov.
    Abdomen of male bronze green......................... 16
16. All the coxæ blackish ....*abbreviatus* LOEW.
    Apical half of fore coxæ yellow...............*lamellatus* LOEW.

10. **Pelastoneurus neglectus**, sp. nov.

PLATE I, FIG. 14.

Female. Length 4 mm.; length of wing 3 mm. Palpi, and face below the transverse suture, glistening with silver white dust. Between the suture and the insertions of the antennæ the dust is golden yellow. Antennæ yellow even to the tip of the third joint, which is distinctly pointed. Arista very long, scarcely tapering, plumose on its apical two-thirds which are black, the basal third being yellow. Front golden green in the middle, passing into violet towards the superior orbits. Postocular cilia silvery white. Thorax metallic green with violet reflections posteriorly. Prealar depressions glistening with thick silvery white dust. There are two distinct black spots on either side, one mesial to the silvery depression and another at the postero-lateral edge of the thorax. Scutellum metallic green, with a dark line down its center. Abdomen dull metallic green above, with black incisures, more cupreous on the sides and venter, covered with black hairs. Each segment bearing a large patch of silvery white dust on its lateral surface. This dust covers the entire sixth segment, which is small and partially concealed. Pleuræ metallic green, above thinly, below more thickly covered with white dust. Fore coxæ entirely yellow, with black hairs on their front surfaces; middle coxæ with yellow apical halves and basal halves dusted with white; hind coxæ yellow, with only their extreme bases dark. Legs entirely yellow, tarsi but very slightly infuscated towards their tips. Wings brownish hyaline, with the typical neuration of the genus. Tegulæ and halteres yellow, the former with black cilia.

Two females, one from the vicinity of Chicago, Ill. (July 6, 1895); the other from Milwaukee, Wis. (June 28, 1895).

This species may be readily recognized by the very long and scarcely tapering arista, and by the third joint of the antenna being pointed and entirely yellow, at least in the female.

11. **Pelastoneurus cognatus** *Loew.*

Two females taken in sweepings near Chicago, Ill., July 5, 1895, and May 8, 1896, agree very closely with Loew's description of this species.

12. Pelastoneurus occidentalis, sp. nov.

PLATE I, FIG. 20.

Male. Length 3 mm.; length of wing 3 mm. Proboscis black. Palpi covered with white dust. Face rather narrow, entirely covered with rather thick white dust. Antennæ black, mesial and lower surfaces of the first and second joints yellow; third joint rounded, pubescent; arista short, rapidly tapering, moderately plumose. Front metallic violet. Postoculur cilia snow white. Thorax black, with green and cupreous reflections; lateral black band faint and the accumulation of brilliant white dust in the prealar depression inconsiderable. Abdomen metallic bronze green with black incisures and with a large blotch of white dust on the side of each segment. Hairs covering the segments rather abundant, black. Sixth segment entirely covered with thick gray dust. Hypopygium slender, nearly as long as the abdomen, black dusted with gray. Lamellæ long and pointed, with ragged, bristly edges. Pleuræ metallic green overlaid with thick gray dust. Coxæ of the same color as the pleuræ except at the extreme tips which are yellow. Legs yellow, tarsi infuscated towards their tips. Wings grayish hyaline, with the typical venation of the genus. Halteres and tegulæ pale yellow, the latter with black cilia.

Female. Length 4 mm.; length of wing 3.5 mm. Basal portion of third antennal joint yellow. Face with brownish dust towards its middle. Front dull black, covered with brown dust. The silvery prealar depressions of the thorax are larger and more conspicuous than in the male.

Four males and one female taken at Pacific Grove, Calif., July 9th to 22nd, 1896.

The most striking character of this species is the structure of the hypopygial lamellæ.

13. Pelastoneurus floridanus, sp. nov.

PLATE II, FIG. 26.

Male. Length 3.5–4 mm.; length of wing 3–3.5 mm. Palpi and face thickly and uniformly covered with silvery white dust, the former rather large, the latter of the usual breadth for a male. Antennæ yellow, the broadly rounded tip of the third joint blackened. Arista rather short, tapering, plumose. Front metallic violet along the orbits, cupreous in the center. Postocular cilia black above, white below. Thorax shining bronze black anteriorly, becoming metallic violet posteriorly. On either side the dorsum is deep velvety black as far as the insertion of the scutellum. There is a very bright and sharply outlined spot of silvery white dust in the posthumeral depression on either side. Prescutellar region and scutellum bronze black, cupreous, or metallic blue-green in different specimens. Abdomen dark cupreous, with black incisures and a large patch of white dust on the side of each segment. Sixth segment wholly covered with white dust. Hypopygium as thick and very nearly as long as the abdomen, black, dusted with white. Lamellæ subtriangular, black, with rather long yellow bases and their edges ragged and fringed with long black hairs. Inner appendages and the portion of the hypopygium from which they arise, mostly yellow. Pleuræ black, thickly covered with white dust. Coxæ also covered with white dust, the middle and hind pairs black with yellow tips, the fore pair yellow except at the base on the outer side where they are slightly infuscated. Legs plain, yellow; tarsi infuscated from the tip of the first joint. In some specimens the tips of the hind femora are infuscated on the upper side. Wings grayish hyaline with the usual Pelastoneuran venation. Halteres and tegulæ light yellow, the latter with prominent black cilia.

Female. Length 3.5–3.75 mm.; length of wing 3.5–3.75 mm. Palpi larger, face broader and more projecting than in the male; the former brown, covered with silvery white dust; the latter chocolate colored with a band of silvery white dust on either side along the orbit. Wings somewhat more infuscated than those of the male. In other respects the coloration of the two sexes is very similar.

Seven males and ten females collected at St. Augustine, Fla., and sent me by Mr. C. W. Johnson. The species resembles *P. argentiferus* Aldrich, from St. Vincent. W. I. Aldrich's species, however, has the hind tibiæ strongly infuscated, the concave, upper portion of the face in the male shining green, the black on the antennæ more extensive, and a pair of white spots just behind the roots of the wings. The lamellæ of the hypopygium, too, in *P. argentiferus* have a very different structure, to judge from Aldrich's descriptions.

14. **Pelastoneurus pictipennis**, sp. nov.

PLATE I, FIG. 19; PLATE II, FIG. 25.

Male. Length 3 mm.; length of wing 2.5 mm. Proboscis rather small, retracted, piceous. Palpi large, blackish, covered with gray dust. Face concave above the suture, projecting somewhat below, black, covered with white but not very brilliant dust. Antennæ reddish, third joint blackened towards the tip; arista densely plumose, tapering, not quite as long as the face. Front opaque dark brown. Postocular cilia black, not very conspicuous. Thorax shining black, violet posteriorly, on either side with a velvety black, dumb-bell-shaped patch and a round silvery white spot in the posthumeral depression. Scutellum shining steel blue with a median longitudinal velvety black band. Abdomen rather short and thick, shining black with violaceous reflections, each segment with a large patch of white dust on its side.

Hypopygium short and thick, black, dusted with white; lamellæ small circular black discs, fringed with rather feeble brown hairs. Pleuræ and coxæ black, covered with white dust, the latter tipped with yellowish brown. Legs yellowish brown, infuscated along the upper surfaces of the femora; tarsi blackened towards their tips. Wings with the typical venation. The costal region is more or less blackened, the space below it being crossed by four blackish bands, the longest and darkest of which overlies the posterior cross-vein. The node at the origin of the third and fourth veins is conspicuously black and there is a minute black spot between it and the second vein. Posterior edge of wing somewhat infuscated. Halteres and tegulæ yellow, the latter with black cilia.

Female. Length 4.5–5 mm.; length of wing 3–3.5 mm. Face broader and more prominent than in the male, covered with dark brown dust in the middle, with white dust along the orbit. Palpi larger than those of the male, covered with white dust. Front dull brown, dusted with white near the insertions of the antennæ. Occiput curiously mottled with velvety black spots. In other respects the coloration of the female agrees with that of the male.

One male and three females from St. Augustine, Fla., received from Mr. C. W. Johnson, and two poorly preserved males and a female collected by Mr. F. Rauterberg near Gotha, Fla. (March, 1896). The black band of the wings serves to distinguish this species at a glance from all the other North American species.

15. Pelastoneurus vagans *Loew.*

PLATE I, FIG. 15.

This is our commonest species, occurring sporadically in sweepings together with species of *Dolichopus*, *Hygroceleuthus*, and *Gymnopternus*. It seems to be rather widely distributed. I have seen specimens from Wisconsin, Illinois, Indiana, New Mexico and western Wyoming.

16. Pelastoneurus lugubris *Loew.*

PLATE II, FIG. 28.

Only the female of this small species was known to Loew. His specimens came from New York. I have taken it in sweepings in July at various localities in Wisconsin, Illinois and Indiana. The male is 2.3 mm. long, with wings only 2 mm. in length. Loew's description of the female will apply to the male, with the following additions: The third antennal joint is more pubescent than in other species of *Pelastoneurus* known to me; the arista is proportionally long, and tapers rapidly. The hypopygium is thick and only half as long as the abdomen; its black lamellæ are circular discs fringed with black hairs; its inner appendages short and thick.

17. Pelastoneurus dissimilipes, sp. nov.

Male. Length 4.5 mm.; length of wing 3.5 mm. Palpi and face uniformly covered with gray dust. Antennæ rather small, deep black, with the exception of a spinous projection on the inner side of the first joint, which is yellow; third joint rounded, as broad as long; arista short, tapering rapidly, with short pubescence on its second segment. Front metallic blue. Postocular cilia black. Thorax blackish bronze, becoming violet posteriorly and brilliant green near the insertions of the wings. Posthumeral depression broadly white with silvery dust; the deep black band lying mesial to this depression is rather narrow. Abdomen slender, blackish bronze, with green and violet reflections, especially posteriorly, with black incisures, and a large patch of white dust on the side of each segment. Hypopygium black, opaque with gray dust, almost as long as the abdomen but not very thick. Lamellæ short, black, triangular, fringed with coarse black hairs; inner appendages piceous. Pleuræ uniformly covered with gray dust. Coxæ black, dusted with gray, the fore pair with their extreme tips yellow. Fore legs black, only the tips of the femur and the base of the metatarsus yellow; fore tarsi densely padded on their plantar surfaces with short and dense white hairs. Middle legs black with nearly the whole apical half of the femur, and all but the apex of the metatarsus yellow; hind tibia and tarsus deep black, femur yellow with a broad black tip and a broad black band running half way down the middle of its upper surface. Wings grayish hyaline. Fourth vein bending up rather gently towards the third (not forming a distinct angle as in the typical neuration of the genus), so that the space between the third and fourth veins is narrow. Halteres and tegulæ light yellow, the latter with black cilia.

Female. Length 4 mm.; length of wing 4 mm. Palpi large, covered with white dust. Face metallic green, subdued by a layer of gray dust which is thickest on the lower projecting portion. Front metallic green, not very bright. Thorax like that of the male, but with a blackish band down the middle, embracing the acrostichal bristles; anterior portion of thorax dusted with yellow. Abdomen brilliant metallic green, with black incisures and larger patches of white dust on the sides of the segments than are found in the male. Pleuræ thickly dusted with white. Coxæ concolorous with the pleuræ, the fore and middle pairs tipped with yellow. Legs yellow, tarsi blackened from the tip of the first joint; extreme bases of all the tibiæ and the basal third of the fore femora black; apical fourth of hind femora dark brown. Venation as in the male.

Four males and one female taken near Monterey, Calif., July 13th to 22d, 1896.

The extensive and peculiar distribution of the black on the legs and antennæ of this species, together with the gentle upward curvature of the fourth vein, will readily distinguish it from all the other species of the genus.

18. Pelastoneurus cyaneus, sp. nov.

PLATE I, FIGS. 16–18.

Male. Length 3.5–4.5 mm.; length of wing 3–4 mm. Proboscis dull black. Palpi covered with white dust. Face rather narrow, covered with white dust which grows thinner on the upper portion, so that the metallic green ground-color is revealed. Antennæ rather small; first and second joints yellow with black upper surfaces; third joint rounded, black with a narrow yellow base; arista short, rapidly tapering and but slightly plumose. Front metallic green with violet reflections. Postocular cilia black. Thorax and scutellum bright metallic violet, the former somewhat more golden green anteriorly and dusted with yellow. Posthumeral depressions conspicuous with silvery white dust, passing into emerald green anteriorly. The deep black band on either side of the thoracic dorsum widens into three successive blotches, one mesial to the posthumeral depression, one at the root of the wing and another near the anterolateral insertion of the scutellum. There is also a small but distinct silvery white spot in front of the hindermost black blotch. Abdomen metallic violet, with black incisures and large patches of silvery white dust on the sides of the segments. Hypopygium two-thirds as long as the abdomen, with large, swollen base, black, with metallic green reflections and dusted with white, opaque except on the upper (morphologically ventral) portion, which is shining black. Lamellæ very small, subtriangular, black, fringed with black cilia; inner appendages slender, black. Pleuræ metallic blackish green, dusted with white. Coxæ concolorous with the pleuræ, all of them with distinct yellow tips, fore coxæ with silvery white dust and prominent black hairs on their anterior surfaces. Legs yellow. Fore tarsi blackened from the tip of the first joint; second and third joints covered with dense, short white hairs on their plantar surfaces. Middle and hind tarsi blackened from the tip of the second joint; tip of the first tarsal joint, tip of the fore and middle tibiæ and tip of hind femur blackened. Wings grayish hyaline, slightly darker towards the costal border, with black veins. Venation typical except that the angle on the fourth vein is not very prominent. Tegulæ and halteres yellow, the former with black cilia.

Female. Length 4–5 mm.; length of wing 4–5 mm. Palpi covered with white dust. Face swollen below, covered with dull ochre-yellow dust, which becomes gray along the orbit. Front metallic green or violet, with a dense accumulation of ochre-yellow dust above the insertions of the antennæ. Thorax shining bronze, black anteriorly, metallic violet posteriorly. There are three deep black connected blotches on either side as in the male; the broad posthumeral depression is filled with pale ochreous or greenish white dust, and the small white spot in front of the hindermost black blotch is very distinct. Scutellum metallic violet. Abdomen metallic green with coppery reflections and very distinct black incisures; the segments with more or less white dust on their sides. Coxæ and legs like those of the male, except that the fore tarsi have no pads of minute hairs on their plantar surfaces, and that the blackening of the tip of the hind femur is less extensive. Wings distinctly brown along the veins and towards the costal margin.

Numerous specimens of both sexes taken in a salt marsh along the road from Monterey to Del Monte, Calif., July 13th to 31st, 1896. I have also examined several male and female specimens of what I take to be this species from Lusk, Wyo. They were collected by Mr. W. A. Snow during July, 1895.

In living specimens the violet coloring of the male is very brilliant and distinguishes it from the males of *P. lamellatus* Loew and *P. abbreviatus* Loew.

Paraclius *Bigot.*

The species of this genus, which is rather closely allied to *Pelastoneurus*, are mostly confined to the Southern States and the West Indies, only one, *P. claviculatus* Loew, being known to occur north of these regions. The species may be distinguished as follows:—

1. Antennæ red 2
   Antennæ black 4
2. Fore coxæ entirely red or yellow 3
   Fore coxæ only tipped with yellow .... *propinquus*, sp. nov.
3. First and second antennal joints black above. *claviculatus* LOEW.
   First and second antennal joints not infuscated above. *filiferus* ALD.
4. Feet entirely black .... *albonotatus* LOEW.
   Feet not entirely black 5
5. Femora black .... *pumilio* LOEW.
   Femora yellow, brown above .... *arcuatus* LOEW.

19. Paraclius propinquus, sp. nov.

PLATE I, FIGS. 22–24.

Male. Length 2.75 mm.; length of wing 2.5 mm. Palpi and face covered with opaque gray dust, the former small, the latter rather narrow, of nearly uniform width throughout and with a metallic green ground-color. Antennæ red; third joint about as long as broad, bluntly pointed, blackened towards the tip; arista rather long, tapering, moderately plumose. Front bright metallic green. Postocular cilia black above, silvery white below. Thorax blackish bronze, passing into dull metallic violet posteriorly, opaque with grayish dust on the humeri. Posthumeral depression with a distinct patch of silvery white dust. In front of the root of the wing on either side there is a large velvety black, dumb-bell-shaped blotch. Scutellum bright metallic blue-green. Abdomen bright metallic cupreous with black incisures and a conspicuous patch of white dust on the side of each segment. Hypopygium rather short and thick, sessile, covered with white dust. Lamellæ short, elliptical, fringed with rather dense hairs which are white on the lower (morphologically dorsal) surface. The upper inner edge of each lamella is produced into a long piceous filament fringed with hairs. Pleuræ and coxæ black, thickly covered with white dust. Tips of the coxæ reddish yellow; fore and middle pairs with very conspicuous black hairs on their anterior lower surfaces. Legs reddish yellow; anterior tarsi, from the tip of the first joint, hind tarsi entirely, upper surfaces of hind femora and tips of hind tibiæ blackened. Middle femora with distinct black cilia along their lower surfaces. Wings grayish hyaline, scarcely darker towards the costal margin. Costa not incrassated. Neuration normal, the arcuate end of the fourth vein forming an obtuse angle with the straight portion of the same vein. Halteres and tegulæ yellow, the latter with conspicuous black cilia.

Female. Length 3.3 mm.; length of wing 3.5 mm. Face somewhat broader than that of the male, covered with yellowish brown dust. Front bright metallic blue. Coloration of the body like that of the male; wings distinctly darker.

One male and two female specimens from Charlotte Harbour and Ormund, Fla., received from Mr. C. W. Johnson.

This species is closely related to *P. filiferus* Ald., which it resembles in the structure of the hypopygium. The fore coxæ of my specimens of *P. propinquus* are strongly infuscated, only their tips being yellow. If present in *P. filiferus*, the conspicuous ciliation of the middle femora is not mentioned by Aldrich.

20. Paraclius filiferus *Aldrich.*

Two females received from Mr. C. W. Johnson, one from Charlotte Harbour, Fla., the other from Lake Worth, Fla., appear to belong to this species. The fore coxæ and hind femora are entirely yellow, the scutellum bright cupreous, the face covered with silvery white dust. The arc-like terminal curvature of the fourth vein is somewhat more decided in this species—"almost a right angle," according to Aldrich—than in *P. propinquus*. Loew's description of the hypopygium of *P. claviculatus:*[1] "Hypopygium longiusculum, subsessile, nigrum, lamellis fuscis, e basi latiore longe attenuatis, nigro-pilosis," may be taken to indicate that this species, too, presents the peculiar hairy filiform appendages which arise from the bases of the lamellæ in *P. filiferus* and *P. propinquus.*

Medeterus *Fischer.*

In his able monograph of this genus[2] Kowarz distinguishes twenty-seven European species. Only two American forms have been described hitherto, both by Loew, in his Monograph of N. American Dolichopodidæ—*M. nigripes* from a female and *M. veles,* from a badly preserved male specimen. Kowarz has established two subdivisions of the genus, the one comprising species with four, the other species with only two scutellar bristles. The latter group has been raised to the rank of a genus (*Oligochœtus*) by Mik.[3] Mik also finds that the species of this genus lack the acrostichal bristles and have only three inner dorsal bristles in a row. Of the eleven new species here described from the United States, nine are typical *Medeterus,* but concerning the generic position of the remaining two, I am in doubt. *M. aberrans,* sp. nov., known to me only from a single female specimen, differs from the other species to such an extent that, as soon as the male is found, it will probably have to be assigned to a new genus. The other doubtful species is *M. petulcus,* sp. nov., of which I have seen only a single male specimen. It differs from other North American species in having only two scutellar bristles, but as it possesses five dorsal bristles in either inner row and also well developed acrostichal bristles, I decline to assign it to Mik's genus, which would then be based on a single character—the number of scutellar bristles. The difficulty is increased by the fact that *M. petulcus* has the front narrow and prolonged

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[1] Cent. VII, 83, p. 106.

[2] Die Dipterengattung Medeterus Fisher, Wien, 1877.

[3] Dipterologische Untersuchungen, 1878, p. 7.

upward as a pyramidal elevation bearing the ocelli at its summit. This is so unlike anything I have seen in any other Dolichopodid, that until I have examined more specimens, I suspect that the projection may be abnormal, and desist from founding a new genus. For the present, then, I include both *M. aberrans* and *M. petulcus* in Fischer's genus.

1. Scutellum with two bristles.................. *petulcus*, sp. nov.
   Scutellum with four bristles.................................. 2
2. Bright metallic green species................ *aberrans*, sp. nov.
   Species not bright metallic green........................... 3
3. Bristles above the fore coxæ black.......................... 4
   Bristles above the fore coxæ white.......................... 7
4. Second joint of hind tarsus three times as long as the metatarsus.................................... *nigripes* LOEW.
   Second joint of hind tarsus not more than twice as long as the metatarsus..................................... 5
5. Thorax vittate... 6
   Thorax not vittate.......................... *maurus*, sp. nov.
6. Male with prominent yellow hairs on the tips of hind tibiæ. *viduus*, sp. nov.
   Male without such hairs.................... *Aldrichii*, sp. nov.
7. Hind metatarsus of male with a small tooth-like projection.. 8
   Hind metatarsus of male without such a projection.........10
8. Face below the suture very glabrous, metallic green. *princeps*, sp. nov.
   Face not glabrous below the suture........................ 9
9. Distal segment of fifth vein one and one-half times as long as the posterior cross-vein.................... *veles* LOEW.
   Distal segment of fifth vein as long as the posterior cross-vein .... *californiensis*, sp. nov.
10. Abdomen deep metallic blue .... *cyanogaster*, sp. nov.
    Abdomen not deep metallic blue..........................11
11. Posterior cross-vein as long or nearly as long as the distal segment of the fifth vein............................12
    Posterior cross-vein twice as long as the distal segment of the fifth vein......................... *xerophilus*, sp. nov.
12. Thorax trivittate........................ *aurivittatus*, sp. nov.
    Thorax not vittate.................... *appendiculatus*, sp. nov.

21. Medeterus petulcus, sp. nov.

Male. Length 2 mm.; length of wing 2–2.5 mm. Proboscis moderate, glabrous, black with white hairs. Face thickly covered with light gray dust. Antennæ black, first and second joints of the usual form, third joint missing in the specimen. Front dusted with gray, produced into a high four-sided pyramidal projection, bearing the ocelli at its summit. Postocular cilia white. Thorax light gray with a faint median brownish stripe running the entire length. Bristles black, humeral bristles few in number, acrostichal bristles distinct, inner dorsal bristles five in each row. Posterior dorsal and lateral bristles prominent. Scutellum concolorous with the thorax, with only two bristles. Abdomen subopaque with gray dust, but of a somewhat more bluish tinge than the thorax. Hairs covering the segments white. Hypopygium long and rather thick, glabrous, black. Appendages very short, yellowish brown. Pleuræ and coxæ bronze-black, dusted with gray. Bristles above the insertions of the fore coxæ and the hairs on the anterior surfaces of the fore coxæ yellow. Legs yellow, all the femora black nearly to their tips. Tarsi infuscated at the tips. Hind metatarsus plain, a little more than half as long as the succeeding joint. Wings slightly opaque whitish, with light yellow veins. Venation normal. Distal segment of the fifth vein twice as long as the posterior cross-vein. Halteres and tegulæ yellow, the latter with pale cilia.

One specimen from Colfax, Washington, collected by Professor J. M. Aldrich.

The species, at least the male, is readily distinguishable by the very prominent front.

22. **Medeterus aberrans**, sp. nov.

PLATE II, FIG. 40.

Female. Length 2.75 mm.; length of wing 2.75 mm. Proboscis and palpi small, piceous, the former with pale hairs. Face metallic green, bluish below, golden above the suture, without dust. Antennæ black, first joint broad and thick, second very short; third acorn-shaped, much narrower than the preceding joints, pilose and bearing a very long, slender and distinctly pubescent apical arista. Front very concave, golden green, with a center which is opaque brown in some lights. Postocular cilia light yellow. Thorax, scutellum and abdomen bright golden green. There is a layer of pale dust on the scutellum and also on the prescutellar region of the thorax, which is not so distinctly flattened as in the other species of *Medeterus*. Thoracic bristles black; acrostical bristles in two rows, very distinct; humeral bristles rather small, sparse, lateral and posterior dorsal large and prominent. Scutellum with four robust bristles. Abdominal segments covered with light yellow hairs. Ovipositor slender, yellow. Pleuræ metallic green, covered with pale dust. Coxæ infuscated, with yellow tips and covered with pale dust. Bristles above the fore coxæ and on the anterior surfaces of the fore and middle coxæ yellow. Legs yellow throughout, only the tip of last tarsal joint blackish. Fore tibiæ without bristles, middle tibia with a prominent black bristle before the middle and two short bristles at the tip. Hind tibia with a single bristle near the base and three bristles at the tip. Hind metatarsus a little more than half the length of the succeeding joint, with a prominent black bristle at its tip on the lower surface. Wings grayish hyaline, with a yellowish cast and light yellow veins. Venation normal; tips of the third and fourth veins close together; distal segment of fifth vein scarcely longer than the posterior cross-vein. Halteres and tegulæ white, the latter with pale cilia.

One specimen from Avalon, N. J. (July 22d), received from Professor J. M. Aldrich.

In the concavity of the front, structure of the antennæ, shape of thorax and general coloration, this species departs from *Medeterus* and resembles our smaller species of *Psilopus*. The neuration, however, is unmistakably that of a typical *Medeterus*.

23. **Medeterus maurus**, sp. nov.

PLATE II, FIG. 46.

Male. Length 3.25–3.5 mm.; length of wing 3.5 mm. Proboscis and palpi black. Face deep metallic blue, with a cross-band of gray dust just above the suture. Antennæ short, yellow; third joint black, except at the base, pilose, broader than long, rounded, with a slight indentation near its middle for the insertion of the slender, naked arista. Postocular cilia white. Front, thorax, scutellum and abdomen black, shining with a faint metallic blue reflection, most pronounced on the abdomen. Thorax and scutellum covered with thin white dust, the latter with four prominent black bristles; the former with numerous small black bristles on its anterior third and moderately long black bristles on the posterolateral portions. The short hairs on the abdominal segments are black in some lights, yellowish in others. Hypopygium slender, as long as the abdomen, shining black. The two pairs of appendages at its tip are rather short, translucent and yellowish. Coxæ and legs black, the knees, middle tibiæ and bases of the middle tarsi yellowish. Hairs on the anterior surfaces of the coxæ and the bristles above the insertions of the fore coxæ, black. Hind metatarsus plain, about half as long as the succeeding joint. Wings clear, iridescent, with yellow veins, growing whitish towards their bases. Venation normal; distal segment of fifth vein one and one-half times as long as the posterior cross-vein. Halteres and tegulæ white, the latter with white cilia.

Female. Length 4 mm.; length of wing 4 mm. Proboscis large, swollen, glabrous, black, with conspicuous yellow hairs. Face somewhat broader, and its deep metallic blue ground-color more distinct than in the male. The abdomen is considerably flattened dorsoventrally, the slender brown ovipositor exserted and covered with a few slender hairs. Legs and coxæ black throughout, excepting the knees which are light yellow.

Two males and two females from Mt. Washington (J. M. Aldrich).

24. Medeterus viduus, sp. nov.

PLATE II, FIG. 39.

Male. Length 4 mm.; length of wing 3.5 mm. Proboscis, palpi and face subopaque, black, the last with a transverse band of gray dust just above the suture. Antennæ yellow, tip of second joint and whole of third joint, black, the latter about as long as wide, pubescent, with slender subapical arista. Front opaque with gray dust. Cheeks glabrous, black. Postocular cilia pale yellow. Thorax opaque with brown dust on the anterior half, with gray dust on the posterior half covering the prescutellar depression. Two distinct gray stripes, bordering the outer edges of the rows of acrostichal bristles, traverse the anterior half of the thorax and become confluent with the gray of the prescutellar depression, as do also two shorter lateral gray streaks just above and in front of the insertions of the wings. Humeral bristles rather sparse and short, and, like the moderately developed dorsal bristles, black. Scutellum covered with gray dust, with four well developed black bristles. Abdomen shining bronze-black, the segments covered with hairs which are black in some lights, grayish in others. On either side of the seventh segment there is a prominent tuft of long black hairs. Hypopygium long and slender, of the same color as the abdomen, appendages slender, with yellowish tips. On the lower (morphologically dorsal) surface of the organ the hairs are conspicuously long. Pleuræ and coxæ black, subopaque with gray dust. Bristles above the fore coxæ and hairs on the anterior surfaces of the fore and middle coxæ, black. Legs black, knees narrowly and indistinctly yellowish. Hind tibia bearing some conspicuously long yellow hairs near its tip on the upper side. Hind metatarsus a little more than half as long as the succeeding joint. Wings hyaline with black veins, becoming somewhat lighter at their bases. Venation normal. Tips of third and fourth veins close together. Distal segment of fifth vein one and a half times as long as the posterior cross-vein. Halteres and tegulæ flesh-colored, the latter with white cilia.

A single male from Olympia, Washington (J. M. Aldrich). The peculiar yellow hairs on the tips of the hind tibiæ will serve to distinguish this species from the other North American forms.

25. Medeterus Aldrichii, sp. nov.

Male. Length 3.5 mm.; length of wing 4 mm. Proboscis very large, swollen, laterally compressed, glabrous, black, with yellow hairs. Palpi glabrous, black. Face below the suture shining deep metallic blue, just above the suture dusted with gray. Below the insertions of the antennæ the ground color of the face is more greenish blue. Basal joint of antennæ yellow, second and third joints black, the latter as long as broad, rounded, pubescent, with slender, naked subapical arista. Front opaque, with brown dust in the middle, with gray dust along the orbit and on the occiput. Postocular cilia white, prominent. Thorax submetallic brownish black, with four distinct gray vittæ. The mesial pair fuse at the neck but remain separate up to the scutellum, thus enclosing a median brown stripe even on the pre-scutellar depression. Before the sides of the scutellum each mesial gray stripe fuses with a lateral gray stripe which runs forward only half the length of the thorax. There is a distinct accumulation of gray dust on the humeri and in the posthumeral depressions. The black bristles on the anterior portion of the thorax are small, but laterally and posteriorly they are long and well developed. Scutellum covered with gray dust and bearing four black bristles. Abdomen shining bronze-black, the bases of the separate segments opaque with gray dust. Hairs covering the segments short, in some lights black, in others yellowish. Hypopygium long and moderately slender, shining black, appendages short and indistinct, somewhat yellow at their tips. The hairs on the lower (morphologically dorsal) surface of the organ are rather short. Pleuræ black, overlaid with a thin layer of gray dust. Bristles above the fore coxæ and the hairs on the anterior surfaces of the fore and middle coxæ black. Legs black throughout. Hind tibia and metatarsus plain. Second joint of hind tarsus about one and two-thirds times as long as the metatarsus. Wings hyaline with veins black almost to their bases. Distal segment of fifth vein only half as long as the posterior cross-vein; tips of the third and fourth veins close together. Halteres yellowish on the under side but distinctly blackened and dusted with gray on their upper surfaces. Tegulæ yellow, edged with black and bearing rather long white cilia.

One specimen of this handsome species from Moscow, Idaho, taken during September by Professor J. M. Aldrich.

26. **Medeterus princeps**, sp. nov.

PLATE II, FIGS. 29–32.

Male. Length 4–4.5 mm.; length of wing 4–4.5 mm. Proboscis much swollen, very glabrous, black. Palpi black, shining, with yellow hairs. Face below suture very bright metallic green, glabrous; just below the insertions of the antennæ there is a thick layer of yellowish dust; between these two regions the metallic green ground-color is exposed, but is not so glabrous as the region below the suture. Antennæ black, arista subapical, nearly as long as the face and the proboscis. Front and occiput densely covered with yellowish gray dust, faintly revealing the metallic green ground-color. Thorax metallic green but subdued to a satiny luster by the heavy layer of gray dust investing it, with five brown, somewhat iridescent vittæ; the three mesial of which fuse posteriorly to form a large brown patch covering the prescutellar depression; the lateral pair are shorter, terminate at the insertions of the wings posteriorly and fuse with the adjacent mesial band anteriorly. Acrostichal and dorsal bristles black. Scutellum uniform submetallic greenish gray, with four black bristles. Abdomen of the same color as the scutellum, the segments covered with short yellow hairs. Along the sides of the segments the smooth black depressions are conspicuous and elongated. Hypopygium rather slender, pedunculate, shining black, and hairless except in the basal portion of the left side, where the overlapping scale-like rudiments of the seventh and eighth (?) segments are coated with gray dust and beset with a few yellowish hairs. Appendages of the hypopygium yellow, posterior pair rather short and broad, straight, fringed with yellowish hairs. Pleuræ sub-metallic greenish gray like the abdomen. Above the insertions of the fore coxæ there are four prominent white bristles on either side. Coxæ black, covered with yellowish white dust and with short silky white hairs on their front faces. Trochanters and legs piceous, the knees lighter, the femora darker towards their bases. The apices of the first to third tarsal joints black, the fourth and fifth joints entirely black. Hairs on the femora white, those on the tibiæ and tarsi white and black, bristles on all parts of the legs black. Hind tibiæ slightly swollen towards their tips which are black like the tips of the anterior tibiæ. Hind metatarsus slightly broader than the succeeding joints, with a small, sharp, tooth-shaped projection on the inner side near the base. Second joint of hind tarsus nearly three times as long as the first. Wings hyaline, rather narrow towards the tips. Veins brown, becoming yellow proximally. Posterior cross-vein slightly bowed, about half as long as the distal segment of the fifth vein. Third and fourth veins gently converging, running parallel with each other close to their tips and ending rather close together. Tegulæ and halteres yellowish white, the former with long white cilia.

Female. Length 5 mm.; length of wing 5 mm. The coloring is the same as on the male. The ovipositor is shining black, yellowish towards the tip. The hind metatarsus lacks the tooth-like projection on the inner side.

Four males and one female of this large and handsome species taken at Farmingdale, N. J., July 14, 1895, (Mr. C. W. Johnson).

27. **Medeterus veles** *Loew.*

PLATE II, FIGS. 36–38.

This is our commonest species in the Middle States. I have taken it in July on the smooth bark of trees in the Chicago parks. The male has a small tooth-like projection on the inner side at the base of the hind metatarsus. This is not mentioned in Loew's description, which was drawn from an imperfectly preserved specimen. The female of *M. veles* resembles the male in coloration. The ovipositor, which in my specimens is exserted, is yellowish brown. The face is dull green below and thickly covered with gray dust above the suture.

28. Medeterus californiensis, sp. nov.

PLATE II, FIGS. 44 AND 45.

Male. Length 3–3.5 mm.; length of wing 3–3.5 mm. Proboscis and palpi black, shining. Face dull metallic green, scarcely shining, above the suture with some yellowish dust. Antennæ black, arista subapical, as long as the face and the proboscis. Front opaque with gray dust. Postocular cilia yellowish white. Thorax opaque light gray with three yellowish brown vittæ extending back only to the anterior edge of the prescutellar depression. Bristles on the thorax black. Scutellum subopaque, gray, with four black bristles. Abdomen subopaque greenish gray with yellowish white hairs on the segments. Hypopygium rather large and swollen, shining black, except on the left side near the base, where the scale-like overlapping elements are subopaque and dusted with gray like the abdomen. Appendages rather long, brownish, the hairy posterior pair somewhat geniculate. Pleuræ subopaque, gray. Bristles above the fore coxæ white. Coxæ dark brown or black, the fore pair with black bristles on their anterior surfaces. Trochanters and basal two-thirds of the femora dark piceous brown, tips of femora, the tibiæ and bases of metatarsi yellowish, tips of metatarsi and the remaining tarsal joints infuscated. Hind metatarsus narrowed at the base where it bears a small tooth-like projection on the inner side. Second joint of hind tarsus two and one-half times as long as the metatarsus. Wings clear, hyaline, with yellowish brown veins that grow lighter proximally. Third and fourth veins parallel and rather close together at their tips. Posterior cross-vein of about the same length as the distal segment of the fifth vein. Halteres whitish with darker pedicels. Tegulæ pale with white cilia.

Female. Length 4–5 mm.; length of wing 3.5–4 mm. Coloring the same as that of the male. Ovipositor long, exserted, dark brown. Hind metatarsus lacking the small tooth-like projection on the inner side of its base.

Four males and six females taken at Palo Alto, Calif., October 20, 1894, by Mr. R. W. Doane and furnished me by the University of Kansas.

29. Medeterus cyanogaster, sp. nov.

Male. Length 2–2.25 mm.; length of wing 2.5 mm. Proboscis piceous, with yellow hairs. Palpi, face and front metallic green or black, covered with gray dust. Antennæ short, first and second joints yellow, third joint broader than long, black, distinctly pilose; arista naked, inserted in an indentation near the apex of the third joint. Postocular cilia white. Thorax and scutellum bluish green, but so thickly covered with light gray dust that the ground-color is invisible. Bristles on the thorax prominent, black. Scutellum with four bristles. Abdomen metallic blue, somewhat greenish and dusted with gray on the two basal segments, but becoming a deep indigo color towards the insertion of the hypopygium. Hairs on the abdominal segments rather sparse, black. Hypopygium moderately long and rather thick, shining black at the base, but becoming lighter towards the tip, which bears well developed yellow appendages. Pleuræ above metallic bluish green, below deep metallic blue, dusted with gray. Coxæ and legs pitchy yellow, coxæ and tarsi of a somewhat darker tint than the femora and tibiæ. Hairs on the anterior surfaces of the coxæ and the few bristles above the insertion of the fore coxæ, white. First joint of hind tarsus plain, second joint about one and two-thirds times as long as the first joint. Wings hyaline and iridescent. Veins yellow, lighter towards their bases. Tips of the third and fourth veins rather close together; distal segment of fifth vein one and one-half times as long as the posterior cross-vein. Tegulæ and halteres light yellow, the latter with white cilia.

Female. Length 2–2.25 mm.; length of wing 2.5 mm. The coloring is the same as that of the male, except that the first abdominal segment is thickly covered with gray dust like the thorax. This may perhaps be the case in well preserved male specimens also.

Three males and three females of this pretty little species were sent me by Professor J. M. Aldrich. They were taken at Colfax, Washington, in July.

30. **Medeterus xerophilus,** sp. nov.

Plate II, Figs. 33–35.

Male. Length 1.5 mm.; length of wing 1.5 mm. Proboscis and palpi small, shining, black. Face dull metallic green, not glabrous. Antennæ black, arista subapical, as long as the face. Front black, covered with opaque gray dust. Postocular cilia pale. Thorax metallic green, thickly covered with gray dust. Dorsal bristles black. Scutellum of the same color as the thorax, with four bristles. Abdomen somewhat flattened dorsoventrally, black, subglabrous, its hairs of an uncertain color, pale in some lights, dark in others. Hypopygium small, slender, more glabrous than the remainder of the abdomen. Appendages minute, yellowish. Pleuræ black, thickly covered with gray dust above, more thinly towards the coxæ. Above the fore coxæ there are a few white bristles. Coxæ black with pale hairs. Legs dark brown or piceous, with yellow knees and the bases of the anterior metatarsi broadly yellow. Hind metatarsi plain, second joint only one and one-half times as long as the metatarsus. Wings rather short and broad, brownish gray, with brown veins growing yellowish towards their bases. Third and fourth veins ending rather far apart, the latter in the very tip of the wing. Posterior cross-vein twice as long as the distal segment of the fifth vein. Sixth vein very faint. The discal cell is rather broad at its proximal end. Halteres yellow. Tegulæ brown, with brown cilia.

Female. Length 2 mm.; length of wing 2 mm. It agrees with the male in coloration. The ovipositor is not exserted as it is in the females of many species of *Medeterus*.

Three male and eleven female specimens swept from the dry ferns in the pine-woods about Pacific Grove, Calif., during July, 1896.

This species, in general appearance and in neuration, resembles the species of *Thrypticus* (*Aphantotimus* Wheeler).

31. **Medeterus aurivittatus**, sp. nov.

PLATE II, FIG. 47.

Male. Length 2.5 mm.; length of wing 2.75 mm. Proboscis moderate, glabrous, black, with white hairs. Palpi and face black, the latter above the suture dull metallic blue, covered with gray dust, which is thickest at the suture and just below the insertions of the antennæ. Antennæ black, of the usual form. Front opaque, with a thick layer of light gray dust. Postocular cilia white. Thorax opaque, with light gray dust, with the black bristles well developed and with three subequal golden yellow or light brown stripes extending back as far as the anterior edge of the prescutellar depression. Scutellum and abdomen dark steel blue, somewhat shining, covered with a thin layer of gray dust. Scutellum with four prominent bristles. Hairs covering the abdominal segments white except those along the posterior edge of each segment, which are black. Hypopygium as long as the abdomen, well developed, glabrous, black, with white hairs on its basal portion; appendages rather thick and short, yellow. Pleuræ greenish black, thickly covered with gray dust. Coxæ and legs black; knees and basal two-thirds of middle metatarsus yellow. Bristles above the base and hairs on the anterior surfaces of the fore coxæ white. Hind metatarsus plain, second joint about one and one-half times as long as the metatarsus. Wings hyaline, veins black, yellow at their bases. Venation normal. Distal portion of fifth vein but little longer than the posterior cross-vein. Halteres and tegulæ whitish, the latter with white cilia.

Female. Length 2.75 mm.; length of wing 2.75 mm. In coloration the female closely resembles the male. The ovipositor, which is extruded in my specimens, is rather short and thick.

Two males and three females collected by J. M. Aldrich at Moscow, Idaho.

32. **Medeterus appendiculatus**, sp. nov.

PLATE II, FIGS. 41–43.

Male. Length 2.5 mm.; length of wing 2 mm. Proboscis of moderate size, shining black. Palpi black. Face opaque with gray dust; on the front the dust is more yellowish gray. Antennæ black; arista apical, but little longer than the face. Postocular cilia whitish. Thorax opaque gray, more yellowish in front of the prescutellar depression. The acrostichal bristles are white, the dorsal bristles black; four red bristles are inserted far apart near the middle of the thorax, the outer pair being a short distance in front of the insertion of the wings. Scutellum opaque gray, with four black bristles. Abdomen metallic green, overlaid with a thick layer of gray dust, bristles white. Hypopygium large and swollen, glabrous, black. Outer appendages brownish yellow, rather large, but slender; inner appendages pale yellow, very delicate, like dichotomously ramifying hairs. Penis very slender, nearly straight. Pleuræ dull metallic green, thickly dusted with white. Bristles above the insertions of the fore coxæ white. Coxæ black, piceous towards their tips, dusted with white and beset with white hairs. Legs yellow, basal two-thirds of femora, trochanters, tips of tibiæ and tarsi from the tip of the first joint piceous. Hind metatarsus plain, second joint two and two-thirds times as long as the metatarsus. Wings hyaline, with brown veins which grow light yellow towards their bases. The costal and posterior margins are parallel. Posterior cross-vein about as long as the distal segment of the fifth vein, angular near its middle, to which is attached a short but very distinct backwardly directed stump-vein. Third vein gently but distinctly deflected downward and running a long distance parallel with the fourth. The ends of these veins are rather far apart. Tegulæ and halteres yellow, the former with pale cilia.

One specimen taken in sweepings on Lance Creek, in Eastern Wyoming, August 14, 1895.

The appendiculate structure of the posterior cross-vein, so striking a feature of this species, is present in both wings of the specimen.

Thrypticus *Gerstaecker*.

Mik's suggestion[1] that my genus *Aphantotimus*[2] is synonymous with Gerstaecker's *Thrypticus* is well founded. I believe this will also hold good of Aldrich's genus *Xanthotricha*.[3] The three species described by Aldrich and the two which I have described agree in presenting most of the generic characters established by Gerstaecker on his *Thrypticus smaragdinus*.[4]

The genus according to Kowarz[5] "hat mit *Medeterus* die meiste habituelle Æhnlichkeit, sie unterscheidet sich von diesem durch den parallelen verlauf der dritten und vierten Längsader." Other characteristics of the species

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[1] Wien. Ent. Zeitschr, 1891.

[2] Psyche, July, 1890, pp. 375-377.

[3] Williston and Aldrich. Diptera of St. Vincent. Trans. Ent. Soc. London, Pt. III, 1896.

[4] Uebersicht d. in d. Umgegend Berlins bis jetzt beobachteten Dolichopodiden, p.p. 43-45.

[5] Die Dipteren-Gattung *Medeterus*, p. 6.

are their small size, the yellow bristles on the body, the flattening in front of the scutellum, the complete or almost complete absence of bristles on the legs, which are plain in both sexes, the small size of the third antennal joint and its long subapical arista, the absence of the sixth vein in the wing and the long hypopygium with its delicate penis flexed under the abdomen. The description of Aldrich's *Xanthotricha minor* from St. Vincent, W. I., is too meager to enable me to distinguish it from my *Aphantotimus Willistoni*. I therefore omit it in the following table:—

1. Femora yellow.. 2
   Femora metallic green.................. *fraterculus* WHEELER.
2. Venter and sixth abdominal segment yellow.
   cupulifera ALDRICH.
   Venter and sixth abdominal segment not yellow............ 3
3. Hypopygium slender, ovipositor-like...... *singularis* ALDRICH.
   Hypopygium short and thick............. *Willistoni* WHEELER.

33. Thrypticus Willistoni *Wheeler.*

PLATE II, FIG. 49.

Aphantotimus Willistoni WHEELER, Psyche, July, 1890, p. 376.

The hypopygium of this species, first described as *Aphantotimus Willistoni*, is shown in fig. 49. The lamellæ are rounded, yellow and fringed with yellow hairs. The long penis seems to be inserted far forward at the posterior end of the venter. I have found this species common at Riverside, Ill., during June, on the rank undergrowth of damp woods along the Desplaines River. I have also taken it in Wyoming.

34. Thrypticus fraterculus *Wheeler.*

PLATE II, FIG. 48.

Aphantotimus fraterculus WHEELER, Psyche, July, 1890, pp. 376–377.

The hypopygium of this species, first described as *Aphantotimus fraterculus*, is represented in fig. 48. The lamellæ are longer than those of the preceding species, with shorter hairs, and extend backwards. The penis, too, is longer and appears to be inserted on the hypopygium itself.

Asyndetus *Loew.*

This genus was separated by Loew[1] from *Diaphorus* and made to include those species which have the posterior cross-vein very near the base of the wing, the third vein ending near the second, and the fourth vein bent downwards with an interruption or attenuation in the angle near the middle of its distal segment. These with several other less important correlated characters appear to establish the genus satisfactorily. The single species here added agrees with the other described forms except in the structure of the second antennal joint, which is like that of species of *Syntormon*, overlapping the third joint on the inner side. This character by itself, however, is hardly of sufficient value to exclude the species from the genus *Asyndetus*. The males of the described species may be distinguished as follows:—

1. Second antennal joint broadly overlapping the third on the inner side .... *syntormoides*, sp. nov.
   Second antennal joint of the usual form 2
2. First joint of fore tarsi incrassated .... *ammophilus* LOEW.
   First joint of fore tarsi not incrassated...................... 3
3. Second joint of fore tarsi with clavate yellow appendages. *appendiculatus* LOEW.
   Second joint of fore tarsi without such appendages......... 4
4. Thorax vittate .... *fratellus* ALDRICH.
   Thorax without vittæ....................... *interruptus* LOEW.

35. Asyndetus syntormoides, sp. nov.

PLATE II, FIGS. 50-52.

Male. Length 2.75-3 mm.; length of wing 2 mm. Head distinctly wider than the thorax; eyes large; face broad, metallic green, thinly dusted with white, concave near the middle. Antennæ large, black; first joint cylindrical; second joint produced into a thumb-like lobe overlapping the third joint on the inside to a distance nearly equal to half its length; third joint large, nearly three times as long as broad, of nearly equal breadth as far as its middle, then tapering to a point, clothed with short gray pile and bearing a dorsal arista covered with very short pubescence. Front large and broad, bright metallic green, with golden reflections. Postocular cilia rather abundant, black above, white below. Thorax, scutellum and abdomen dark metallic green, the first with violet, the second with golden, the last with cupreous

[1] Cent. VIII, 58-59, pp. 148-150.

reflections near the bases of its segments. Hypopygium small, black, embedded, provided with four black bristles which project backwards. Pleuræ, coxæ and legs black, femora with metallic green reflections, tibiæ and all but the tips of the fore and middle metatarsi yellow. Fore tarsi plain, first joint as long as the second to fifth joints taken together. These latter are very short. None of the pulvilli are enlarged. Wings hyaline with black veins which become brownish towards the base; costa ending at the third vein which runs near the second and terminates very near the tip of the wing. Fourth vein delicate but complete throughout; its tip bends downward and ends behind the tip of the wing. Posterior cross-vein near the base of the wing as in other species of the genus. Halteres and tegulæ yellow, the latter with pale cilia.

Female. Length 2.5 mm.; length of wing 2.25 mm. Face but little broader than that of the male. Thorax with golden instead of violet reflections. In other respects the coloration is that of the male. The second joint of the antenna has a much shorter overlapping projection than in the male; the third joint is scarcely longer than broad, rounded, terminating in a blunt point; the arista is distinctly dorsal but shorter than that of the male.

Three specimens of this interesting species received from Mr. C. W. Johnson; two males labelled New Bedford, Mass., July 15, 1896, and a female from Avalon, N. J., taken July 22, 1894. There is scarcely a doubt that the two sexes belong to the same species. Another male specimen collected by L. E. Hood at E. Boston, Mass., was sent me by Mr. Samuel Henshaw.

Porphyrops *Loew.*

In the following amplification of Loew's table of North American species of *Porphyrops*, all the described forms are included with the exception of Walker's *Porphyrops pilosicornis*. This species has not yet been recognized and Walker's description of the antennal arista as "proceeding from the base of the third joint and more than twice its length" makes it very doubtful whether it is a *Porphyrops* at all.

1. Feet black . . . . *melampus* LOEW.
   Feet yellow 2
2. All the coxæ completely black or greenish black 3
   Coxæ more or less yellow 4
3. Middle coxæ with black bristles at tip . . . . *longipes* LOEW.
   Middle coxæ without black bristles at tip . . . . . *nigricoxa* LOEW.
4. Fore coxæ not blackened at the base . . . . *fumipennis* LOEW.
   Fore coxæ blackened at the base 5

5. Antennal arista with a terminal lamel in the male.. *signifer* O. S.
   Arista without a terminal lamel.......................... 6
6. Third antennal joint of male as long as the thorax. *xipheres*, sp. nov.
   Third antennal joint of male not as long as the thorax...... 7
7. Hypopygial lamellæ furcate................. *rotundiceps* Loew.
   Hypopygial lamellæ simple, long and pointed.. *effilatus*, sp nov.

36. Porphyrops xipheres, sp. nov.

Plate II, Fig. 53.

Male. Length 3.5 mm.; length of wing 3 mm. Palpi small, dusted with white. Face broad for a male, covered with silvery white dust. Antennæ black; first and second joints short, third joint flattened, as long as the thorax, slowly tapering to the tip and covered with short and almost imperceptible pile; arista terminal, very short, with short pubescence, its basal segment somewhat thickened. Front black, rather opaque. Postocular cilia abundant, snowy white. Thorax and scutellum blackish metallic green, the latter with bluish reflections. Abdomen dark metallic cupreous green; edges of the segments black; basal segments bearing long pale hairs on their sides. Hypopygium shining black, with protruding appendages; lamellæ triangular, tapering, covered with erect hairs, black, each with a small white spot near its base; internal appendages club-shaped. Pleuræ thickly covered with gray dust, except above the base of the middle coxæ where the metallic green ground-color is exposed. Coxæ concolorous with the pleuræ, only their extreme tips yellow; anterior surfaces of fore coxæ clothed with conspicuous silvery white hairs. Middle coxæ each with a tuft of similar hairs and a couple of stout, curved black bristles. Legs plain, yellow, anterior tarsi from the tip of the first joint, the hind tibiæ, which are somewhat incrassated, hind tarsi and hind femora on their upper surface near the tip, black. Wings grayish hyaline, not narrowed toward the base; veins brown; third and fourth veins nearly parallel. Halteres and tegulæ yellow, the latter with long white cilia.

One specimen from Delaware County, Pa., June 8, 1892, received from Mr. C. W. Johnson.

This species may be readily distinguished from the other described North American forms by the peculiar elongation of the third antennal joint.

37. Porphyrops effilatus, sp. nov.

Plate II, Figs. 54 and 55.

Male. Length 3.5 mm.; length of wing 3 mm. Palpi and face covered with silvery white dust; the latter very narrow. Antennæ black, third joint lanceolate, twice as long as broad at the base, clothed with very short pile; arista apical, very little longer than the antennæ, with scarcely perceptible pubescence. Front shining dark metallic green. Postocular cilia abundant, black above, snowy white below. Thorax, scutellum and abdomen rather dark metallic green, in some specimens with golden or coppery reflections; the thorax with a thin layer of white dust anteriorly, the abdomen growing darker towards the tip and bearing long white hairs on the sides of the basal segments. Hypopygium shining black; lamellæ simple, about one-third as long as the abdomen, each drawn out into a fine point which is often convoluted in dried specimens. These appendages are yellow, infuscated at their tips and fringed with delicate hairs along their edges. Internal hypopygial appendages club-shaped, black or dark brown. Pleuræ dark metallic green, covered with white dust which is rather thin on the mesopleuræ. Coxæ concolorous with the pleuræ, fore pair broadly, middle and hind pairs more narrowly tipped with yellow; fore and middle pairs thickly covered with silvery white hairs on their anterior surfaces. There are no black bristles on the middle coxæ, but a spur-like cluster of white bristles at the tip. Legs rather bristly; fore and middle pairs yellow, the former with their femora blackish green excepting their bases and apices; tarsi blackened from the tip of the first joint; fore metatarsus plain, hardly as long as the remaining four joints taken together. Posterior surfaces of fore femora with several long, stout hairs. Hind legs slightly elongated, their tibiæ and metatarsi somewhat incrassated, deep black, with the exception of the basal halves of the femora which are yellow and the basal portion of the tibiæ which is brownish on the upper surface. Wings slightly narrowed towards their bases, grayish hyaline; veins brown with yellow roots; the third and fourth veins at first converge gently, but on approaching the tip of the wing become parallel, the fourth terminating a very short distance before the tip. Halteres and tegulae pale yellow, the latter with white cilia.

Female. Length 3.5 mm.; length of wing 3.25 mm. Proboscis and palpi large. Face broad, somewhat projecting, with strongly marked transverse suture; both the palpi and face covered with gray dust. Antennæ small, black; third joint of about the same shape as that of the male, but not one and a half times as long as broad; arista longer than the antenna. Postocular cilia abundant, silvery white. Front, thorax, scutellum and abdomen bright cupreous, the abdomen more metallic green on the sides. Venter and pleuræ thickly covered with gray dust. White hairs on the anterior faces of the fore and middle coxæ distinct. Legs resembling those of the male in coloration, except that only the apical third of the hind tibia is black. Fore and middle tarsi with black tips to the first and second joints; third, fourth and fifth joint and the whole hind tarsus black. Wings broader towards their bases, and veins more extensively yellow at their roots than in the male. Third and fourth veins lyrate, at first approaching each other gradually and then separating slightly at their tips.

Three males from Milwaukee, Wis., and two males and two females collected in the cañons of Buck Creek and Little Wind River, Wyoming, during Aug. and Sept., 1895.

This species, which I formerly took to be the same as Loew's *P. longipes*,[1] appears to me, after careful reperusal

[1] Psyche, June, 1890.

of Loew's description, to be quite distinct. Loew's species is described as having entirely black coxæ, a black thorn-like tuft of bristles on the middle coxa and bipartite hypopygial lamellæ. *P. effilatus* has the tips of the coxæ yellow, a white thorn-like tuft of bristles on the middle coxa and simple hypopygial lamellæ.

Synarthrus *Loew.*

Loew established the genera *Syntormon* and *Synarthrus* in his "Neue Beiträge" V, 1857, p. 35, for certain species previously included in Meigen's genus *Rhaphium*. These species agreed in having the second antennal joint overlapping the third on the mesial side with a thumb-like projection. The species of *Syntormon* were distinguished from those of *Synarthrus* in having the first antennal joint hairy on the upper side. Loew, when he came to describe the Dolichopodidæ of North America, retained the two genera, but found only species of *Synarthrus* represented in this country, i. e., species without hairs on the first antennal joint. Schiner in his "Fauna Austriaca," Diptera I, p. 192, 1862, united Loew's genera, retaining the name *Syntormon*, but discarding *Synarthrus*. His example was followed by Mik, who found that in *Syntormon rufipes* Zett. the female has the first joint of the antennæ naked above, whereas the male may or may not have a hair on the upper surface of this joint. Thus the only character on which the genus *Synarthrus* was originally founded proved to be of no value.

When we examine the American species described by Loew and the new ones here described, we find that they constitute a very compact group, if we exclude Loew's *Synarthrus barbatus*. Of this peculiar species Loew says:[1] "Its position in the genus *Synarthrus* can only be a temporary one, brought about by the difficulties of placing it into another genus. It is sufficiently distinguished from the other species of *Synarthrus* by the pecularity alone, that

[1] Monog., p. 134.

the second joint of the antennæ encroaches only very little on the inner side of the third. In its general appearance it approaches the species of *Porphyrops* very closely, so that I leave it undecided whether it would not be better located there. The size of the pulvilli of the fore tarsi betrays a relationship with *Eutarsus* and *Diaphorus*, the structure of the antennæ, however, does not allow its location in these two genera. To erect a new genus does not seem advisable, as the species shows close relationship in various directions." Loew's placing of this species in the genus *Synarthrus* has led me into an oversight. I find that I have redescribed the species as *Xiphandrium americanum*.[1] The species may therefore be known as *Xiphandrium barbatum* (Loew), if it really be a *Xiphandrium*, which is somewhat doubtful. For the present I will not decide on its position, but will merely exclude it from the genus *Synarthrus*. We then have left Loew's *S. cinereiventris* and *S. palmaris* and the two new species described below, *S. affinis* and *S. stratægus*. Now these four forms all agree in possessing females with peculiar broad faces which project forward below like a roof. The males, however, resemble the males of *Syntormon* in that they have peculiarly ornamented hind metatarsi. The remarkable facial structure of the female is a character of sufficient importance to justify separating these species from *Syntormon* as a distinct genus. In doing this I would reinstate Loew's generic name *Synarthrus* for these species, since he first described two of the North American species under this name, and since the introduction of a new generic name would be superfluous. There is in the Western States another group of Dolichopodidæ resembling *Syntormon* and *Synarthrus* in having an overlapping second antennal joint. These also form a natural and compact group, rich in plastic characters. For their accommodation I have erected the genus *Parasyntormon* (q. v.). The males of the four species of *Synarthrus* known to me may be tabulated as follows:—

[1] Ent. News., May, 1896, p. 154.

1. Middle tarsi of male modified.................*palmaris* LOEW.
   Middle tarsi of male plain.............................. 2
2. Fore coxæ entirely yellow.................*cinereiventris* LOEW.
   Fore coxæ only tipped with yellow........................ 3
3. Front metallic violet...........................*affinis*, sp. nov.
   Front dull metallic green...................*stratægus*, sp. nov.

38. Synarthrus cinereiventris *Loew.*

PLATE III, FIGS. 62 AND 63.

This species appears to be very rare in the Middle States, the male from which I described this sex[1] being the only specimen I have ever found. It is easily distinguished from the males of the other species in having a close-set graduated series of six robust black bristles on the lower surface of the proximal half of the middle femur. The posterior cross-vein in this species is about the same length as the distal segment of the fifth vein.

39. Synarthrus affinis, sp. nov.

PLATE III, FIGS. 56–59.

Male. 3.5–4 mm.; length of wing 2.5–3 mm. Palpi very small, white. Face narrow below, covered with silvery white dust, more gray towards the antennæ. Antennæ black, basal joint with a few distinct hairs on its mesial surface, terminating in a prominent ventral projection; overlapping portion of second joint thumb-shaped; third joint as long as the face, completely covered with short but distinct pile, rapidly tapering, its ventral more convex than its dorsal contour; arista very nearly apical, as long as the third joint, pubescent. Front shining metallic violet. Postocular cilia of moderate length, white. Thorax metallic golden green, somewhat dimmed with pale dust, especially in front. Scutellum metallic bluish green. In some specimens the abdomen is metallic golden green, the basal portion of each segment more cupreous, in others the abdomen is cupreous and the bases of the segments are dark. Hypopygium almost completely concealed. Pleuræ dark metallic green, covered with white dust. Coxæ black, turning yellow towards their tips, covered with pale hairs. Legs yellow, tarsi infuscated or blackened from the tip of the first joint; hind femora with a broad black band near the tip; tip of hind tibia distinctly blackened; hind metatarsus with a peculiar recurrent sickle-shaped black bristle on its plantar surface; middle femur with an even series of black bristles along its lower surface

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[1] Psyche, Vol. V, 1890, p. 362.

and a single projecting bristle near the tip on the outer side. Bristles on the posterior legs similar to those in *S. cinereiventris.* Wings hyaline gray, narrowed towards their bases; third and fourth veins converging but slightly towards their tips. Distal segment of fifth vein about one and one-half times as long as the posterior cross-vein. Halteres yellow, with darker peduncles. Tegulæ brown, with delicate white cilia.

Female. Length 3–4 mm.; length of wing 2.5–3 mm. Palpi large, gray, withdrawn under a roof-shaped projection, into which the epistoma of the broad face is prolonged. Third joint of antennæ scarcely longer than broad, rounded, with only an indication of a point; arista distinctly dorsal, about half the length of the eye, pubescent; second antennal joint with a distinct thumb-shaped projection overlapping the inner side of the third joint; first joint very short, lacking the proximal ventral projection of the male. Thorax, scutellum and abdomen colored like those of the male. Hind femur without the broad black band and hind tibia but very slightly infuscated at its tip. Hind metatarsus without a recurrent sickle-shaped bristle and there is no row of conspicuous bristles on the lower surface of the median femur. Wings not narrowed towards the base.

Many specimens of both sexes of this pretty species were swept from low vegetation near water in the pine woods back of Monterey, Calif., during July, 1896.

The species resembles the eastern *S. cinereiventris* with which the male has the recurrent metatarsal spine in common. *S. cinereiventris,* however, has entirely yellow hind femora and fore coxæ, and the bristles on the lower surfaces of its middle femora are larger and more conspicuous than they are in *S. affinis.* Loew's description of the female of *S. cinereiventris* shows that this species must be very similar to the female of the Californian species. They may be distinguished by the coloring of the fore coxæ.

40. **Synarthrus stratægus,** sp. nov.

PLATE III, FIGS. 60 AND 61.

Male. Length 4–4.5 mm.; length of wing 3.5–4 mm. Face covered with silvery white dust. Antennæ small, black; basal joint with a sharp ventral projection on its inner side and a few very short hairs on its mesial and upper surface; second joint overlapping the third on the mesial side with a thumb-shaped projection; third joint pointed, scarcely twice as long as broad, more convex along its ventral than along its dorsal edge, covered with distinct but delicate pile; arista very nearly apical, about half as long as the eye, covered with extremely short pubescence. Front bronze black. Postocular cilia rather delicate, black above, glistening white below. Thorax and scutellum bronze black, with greenish reflections, overlaid with gray dust. Abdomen dull metallic green, bases of segments and small, almost completely imbedded hypopygium, black. Hairs and bristles covering the abdomen black, long towards the posterior edges of the segments, especially on the edge of the first segment; first and second segments with long and projecting, but rather delicate white hairs along their sides. Sides of the segments thinly, venter more thickly covered with gray dust. Pleuræ and coxæ dull metallic green, overlaid with white dust, the latter with yellow tips and white hairs; each coxa also bears a prominent black bristle, the fore and middle coxa on the anterior surface near the tip, the hind pair on the posterior surface near the middle. Legs yellow; fore femora metallic green except the apical third; middle femora metallic green only at the base; hind femora with two broad metallic green bands, one at the base and one near the apex. Fore tibiæ with a row of regular short black bristles on the anterior surface; middle femora ciliated with black bristles on their lower surfaces; hind tibiæ somewhat incrassated towards their tips but not blackened; both the middle and hind tibiæ rather bristly; fore and middle tarsi blackened from the tip of the first joint. Hind tarsi entirely black; hind metatarsus somewhat thickened and distinctly excavated on its plantar surface where it bears near the proximal end two strong and somewhat recurved black bristles. Second joint of hind tarsi equalling the first in length. Wings grayish hyaline, not narrowed towards the base, so that the anal angle is prominent; third and fourth veins divaricating very slightly towards their tips in the costa; third vein near its termination distinctly but gently bent down towards the fourth. Posterior cross-vein of about the same length as the distal segment of the fifth vein. Halteres and tegulæ yellow; the latter margined with black and bearing delicate white cilia.

Female. Length 5 mm.; length of wing 4 mm. Face and palpi covered with plumbeous dust, the former very broad and produced below into a projecting roof-shaped epistoma, overhanging the palpi and proboscis. Antennæ small; third joint about as long as broad, with a very short, blunt apex, on which the arista is inserted; pile short; arista of about the same length as in the male, with scarcely perceptible pubescence. Overlapping lobe of second joint well developed; first joint short, with a distinct ventral projection smaller than that of the male. Coloring of the thorax, scutellum and abdomen like the corresponding parts of the male, but the white hairs on the basal segments of the abdomen are less prominent. Legs plain; middle and hind femora entirely yellow; basal half of fore femora infuscated. Wings more yellowish brown than in the male, especially along the posterior cross-vein and near the middle of the distal segment of the fourth vein.

Four males from Lusk, Wyo., collected by Mr. W. A. Snow during July, 1895, and a male and female collected by myself near Monterey, Calif., during July, 1896.

This is the largest of the North American species known to me. The males are readily recognized by the peculiar structure of the hind metatarsi.

Parasyntormon, gen. nov.

Species in general shape and coloration resembling species of *Sympycnus*. Face of male narrow. Antennæ inserted high up, large; first joint without hairs on its upper surface, rather long, usually with a blunt ventral projection near its tip; second joint overlapping the third on the mesial side with a thumb-shaped lobe; third joint large, flattened, of variable shape, usually longer than broad, distinctly pilose; arista dorsal, subapical or apical, long, more or less pubescent. Thorax convex behind, with prominent dorsal bristles; acrostichal bristles in a single row. Scutellum with only two bristles. Abdomen slender, laterally compressed, basal segments largely yellow in most of the species. Hypopygium small, embedded, only the small appendages projecting. These consist of a pair of anteriorly directed club-shaped organs with few hairs and a pair of hirsute posterior appendages, each of which terminates in a long hair. Wings distinctly narrowed towards their bases. Third vein gradually bent down towards the tip till it approaches the end of the fourth vein, which is as gradually bent up and terminates in the tip of the wing. Posterior cross-vein short, about one-third or even less than the length of the distal segment of the fifth vein, thus making the discal cell very short and narrow. Legs slender, hind pair longest; hind metatarsus without bristles, shorter than the succeeding joint; middle and hind legs plain in all of the known species; fore tarsi similarly modified in the males of all the species as follows: first joint slender, as long as the remaining joints taken together, bearing a row of three or four black bristles on its plantar surface near the base; second, third, fourth and fifth joints very short, subequal; second joint distinctly incrassated, third with a small recurved bristle on its plantar surface near the base. Antennæ of female much smaller than those of the male, overlapping lobe of second joint much shorter; third joint scarcely longer than broad, roundish angular in outline, with short, distinctly dorsal arista. Face and legs plain, the former somewhat broader than in the male. Wings not narrowed towards their bases.

The six species seem to be restricted to the Western United States. They may be distinguished as follows:—

1. Second and third abdominal segments largely yellow....... 2
   Abdomen entirely cupreous.................... *asellus*, sp. nov.
2. Third antennal joint of male quadrilateral, with truncated tip.
   occidentale (ALD.)
   Third antennal joint of male pointed...................... 3
3. Arista of male distinctly dorsal.......................... 5
   Arista of male subapical.................................. 4
4. Basal joint of antenna largely yellow........... *lagotis*, sp. nov.
   Basal joint of antenna black.................. *hinnulus*, sp. nov.
5. Arista inserted near the tip of third antennal joint.
   emarginatum, sp. nov.
   Arista inserted half-way between the base and tip of third antennal joint......................... *montivagum*, sp. nov.

41. Parasyntormon asellus, sp. nov.

PLATE III, FIGS. 64–67.

Male. Length 2.5–3 mm.; length of wing 2–2.5 mm. Proboscis and palpi small, blackish, the latter covered with gray dust. Face rather broad for a male, overlaid with dull gray dust. Antennæ black, unusually long; first joint long, gradually enlarging to its tip, without hairs or a ventral projection, in some specimens brownish; second joint with the usual black hairs, overlapping the third on the inside with a thumb-like lobe, which is a third as long as the third joint; third joint somewhat longer than the head, tapering, covered with conspicuous pile; arista apical, scarcely one-fifth as long as the third joint, rather thick, pubescent. Front covered with dull gray dust like the face. Postocular cilia black above, snowy white below. Thorax metallic green, so thickly covered with grayish brown dust that the ground-color is scarcely perceptible; bristles, especially those on the humeri, prominent. Scutellum of the same dull color as the thorax, with only two large bristles. Abdomen greenish bronze, blacker towards the tip. Appendages of the small hypopygium black, exserted, consisting of a pair of posteriorly directed projections fringed with diverging black hairs and each prolonged into a long hair, and a pair of club-shaped, truncated, anteriorly directed appendages with but few black hairs; penis slender, yellow, directed backwards. Pleuræ, middle and hind coxæ dark colored, opaque with a thick layer of gray dust; fore coxæ yellow, very slightly infuscated at the base. Legs yellow, tips of the hind tibiæ and all the tarsi from the tip of the first joint, infuscated; middle and hind tarsi plain; fore metatarsus rather slender, with three prominent equidistant black bristles on the basal half of its plantar surface; second joint distinctly incrassated, third joint with a curved spur-like bristle near its proximal end on the inside. Wings grayish hyaline, rather broad at the tip, narrowed towards the base. Second and third veins distinctly diverging and rather far apart at their tips in the costa; third vein bending down gently but running parallel with the fourth for some distance, the fourth ascending gently during the first part of its course. Discal cell small and narrow, the posterior cross-vein being short, the distal segment of the fifth vein nearly four times as long as the posterior cross-vein. Halteres and tegulæ brownish yellow, the latter with black cilia.

Female. Length 2.5–3 mm.; length of wing 2–2.5 mm. Proboscis and palpi larger than those of the male, the latter with whitish edges. Face covered with gray dust, not very much broader. Antennæ much shorter but with longer arista than in the male; the overlapping portion of the second joint is a short lobe, the third joint is somewhat pentagonal and bluntly pointed, but little longer than broad, and covered with short but distinct pile. The arista is præapical, and slightly pubescent. The coloring of the body and legs as in the male; venter covered with gray dust. Fore tarsi plain. Wings with distinct anal angle not narrowed proximally as in the male.

Many specimens of both sexes of this species were taken by me at Coronado, Calif., early in March, 1897, while sweeping in a salt-marsh on San Diego Bay.

42. Parasyntormon occidentale (*Aldrich.*)

PLATE III, FIGS. 68 AND 69.

Two male specimens collected on the banks of Hunter's Creek, in the Wind River Mts., Wyo., Sept. 10, 1896, agree very well with the description of Aldrich's *Sympycnus occidentalis.*[1] The species certainly seems to be a *Sympycnus* at first sight but I would place it with *P. asellus*, which it closely resembles in the structure of the hypopygium, the overlapping of the second antennal joint, the large size of the third antennal joint, the venation of the wings and the ornamentation of the fore tarsi. On the other hand, the species undoubtedly approaches *Sympycnus* in having the antennal arista long and inserted near the base of the third joint. The hind feet, of which Aldrich could give no description as they were absent in his specimen, are yellow, the tarsi blackened from the tip of the first joint. The hind tibiæ are slightly incrassated.

43. Parasyntormon lagotis, sp. nov.

PLATE III, FIGS. 70 AND 71.

Male. Length 2.5–3 mm.; length of wing 2–2.5 mm. Palpi small, covered like the rather broad face and the front with thick grayish brown dust. Antennæ long, basal joint rather slender at its insertion, smooth, light yellow, black along the dorsal side, without hairs, terminating in a blunt projection on the inner side; second and third joints dark brown or black, the latter long and tapering, with distinctly subapical arista, the former short and overlapping the third joint on the inside with a prominent thumb-shaped lobe; third joint covered with long pile. arista rather thick, about half as long as the third joint, pubescent. Ground-color of thorax and scutellum metallic green, but so thickly covered with brown dust as to be almost invisible. Abdomen laterally compressed, first segment blackish, second and third segments light yellow with black or cupreous posterior edges; in some specimens the dark or cupreous portion of the segment extends some distance forward in the median dorsal line. Remaining segments cupreous. Hypopygium and its appendages very similar to those of *P. asellus*, except that the posterior hairy pair of appendages are of a lighter color. Pleuræ covered with gray dust. Fore coxæ entirely yellow, with numerous black hairs on their anterior surfaces. Middle and hind coxæ at their bases dark like the

[1] Kans. Univ. Quart., Vol. II, 1894, p. 153.

pleuræ, but yellowish at their tips, each with a prominent black bristle on the outer side. Legs yellow, tarsi infuscated from the tip of the first joint. Fore femora ciliated with black hairs on their lower surfaces; fore metatarsus with three large black bristles on its plantar surface near the proximal end; second joint distinctly incrassated; third joint with a spur-like curved bristle on the under side near its proximal end. Wings, tegulæ and halteres closely resembling those of the male *P. asellus.*

Female. Length 2.5 mm.; length of wing 2.5 mm. Face somewhat broader than that of the male. Antennæ short, first joint much like that of the male in form and color; second and third joints dark brown, the former with a short overlapping lobe, the latter pilose, as broad as long, with a blunt point and distinctly dorsal arista. Arista rather robust, pubescent, longer than the arista of the male. Fore femora eciliate, fore tarsi plain. Wings with broad bases and distinct anal angles. Second and third abdominal segments yellow, the dark posterior edges of the segments and the dark median dorsal stripe more sharply defined than they are in the male specimens.

Four males and one female taken in sweepings near Monterey, Calif., during July, 1896.

The species may be readily distinguished from *P. asellus* by the yellow of the first antennal joint and of the second and third abdominal segments in both sexes. The modification of the fore tarsi in the males of the two species is remarkably similar.

44. **Parasyntormon hinnulus**, sp. nov.

PLATE III, FIGS. 72 AND 73.

Male. Length 2 mm.; length of wing 1.75 mm. Palpi and face black, probably dusted with gray in well preserved specimens. Antennæ black; first joint rather small, broadened towards the tip, but without a large projection; second joint short, overlapping the third on the inside with a prominent thumb-shaped lobe; third joint tapering, pointed, moderately pilose; arista inserted distinctly before the tip, rather thick, short, pubescent, a little over half the length of the third joint. Front dark, covered with gray dust. Postocular cilia black above, white below. Thorax and scutellum dull metallic green covered with brownish dust. Abdomen cupreous, darker on the posterior segments; first segment dull brownish, second and third segments yellow with blackish bronze posterior margins and mid-dorsal stripe; venter yellow. Hypopygium similar to that of *S. asellus.* Pleuræ dull metallic green covered with gray dust; metapleuræ yellow. Fore and hind coxæ yellow, the former with a few black hairs; middle coxæ blackened. Legs yellow, middle and hind tarsi and tips of hind tibiæ infuscated; fore tarsi with three last joints infuscated, first joint with three or four black bristles in a row near its proximal end on the plantar surface; second joint distinctly incrassated, third joint with a curved black bristle near its proximal end. Fore femur provided with a series of weak black cilia on its under surface. Wings grayish hyaline, scarcely narrowed towards their bases. Third and fourth veins parallel, the latter ending in the tip of the wing; distal segment of fifth vein about three times the length of the posterior cross-vein. Halteres and tegulæ yellow, the latter bordered and ciliated with black.

Two males taken in sweepings near Lusk, Wyoming, August 14th and 26th, 1895. The colors are not well preserved. The species is closely related to *P. lagotis*, but has the basal antennal joint entirely black.

45. **Parasyntormon emarginatum**, sp. nov.

PLATE III, FIG. 75.

Male. Length 2.25–2.5 mm.; length of wing 1.75–2 mm. Proboscis and palpi piceous, with white hairs. Face narrow, covered with gray dust, more white below. Antennæ rather large, black; first joint subcylindrical, without hairs, second joint overlapping the third on the inside with a large thumb-shaped lobe; third joint broad, pilose, rapidly and acutely tapering at the tip; insertion of the rather slender, slightly pubescent arista very decidedly dorsal, being about one-fifth the length of the antenna behind the tip. On the ventral side of the third joint, opposite the insertion of the arista, there is a small but distinct notch. Postocular cilia short, pale below. Front dull black. Thorax and scutellum rather shining dark metallic green, overlaid with brown dust. Abdomen cupreous, ventral halves of second and third segments yellow. Hypopygium black, shaped like that of *P. asellus*. Pleuræ dull blackish green, thickly covered with gray dust. Coxæ yellow, basal half of middle pair black. Legs yellow; tarsi from the tip of the first joint, tips of hind femora and hind tibiæ, black; fore femora with a series of conspicuous black cilia on their lower surfaces; fore tarsi with two to four black bristles on the lower surface of the first joint near the proximal end, second joint distinctly incrassated especially towards its tip, third joint with a hook-shaped bristle near the base on the inside. Wings grayish hyaline, scarcely narrowed basally. Third and fourth veins parallel, the latter ending in the tip of the wing. Distal segment of fifth vein about three times as long as the posterior cross-vein. Halteres and tegulæ yellow, the latter with black edges and cilia.

Female. Length 2.5 mm.; length of wing 2.5 mm. Palpi larger than those of the male, face much broader, covered with light gray dust. Antennæ short, owing to the much smaller size of the third joint, which is pentagonal, but little longer than broad, ending in a very blunt point, with dorsally inserted arista; thumb-shaped overlapping lobe of the second joint shorter than in the male. Coloration of the body and legs like that of the male. Fore femora eciliate, fore tarsi plain. Wing somewhat broader at the base than in the male.

Seven males and one female from Monterey and San Diego, Calif.

The male of this species is distinguished by the pronounced notch in the third antennal joint and the very distinctly dorsal insertion of the arista.

46. **Parasyntormon montivagum,** sp. nov.

PLATE III, FIG. 74.

Male. Length 2.25-3.25 mm.; length of wing 2.5-3 mm. Proboscis and palpi piceous. Face very narrow, the eyes almost meeting. Antennæ large; first joint long, without hairs, with a prominent ventral projection, yellow below, black along its dorsal surface; second and third joints piceous, second overlapping the third on the inner side with a broad thumb-shaped lobe; third joint large, covered with delicate pile, with a blunt tip and a faint indentation in its convex ventral contour; dorsal contour nearly straight; arista very long, with very short pubescence, inserted half-way between the base and the apex of the third joint. Front black, covered with grayish dust. Postocular cilia sparse, pale below. Thorax and scutellum dull metallic green, covered with grayish dust. Abdomen club-shaped, laterally compressed; second, third and fourth segments yellow, with their posterior edges blackened, and in some specimens with a black mid-dorsal line; venter yellow; first, fifth and sixth segments and hypopygium coppery black. Hypopygium like that of the other species of the genus. Pleuræ dull metallic green, covered with pale dust. Coxæ yellow, middle pair with a narrow black streak on their outer surfaces; anterior surfaces of fore coxæ with black hairs. Legs yellow, tarsi infuscated on the fourth and fifth joints; fore tarsi resembling those of other species of the genus; first joint slender, bearing three black bristles in a row on the plantar surface near the proximal end; second joint short, distinctly incrassated; third joint with a short, somewhat recurved spur-like bristle on the inner side near the proximal end. Wings grayish hyaline, distinctly narrowed towards the base. Venation as in other species of the genus; the posterior cross-vein being about one-third as long as the distal segment of the fifth vein. Halteres and tegulæ pale yellow, the latter with white cilia.

Female. Length 2.5-3 mm.; length of wing 2.5-3 mm. Face much broader than that of the male, covered with gray dust. Antennæ smaller; second joint with a short, blunt, overlapping process; third joint scarcely longer than broad, somewhat spade-shaped; arista short, inserted dorsally. Abdomen colored like that of the male. Wings not narrowed towards the base, with rather a prominent anal angle. Legs plain, tarsi somewhat more infuscated than they are in the male.

Eight males and three females taken during August and September, 1895, at various localities in Wyoming, from Lusk to Hunter's Creek in the Wind River Mts. The species seemed to occur most frequently in the latter locality at an altitude of from 7,000–8,000 feet.

The antennæ resemble those of *P. emarginatum*, but the third joint is broader, less pointed, and the arista is inserted much nearer the base in *P. montivagum*.

Sympycnus *Loew.*

The genus *Sympycnus* as originally defined by Loew really includes, I am convinced, two groups of forms which are worthy of separation as distinct genera. One group, corresponding very closely with *Sympycnus* as defined by Kowarz,[1] comprises species with small third antennal joint, plain arista and the first joint of the fore tarsi in both sexes longer than the fifth. To this group belong Loew's *S. tertianus* from Alaska, and *S. lineatus* from the Middle States, Aldrich's *S. falco* and *S. similis* from St. Vincent and three new species from the Western States. The other group, to which I assign Loew's *S. frontalis* and *S. nodatus* and four new western species, all agree in having the third antennal joint much larger than that of the former group, the arista usually more or less thickened and elongated in the male, and the first joint of the fore tarsi shorter than the fifth in the same sex. To this group I have given the name *Nothosympycnus.* In most other characters the genera agree but the above mentioned differences are even greater than those which separate such well-founded genera as *Dolichopus* and *Hygroceleuthus*, genera which are also separated on secondary sexual characters only. Only the males are included in the following table of *Sympycnus* (sens. str.):—

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[1] Die Europäischen Arten d. Dipteren-Gattung *Sympycnus* Loew. Wien. Ent. Zeitg., VIII, Jahrg. 5, Heft. 31, Mai, 1889.

1. Fifth joint of fore tarsi with a projection below 2
   Fifth joint of fore tarsi without a projection 3
2. Fore tibiæ with a row of stubby bristles .... *similis* ALD.
   Fore tibiæ without a row of stubby bristles.......... *falco* ALD.
3. Fourth vein ending before the tip of the wing.............. 4
   Fourth vein ending in the tip of the wing.................. 5
4. Third joint of hind tarsi shorter than the fourth. *tertianus* LOEW.
   Third joint of hind tarsi longer than the fourth. *marcidus*, sp. nov.
5. Pulvilli of fore tarsi enlarged................................ 6
   Pulvilli of fore tarsi not enlarged.. .... *lineatus* LOEW.
6. Middle tarsi plain........................ *cuprinus*, sp. nov.
   Fourth and fifth joints of middle tarsi dilated.... *pugil*, sp. nov.

47. Sympycnus marcidus, sp. nov.

PLATE IV, FIGS. 92–95.

Male. Length 2.5–3 mm.; length of wing 2.5 mm. Proboscis very small, retracted, piceous; palpi minute, yellowish. Face very narrow, covered with white dust, the eyes almost meeting in dried specimens. Antennæ very small, black; first and second joints short, of the usual form; third joint as long as broad, terminating in a broad, blunt point covered with conspicuous pile; arista inserted dorsally, tapering, pubescent. Front bronze black. Postocular cilia white. Thorax and scutellum dull metallic green, dusted with white, the former with an indistinct black vitta down the middle. Prescutellar depression distinct, but short. Abdomen metallic green, more cupreous dorsally and posteriorly, dusted with white along the sides; venter yellowish. Hypopygium shining black, subglobose, with a pair of relatively long, straight, pale appendages projecting downward. Pleuræ dull metallic green, covered with gray dust; metapleuræ yellowish. Coxæ yellow; middle and hind pairs infuscated on their outer surfaces; fore pair covered with distinct white hairs. Legs yellow, blackened from the tip of the first tarsal joint; fore tibiæ not incrassated, without bristles; fore tarsi considerably shorter than the fore tibiæ; first joint as long as the four succeeding joints taken together; the latter subequal; fifth joint broadened, with distinctly enlarged white pulvilli. Middle legs slender; tibia with four or five conspicuous black bristles scattered along the outer surface; middle tarsi nearly as long as the tibiæ. Hind tarsi somewhat compressed from side to side, joints gradually decreasing in length and thickness to the tip; third joint bearing on its outer upper edge a series of long bristles; the most distal of which is strongest and distinctly geniculate; fourth joint with a few peculiar erect bristles on its outer surface. Hind tibiæ and tips of hind femora brownish in many specimens. Wings grayish hyaline, narrowed towards the base. Third vein ending very near, but distinctly in front of the tip of the wing;

posterior cross-vein one-third the length of the distal segment of the fifth vein, which is complete to the very margin of the wing; sixth vein absent. Halteres and tegulæ yellow, the latter with white cilia.

Female. Length 2.75 mm.; length of wing 2.75 mm. Proboscis large, projecting, piceous, black at the base; palpi large, yellow, with a few long black hairs. Face much broader than that of the male, covered with gray dust. Third joint of antenna broader than long, its point much blunter than that of the male. Wings more blackish and with more prominent anal angle; sixth vein distinct. Legs plain; fore tarsi of about the same length as the fore tibiæ.

Nine males and three females taken during September in sweepings in the long grass near water-courses at the following localities in western Wyoming: Little Wind River Cañon, Dinwiddie Creek, Buck Creek, Dubois (7,200 ft.).

Sympycnus marcidus resembles Loew's *S. tertianus* from Alaska. Both species have the third vein ending distinctly before the tip of the wing and the third joint of the hind tarsi fringed with long hairs in the male. In these respects the two species agree with the European forms (see Kowarz.) and differ from all the other North American forms known to me. *S. marcidus* differs from *S. tertianus* in having the first joint of the hind tarsi longer than the second and the third longer than the fourth.

48. Sympycnus lineatus *Loew.*

Plate IV, Figs. 96–98.

I have frequently taken this species in sweepings in dark woods in several localities in Wisconsin, especially in Milwaukee and Price Counties. In the male the first joint of the antennæ is small and short, the second larger, the third pointed oval. The arista is pale and rather sparsely pubescent. In the female the third joint is smaller and has a shorter, blunter point. The sixth vein is very nearly obliterated; the posterior cross-vein is longer and much nearer the posterior margin than in other species of *Sympycnus* known to me, being about three-fifths as long as the distal segment of the fifth vein.

49. Sympycnus cuprinus, sp. nov.

PLATE IV, FIGS. 99 AND 100.

Male. Length 2.5 mm.; length of wing 2.25 mm. Proboscis small, retracted. Palpi minute, covered with silvery white dust; face broader above than below, where the eyes nearly meet, covered with white dust. Antennæ black, first and second joints of the usual shape; third joint a little more than twice as long as broad, rapidly tapering from its base to a sharp point, covered with delicate grayish pile, and having the moderately long pubescent arista inserted near the base on the dorsal side. This side has the appearance of being somewhat excised, so that the pointed tip of the third joint curves up slightly. Front dull black, covered with gray dust. Postocular cilia and a number of hairs on the cheeks, white. Thorax dark blackish green, thickly covered with grayish brown dust; scutellum somewhat brighter metallic green. Abdomen metallic green, second to sixth segments broadly cupreous at their bases. Hypopygium cupreous, of moderate size, with completely concealed appendages. Pleuræ black, thickly covered with slate-colored dust. Coxæ concolorous with the pleuræ but with yellow tips; fore coxæ with several silvery white hairs on their anterior surfaces; middle and hind coxæ with white bristles on their outer surfaces. Legs yellow; basal half or two-thirds of fore femora black, hind femora black on the upper surfaces of their distal halves and at the tip; fore and middle tarsi blackened from the tip of the first joint, hind tarsi completely and tips of hind tibiæ, black. Fore tibiæ not incrassated; fore tarsi about as long as the fore tibiæ, first joint a little longer than the second and third joints taken together, second to fifth joints short, subequal; fifth joint somewhat thickened, with a pair of conspicuously enlarged pale pulvilli. Hind tarsi plain, with subequal joints. Wings gray, but little narrowed toward their bases. Fourth vein terminating in the tip of the wing, and parallel with the tip of the third vein which bends downward very little. Posterior cross-vein about one-third the length of the distal segment of the fifth vein; sixth vein distinct. Halteres and tegulæ yellow, the latter edged with black and bearing long cilia which appear yellow in some lights, dark brown in others.

Female. Length 2.5–3 mm.; length of wing 2.5 mm. Proboscis swollen, projecting, piceous. Palpi yellow, rather long and pointed, covered with white dust and bearing a few conspicuous black hairs. Face broad, its lower edge far from reaching the lower corners of the eyes, covered with opaque gray dust. Third antennal joint much shorter than that of the male, scarcely longer than broad, ending in a blunt but distinct point. Coloration of body and legs like that of the male. Fore tarsi plain. Wings darker and somewhat broader towards the base than those of the male.

Numerous specimens of both sexes taken during July in company with *Nothosympycnus vegetus* near Monterey, Calif.

50. Sympycnus pugil, sp. nov.

PLATE IV, FIGS. 101 AND 102.

Male. Length 2.5 mm.; length of wing 2.5 mm. Face covered with gray dust. Antennæ black; third joint small, with a blunt point, pilose, arista slender, tapering, with short pubescence. Front dull metallic green. Postocular cilia black above, white below. Thorax, scutellum and abdomen dull metallic green, the first with a thin layer of white dust. Abdomen laterally compressed, venter somewhat yellowish. Hypopygium large, rounded; appendages exserted, dull dark green, overlaid with gray dust. Coxæ and legs yellow; middle and hind coxæ and upper surfaces of hind femora infuscated; fore and hind tarsi blackened from the tip of the first joint; first joint of fore tarsi nearly as long as all the remaining joints taken together; second, third and fourth joints short, thickened and of about equal length; fifth joint distinctly broader and longer than the preceding joint, indented at the tip and furnished with several black bristles and much enlarged pulvilli; claws appear to be absent. Middle tarsi with the fourth and fifth joints entirely black, but only the extreme tips of the first, second and third joints black; first joint slender, as long as the second and third taken together, these of about equal length and each a little shorter than the fourth and fifth joints taken together; fourth and fifth joints of equal length, distinctly dilated and fringed with black bristles. Hind tarsi shorter than the hind tibiæ, first, second and third joints distinctly thicker than the fourth and fifth; first and second joints subequal, the second bearing a few long bristles on its upper side near the tip; third joint a little longer than the fourth. Wings gray, narrowed towards the base; fourth vein terminating exactly in the tip of the wing; distal segment of fifth vein scarcely longer than the posterior cross-vein; sixth vein apparently absent. Halteres and tegulæ yellow, the latter with long yellowish cilia.

One specimen from Seattle, Washington, received from Professor J. M. Aldrich.

This species differs from all the other North American *Sympycnus* in having all the feet ornamented.

Nothosympycnus, nov. gen.

This genus, which was defined in connection with *Sympycnus*, from which it was separated, appears to have affinities with *Parasyntormon* and through this genus with *Syntormon*. From *Parasyntormon* it differs in the structure of the fore tarsi of the male, and in not having the overlapping lobe of the second antennal joint. Of the six species included in the following table, three occur in the Eastern and Middle, and three in the Western States. The table includes only the males.

1. Front metallic violet.. 2
   Front not metallic violet.. 5
2. Fore tibiæ incrassated.. 3
   Fore tibiæ not incrassated.. 4
3. Second joint of fore tarsi tipped with a long bristle. *fortunatus*, sp. nov.
   Second joint of fore tarsi without a long bristle..*vegetus*, sp. nov.
4. All the coxæ yellow..*frontalis* LOEW.
   Only the tips of the fore coxæ yellow..................*sobrinus*, sp. nov.
5. Arista with a pointed tip..................................*Oreas*, sp. nov.
   Arista with a dilated tip..................................*nodatus*, LOEW.

51. Nothosympycnus fortunatus, sp. nov.

PLATE III, FIGS. 83–85.

Male. Length 3.25 mm.; length of wing 3 mm. Proboscis and palpi piceous, tipped with yellow. Face extremely narrow, so that the eyes almost meet, covered with light gray dust. Antennæ long, dark brown; first joint cylindrical; third joint large, oval, evenly rounded anteriorly, pilose; arista inserted near its base on the dorsal side, as long as the head and proboscis, black, finely and densely plumose on either side, tip somewhat broadened. Front brilliant metallic violet; circumocellar region velvety black in some lights. Postocular cilia conspicuous, black above, pale below. Thorax dull black, covered with brown dust except on a median vitta-shaped area and on two roundish regions near the humeri; these three regions appearing as dark spots. Scutellum bright metallic violet. Abdomen slender, laterally compressed, brownish black except the bases of the first, second and third segments and the venter, which are light yellow. Hypopygium very prominent, sessile but separated from the last abdominal segment by a constriction; appendages brownish, posterior pair small and hairy, anterior pair distinctly larger, blunt; penis scarcely longer than the posterior appendages, rather thick, directed backwards; hairs covering the abdomen and scape of the hypopygium black. Pleuræ metallic blue green, covered with white dust except near the humeri, where the shining green ground-color is revealed. Coxæ white; fore pair with delicate silvery white hairs on their anterior surfaces; those of the middle and hind pairs each with a black bristle on the outer side. Fore leg white, tibia distinctly swollen, tarsi infuscated from the middle of the second joint; first joint very short and somewhat incrassated, second joint nearly as long as the third, fourth and fifth joints taken together, bearing near its tip on the upper side a long slender bristle; third and fourth joints with several longer hairs on their upper surfaces; fifth joint black. Middle femora white with a series of inconspicuous black cilia on the under side; middle tibiæ and tarsi yellowish, the latter infuscated from the tip of the first joint, which is considerably longer than all the remaining joints taken together. Hind legs with basal third of femur white, middle third yellow, apical third brown; tibiæ yellow, infuscated at the tip and rather bristly throughout; tarsi entirely dark brown, first joint distinctly shorter and thicker than the second. Wings gray, much narrowed towards the base, so that the anal margin which is fringed with delicate hairs runs close to the sixth vein; near the tip of the fifth vein the posterior margin forms a distinct sinus. Third and fourth veins parallel, the latter terminating in the tip of the wing; distal segment of the fifth vein about two and one-half times as long as the posterior cross-vein, which is short; discal cell short and narrow. Halteres and tegulæ light yellow; the latter edged with yellowish brown and bearing a few very long delicate white cilia.

A single specimen from Natrona, Pennsylvania, (August 1, 1895), sent me by Mr. C. W. Johnson.

This very pretty species resembles Loew's *Sympycnus (Nothosympycnus) frontalis*, but may be readily distinguished by the peculiar densely plumose arista and the structure and ornamentation of the fore tarsi. In the fore tarsus of the male of Loew's species the first joint is extremely short and not quite as long as the last one, the second almost as long as the two following together, the third considerably shorter than the fourth joint, which is fringed on its upper side with curved hairs. In *Nothosympycnus fortunatus* the third joint is much longer than the fourth and both the third and fourth joints are fringed. The long bristle on the second joint of *N. fortunatus* seems not to occur in *N. frontalis* Loew.

52. **Nothosympycnus vegetus,** sp. nov.

PLATE III, FIGS. 76-79.

Male. Length 2.5-3.25 mm.; length of wing 2.75-3 mm. Palpi and proboscis very small, piceous. Face very narrow, covered with white dust; eyes almost meeting below. Antennæ brownish black; first joint robust, second small, third large, oval, evenly rounded anteriorly, nearly twice as long as broad, covered with grayish pile and bearing near the base on the dorsal side a very long, scarcely pubescent arista, which terminates in a black lamel. Front metallic violet. Postocular cilia snow-white. Thorax varying from dull green to black with cupreous and blue reflections. Scutellum metallic blue. Abdomen bronze black, venter and the sides and bases of the second, third and fourth segments yellow. Hypopygium small; appendages yellowish brown, short, scarcely protruding. Pleuræ bluish green, thickly covered with white dust; metapleuræ yellowish below. Coxæ yellow, middle pair somewhat infuscated towards their bases; fore pair with a few yellowish brown hairs near their tips; hairs on the middle and hind pairs black. Legs yellow, hind tibiæ and tips of hind femora brown; hind tarsi entirely black, fore and middle tarsi blackened from the tip of the first joint. Fore tibiæ swollen, with a single bristle on the anterior surface near the base; fore tarsi longer than the fore tibiæ; first joint very short and rather thick, second joint nearly as long as the third and fourth joints taken together; third, fourth and fifth joints successively shorter, the third and fourth with somewhat longer and denser hairs on their upper surfaces. Middle tarsi slender, shorter than the middle tibiæ, first joint longer than all the remaining joints together; middle femora with two preapical bristles; middle and hind tibiæ with several prominent bristles on their posterior surfaces. Hind tarsi nearly as long as the hind tibiæ; first joint distinctly thicker and shorter than the second. Wings gray, much narrowed towards their bases, so that the posterior margin runs close to the sixth vein. Third vein gently bent downwards near its tip and running parallel with the fourth vein which terminates exactly in the tip of the wing; posterior cross-vein one-third as long as the distal segment of the fifth vein. Halteres and tegulæ yellow, the latter with long yellow cilia.

Female. Length 2.5 mm.; length of wing 3 mm. Palpi and proboscis larger, face broader than in the male; the former are piceous, the latter covered with gray dust. Third antennal joint not longer than broad, evenly rounded, arista dorsal, nearly as long as that of the male and pubescent, but tapering to a point. Coloration of body like that of the male. Legs plain throughout, first joint of fore tarsi nearly as long as the remaining joints taken together; fore tibiæ not swollen; hind tibiæ and femora without brown tips. Wings broader towards the base than in the male; sixth vein delicate but distinct.

Numerous specimens of both sexes taken in sweepings during July, 1896, about marshy spots in woods near Monterey, Calif.

The species resembles the eastern *N. fortunatus*, but may be readily distinguished by the lamellate arista of the male and the wing being less narrowed at the base.

53. Nothosympycnus sobrinus, sp. nov.

PLATE III, FIGS. 88–91.

Male. Length 3 mm.; length of wings 3 mm. Palpi small, piceous. Face rather broad, covered with brilliant snow-white dust. Antennæ black; first joint long, cylindrical; third joint rather large, oval, pilose, bearing near its base on the dorsal side a rather short, slightly pubescent arista which is slightly but distinctly incrassated just before the pointed tip. Front shining metallic violet. Postocular cilia black above, white below. Thorax dark bronze green, covered with brownish dust. Scutellum with a distinct violet reflection. Abdomen slender, laterally compressed, obliquely truncated posteriorly, of the same color as the thorax, venter yellow. Hypopygium small, almost entirely concealed, only the tips of the minute yellow appendages projecting. Pleuræ and coxæ dark bronze green, thickly covered with gray dust. Fore coxæ with yellow tips and with some distinct yellow hairs on their anterior surfaces. Legs yellow, more or less infuscated on the upper surfaces and tips of the femora and the tips of the tibiæ. Tarsi infuscated from the tip of the first joint. Fore tibiæ not incrassated, bearing a single conspicuous bristle on the outer surface near the middle; first joint of fore tarsi very short, second joint slender, as long as the third and fourth together; third and fourth subequal, with a few long hairs on their upper surfaces near their tips; fifth joint rather slender, a little more than twice as long as the first joint. First joint of middle tarsi slender, longer than all the remaining joints together; second a little longer than the third and fourth together, slightly widened at the tip and produced into a point provided with a few long hairs; third and fourth joints short, subequal, slightly flattened, oval; fifth joint slender, nearly as long as the third and fourth joints together. Hind tarsi shorter than the tibiæ; first joint distinctly shorter and a little thicker than the second joint. Wings gray, with prominent anal angle; third and fourth veins nearly parallel, the latter ending exactly in the tip of the wing; posterior cross-vein about two and one-half times its own length from the posterior margin, measured along the distal segment of the fifth vein. Sixth vein absent. Halteres and tegulæ yellow, the latter edged with black and bearing a flabelliform cluster of unusually long yellowish brown cilia.

One specimen from Lewiston, Idaho, received from Professor J. M. Aldrich.

This species resembles Loew's *N. frontalis*. Loew's species, however, has the basal segments of the abdomen largely yellow, the scutellum concolorous with the thorax, a larger hypopygium, the posterior margin of the pleuræ and all the coxæ yellowish, and the third joint of the fore tarsi of the male considerably shorter than the fourth. The middle tarsi are similar in the two species.

54. **Nothosympycnus Oreas**, sp. nov.

PLATE III, FIGS. 86 AND 87.

Male. Length 3 mm.; length of wing 2.75 mm. Proboscis and palpi brown. Face very narrow, especially near the middle, where the eyes almost meet, covered with gray dust. Antennæ long, dark brown, first joint cylindrical, rather long, with a blunt ventral projection at the tip; third joint large, oval, evenly rounded, pilose; arista inserted near the base on the dorsal side, very long, tapering to a point, somewhat flattened owing to a delicate pubescence along its two opposite edges; this pubescence is scarcely perceptible on the basal segment of the arista, but long and distinct before the tip. Front metallic green, more golden along the orbits. Postocular cilia distinct, black above, snow-white below. Thorax and scutellum metallic green, thickly overlaid with yellow dust especially in front. This dust is absent on a mid-dorsal vittiform area. Abdomen elongate, laterally compressed, dull brownish black, with the sides and venter of the first to fourth segments yellow. Hypopygium not constricted at the base; posterior appendages small, yellow, bristling with short hairs; anterior appendages very short, blunt, black; penis yellow, rather slender, pointed, twice as long as the posterior appendages and directed backwards. Pleuræ greenish black, opaque with gray dust. Fore coxæ yellow, slightly infuscated at their bases, anterior surfaces with white hairs; middle and hind coxæ brown with yellow tips. Legs yellow; tarsi blackened from the tip of the first joint; apical half of hind femur and tip of hind tibia infuscated. Fore tibia distinctly swollen; first joint of fore tarsus very short, second and third joints much longer, subequal; fourth and fifth joints equal, each about half as long as the third joint; third and fourth joints fringed on their upper surfaces with long hairs. Hind metatarsus distinctly broader and shorter than the succeeding joint. Wings gray, broad and subtruncated at the tip, much narrowed towards the base, so that the hairy anal margin lies close to the sixth vein. Third and fourth veins nearly parallel, the apical segment of the latter being bowed forward slightly and terminating in the tip of the wing; posterior cross-vein distinctly beyond the middle of the wing, not one-third the length of the distal segment of the fifth vein. Tegulæ and halteres yellow, the former edged with brown and fringed with yellow cilia; the latter with brownish peduncles.

One specimen collected in sweepings at Buck Creek, Wyoming, August 14, 1895.

The species resembles *N. fortunatus* but may be at once distinguished by the longer, tapering and less plumose arista, by the green front, more wedge-shaped wing, the subequality of the second and third joints of the fore tarsi, the absence of the long bristle on the second joint, and the structure of the hypopygium.

55. Nothosympycnus nodatus *Loew.*

Plate III, Figs. 80–82.

Several males and females in my collection agree very closely with Loew's description. They were taken in damp woods in the vicinity of Milwaukee and Chicago. The tip of the wing of the male is more pointed than that of *N. fortuntatus*, the basal portion somewhat less narrowed. The posterior appendages of the hypopygium are yellow, the anterior pair black, the penis yellow, delicate, extending backwards, but not so far as in *N. Oreas*. The fore tibiæ of the male are not incrassated.

Teuchophorus *Loew.*

This genus, which is allied to *Campsicnemus* and *Chrysotus*, has not been found hitherto in this country. The single species here described conforms to Loew's definition of the genus, the main peculiarities of which are in the male the thickening of the costa, the obliquity of the posterior cross-vein, the rudimental nature of the sixth vein and the peculiar modification and spinulation of the legs, especially of the hind pair. Our species seems to be rather closely related to the three European species: *T. spinigerellus* Zett., *T. calcaratus* Macq., and *T. monacanthus* Loew; the principal difference being in the ornamentation of the hind femora of the male.

56. **Teuchophorus clavigerellus**, sp. nov.

PLATE IV, FIGS. 103 AND 104.

Male. Length 1.3 mm.; length of wing 1.5 mm. Proboscis and palpi black, the latter with yellow hairs. Face very narrow, especially below, covered with white dust. Antennæ short, third joint very short, much broader than long, apparently set into the second joint, arista dorsal, covered with short pubescence. Front, thorax, scutellum and abdomen rather dark metallic green with golden reflections. Acrostichal bristles in two irregular rows, dorsal and humeral bristles very well developed. Scutellum with two macrochætæ and several small bristles along its posterior edge. Abdomen laterally compressed, its bristles mostly black, but some along the sides of the segments yellow. Hypopygium small, black, with two pairs of small pointed, yellow appendages directed backwards. Pleuræ green, dusted with white. Coxæ and legs light yellow. Fore tibia without conspicuous bristles, fore tarsi blackened from the tip of the first joint, which is rather slender, as long as the four remaining joints taken together, and furnished with four long bristles on its outer side. Middle femur with a few long bristles near its base on the lower side; middle tibia with four long bristles on its upper and two long bristles on its lower surface; middle tarsi plain, blackened from the tip of the first joint; joints gradually decreasing in length to the tip. Hind femur with several long bristles on the anterior surface near the tip; hind tibia perceptibly thickened, blackened on the upper side near the base and bearing near this point a peculiar black appendage, somewhat dilated at the tip. This appendage which, to judge from its striated surface, seems to be made up of several agglutinated hairs, is directed forwards and inwards when the leg is in a walking position. Distal to the appendage the hind tibia is provided with several conspicuously large black bristles on the anterior surface and several much smaller ones on the posterior surface. Hind tarsi tapering gradually, blackened from the tip of the first joint, which is scarcely shorter than the second. Wings gray, immaculate; third and fourth veins perfectly parallel, the latter ending in the tip of the wing. Costa with a pronounced thickening beyond the tip of the first vein. Posterior cross-vein oblique, about two and one-half times its own length distant from the posterior border when measured along the distal segment of the fifth vein. Halteres and tegulæ yellow, the latter with long brown cilia.

One specimen of this interesting species taken by Professor J. M. Aldrich in South Dakota. The head has collapsed in drying, so that I am unable to give an adequate description of the antennæ.

Campsicnemus *Haliday*.

More than twenty species of this interesting genus have been described from Europe, but up to the present time only two were known from this continent, viz., *C. hirtipes* Loew (figs. 107–109) and *C. claudicans* Loew (fig. 113). The four new species here added occur in the Western States, and are mostly alpine or boreal. In the following tables only the males are included:—

1. Middle tibiæ more or less incrassated 2
   Middle tibiæ not incrassated .... *degener*, sp. nov.
2. Middle tibiæ with only a slight proximal thickening. *hirtipes* Loew.
   Middle tibiæ incrassated throughout 3
3. Middle tibiæ with a pedunculated knob near their apices. *Philoctetes*, sp. nov.
   Middle tibiæ without a knob 4
4. Middle tibiæ entirely black .... *Œdipus*, sp. nov.
   Middle tibiæ in great part yellow 5
5. Middle metatarsus strongly curved .... *Thersites*, sp. nov.
   Middle metatarsus not strongly curved .... *claudicans* Loew.

57. Campsicnemus degener, sp. nov.

PLATE IV, FIGS. 110–112.

Male. Length 1.5–2.3 mm.; length of wing 2–2.5 mm. Proboscis and palpi piceous, the latter with white hairs. Face narrow, covered with ochre yellow dust. Antennæ black, third joint small, not very pointed, pubescent, arista slender, with very short pubescence. Front steel-blue towards the orbits. Postocular cilia black above, yellow below. Thorax subopaque with yellowish brown dust, and with a median bluish stripe. Scutellum opaque brown in the middle, shining steel-blue along its lateral and posterior edges. Abdomen bronze black, more shining than the thorax. Pleuræ opaque, dusted, yellow above, drab below. Fore coxæ yellow, somewhat infuscated at their bases, with white hairs on their anterior surfaces; middle and hind coxæ black, covered with drab dust like the inferior pleuræ. Legs yellow, tarsi infuscated from the tip of the first joint. Femur of the middle leg suddenly tapering from its middle to its tip, beset on its lower side with several long black bristles; the middle tibia is very slightly bowed proximally and bears a similar series of blunt but rather weak bristles on its under side. Wings gray with black veins. Venation regular. There is a rather large and distinct black spot on the distal segment of the fourth vein just before its middle. This spot is preceded by a faint and less definitely outlined white spot of about the same size. Halteres yellow. Tegulæ pale with black cilia.

Female. Length 2.5 mm.; length of wing 2.5 mm. Face but little broader than that of the male, and covered with pale yellow or gray dust. Third antennal joint distinctly shorter and with a rounder apex. The knees of the middle and hind legs are blackened, and, in some specimens, the lower surfaces of the fore femora are infuscated. Middle femora plain, with a row of ordinary bristles in the place of the prominent bristles of the male. In other particulars the female closely resembles the male.

Two males and five females taken in marshy spots in the pine woods about Pacific Grove, Calif., July 13th to 22nd, 1896. Numerous specimens of both sexes collected by Professor J. M. Aldrich at Vollmer, Idaho, Sept. 26, 1896, do not differ in any way from the Californian specimens.

58. Campsicnemus hirtipes *Loew.*

This is the only species of the genus I have been able to find in the Middle States. It occurs in marshes, often very late in the autumn. There is a lapsus in the legend of Loew's figures in his plate VI,[1] fig. 33. The antenna of the male of this species is erroneously assigned to *C. claudicans*, whereas the antenna of the male *claudicans* seems to be assigned to *hirtipes*.

59. Campsicnemus Philoctetes, sp. nov.

PLATE IV, FIGS. 115-117.

Male. Length 2.5 mm.; length of wing 3 mm. Palpi, face and lower portion of eyes covered with ochre-yellow pile. Eyes almost meeting just above the middle of the face. Antennæ black, third joint of moderate size, somewhat pointed. Front dull steel-blue. Postocular cilia black above, pale yellow below. Thorax bronze black, shining, covered with brown dust

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[1] Monogr. 2.

anteriorly; scutellum steel-blue; abdomen shining black with greenish reflections; venter piceous. Pleuræ above dusted with yellowish dust, below with a thin layer of white dust. Fore coxæ and trochanters yellow, the former more or less infuscated proximally, with short yellowish hairs. Middle and hind coxæ and trochanters black, dusted with white like the lower pleuræ. Legs yellow, the fore tarsi, knees of the hind legs and the hind tarsi from the tip of the first joint, black. Middle legs with the femur moderately, the tibia strongly incrassated. The latter is flattened, twisted and deeply excised at its distal end. From the hollow of the excision a pedunculated knob projects forward when the leg is in the walking position. Middle femur ciliated on its lower side with rather feeble black bristles; the bristles on the middle tibia are arranged as follows: first, a series of feeble, blunt bristles on the lower (inner) surface, terminating beyond the middle with a few powerful bristles, and at the apex with several medium-sized bristles; second, a series of bristles, rapidly increasing in length, on the upper surface. Those which terminate this series are extremely long and powerful. Beyond the middle on the anterior surface of the tibia and proximal to the projecting knob there is a dense patch of short black spines. Middle metatarsus incrassated, moderately bent and terminating in a scoop-shaped projection. A row of regular and powerful bristles runs along its whole concave surface. Remaining tarsal joints plain. The middle legs are blackened from the patch of spines to the end of the tarsus, the transition from the yellow to the black on the tibia being very abrupt. Wings grayish hyaline. Their costal and posterior borders are nearly parallel. There is a slight trace of infuscation in the little depression on the distal segment of the fourth vein. Halteres yellow. Tegulæ brown with black cilia.

Five male specimens taken at the following localities in Wyoming in July and September: Lusk, Little Wind River cañons, Hunter's Creek, Jackson's Lake. Also one male and four females from South Dakota, April 14, 1890, collected by J. M. Aldrich. The male of this species is very readily recognized by the projecting pedunculated knob on the remarkably incrassated middle tibiæ.

60. Campsicnemus Œdipus, sp. nov.

PLATE IV, FIG. 114.

Male. Length 2 mm.; length of wing 2.5 mm. Face very narrow, covered with ochre-yellow dust. Antennæ black, third joint small, pointed. Front shining black, with a bluish reflection. Postocular cilia black above, yellow below. Thorax, scutellum and abdomen shining black, the scutellum with bluish, the abdomen with bronze reflections. Pleuræ black with pale dust. Coxæ black, the fore pair yellowish towards their tips. Fore legs black, with the distal half of the femur and the basal half of the tibia yellow or piceous. Middle tibia and metatarsus incrassated, the former twisted, the latter considerably curved and terminating in a pointed and somewhat sinuate projection. The whole leg is black except the distal half of the femur, which is yellow. Middle femur ciliated with weak bristles on its lower side; middle tibia with a row of blunt bristles on its under side passing distally into larger bristles of the ordinary type. There is a long patch of short black spines on the middle of the outer surface of the tibia and several bristles, smaller than those of *C. Philoctetes.* The bristles which run along the concave surface of the metatarsus are also weaker than the corresponding bristles in that species. Hind legs yellow, the bases of the femora, the knees, the tips of the tibiæ and the tarsi from the tip of the first joint, blackened. Wings grayish hyaline, with a distinct small black spot on the concavity in the distal segment of the fourth vein. Halteres and tegulæ yellow, the latter with black cilia.

Female. Of about the same size as the male. The third antennal joint is distinctly shorter and more rounded at the tip. The middle tibiæ and tarsi are plain and colored like the corresponding parts of the hind legs. In most of my specimens the portions of the legs which are yellow in the males are piceous in the females, but this may be due to poor preservation.

Three males and seven females taken September 12, 1895, in the damp meadows of the Two-gwo-te-ee Pass, Wyoming.

61. **Campsicnemus Thersites,** sp. nov.

PLATE IV, FIG. 118.

Male. Length 1.5–2 mm.; length of wing 2–2.5 mm. Face very narrow, covered with ochre-yellow dust. Antennæ black, third joint small, pointed. Front black with bluish reflections. Postocular cilia black above, whitish below. Thorax, scutellum and abdomen shining black, the scutellum with bluish, the abdomen with bronze-green reflections. Pleuræ and coxæ greenish black overlaid with white dust, fore pair of coxæ in some specimens more piceous or yellowish. Legs yellow, knees, tarsi and tips of tibiæ black. In many specimens the bases of the femora are more or less infuscated. Middle tibiæ greatly incrassated, flattened anteroposteriorly, but not twisted, broadest in the middle, deeply excised on the outer side of the distal half. This side bears two clusters of small black spines, one smaller cluster at the middle and a larger one in the excision below it, and a series of long robust black spines which increase in length from the base of the tibia to the excision. The lower surfaces of the middle tibia and femur bear series of weak cilia. These become longer and stouter towards the distal end of the tibia. Middle metatarsus thickened and bent in a complete semicircle. Proximally the thickening is greatest and bears on its upper surface a number of diverging, robust bristles; distally the joint ends in a strong, somewhat recurved projection. The upper and lower surfaces of the joint are fringed with weaker bristles. Remaining tarsal joints plain. Wings grayish hyaline, immaculate, with black veins. Halteres and tegulæ yellow, the latter with black cilia.

Female. Length 2 mm.; length of wing 2.5 mm. The third antennal joint is distinctly shorter and blunter, but the face seems to be no broader than in the male. Middle legs plain, resembling the hind legs in spinulation. In my specimens the basal half of all the femora is black and the yellow on the other portions of the legs is more brownish.

This species was taken in considerable numbers in the rank grass near water at the following localities in Wyoming during August and September, 1895: Natrona Co., Wind River Mts., Two-gwo-te-ee Pass. It was most common in the last locality.

62. Campsicnemus claudicans *Loew.*

PLATE IV, FIG. 113.

Three males and three females collected by Professor J. M. Aldrich on Craig's Mt., Idaho, agree very closely with Loew's description of this species. His specimens were from Sitka, Alaska, but the mountain fauna of Idaho, Wyoming and Dakota undoubtedly comprises several boreal forms, so that the occurrence of *C. claudicans* within the confines of the United States need not surprise us. The male of *C. claudicans* resembles *C. Thersites* and *C. Philoctetes.* It may be distinguished from the latter by the absence of the knob-shaped process and the longer series of short black spines on the middle tibia; from the former it differs in having the middle metatarsus nearly straight and terminating in a shorter point. It differs from both in having a distinct black spot on the distal segment of the fourth vein.

Hydrophorus *Fallen.*

The species of *Hydrophorus* described by former writers and the five new forms here added probably represent only a small fragment of our species of this genus. In distinguishing the species, which are by no means rich in plastic characters, I have relied mainly on the spinulation of the fore femur and tibia in the male, as the venation of the wings is very rigid and uniform and the antennæ and face rarely offer available characters. I have excluded from the dichotomic table *H. albo florens* Walker and *H. chrysologus* Walker (described as species of *Medeterus*), although Osten Sacken believes that he has recognized the former. Walker's *M. chrysologus* appears to be only a variety of the female of his *M. glaber*. Osten Sacken includes Say's *Medeterus lateralis* and *M. punctipennis* under *Hydrophorus*, but their position here is extremely doubtful. The legs of the former species are described by Say as "whitish," those of the latter as "white," neither of which terms will apply to the legs of any of the known species of *Hydrophorus*, unless Say refers only to the white dust covering the legs.

1. Veins of wing blackened throughout 2
   Veins more or less yellow at the base 8
2. Wing with two conspicuous black spots 3
   Wing with faint spots or immaculate 4
3. Face of male covered with white dust ....*glaber* WALKER.
   Face of male covered with yellow dust ....*algens*, sp. nov.
4. Third antennal joint elongated ....*cerutias* LOEW.
   Third antennal joint not elongated 5
5. Wings with two faint gray spots ....*pirata* LOEW.
   Wings immaculate 6
6. Face of male covered with white dust 7
   Face of male covered with yellow dust ....*parvus* LOEW.
7. Thorax with cupreous vittæ ....*æstuum* LOEW.
   Thorax evittate ....*innotatus* LOEW.
8. Fore tibia ending in a blunt point.......*philombrius* WHEELER.
   Fore tibia truncated at the distal end 9
9. Tip of fore tibia with a large erect black spine.
   eldoradensis, sp. nov.
   Tip of fore tibia without such a spine 10
10. Tip of fore tibia with a pair of small spines on the inner side
    agalma, sp. nov.
    Tip of fore tibia without a pair of spines 11
11. Basal half of costa yellow; large species...*Magdalenæ*, sp. nov.
    Costa yellow only at extreme root; small species, *sodalis*, sp. nov.

63. Hydrophorus algens, sp. nov.

PLATE IV, FIG. 123.

Male. Length 3.5 mm.; length of wing 4.5 mm. Palpi and face covered with thick brownish yellow dust. Antennæ black, as broad as long, with rather prominent ventral projection; arista black. Front and occiput metallic green with golden reflections and covered with brown dust, very thick anteriorly. Postocular cilia black above, yellow below. Thorax, scutellum and abdomen bronze black with greenish reflections, not very bright; humeral region and a large area above the pleuræ and before the wing covered with thick reddish brown dust. Pleuræ, sides and venter of abdomen covered with frosty white or gray dust. Abdomen truncated posteriorly; hypopygial appendages black, thick, short and projecting. Coxæ concolorous with the lower pleuræ; fore and middle pairs with abundant yellow hairs on their fore faces. Legs blackish bronze green; tarsi black; all the pulvilli enlarged, flesh-colored; fore femora and tabiæ covered with long yellowish hairs, the former rather slender for a male; inner lower surface of fore femur with only six or seven graduated black spines on the proximal half. Denticular spines on the lower (inner) surface of the tibia short and distinct only on the distal half, fading away proximally; tip of the fore tibia without a tooth or projection, but the hairs of the strigil near the tip are long and distinct. Wings gray, in some cases brownish or blackish towards the base along the second and third veins. Venation normal, veins black throughout. There is a conspicuous round black spot near the middle of the distal segment of the fourth vein and another of about the same size covering the anterior half of the posterior cross-vein. Halteres yellow, knob distinctly infuscated. Tegulæ brownish, with light yellow cilia.

Female. Length 3.5 mm.; length of wing 4.5 mm. Coloration like that of the male. Spines on the fore femora shorter and less numerous than those of the male, spines on the fore tibia longer and more numerous, extending the whole length of the inner surface.

Three males and one female collected in sweepings in the Two-gwo-te-ee Pass, Western Wyoming, September 12, 1895.

This species resembles the European *H. bipunctatus* Lehm. in having bimaculate wings. The female of the European species is described as lacking the femoral spines. *H. algens* may yet prove to be the same as Walker's *H. chrysologus* or his *H. glaber*.

64. Hydrophorus parvus *Loew.*

PLATE IV, FIG. 119.

A male and female *Hydrophorus* taken by me in a marsh near Worcester, Mass., April 1, 1891, agree very closely with Loew's description of this species. The abdomen of the male is about as long as the thorax, and truncated behind; the two anterior hypopygial appendages project downwards and backwards. The fore leg of the male is represented in fig. 119. The third and fourth veins are parallel as described by Loew, but their extreme tips diverge in joining the costa. There is a slight swelling at the juncture of the first vein with the costa. The pulvilli are enlarged. The face of the female is scarcely wider than that of the male, narrowed above and covered with brownish ochraceous dust. The halteres are black in both sexes.

65. Hydrophorus philombrius *Wheeler.*

PLATE IV, FIGS. 126 AND 127.

This species was described[1] from a male specimen taken in Wisconsin. Another male recently received from Jacksonville, Texas (Nov. 20, 1895), enables me to add the following to my former description:—

Cheeks broad, flap-shaped, dependent, covered with gray dust. Fore femora with two rows of pointed black spines on the lower side; the upper row running the full length of the femur and consisting of short spines, the lower row consisting of four or five graduated spines near the base, the more distal ones being unusually long. Tip of fore tibia drawn out into a distinct blunt projection, the spines on which are rather small, like the other spines in the series on the lower surface of the fore tibia. The white pulvilli and empodia distinctly larger than they are in the male of *H. agalma*. Veins of the wings black nearly to their roots; costa somewhat thickened beyond the tip of the first vein, which ends near the middle of the wing. Hypopygial appendages projecting more than in other North American species; a slender anterior pair with rounded tips project forwards; the posterior appendages are short, thick and blunt and covered with short white hairs.

H. philombrius is readily distinguished from the other species by the four distinct metallic crimson vittæ on the thorax, the unusually long spines on the base of the fore femur, the blunt elongation of the tip of the fore tibia, and the well developed and projecting hypopygial appendages.

66. Hydrophorus eldoradensis, sp. nov.

PLATE IV, FIG. 125.

Male. Length 2.5–3 mm.; length of wing 4.5–5 mm. Proboscis and palpi fuscous. Face thickly covered with silvery white dust. Antennæ of the usual form, black; arista short, black, with a pale tip. Front dull olive green or brown, covered with white dust, thickest along the orbits. Occiput bluish metallic green dusted with white. Cheeks broad, lobe-shaped, dependent, thickly covered with white dust. Body and legs metallic blue-green covered with a thick coating of snow-white dust. Disc of thorax cupreous, with a

[1] Psyche, July, 1890, p. 378.

pair of dorsal vittæ, one on either side of the single row of acrostichal bristles. These vittæ, fused in some specimens to form a single vitta, fade away towards the middle of the thorax. In some lights the thorax has a mottled appearance owing to large spots of thinner dust which reveal the metallic green ground-color more distinctly. Abdomen flattened dorsoventrally and pointed. Hypopygium completely concealed in a median cleft of the fifth segment; the sternite of the fourth segment has its posterior edge bent into a V, the apex of which projects slightly and is directed forwards. All the segments of the abdomen covered with rather long snow-white hairs. Pleuræ and coxæ with white dust thicker than elsewhere on the body, the white hairs on the anterior and outer surfaces of the coxæ very short and inconspicuous. Legs rather slender, metallic blue-green, dusted with white. Tarsi black, all their claws and pulvilli enlarged, the latter white. Fore femur with two irregular rows of black spines on its lower anterior surface. These spines extend nearly the whole length of the femur. Fore tibia provided with a regular row of long tooth-like spines, the first of which at the tip of the tibia is large and pointed and projecting at right angles to the long axis of the tibia; the remaining teeth in the series gradually decrease in length proximally and are inserted more obliquely. Wings hyaline. Veins dark brown or black, with light yellow bases. Costa yellow to half way between the tips of the first and second veins, becoming abruptly black at this point. Venation normal, except that the tip of the third vein is rather strongly bent downwards before reaching the costa. Halteres and tegulæ pale flesh-colored, the latter with white cilia.

Female. Length 3.5–4 mm.; length of wing 4.5–5 mm. Same as the male in the coloration and in the spinulation of the fore femora and fore tibiæ. The abdomen is broad and flat, the sternites of the fourth and fifth segments flattened and plain.

Numerous specimens of both sexes from the following localities: Palo Alto, Calif., August 6, 1894 (Leland Stanford Jr. Univ.); Lusk, Wyo., July, 1895 (Univ. of Kansas Collection); Las Cruces, N. M., August 23rd; Magdalena Mts., N. M., August, 1894 (A. W. Snow); Jacksonville, Tex. (C. W. Johnson); Douglas Co., Kansas (A. W. Snow). I have taken this species in great numbers in Wyoming during August. The specimens from different localities vary in color, those from New Mexico having more silvery dust than Californian specimens.

67. **Hydrophorus agalma**, sp. nov.

PLATE IV, FIGS. 120 AND 121.

Male. Length 4.5 mm.; length of wing 4 mm. Palpi and face thickly covered with silvery white dust, the former with white hairs, the latter distinctly narrowed above. Antennæ black, of the usual shape, first and second joints together longer than the third; base of arista rather thick, black apical half attenuated, white. Front opaque brown, more cupreous behind.

Cheeks very narrow. Postocular cilia above short and black, below long and abundant, silvery white. Thorax and scutellum metallic crimson, the former bordered with metallic green and bearing a pair of dark purple vittæ, one on either side of the single row of very short acrostichal bristles. Lateral and humeral bristles very few, scattered. Abdomen somewhat longer than the thorax, gradually tapering, somewhat compressed dorsoventrally, metallic green, with cupreous reflections, covered with pale dust, so that it is distinctly less shining than the thorax. Hypopygium black, concealed; sternite of fourth abdominal segment with a deep notch in its posterior border. Pleuræ, coxæ and legs metallic green dusted with white; anterior surfaces of fore coxæ with conspicuously long, silky white hairs. Fore femora thickened towards the base, gracefully attenuated towards the tip, bearing a series of about six blunt black spines on the lower anterior surface near the base. Fore tibiæ with a pair of spines at the tip and a series of minute, thick-set tooth-like spines along the lower (inner) surface. Fifth joint of middle tarsi dilated and flattened, as broad as long. Claws and pulvilli not so much enlarged as in many other species of *Hydrophorus*. Wings grayish hyaline, broader at the base than at the apex, owing to a distinct bulging of the costa as far as the tip of the first vein, which enters the costa at the middle of the wing. Tip of third vein gradually bent down towards the fourth. Veins dark brown at their tips, bright honey yellow at the base, the costa being honey yellow to a point midway between the tips of the first and second veins. Halteres and tegulæ yellow, the latter with white cilia.

Female. Length 4 mm.; length of wing 4 mm. Like the male except in the following respects: Face covered with light yellow dust. Front covered with yellow dust except when seen from above; then it appears cupreous, passing into metallic green on the occiput. Abdomen more flattened, fourth sternite without a notch. White hairs on fore coxæ much shorter. Fore femora with a row of short, pointed spines extending along its whole lower surface. Tooth-like spines on the lower surface of the fore tibia much longer and further apart than in the male. Fifth joint of middle tarsi not dilated.

A male and female collected by Professor J. M. Aldrich at Battle Creek, Michigan, during July, 1897.

The sexual differences in the armature of the fore legs are peculiar. It can hardly be doubted that the female represents the more primitive condition, although she seems to have the more pronounced development of spines.

68. **Hydrophorus Magdalenæ**, sp. nov.

PLATE IV, FIG. 124.

Male. Length 4 mm.; length of wing 5.5 mm. Proboscis dull black, palpi brown. Face metallic green, lower two-thirds thickly covered with snow-white dust; upper third with a little ochre-yellow dust in a median depression and along the orbits. Antennæ black, of the usual size and shape; arista rather long. Front and occiput metallic golden green, the former thickly, the latter more thinly covered with velvety brown dust. Cheeks long, lobe-shaped, dependent, covered with silvery white dust. Postocular cilia black above, white below. Thorax metallic green, obscurely vittate with cupreous, thickly covered with brown dust. Scutellum cupreous, more shining than the thorax. Abdomen but slightly compressed dorsoventrally, scarcely longer than the thorax, shining metallic green, with violet and cupreous reflections, segments with rather sparse white hairs. Hypopygium slightly projecting; posterior edge of fourth sternite rather prominent; appendages short, thick, brown, covered with short hairs. Venter, pleuræ and coxæ metallic green, with a covering of grayish dust, which is so thick on the metapleuræ and coxæ that the metallic ground-color is completely hidden; fore coxæ with white hairs on their anterior surfaces. Legs metallic cupreous green; tarsi black, with enlarged claws and dilated flesh-colored pulvilli. Fore femora with two irregular rows of black spines on their lower anterior surfaces. Fore tibia with a row of black tooth-like spines, scarcely longer at the distal than at the proximal end, inserted obliquely throughout. Wings grayish hyaline. Venation normal; veins black, becoming honey yellow towards the base; costa becoming suddenly black before the middle of the distance between the tips of the first and second veins. Halteres and tegulæ yellow, the latter with white cilia.

Female. Length 4–4.5 mm.; length of wing 6 mm. Closely resembles the male both in coloration and in the spinulation of the fore femora and fore tibiæ. The sternites of the venter are flattened, the pulvilli not dilated.

Two males and three females from Magdalena, N. Mex., collected by Mr. A. W. Snow.

69. **Hydrophorus sodalis**, sp. nov.

Plate IV, Fig. 122.

Male. Length 2.5 mm.; length of wing 3–3.5 mm. Proboscis and palpi black. Face of moderate width, with a median longitudinal depression above; lower two-thirds thickly covered with silvery white dust, upper third rather shining, except near the orbit, where it is obscured by a thin layer of yellowish dust. Antennæ black, of the usual form. Front cupreous, appearing opaque in some lights. Postocular cilia black above, silvery white or light yellow and abundant below. Cheeks broad, lobe-like, dependent, covered with white dust. Occiput, thorax, scutellum and abdomen cupreous or metallic green; the thorax subopaque with brownish dust, the abdomen not longer than the thorax, in some specimens distinctly shorter, rather thick, obliquely truncated behind. Hypopygium black, almost completely concealed; sternite of fourth segment projecting, its posterior edge V-shaped. Venter, sides of abdomen, pleuræ and coxæ thickly covered with white dust, so that the cupreous or metallic green ground-color is almost completely concealed; fore coxæ with some yellowish, bristle-like hairs on their fore faces. Legs metallic green with cupreous reflections; tarsi black; pulvilli and empodia moderately enlarged. Fore femur with numerous black spines on its lower anterior surface in one row, five to seven spines in the broader basal portion of the femur are considerably longer than the other spines, which are inserted in two or three irregular rows. Tooth-like black spines on the lower surface of the fore tibia well developed. Wings hyaline, anterior and posterior margins parallel. Venation normal, veins black, yellow at their roots, where the wing membrane, too, is suffused with yellow. Halteres and tegulæ yellow, the former with slightly infuscated pedicels, the latter with white cilia.

Female. Length 2.5–2.75 mm.; length of wing 3.5–4 mm. The dust on the lower two-thirds of the face is ochre-yellow, more whitish towards the orbits. The armature of the fore legs is like that of the male.

The species was taken in considerable numbers about damp spots at the following localities in Wyoming during August and September: Lusk, Ft. Caspar, Natrona Co., Dubois, Hunter's Creek, Black Rock Creek.

It is certainly very closely related to Loew's *H. innotatus* from Sitka; Loew's species, however, has the knob of the halteres blackened, black bristles on the upper half of the fore coxæ, and the veins of the wing "black up to the extreme root." His description of the spines on the fore femur is not sufficiently explicit.

Thinophilus *Walker.*

Mik in his Dipterologische Untersuchungen[1] attempts to establish a new genus, *Schœnophilus*, on those species of Walker's original genus, *Thinophilus*, which have a more apical arista, only two scutellar bristles, only four mesial dorsal bristles in either row, and the humeral bristles poorly developed. In *Thinophilus*, as redefined by Mik, the antennal arista is distinctly dorsal, there are four scutellar bristles, six mesial dorsal bristles in each row, and the humeral bristles are distinct. The American species that may be assigned to these genera have been little studied as yet. Only two forms are known to me, one described as *Thinophilus pectinifer*[2] Wheeler and the one here described as *T. neglectus.* They evidently belong to the same genus,

[1] Wien., 1878, p. 9.
[2] Entom. News, May, 1896, pp. 155 and 156.

although they differ considerably in size. Both have no acrostichal bristles, both have six mesial dorsal bristles in a row, and both have well developed humeral bristles, the transverse row of the latter, to which Mik has called attention, being very distinct in *pectinifer*. This species has four scutellar bristles, but *neglectus* has only two. This important character must be omitted from Mik's characterization of *Schœnophilus*, if this species, as seems to me advisable, is to be placed in the genus *Thinophilus*. If this is done, the genus *Schœnophilus* will appear to be established on rather insufficient characters.

70. **Thinophilus neglectus**, sp. nov.

Female. Length 2.75–3.5 mm.; length of wing 2.5–2.75 mm. Proboscis black, not very prominent, in some specimens much retracted. Palpi large, pale yellow, covered with silvery white dust. Ground-color of the broad face dark, but almost completely concealed by a thick layer of white dust. Antennæ yellow, third joint rounded, reddish brown towards the tip and covered with pale pubescence; arista bare, distinctly dorsal, pale yellow. Front thickly overlaid with brownish yellow dust; on the occiput and cheeks the dust is gray. Postocular cilia black above, silvery white below, abundant. Thorax and scutellum opaque with a thick layer of dull brownish yellow dust. Acrostichal bristles absent, six mesial dorsal bristles in a row on either side; humeral bristles well developed, but not forming a conspicuous transverse row on either side. Scutellum with only two bristles. Abdomen with five visible segments, pale metallic green, thickly covered with silvery white dust and with short white hairs. Ovipositor blackish above, yellow below, terminating in a comb of ten small black teeth. Pleuræ, coxæ and bases of the femora silvery with white dust, the dark ground-color of these parts being almost completely hidden. Coxæ infuscated, with yellow tips; fore coxæ with numerous conspicuous white hairs on their anterior surfaces. There are similar hairs above the insertions of the fore coxæ and on the anterior surfaces of the middle coxæ. Legs yellow, rather short. Basal third to two-thirds of the femora more or less infuscated. In some specimens the bases of the hind tibiæ are also infuscated. Tips of the separate tarsal joints blackish, fourth and fifth joints entirely black, rather broad, with large pulvilli. Femora clothed with delicate white hairs and beset with a few black bristles near their tips. There are also short silvery white hairs on the tibiæ and tarsi in addition to the usual black bristles. Wings rather opaque whitish or, in some specimens, more hyaline, yellowish towards the costa, with yellow veins. Some specimens have a distinct dark cloud on the posterior cross-vein and a similar cloud on the gently up-curved middle of the distal segment of the fourth vein. Tegulæ and halteres light yellow. The cilia of the former are pale and extremely short.

Four specimens of this little species were received from Mr. C. W. Johnson. They were collected at Cape May, N. J., June 6, 1891.

Plagioneurus *Loew.*

71. Plagioneurus univittatus *Loew.*

PLATE IV, FIG. 105.

Williston in a brief note[1] showed that Loew was mistaken in supposing the hypopygium of the male of this species to be disengaged. The only other generic character which Williston noted in his specimen is the slightly narrower face of the male. From a study of four male and four female specimens in my possession I am able to add the following details:—

The third antennal joint is distinctly larger in the male; the white post-ocular cilia and the white hairs on the fore coxæ and on the lower surfaces of all the femora are longer than they are in the female. The abdomen is laterally compressed, of about equal height throughout, and appears truncated at the end of the sixth segment because the small hypopygium is so completely withdrawn. In one specimen I can make out the following details: the sixth segment bears above on either side two macrochætæ, ventrally a tuft of flattened black bristles. What I take to be the lamellæ of the hypopygium lie just below the tergum of the sixth segment. They are dusted with gray and covered with long radiating white hairs. The inner appendages are small and furnished on either side with three rather short black hooks.

Plagioneurus univittatus is remarkable, first, because it is the only species of a strongly marked genus, and secondly, because it has an unusual geographical distribution. It occurs in Brazil and Cuba according to Loew, in San Domingo (Williston), Florida (C. W. Johnson)[2] and in the Middle States. I have taken it in Wisconsin and Illinois from the beginning of July to the end of August, in meadow-grass in company with *Hygroceleuthus latipes*, various species of *Dolichopus*, *Pelastoneurus vagans*, *Scellus exustus*, etc. This very wide distribution, together with the fact that only one species of this genus is known, would seem to indicate that *Plagioneurus univittatus* is a very ancient relict member of the Dolichopodidæ.

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[1] Dipterological Notes and Descriptions, p. 295.
[2] Proc. Acad. Nat. Sci., Phila., 1895, p. 320.

Neurigona *Rondani.*

Saucropus LOEW.

1. Abdomen, at least near the base, with black or metallic fasciæ 2
   Abdomen without fasciæ.................... *floridula*, sp. nov.
2. Thoracic dorsum, at least anteriorly, yellow................ 3
   Thoracic dorsum metallic green............................ 6
3. Face protruding below.................... *signifera* ALDRICH.
   Face not protruding below................................ 4
4. Thorax with median black line and prescutellar spot. *dimidiata* LOEW.
   Thorax with prescutellar spot only......................... 5
5. Metanotum entirely black.................... *carbonifer* LOEW.
   Metanotum only infuscated above .... *rubella* LOEW.
6. Abdomen fasciate with vivid metallic green... *superbiens* LOEW.
   Abdomen fasciate with black................................ 7
7. Abdomen black, venter and posterior edges of segments yellow. *lienosa*, sp. nov.
   Abdomen yellow, bases of segments black....... *tenuis* (LOEW.)

72. Neurigona floridula, sp. nov.

Female. Length 4.5-5 mm.; length of wing 4.75-5 mm. Proboscis reddish yellow with pale hairs. Palpi and face pale yellow thickly covered with silvery white dust, the latter of the usual width for the female, and with the portion below the transverse suture receding. Antennæ yellow, third joint lacking in my specimens. Front and occiput black, thickly covered with silvery white dust. Postocular cilia silvery white. Eyes green. Thorax, scutellum and abdomen reddish yellow, covered with white dust, which is most abundant on the lateral portions of the thoracic dorsum and the pleuræ. Prescutellar depression shallow. Scutellum with two median long bristles and two feeble lateral bristles. Abdomen covered with short black hairs. Pleuræ with a black spot below the insertion of the wing. Coxæ reddish yellow, dusted with white like the pleuræ. Anterior surfaces of fore coxæ beset with short white hairs and with a few conspicuous black bristles near their proximal ends. Similar bristles occur in a corresponding position in the middle coxæ. Hind coxa with a single bristle on the lateral surface and a few bristles near the tip. Legs and metathoracic epimera light yellow, the former very slender and covered with small black hairs. Last joint of all the tarsi black. Fore tarsi twice as long as the fore tibiæ, middle tarsi nearly twice as long as the middle tibiæ, hind tarsi scarcely as long as the hind tibiæ. Hind metatarsus distinctly shorter than the succeeding joint. Wings scarcely narrowed towards the base, distinctly yellowish, with yellow veins. Apical segment of fourth vein rather sharply bent upwards near its middle and ending rather close to the tip of the third vein. Posterior cross-vein about two and one-half times its length distant from the posterior margin measured along the distal segment of the fifth vein. Halteres and tegulæ yellow, the latter with yellow cilia.

Two female specimens, one from Grant Falls, Maryland, taken May 18th (University of Kansas), and one from Dover, N. J., taken in June (Mr. C. W. Johnson). I have also taken a single female specimen during June, 1898, at Riverside, Ill.

The species resembles *N. rubella* Loew, but lacks the black prescutellar spot and black abdominal fasciæ of that species.

73. Neurigona superbiens *Loew.*

This species appears to be the same as *Dactylomyia gracilipes* Aldrich.[1] This latter species, specimens of which I have received from Professor Aldrich and also collected on the bark of trees in the Chicago parks during June and July, is the same as some specimens taken by me at Wood's Hole, Mass., some years ago, and labelled in my collection "*Saucropus superbiens* Loew." The coloration of the abdomen is very variable. Professor Aldrich may be justified in establishing a new genus, but the characters do not seem to me to be of sufficient value. Until our North American species of *Neurigona* are better known I propose to retain the species in the old genus.

74. Neurigona lienosa, sp. nov.

Female. Length 4.75 mm.; length of wing 3.75 mm. Proboscis yellow, palpi and face yellow covered with silvery white dust, the latter of the usual breadth for the female. Antennæ yellow, the small third joint with a blunt point and covered with dark pubescence; arista distinctly pubescent. Front and occiput metallic green, thickly covered with white dust. Postocular cilia snow-white. Thorax dull metallic green, the ground-color almost hidden under a thick coating of brown dust. Dorsal bristles prominent along the anterior border of the thorax. Scutellum slightly brighter metallic green than the thorax, but also with a covering of dust. The scutellum bears two strong mesial and two weak lateral bristles. First abdominal segment dark brown, succeeding segments black dusted with white, posterior edges of second, third and fourth segments and venter yellow. Ovipositor yellow at the base, tip black with delicate hairs. Pleuræ blackish metallic green, thickly covered with white dust. Metathoracic epimera dark brown. Coxæ yellow,

[1] Kans. Univ. Quarterly. Vol. II, No. 3, 1894, pp. 151-152.

fore and middle pairs with prominent black bristles on their anterior surfaces near their tips; hairs on the upper portions of the fore coxæ delicate, pale. Hind coxa with a single black bristle on its outer surface. Legs pale yellow with black hairs. Tarsi infuscated towards their tips. Fore tarsi scarcely twice as long as the fore tibiæ; middle tarsi one and one-third times as long as the middle tibiæ; hind tarsi scarcely as long as the hind tibiæ. Hind metatarsus distinctly shorter than the succeeding joint. Wings grayish hyaline with a yellowish tinge, broader in the middle, slightly narrowed towards the base. Distal segment of fourth vein moderately bent forward near its middle and ending not very close to the third vein. Distal segment of fifth vein nearly two and one-half times as long as the posterior cross-vein. Halteres and tegulæ dark brown, the latter with pale cilia.

A single specimen taken in sweepings in the pine-woods near Monterey, Calif., July 22, 1896.

The species differs from the other described North American species in having very little yellow on the abdomen.

75. **Neurigona tenuis** (*Loew.*)

PLATE IV, FIG. 105.

Saucropus tenuis LOEW.

Loew described this species from a female taken in the Middle States. I have seen two males which I believe belong here—one collected by Mr. C. W. Johnson at Pope's Creek, Md., May 22, 1896, and another somewhat larger specimen collected by Mr. A. W. Snow in the Magdalena Mts., N. Mex., during August, 1894. Apart from this difference in size and a few insignificant characters, the two specimens resemble each other very closely.

Male. Length 3.75–4.25 mm.; length of wing 3–4 mm. Proboscis and palpi yellow, the latter dusted with white. Face very narrow, linear, covered with glistening white dust. Antennæ yellow, apex of third joint blunt, pubescent and infuscated. Postocular cilia above and below white. Front and thorax dull metallic green, thickly covered with white dust. Humeri in the eastern specimen yellow. Scutellum dull light metallic green, with white dust and yellow posterior border. Abdomen arched, compressed laterally; first segment yellow, slightly infuscated and with the bristles along its posterior edge rather prominent; second and third segments yellow, each with a large black dorsal triangle, fourth segment black edged with yellow. The third and fourth segments have long pale hairs on the venter and there are similar hairs on the posterolateral edges of the fourth and fifth segments. Hypopygium large, hood-shaped, protruding, sessile, black; basal portion opaque and somewhat hairy, appendages more glabrous. On the lower (morphologically dorsal) surface is a small, pale, rounded projection bristling with pale hairs. Pleuræ dark metallic green covered with white dust. In the eastern specimen the space between the humerus and the insertion of the fore coxa and also much of the region above the middle coxa is yellow. In both specimens the metathoracic epimera are yellow. Coxæ yellow; fore pair very long; hind pair with a large fuscous spot not very sharply outlined; hairs on fore coxæ pale and inconspicuous. Legs very long and slender, pale yellow, slightly infuscated towards the tips of the tarsi. Middle femora with some prominent black bristles on their undersides near the base; in the corresponding region the hind femora are beset with a couple of stouter, longer yellow bristles. Fore tibia with a regular series of short hook-like spines along its lower surface. Fore tarsi slender, not quite as long as the fore tibiæ; first joint longer than the second to fifth taken together, on its inner surface with a regular series of small, curved, flattened spines; second and third joints plain, of about equal length, narrower than the first joint, fourth and fifth joints dilated, the former paler near the base and fringed with flattened black hairs, the latter entirely black, with shorter hairs. Wings somewhat narrowed towards their bases, yellowish gray, with brown veins. Fourth vein gently bent upwards near its middle, thence running parallel with the third vein and ending not very close to it in the costa. Posterior cross-vein about one-third the length of the distal segment of the fifth vein. Tegulæ and halteres pale yellow, the former with rather long yellow cilia.

INDEX TO NEW SPECIES

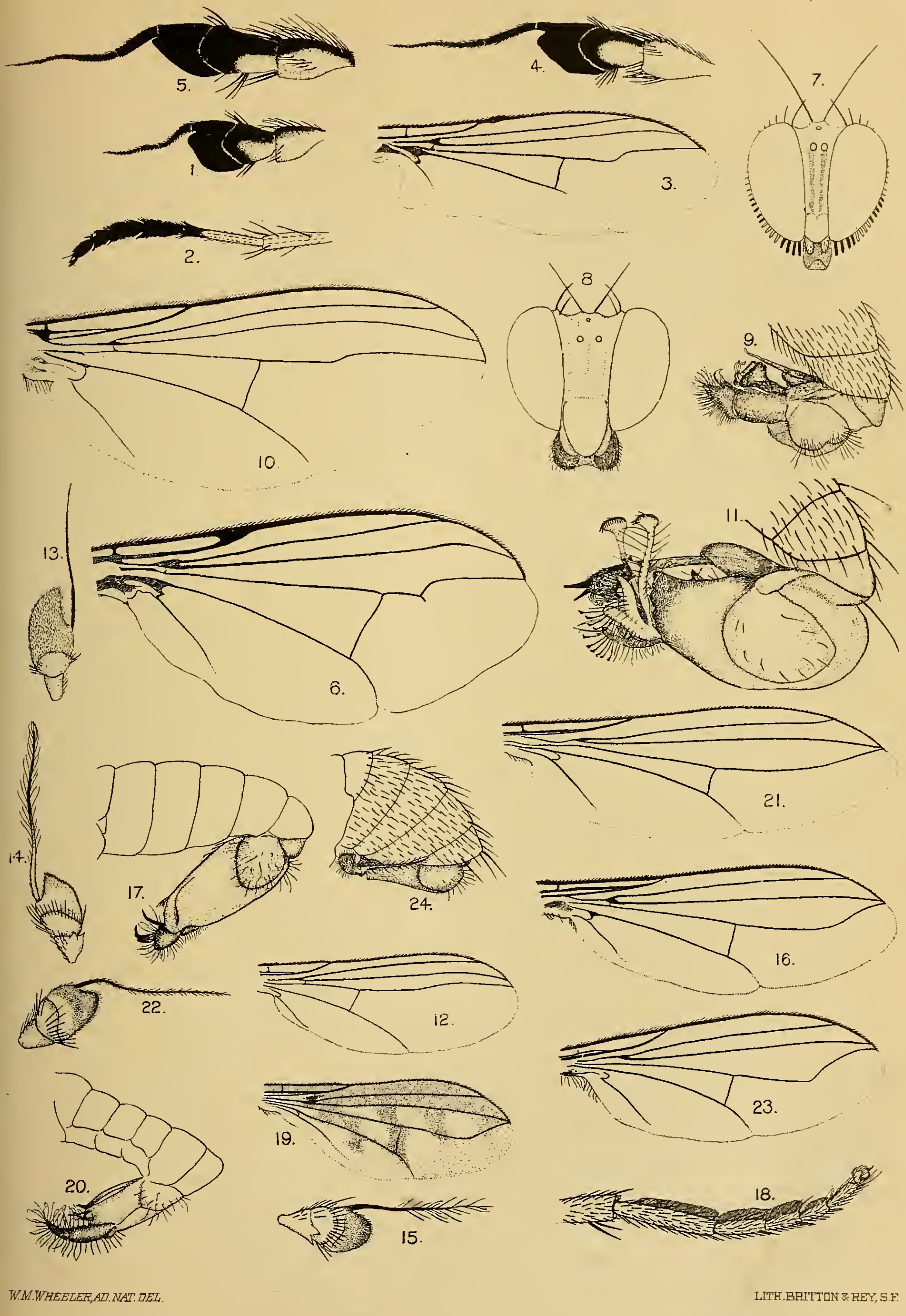
OF

DOLICHOPODIDÆ FROM THE UNITED STATES.

New genera and species in **full face**, synonyms in *italics*.

EXPLANATION OF PLATE I.

Fig. 1.	*Hygroceleuthus*	*Aldrichii*,	sp. nov.,	♂, antenna (mesial aspect).
2.	"	"	"	♂, middle leg.
3.	"	"	"	♂, wing.
4.	"	*crenatus*	O. S.,	♂, antenna (mesial aspect).
5.	"	*consanguineus*,	sp. nov.,	♂, " " "
6.	"	"	"	♂, wing.
7.	"	"	"	♂, face.
8.	*Polymedon*	*castus*,	sp. nov.,	♀, face.
9.	*Hercostomus*	*procerus*,	sp. nov.,	♂, hypopygium.
10.	"	"	"	♂, wing.
11.	"	*impudicus*,	"	♂, hypopygium.
12.	"	"	"	♂, wing.
13.	"	"	"	♂, antenna (mesial aspect).
14.	*Pelastoneurus*	*neglectus*,	sp. nov.,	♀, " " "
15.	"	*vagans*	Loew.,	♀, " " "
16.	"	*cyaneus*,	sp. nov.,	♂, wing.
17.	"	"	"	♂, hypopygium.
18.	"	"	"	♂, fore tarsus.
19.	"	*pictipennis*,	"	♀, wing.
20.	"	*occidentalis*,	"	♂, hypopygium.
21.	"	*nigrescens*,	"	♀, wing.
22.	*Paraclius*	*propinquus*,	sp. nov.,	♂, antenna (mesial aspect).
23.	"	"	"	♂, wing.
24.	"	"	"	♂, hypopygium.



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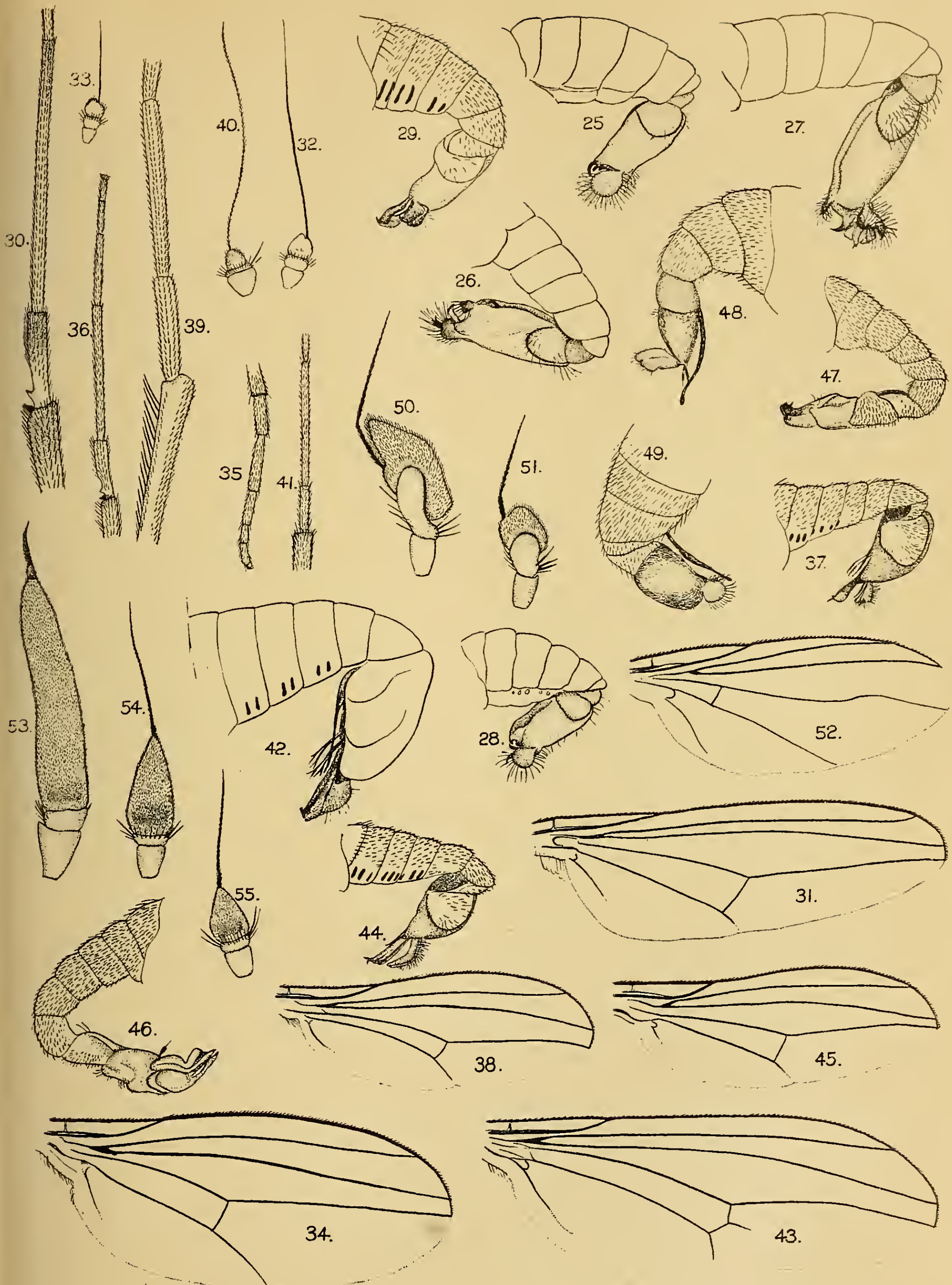
EXPLANATION OF PLATE II.

Fig. 25.	*Pelastoneurus*	*pictipennis*,	sp. nov.,	♂,	hypopygium.
26.	"	*floridanus*,	"	♂,	"
27.	"	*nigrescens*,	"	♂,	"
28.	"	*lugubris*	Loew.,	♂,	"
29.	*Medeterus*	*princeps*,	sp. nov.,	♂,	hypopygium.
30.	"	"	"	♂,	base of hind tarsus.
31.	"	"	"	♂,	wing.
32.	"	"	"	♂,	antenna.
33.	"	*xerophilus*,	"	♀,	"
34.	"	"	"	♀,	wing.
35.	"	"	"	♂,	hind tarsus.
36.	"	*veles*	Loew.,	♂,	" "
37.	"	"	"	♂,	hypopygium.
38.	"	"	"	♂,	wing.
39.	"	*viduus*,	sp. nov.,	♂,	tip of hind tibia and base of tarsus.
40.	"	*aberrans*,	"	♀,	antenna.
41.	"	*appendiculatus*,	"	♂,	base of hind tarsus.
42.	"	"	"	♂,	hypopygium.
43.	"	"	"	♂,	wing.
44.	"	*californiensis*,	"	♂,	hypopygium.
45.	"	"	"	♂,	wing.
46.	"	*maurus*,	"	♂,	hypopygium.
47.	"	*aurovittatus*,	"	♂,	"
48.	*Thrypticus*	*fraterculus*	Wheeler,	♂,	hypopygium.
49.	"	*Willistoni*	"	♂,	"
50.	*Asyndetus*	*syntormoides*,	sp. nov.,	♂,	antenna (mesial aspect).
51.	"	"	"	♀,	" " "
52.	"	"	"	♂,	wing.
53.	*Porphyrops*	*xipheres*,	sp. nov.,	♂,	antenna.
54.	"	*effilatus*,	"	♂,	"
55.	"	"	"	♀,	"



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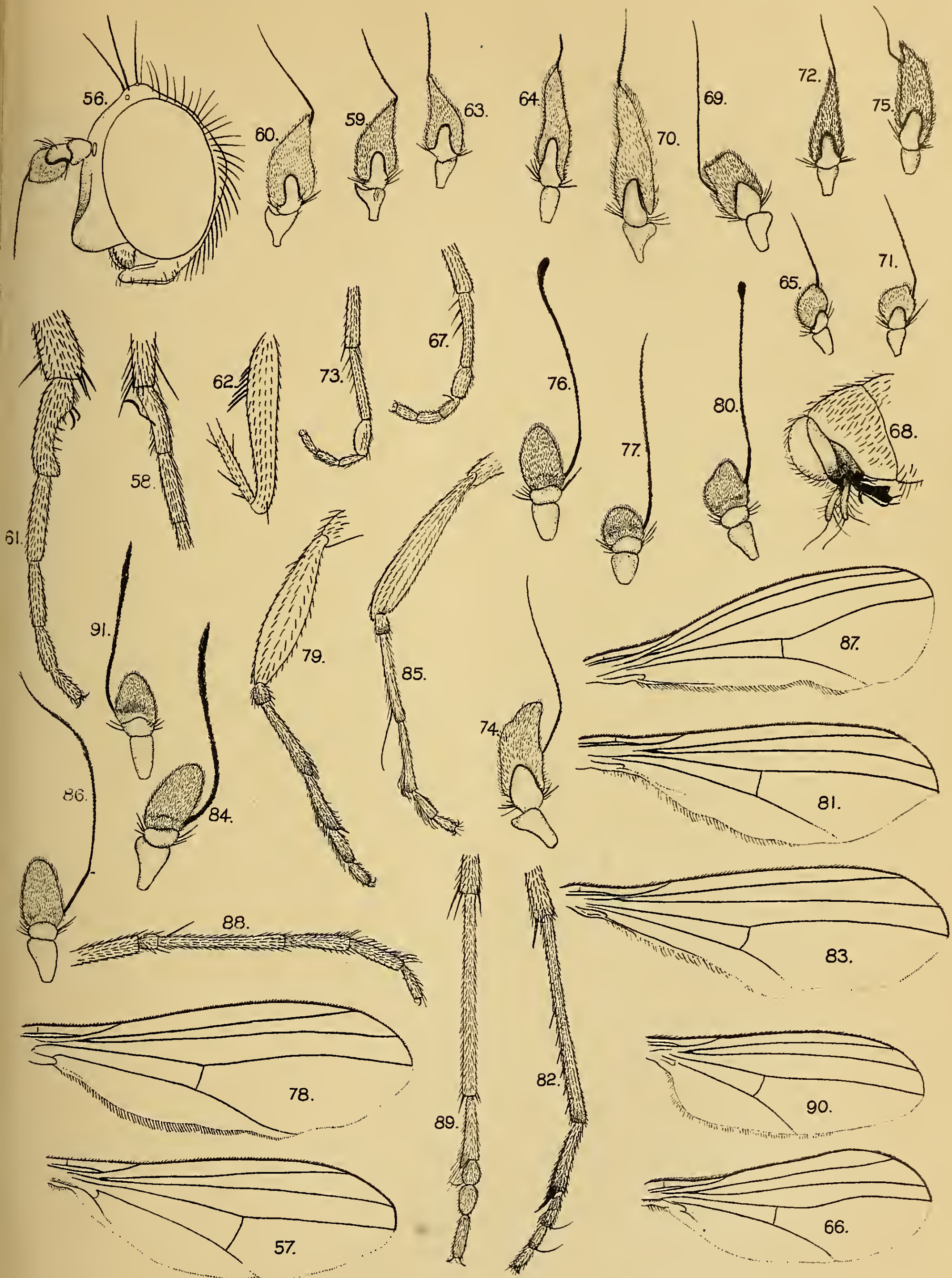
EXPLANATION OF PLATE III.

Fig. 56. *Synarthrus affinis*, sp. nov, ♀, head, (lateral aspect).
57. " " " ♂, wing.
58. " " " ♂, base of hind tarsus.
59. " " " ♂, antenna (mesial aspect).
60. " *stratægus*, " ♂, " " "
61. " " " ♂, hind tarsus.
62. " *cinereiventris* LOEW., ♂, middle femur.
63. " " " ♂, antenna (mesial aspect).
64. *Parasyntormon asellus*, sp. nov., ♂, antenna (mesial aspect).
65. " " " ♀, " " "
66. " " " ♂, wing.
67. " " " ♂, fore tarsus.
68. " *occidentalis* ALDRICH, ♂, hypopygium.
69. " " " ♂, antenna (mesial aspect).
70. " *lagotis*, sp. nov., ♂, " " "
71. " " " ♀, " " "
72. " *hinnulus*, " ♂, " " "
73. " " " ♂, fore tarsus.
74. " *montivagum*, " ♂, antenna (mesial aspect).
75. " *emarginatum*, " ♂, " " "
76. *Nothosympycnus vegetus*, sp. nov., ♂, antenna.
77. " " " ♀, "
78. " " " ♂, wing.
79. " " " ♂, fore leg.
80. " *nodatus* LOEW., ♂, antenna.
81. " " " ♂, wing.
82. " " " ♂, middle leg.
83. " *fortunatus*, sp. nov., ♂, wing.
84. " " " ♂, antenna.
85. " " " ♂, fore leg.
86. " *Oreas*, " ♂, antenna.
87. " " " ♂, wing.
88. " *sobrinus*, " ♂, fore tarsus.
89. " " " ♂, middle tarsus.
90. " " " ♂, wing.
91. " " " ♂, antenna.



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EXPLANATION OF PLATE IV.

Fig. 92. *Sympycnus marcidus*, sp. nov., ♂, hind tarsus.

93. " " " ♂, wing.

94. " " " ♂, antenna.

95. " " " ♀, "

96. " *lineatus* Loew, ♂, "

97. " " " ♀, "

98. " " " ♂, wing.

99. " *cuprinus*, sp. nov., ♂, antenna.

100. " " " ♀, "

101. *Sympycnus pugil*, sp. nov., ♂, fore tarsus.

102. " " " ♂, middle tarsus.

103. *Teuchophorus clavigerellus*, sp. nov., ♂, hind leg.

104. " " " ♂, wing.

105. *Plagioneurus univittatus* Loew., ♂, tip of abdomen.

106. *Neurigona tenuis* Loew., ♂, fore tarsus.

107. *Campsicnemus hirtipes* Loew., ♂, middle leg (posterior aspect).

108. " " " ♂, antenna.

109. " " " ♀, "

110. " *degener*, sp. nov., ♂, middle leg.

111. " " " ♂, antenna.

112. " " " ♀, "

113. " *claudicans* Loew., ♂, middle leg (anterior aspect).

114. " *Œdipus*, sp. nov., ♂, " " (posterior ").

115. " *Philoctetes*, " ♂, " " (anterior ").

116. " " " ♂, " " (mesial ").

117. " " " ♂, antenna.

118. " *Thersites*, " ♂, middle leg (anterior aspect).

119. *Hydrophorus parvus* Loew., ♂, fore femur and tibia.

120. " *agalma*, sp. nov., ♂, " " " "

121. " " " ♀, " " " "

122. " *sodalis*, " ♂, " " " "

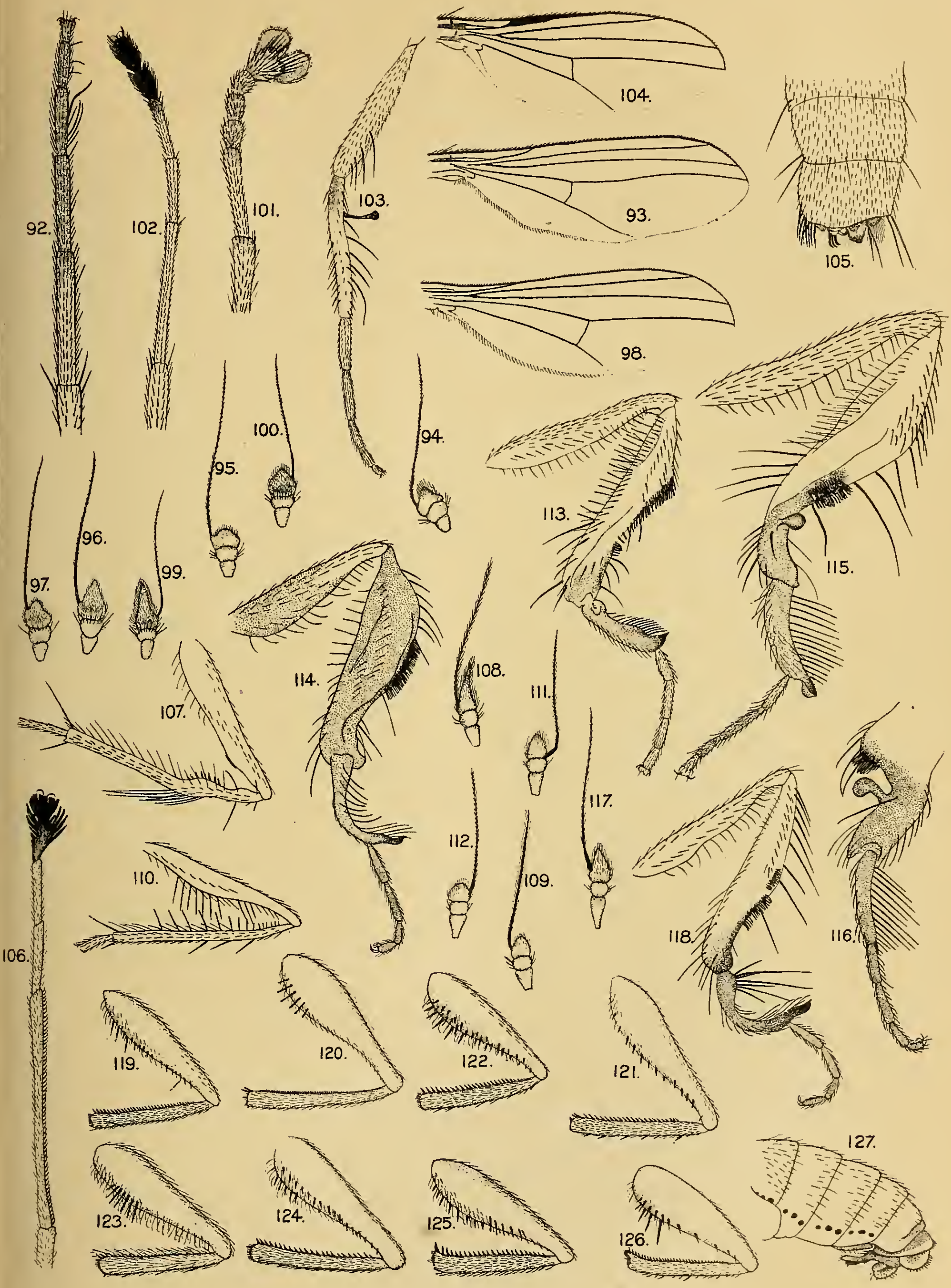
123. " *algens*, " ♂, " " " "

124. " *Magdalenæ*, " ♂, " " " "

125. " *eldoradensis*, " ♂, " " " "

126. " *philombrius* Wheeler, ♂, " " " "

127. " " " ♂, abdomen.



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PROCEEDINGS

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Researches in American Oligochæta, with Especial Reference to those of the Pacific Coast and Adjacent Islands.

BY

GUSTAV EISEN, PH. D.,

WITH TEN PLATES.

Issued January 20, 1900.

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RESEARCHES IN AMERICAN OLIGOCHÆTA, WITH ESPECIAL REFERENCE TO THOSE OF THE PACIFIC COAST AND ADJACENT ISLANDS.

BY GUSTAV EISEN, PH. D.

CONTENTS.

PLATES V–XIV.

 December 14, 1899.

Introduction.

These researches are based upon collections made in various parts of North America during the last few years. The paper completes the account of all species of the Terricolide families mentioned, on hand at the time of going to press. There remain to be worked up some new species of *Diplocardia* from Nebraska, received from Professor H. B. Ward, and some very interesting species of *Benhamia* and *Ocnerodrilus*, collected by Mr. Robert E. Snodgrass on the Galapagos Islands and on Clipperton Island. These specimens were received too late to be described in the present paper.

An account of the family of Enchytraeidæ, of which there are at least over fifty new species on the Pacific Coast, is now under way and it is expected will be finished during the coming year.

The author is under great obligation to those who have contributed to his work by presenting specimens. Among those who have thus aided in making known our interesting and important fauna of Oligochæta are: Professor Albert Koebele of Honolulu, Hawaii; Professor C. H. Gilbert and Mr. R. C. McGregor of Stanford University; Dr. H. W. Harkness and Mr. Alexander Craw of San Francisco; Professor C. H. Tyler-Townsend of Las Cruces, New Mexico; Professor Frank Smith of Champaign, Illinois, and Messrs. Brimley Brothers of Raleigh, North Carolina.

GEOSCOLECIDÆ.

Pontoscolex *Schmarda.*

Pontoscolex corethrurus *(Fr. Müller)* mexicanus, subsp. nov.

PLATE V, FIGS. 1–16; PLATE VI, FIGS. 17–23; PLATE VII, FIGS. 24–26, 35–37.

Definition.—Length 95–110 mm. (those from Baja California 200 mm.); diameter 3–4 mm.; somites 145–212. Setæ bifid, slightly ornamented; setæ *c* and *d* wider apart in II than they are in III and IV; setæ *c* in II in line with *d* in III; setæ *d* in II more dorsal than setæ *d* in III and IV. Penial setæ with eight or nine pockets at apex. Prostomium present, but retractile; mouth at apex and terminal. Caudal zone 28–76 somites from tail-end, and 107–118 somites from the head. Clitellum in XV–1/4 XXIII. Tubercula pubertatis in XIX–XXII. Gizzard in VI. Sacculated intestine commences in XVII. Calciferous diverticles in VII, VIII, and IX. Spermathecal pores in the posterior part of VI, VII, VIII, but the main body of the spermathecæ respectively in VII, VIII, IX. The spermathecal duct about five times longer than the pouch. Nephropores in line with setæ *c* and *d* in all somites except III, where they are absent, and in II, where they are slightly more ventral than in *c*. Hearts in XI and XII. One pair of testes in XII. One pair of sperm-funnels in XII. Ovaries in XIII; oviducts in XIV. One pair very long, dorsal sperm-sacs extending to the posterior part of the clitellum. Spermiducal pores in the anterior part of XXI. Septal formula:—

$$\overline{\overline{\overline{\overline{\text{III/IV}}}}},\ \text{O},\ \text{O},\ \overline{\overline{\overline{\text{VI/VII}}}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\text{VIII/IX}}},\ \text{O},\ \overline{\text{X/XI}}.$$

No additional capillaries in the caudal zone.

Habitat.—Mexico and Central America.

This worm was found to be very common in the coast territory from the Cape Region in Baja California through Mexico, Guatemala, and Salvador in Central America. Specimens are represented from the following localities in Baja California: Todos Santos, Miraflores, San José del Cabo and all parts of the Cape Region. (Eisen 21.) Todos Santos is the most northern point where the species was found, and it is doubtful if it extends further north. It has not been found in California, U. S. A. In Mexico I have collected specimens in abundance at Mazatlan, San Blas, and Tepic. As the latter place is over 4,000 feet above the sea, it will be seen that the species possesses a great vertical range. I do not think, however, that it occurs in localities subject to frosts. In Guatemala, Salvador and Honduras, the species extends from the Atlantic to the Pacific. The Cape Region specimens are all from the lowlands. They are larger than those from the mainland of Mexico and from Central America, but I have found no other distinguishing feature.

The anatomical and histological description given below is based on specimens from Tepic, taken in the vicinity of the city. The Central American specimens were not sufficiently well preserved to warrant sectioning, and the Cape Region specimens appeared to me to be so similar, except in size, that no effort was made to study their finer anatomy.

Characteristics.—The following points in the structure of *Pontoscolex corethrurus* subsp. *mexicanus* are either especially characteristic of this form or they have not before been mentioned as belonging to *Pontoscolex corethrurus* by those who have previously studied the species.

1. The septum III/IV is very wide and greatly thickened.

2. Tubercula pubertatis are present in somites XIX–XXII. The glandular cells characteristic of these organs penetrate into the muscular layers of the body-wall.

3. The spermathecæ open into the posterior parts of somites VI, VII, VIII, but the main pouches are in somites VII, VIII, IX. The spermathecal pores are thus preseptal.

4. Setæ *c* and *d* in somite II are not in line with setæ *c* and *d* in somites III, IV and following; but setæ *c* in somite II are in line with setæ *d* in III and IV, and setæ *d* in II are more dorsal than setæ *d* in the other somites.

5. Setæ *c* and *d* in somite II are somewhat larger than any other of the anterior setæ.

6. The spermathecæ are much longer than those figured by Perrier. The duct is about four and a half to five times the length of the pouch and about one-third its width.

7. There are no extra blood capillaries in the caudal zone, such as those described by Horst in his account of *Pontoscolex corethrurus*.

8. The male pore is on the anterior part of somite XXI and not in the intersegmental groove. Whether this is a constant feature I am unable to say. The pores are not visible from the exterior.

9. There is a large prostomium which is generally found retracted in preserved specimens.

10. The caudal zone is characterized by a large number of what seem to be sense-cells without terminal sense-hairs.

11. In the anterior part of the anterior somites the longitudinal muscular layer is separated from the transverse muscular layer by vacuoles traversed only by isolated strands of mixed muscular tissue.

Affinity.—After a consideration of the foregoing peculiarities in structure, the question naturally arises whether the form of *Pontoscolex* from Tepic and Baja California is a variety, a subspecies, a distinct species, or, perchance, identical with the *Pontoscolex corethrurus* described by a number of investigators. With our present knowledge of the anatomy of the type-specimens of *P. corethrurus* and of those specimens from other localities which have been referred to this species, this question cannot be satisfactorily answered without a re-examination of all the types. The descriptions given by the various investigators either differ considerably from each other in essential points, or they are insufficient to enable one to satisfactorily determine a specimen. Dr. Rosa (1) has, as is well known, endeavored to harmonize all the conflicting statements and descriptions, and has expressed the opinion that all refer to one single species, which must then be known as *Pontoscolex corethrurus* (Fr. Müller). Horst and Beddard, who are the only other investigators of this species, readily coincided with the views expressed by Rosa; and Beddard, in his large monograph on the Oligochæta, has joined the variously described species, *Urochæta hystrix*, *U. dubia* and *Pontoscolex corethrurus*, under the one head, *P. corethrurus*. I do not concur with them in this arrangement, as my specimens differ from those described by Beddard in at least one very important point, namely, the location of the spermathecal pores. Beddard distinctly states (45) that "the aperture is in each case placed quite close to the anterior margin of the segment." In another place he states that the spermathacæ are in segments VII, VIII and IX. It can only be understood from this that the pores are situated in the anterior parts of VII, VIII and IX, and near to the anterior margin of the respective segments. In my specimens from Mexico, the pores of the spermathecæ are preseptal, that is, they are situated in the posterior part of the somites, which character I think is of sufficient importance to be of specific value. If, after re-examination, the postseptal position of the spermathecæ in the species examined by Beddard, Rosa, and Horst proves to be constant, then there will remain no doubt as to the specific difference of my Mexican specimens.

A re-examination of the various specimens described as *Pontoscolex corethrurus* is, therefore, highly desirable, and until this is made the question of the distribution of *Pontoscolex* cannot be finally settled. There is every reason to believe that several additional species of *Pontoscolex* will soon be found. In his monograph on the Oligochæta, Beddard recognizes the following species: *P. corethrurus* (Fr. Müller), *P. arenicola* Schmarda and *P. hawaiiensis* Beddard. To this number has recently been added another, *P. Lilljeborgii* (Eisen 19). The fact that we possess four distinct species of *Pontoscolex* argues very strongly against the supposition that *Urochæta hystrix*, *U. dubia* and *Pontoscolex corethrurus* are one and the same species.

Following will be given a detailed description of *Pontoscolex corethrurus* subsp. *mexicanus*.

EXTERNAL CHARACTERS.

Size.—(figs. 1–6.) The average length of the Tepic specimens is much less than that of the specimens from the Cape Region. The largest of them average 111 mm., the smallest 95 mm.; the width in front of the clitellum at the narrowest part is about 3 mm. Specimens from the Cape Region measure 200 mm. in length, with a diameter of 4 mm. The number of somites in the Tepic specimens ranges between 145 and 212. Figure 1 represents a specimen natural size, narcotized and preserved in alcohol. The specimen is not, however, as extended as when crawling about during life.

Setæ.—The anterior setæ are strictly paired and the dorsal setæ are likewise paired till they reach somite XII, where they begin to separate a little, continuing about equidistantly in XII, XIII and XIV, and running only slightly deltoid. In XV they separate more, and in XVIII they are at the greatest distance apart, continuing to remain the same to about somite XLII. In or near this latter somite setæ *c* continue in a straight line to the caudal zone, or for about 44 somites from the tail-end. From the caudal zone to the tail-end the arrangement of the setæ is quincuncial, in the same manner as has so often been described and figured by various investigators. The difference in the size and location of the setæ in somite II (figs. 3 and 4) has already been mentioned.

There is a difference between the penial setæ of my specimens (fig. 7) and those figured by Perrier. His figure represents a penial seta with sixteen cup-shaped depressions, while the setæ of my specimens have only eight or nine.

Anterior Somites.—(figs. 2, 3, 4.) Although Horst (17) has shown that there exists a real prostomium extending beyond somite I, Beddard (86) has nevertheless found it necessary to question the presence of this lobe. Thus we find in his definition of the species, "prostomium absent." My sections show conclusively that Horst is correct in his statement, and that a prostomium is really present, though it is of small size (supposing, of course, that my Mexican specimens do not differ in character from those of Horst, or that Beddard and Horst really examined the same species, of which I am not convinced).

The prostomium is frequently retracted, and in specimens which have been directly immersed in alcohol it is probably always retracted to such an extent that it cannot be seen from the exterior. In figs. 2 and 3 the prostomium is shown as seen from the lateral and ventral sides; in fig. 4 it is seen retracted. This peculiarity probably accounts for the statements of various authors as to its presence or absence.

The inner, anterior lips (fig. 9) of the prostomium are distinct and swollen, showing a bilobed apex. The entrance to the alimentary canal begins between the two lobes.

Somite I is much wider dorsally than ventrally, as shown in fig. 9. The surface of the posterior part of somite I is sulcate in the direction of the long diameter of the body, and the whole of somite II is similarly sulcate and rugose (figs. 2–4). Somite II is much wider than somite III and slightly wider than the dorsal part of somite I. Somite II is the most anterior somite having setæ. The anterior somites increase in width towards IX, and somites VI–IX are generally much shorter and more prominently ringed than the others. Somites X to XIV are of almost the same size, and the middle ring of each of these somites projects much less than do those in the anterior somites.

Clitellum.—(fig. 5.) The clitellum begins with somite XV and extends through one-fourth of XXII. It is well defined, especially with the beginning of the anterior part of somite XV. Anterior to this, the body is narrower than in somite XV and those following.

Exteriorly viewed, the clitellum is saddle-shaped, but there is a continuous row of clitellar cells even on the ventral side of the body. This ventral zone is quite narrow, gradually increasing in width towards the tubercula pubertatis (fig. 5).

Caudal Zone.—(fig. 1.) The location of the caudal zone varies considerably in different individuals, as may be seen from the following table of specimens taken at random from the collection from Tepic. The numerals indicate the number of somites from head to zone and from end of zone to end of tail, etc.

	From head to caudal zone.	Caudal zone.	From end of caudal zone to end of tail.	Total.
No. 1.	111	6	74	191
No. 2.	108	5	76	189
No. 3.	118	6	71	195
No. 4.	111	5	54	170
No. 5.	107	5	48	160
No. 6.	113	5	44	162
No. 7.	107	4	wanting	117
No. 8.	118	8	74	212
No. 9.	110	7	28	145

As will be seen from the above table, the caudal zone generally consists of from five to seven somites, the number differing according to its location. The distance from the clitellum is more constant than the distance from the tail-end. The former varies from 107 to 118 somites, the latter varies from 28 (or none) to 74 somites. The two specimens with the very short tail may have had a portion broken off; still the variation is such as to clearly show that the distance to the tail-end is the least constant one. The structure of the caudal zone will be referred to later.

Tubercula Pubertatis.—(figs. 19, 20.) The continuous elevated ridges constituting the tubercula pubertatis have already been referred to as occupying somites ½ XIX–½ XXIII. They begin in the center of XIX and end in the center of somite XXIII. Cross-sections show that this ridge is a true tubercula pubertatis organ, being composed of the same kind of glandular cells as are found in other genera, such as *Sparganophilus* and *Benhamia*, and which have also been figured by Beddard, Benham and others. There is a great similarity between the structure of these tubercles in the present species and those found in *Sparganophilus*. The glandular cells (fig. 20) are long and narrow, pear-shaped, or oblong and club-like, with round nuclei near the wide distal apex. Between them are also found other glandular clitellar cells, as well as a few hair-tipped sense-cells. The most interesting feature of these true tubercula pubertatis cells is that they extend through the two muscular layers of the body-wall to the cœlomic epithelium, but do not penetrate into the cœlomic cavity (fig. 19). Similar cells are found in *Diplocardia Koebelei*.

Beddard has shown that there are, as regards structure, two kinds of tubercula pubertatis. In one of these the glandular cells extend into the cœlom, as in *Perichæta*, while the other kind is associated with glands which do not extend into the cœlomic cavity, but which are confined to the epidermis. Beddard's suggestion that this morphological distinction may not prove to be of very great importance is undoubtedly correct. In *Pontoscolex* we find that these glands are intermediate between the two extreme types. In a very few instances I have observed one or two of them penetrating the cœlomic epithelium, which makes the transition all the more complete, and proves what has already been suggested (Eisen 18), that in the terrestrial Oligochæta the tubercula pubertatis are always of the same morphological nature, whether their exterior forms take the shape of ridges or papillæ; also that the differences consist principally in the size of the glands and in the number of sense-cells between them. In *Pontoscolex* these sense-cells are few and small; they are never found on the ridge of the papillæ, but are confined to a narrow groove on either side, very much as in *Sparganophilus*. The tips of the sense-cells project through the cuticle; they are knob-like, appearing very much like minute pin-heads, and are about as long as the cuticle is deep (fig. 20).

The tubercula pubertatis glands do not immediately join the clitellar glands. There is a narrow zone of narrow glandular cells which separates the tubercula pubertatis ridge from the regular clitellar cells (fig. 20).

INTERNAL CHARACTERS.

Body-wall.—(figs. 11, 17, 20.) In a longitudinal section of the body-wall we may readily observe how in the anterior somites the muscular layers are arranged in a characteristic manner. The general rule in Oligochæta is for the two muscular layers to be rather closely superposed, continuing in the same intimate relation throughout their length. In all the anterior somites of *Pontoscolex* the distance between these two muscular layers varies, even in various parts of the same somite. Thus, in the posterior part of one of these somites, beginning at the center, the two muscular layers are, as usual, placed one on the other, with no prominent space between. In the anterior part of the same somite the two layers are not so placed, there being large open spaces between them, separated only by narrow muscular strands (figs. 9, 17). The most anterior somites are most differentiated in this respect, the posterior ones the least so, and between these two extremes there is a series of intermediate grades. Thus, in somites II to VI there are six small openings; in VII to IX, five openings; in X, four openings; in XI, three; in XII, two; and in XIII there is but one. It is not claimed that these numbers are always constant, but they were the same in the three specimens which I sectioned up longitudinally. In the posterior somites, beginning with XIV, the two muscular layers are as intimately superposed as in most other worms.

We may also note another peculiarity of the epidermis, namely, the absence of unicellular glands in the anterior part of the somites lying furthest anteriorly. Even in the other somites it is found that the posterior part contains more unicellular glands or goblet cells than the anterior part (figs. 11, 17). These glands are of two kind, judging from their staining qualities. In almost every longitudinal section there will be found one or two unicellular glands which stain reddish with such stains as toluidine or thionin; while all the other glands take a bluish stain. The position of the reddish staining glands appears to be quite constant in the posterior part of the somite.

Auditory Cells.—(figs. 98–111.) In a previous paper (Eisen 19) the auditory cells have already been described in detail. After these investigations were completed, however, a few very young specimens of *Pontoscolex* from Tahiti were received through the courtesy of Mr. Alexander Craw. As the worms were alive when brought to me, opportunity was afforded for careful fixing, and the study of these specimens has enabled me to settle some points which were left in doubt in the former paper. Especial reference is made to the very minute structures found in every auditory cell, which the author described as nerve-endings or nerve-plates. This decision does not now appear to be correct, however. The new methods of fixing have made it possible to more clearly demonstrate their minute structure.

In a former paper on the blood of *Batrachoseps* (Eisen 21) the name archosome was suggested for the structure composed of centrosome and spheres, and in the following descriptions this term will be used to designate the structures which were at first supposed to be nerve-plates. They are not situated on or at the surface of the cell, but in its interior, about half way between the nucleus and the cell-wall. The archosomes are of varying size: some are very small (possibly due to a state of shrinkage) and show no interior structure; others are comparatively large and are distinctly differentiated. The largest archosomes appear as a flat disc, as large or larger than the nucleus of the cell. Between these two extremes there is a series of intermediate sizes and forms. But, small or large, the archosomes always appear to be surrounded by a defining membrane which is very sharply defined in the largest of them. The archosomes, even in the small cells, are frequently unequal both in size and form (figs. 100, 101); more rarely they are of the same size (figs. 99, 109, 102, 106).

In each archosome there are nearly always two definable zones, one interior to the other. The outer of these zones, which is much the larger, I identify as the archoplasm or centrosphere (Eisen 20). In this sphere there may be seen one or more dark-staining dots, the centrosomes, surrounded by a more or less diffused zone or sphere,—the somosphere (Eisen 20). The latter is either star-like, as in fig. 106, or well defined and spherical, as in figs. 105 and 106. In some archosomes I have found two separate somospheres, each with one or more centrosomes. In fig. 107 one of the somospheres in *a* is much larger than the other and contains two centrosomes connected by a dark band. In the specimens from Tahiti, I have never found a cell in which more than two archosomes could be identified with certainty. Their position in the cell is very constant, always below the nucleus, close to the central cylinder of cytoplasm, which projects from the nucleus downwards. In a specimen from Mexico, four or more archosomes (Eisen 19) were found in some of the cells.

The radiations which are frequently seen projecting from the archosome and which are, sometimes, as clearly defined as fibers are probably of strictly cytoplasmic nature and possess, perhaps, the function of supporting the archosome. As regards the other structures of these cells, I can add but little to the previous descriptions. The cytoplasmic agglomeration designated as otosome is easily fixed with corrosive sublimate or alcohol, but not so well with other fixatives. It cannot be demonstrated in every cell. The very fine plates supporting the cytoplasmic cap above the nucleus (fig. 98) are rarely satisfactorily stained except by the Benda iron-hæmatoxylin method.

Finally, mention must be made of a most peculiar form (fig. 100) of archosome which the author has observed only a few times. Its shape is that of a long sausage-like body of reticulated structure throughout, in which are seen several dark-staining granules, especially at the poles. Its location is always the same as that of the other archosomes, among which it appears to be an unusual or abnormal form. As regards earlier observations of the otosme, I find that Dr. Horst (17) distinctly but faintly outlines this body (fig. 37, Tab. IV,) but makes it appear as though connected with a tube running between the cell and the cuticle. He does not refer to it in the text.

Caudal Zone.—(figs. 1, 21, 22.) The location of this zone has already been described. It has been generally known as the "zone of growth," almost ever since it was so called by Schmarda. The zone of growth was first referred to as such by Fritz Müller, and since his time every investigator who has had an opportunity to study this interesting genus has speculated upon the significance and purport of this unusual structure. Fritz Müller and Beddard are of the opinion that the zone of growth is a place where new segments originate and where they may be most readily renewed. Beddard assumes that this swollen zone will easily break, and that at this point rapid segmentation is possible.

Horst (17) does not share Beddard's opinion. He points out that the zone is characterized by a large number of capillaries and figures these vessels (Tab. IV, fig. 40), but suggests no special use for them in this region. Upon what feature of the zone Beddard founds his theory of regeneration is not quite evident. Out of many hundreds of specimens of *Pontoscolex* collected by the writer, only one was found in which the caudal zone forms the terminus of the body, and here it is evident that the tail-end has been lost. I do not find, however, that *Pontoscolex* is more easily torn than other worms, and cannot see how the above theory explains the formation of this extraordinary structure, as far as known, only once paralleled elsewhere. I have sectioned a number of these zones of growth but have yet to find a single cell in mitosis, though the specimens were young and undoubtedly growing. This certainly seems to indicate that if the caudal zone is a place for active growth, the activity is apparent only under certain conditions, as when the tail is being regenerated, as suggested by Beddard. But if regeneration of the tail of *Pontoscolex* is an occurrence so common that a special organ is required for the work, we should expect to find a large number of worms with broken tails, which is not the case.

In regard to this zone, I can only say that the specimens examined by Dr. Horst differ materially from those I have studied. While Dr. Horst has found an increased number of blood capillaries in the zone, I, on the contrary, find the zone to be remarkably free from blood-vessels in the epidermal layers. The long row of capillaries seen in Horst's figure does not appear in my preparations, and there is certainly nothing easier to demonstrate in an Oligochæta than blood-vessels, large or small.

The caudal zone is characterized by the very narrow segments of which it is composed. Any other portion of the worm of an equal length contains only about half as many segments as the zone itself. This further implies that the zone contains about twice as many septa and twice as many nerve-glanglia as any other portion of the body, and is therefore stronger and more sensitive than any other portion.

The structure of the epidermis of the zone is quite interesting. Horst and Beddard have commented upon the absence of glandular goblet cells in the epidermis of the zone, and Beddard has used this as an argument in favor of his theory of regeneration and growth. Horst (17) has pointed out that the absence of goblet cells and the presence of columnar epithelial cells makes a structure different from that which we would expect to find in a zone of growth,—such a one as is found in *Nais*, *Chætogaster*, *Lumbriculus*, etc.,—and that there is, in fact, no trace of any embryonic or primitive features in the zone. If to this is added the fact that the zone is most regular in the size and number of its somites, it appears as though very little remains to indicate that it is a zone of growth and regeneration.

If the histological structure of the epithelium of a segment of the zone is considered, it is found to consist of two distinct structures: one of these borders the intersegmental groove and is composed of uniform, large and regular supporting cells with large ovoid nuclei; the other occupies the larger portion of the epidermis and lines the outer convex part of the somite; it contains comparatively few supporting cells, but has a large number of cells of a different nature. In fig. 21 I have endeavored to illustrate this;

i. gr. represents the part of the epithelium facing the intersegmental groove, while *ex* indicates the convex part. The great majority of the cells are long and narrow, tapering from the cuticle.

Figure 22 represents a single cell. Of these cells there are two different forms: one has a short nucleus in which is always seen a large central nucleolus; the nucleus of the other is longer and narrower, generally without any nucleolus. The cytoplasm of the two cells differs; it is agglomerated behind the nucleus in one, but is not so placed in the other. This cytoplasmic clot stains a brilliant red with thionin, just as do the nuclear chromosomes of the several cells. The structure of these cells points to a difference in function also, and undoubtedly they serve a purpose other than that of supporting cells. I believe them to be some kind of sense-cells. The free distal ends are drawn out finely and are frequently seen penetrating the basal membrane separating the epithelium from the muscular layers, finally losing themselves among the muscles and connective tissues. The cells cannot be organs of smell or taste, because they do not end in sense-hairs; but they are eminently adapted to function as organs of touch, and are probably especially sensitive to vibrations. Their free ends offer an unusually large surface to the exterior. The distal ends, which are very thin, project beyond the regular line of the epidermis and connect with nerve-fibres. Similar cells are found among the goblet and supporting cells of the epidermis of the general body-wall, but they are present there in small numbers. I also find such cells to be numerous in the cephalic lobe of many species, a proper location, the prostomium being principally an organ of touch. The decreased number of supporting cells, the narrowness of the somites, enabling twice the number of nerve-centers to be present in the same space, and the great number of "touch cells" would, therefore, it seems to me, make the caudal zone especially sensitive to vibration or to touch, and increase its efficiency as an organ of touch.

But what would be the advantage of such a zone? Undoubtedly a greater sensitiveness at the point of the tail of the worm where it projects out of the mud or soil. *Pontoscolex* is mainly a mud worm, one species, *Pontoscolex Lilljborgii*, being Limicolide in its habits. The species under discussion was found to be common in wet places,—along river banks, etc., where the mud was barely covered by water. The least movement of the ground causes the worms to retire rapidly down the burrows. Like all other aquatic Oligochæta, the favorite position of *Pontoscolex* is with the tip of the tail extending above the mud, making the caudal zone its point of contact with the surface of the soil. It is evident that were this point especially sensitive it would be of great advantage to the worm, enabling it to quickly detect vibrations caused by the approach of birds or other enemies, and giving it time to retreat into the burrow.

But I believe the caudal zone to possess also another function of no small importance. It is especially rich in muscular fibres (fig. 21), much more so than the somites adjoining the zone. Upon several occasions I have observed the caudal zone to bulge out and increase in width when the live worm was touched. This swelling up of a portion of its body would undoubtedly help the worm to retain its hold in the ground, and prevent its being easily pulled out.

Protective Structures.—Other devices which enable this worm to retain its hold in the ground are the peculiar vacuoles in the anterior somites and the corkscrew twist of the body. The former enables the worm to suddenly extend the muscular layers and to hug the soil closer. The corkscrew twist must serve the same purpose.

The extensive distribution of *Pontoscolex* would indicate that it must be unusually well protected. To the protective organs just described we must also add the intratyphlosolar canals which enable the typhlosole to discharge into the intestine; these canals will be described later. To recapitulate, the organs and structures which are especially favorable to the survival and consequent distribution of *Pontoscolex* are as follows:—

1. The anterior vacuoles in the muscular layers of the body-wall, which enable the body to suddenly expand and to cling to the burrow.

2. The caudal zone which partly serves the same purpose and which also enables the worm to quickly perceive the approach of enemies.

3. The corkscrew-like twist of the posterior portion of the body, which enables the worm to more readily cling to the soil.

4. The auditory cells in the epidermis.

5. The intra-typhlosolar canals, which enable the typhlosole to evacuate itself into the intestine.

6. The quincuncial arrangement of the posterior setæ, enabling the worm to cling to the burrow with greater tenacity.

Septa.—(fig. 9.) There are especially thickened septa. The one furthest anterior is found between somites III and IV, and therefore bounds the posterior surface of the very large suprapharyngeal gland. This septum is as thick as any of the posterior ones. No such septum is figured by Horst (17, fig. 33), and this further strengthens me in the belief that the specimens he studied belong to a different species from mine. The septa which should be separating IV/V and V/VI are absent, but the following septa are greatly thickened. There is no septum between IX and X, a character which is possibly of generic importance.

Spermathecæ.—(figs. 8, 11.) The spermathecæ of *Pontoscolex corethrurus* have more than once been wrongly located, and nowhere do I find it explicitly stated where and how they are situated. The most important character of spermathecæ generally is the position of the pores. The pores may be either preseptal or postseptal, and the main body of the spermathecæ is situated either in the same somite as the pores, or in a somite anterior or posterior to the somite containing the pores. Beddard's statement that the spermathecæ are found in somites VI, VII and VIII has already been referred to in this paper. Horst (17) in his latest paper does not refer to the spermathecal pores, and in an earlier paper (7) he states that these pores are on the front margins of VI, VII and VIII, in front of the nephropores. If this is constant, then the species described by Perrier, Rosa, Horst and Beddard cannot be identical with my species, in which the spermathecal pores are situated in the posterior part of VI, VII and VIII, while the spermathecæ themselves are in VII, VIII and IX.

Suprapharyngeal Glands.—(fig. 9.) This very large mass of glands which discharges into the pharynx extends backwards to the posterior part of somite III, where it is bounded by the very thick septum separating III and IV. From this septum there radiate forward a number of muscular strands which separate the lobes of the above glands, and which are, furthermore, attached posteriorly to the muscular walls of the pharynx. The glands are distinctly unicellular, each with its own duct, which in many instances can readily be followed to the pharynx. The discharge pockets (fig. 10) are globular, with very narrow ducts. The pharyngeal glands are developed only dorsally. There are no other septal glands.

Calciferous Diverticles.—(figs. 23, 24, 25.) The three pairs of calciferous diverticles open separately into the intestine from the posterior part of their respective somites. Each diverticle opens independently of the others and on the dorsal part of the intestine. The histology of the diverticle has already been described in a general way by Perrier (5), more particularly the vascular part connected with these organs. I can add only a few details.

The three pairs of calciferous diverticles are similar in their structure and secretions, the latter being composed of spherical lime-globules without any characteristic structure. The secreting cells are narrow and only one layer thick, with round or oblong nuclei slightly narrower than the cell is wide. The lime-globules vary considerably in size, the largest being of the same diameter as the larger nuclei of the secreting cells. No crystals were found.

A cross-section of a calciferous diverticle shows it to be composed of layers and hexagonal chambers rather regularly arranged in rows. Between each chamber there is a tiny blood-sinus. This blood-sinus surrounds the glands on all sides, but it is larger at certain points. On the exterior of the diverticle we find blood-vessels with distinct walls. On the dorsal side of the diverticle the blood-vessels are covered by chloragogen cells which are characterized by the manner of their attachment. Instead of being affixed by a single spur, they adhere to the vessels by means of several narrow projections (fig. 24). Each diverticle enters the intestine by a separate ciliated duct, the ciliation continuing some little distance into the diverticle (fig. 25, *X*). The blood-vessel supplying the diverticle is directly connected with the large median, dorsal vessel, a section through this part showing the two vessels to be continuous and even and without valves.

There is a continuous blood-sinus in the sacculated intestine in the clitellar somites, which varies greatly in thickness. The blood is never found crystalized, as, for instance, in *Sparganophilus*.

In somites XVI and XVII the muscular layer of the intestine is considerably increased in thickness, and is about three times as wide as usual. The sacculated intestine commences in XVIII. The intestinal epithelium in somites XVI and XVII is strongly ciliated.

Typhlosole.—(figs. 36 and 37.) This organ is large, being sometimes twice as long as the diameter of the intestine. It is twisted and folded, but always dorsal. The blood-sinus occupying the center of the typhlosole is at certain intervals enlarged, forming globular or oval chambers. The epithelium of the typhlosole consists of rather short cells of the same nature as the cells of the intestine proper. The central blood-sinus in the typhlosole is confined by a distinct and nucleated membrane (fig. 36 *b*). The typhlosole consists of an enormously enlarged epithelial fold with a central blood-vessel, and is thus not a mere fold of the whole intestine, as for instance in *Allolobophora*, where the center of the typhlosole is occupied by two rows of chloragogen cells. In our species of *Pontoscolex* the blood-vessel occupies the central part of the typhlosole, there being no trace of chloragogen cells.

The blood-supply of the typhlosole is derived from the dorsal vessel in two different ways, alternating with each other in each somite. One of these methods of supplying the blood is by a median, perpendicular vessel which dips down from the dorsal median vessel into the typhlosole. This vessel is very short. Besides this perpendicular vessel, there are paired lateral vessels which start out sideways from the dorsal vessel and alternate with the perpendicular vessel (fig. 35). They connect more laterally with the blood-sinus of the typhlosole (fig. 36 *a*).

Intra-typhlosolar Canals.—(fig. 36.) Throughout the length of the typhlosole there exist in the upper part of this organ a great number of internal ciliated canals enclosed by a muscular investment continuous with the circular muscular layer of the intestine. These canals, which are short, occupy the part of the typhlosole situated between the lateral and median vessels which supply the typhlosole with blood, as previously described. In transverse sections passing directly through, or in the immediate vicinity of, these vessels, no intratyphlosolar canals are cut through; but as we approach midway between these lateral and perpendicular vessels cross-sections of these canals come into view. Generally there is but one canal, but there may be two or even three parallel canals, of which one is larger than the others. These intratyphlosolar canals originate in the interior of the typhlosole, follow this organ in a parallel line for some little distance, and then bend sufficiently to open out into the upper part of the intestine at its junction with the typhlosole (figs. 37, *a*, *b*, *c*). There is no connection between the canal and the cœlomic cavity.

These canals are all of the same uniform structure,—a single row of cells with very large nuclei. The cells are ciliated along the lumen of the canal and resemble those of the sperm-duct. These canals probably serve as safety valves, enabling the typhlosole to discharge superfluous blood into the intestine. The advantage of such canals is apparent in a typhlosole of such large dimensions as that of *Pontoscolex*.

Chloragogen Cells.—(figs. 24, 26, 37.) The chloragogen cells of the dorsal vessel are of a different structure from those of the intestine. They lack the granules possessed by the latter and they stain less intensely with aniline stains, such as eosin. The chloragogen cells of the intestine are much longer on the dorsal side, gradually diminishing laterally. The long dorsal cells are separated from each other by very narrow interstitial cells with narrow nuclei (fig. 37 *a*). Further down the sides of the intestine no such interstitial cells are found.

Corresponding to the long dorsal chloragogen cells we find similarly very long epithelial cells on the opposite and inner side of the intestine (fig. 36); they are, however, slightly shorter than the chloragogen cells. Laterally the epithelial cells narrow down in the same way as the chloragogen cells on the opposite side of the blood-sinus.

Vascular System.—The dorsal vessel is much enlarged, occupying about one-fifth of the body-cavity in somites XI to XVII, though even posterior to the latter segment it is of considerable size and of nearly the same thickness. The dorsal vessel is not strictly double, as for instance in *Pontoscolex hawaiiensis* Beddard, but it may be said to be rudimentary double. By this I mean that cross-sections show that in certain places, probably in the center of the somites, the vessel is divided through the center by an upright bar, which undoubtedly represents a diaphragm dividing the vessel longitudinally. After entering somite X the dorsal vessel narrows down. The supraintestinal vessel is enlarged in two or three somites, the enlargement beginning just in front of the sacculated intestine in XVII and extending forward as far as XII, at which point it becomes much narrower.

There are two pairs of hearts in XI and XII, both connected with the supraintestinal vessel. There is considerable difficulty connected with the counting of the septa, owing to their thinness and intricate folding, but it is certain that the last heart is found in the same somite as the sperm-funnel.

Nephridia.—The nephridium is furnished with a cœcal pouch, and is of large size. It is differentiated into two large wings at the junction of which is situated a bulbous spinxter (figs. 12–16). The upper part of this spinxter is ciliated. It consists of a number of closely packed, lamellæ-like cells, with lamellated cytoplasm. The cœcum leads into a short narrow duct which opens into a bulbous, glandular chamber. The glandular pouch is present in all nepridia posterior to the clitellum. The spur is long and unusually narrow. The windings are much smaller than in most other nephridia. There is a narrow "bridge" without cilia. I have not had the time to study out the course of the canals, but it appears to be more complicated than in *Kerria*, *Argilophilus* and *Microscolex*, in each of which genera I have followed them in detail. There are numerous blood-vessels both in the pouch and the folds, as well as in the spur; and owing to them and to the numerous muscles attaching the nephridia to the body-wall, the study of the ducts is difficult. The nephrostome is of large size, larger than I have seen in any other nephridium. In form and structure it resembles the drawing given by Perrier, but the funnel is always situated in the somite next anterior to the nephropore. The nephridium is readily dissected out entire. The most anterior nephridium has the form delineated by Perrier. I can find none of the funnels described by Beddard as belonging to this nephridium. The peculiar gland forming an appendix to the central part of the nephridium consists of several rows of very large bottle-like cells (fig. 12*b*.) with a coarsely granulated secretion which is so dense as to hide the nucleus of the cell even in quite thin sections. This granular substance stains intensely blue with the methylen colors. The cells open into a wide, common lumen. The inner cells are surrounded by much smaller cells with distinct membranes, also containing a coarse granulation, which, however, stains but feebly.

Lymphocytes. — (figs. 110, 111.) The lymph of the cœlomic cavity contains numerous lymphocytes of various kinds, but principally amœbocytes. The lymph exuded from the irritated animals consists almost exclusively of amœbocytes and a few eosinophile cells.

The amœbocytes are of different sizes and forms, some being perfectly round and showing no pseudopodia, while others show numerous examples of such amœboid projections. Between these two extremes there are numerous intermediate gradations. One of the most extreme forms is figured at *G.*, fig. 110. The pseudopodia may be broad or pointed, many or few. The cytoplasm shows in places a branching or foaming structure (*D*) with concentrations of greater density in the longer arms. The archosome (Eisen 20) is more or less well defined and shows at least two concentrically arranged zones, one exterior to the other. The interior zone stains darker, and may, perhaps, be composed of centrosomes. The archosome is often surrounded by a denser granulated cytoplasm which is probably homologous with the granosphere. In double staining with eosin and methylen-blue, the archosome with the granosphere stains distinctly red, while the balance of the cell stains blue. The nucleus varies in shape and is either rounded and even, or polymorphous, as in leucocytes; but as there are intermediate forms, I conclude that all belong to the same class of lymphocytes.

Eosinophiles.—These are found in limited number; they are smaller than the amœbocytes, round, globular, without any amœboid projections, and their cytoplasm is composed of numerous intensely staining globules of erythrophile nature. The diameter of the eosinophile granules is about one-twentieth that of the cell itself. The nucleus of the eosinophile cell is much smaller than that of the amœbocyte.

Microcytes.—(fig. 117.) This name is proposed for very minute, non-nucleated bodies occurring in large numbers in the lymph, scattered among the lymphocytes. These bodies are oval in shape, pointed at both ends, and of different sizes. The largest of them are never longer than the short diameter of the nucleus of the lymphocyte, but they are generally very much smaller. The majority of microcytes show a central dark-staining point, while others are apparently homogeneous, with only a shaded center. These microcytes are scattered everywhere in the lymph and even among the tissues, and now and then are found even in the cytoplasm of the amœbocytes. The smallest microcytes in some respects resemble bacteria, but the great variation in size precludes the possibility of their being such. It is possible that the microcytes are homologous with plasmocytes (Eisen 20). I believe they will be found to constitute regular elements of the lymph.

OCNERODRILINÆ.

General Remarks.

There can be no doubt, as Michaelsen has pointed out, that Beddard's genus *Ilyogenia* is a true Ocnerodrilide, the only distinguishing character being the absence of prostates. The same character distinguishes the author's genus *Phœnicodrilus*, which, being later than Beddard's genus, must be withdrawn.

The prostates in *Ocnerodrilus* vary so much in size and development that it is difficult to determine when they are entirely absent. In *Phœnicodrilus tepicensis* a trace of the prostate remains as an atrial chamber near the male pore. In the closely related species *P. taste* there is no trace of this muscular part of the prostate. The former species thus stands intermediate between *Ocnerodrilus* and *Ilyogenia* or *Phœnicodrilus taste*. *Pygmæodrilus* has already been withdrawn by Michaelsen, but I prefer to retain both *Ilyogenia* and *Pygmæodrilus* as subgenera, to which I have added five others, each subgenus being defined by several characters.

Most of the African species belonging to group V seem to differ from all the other species in having the male pores approximated, a fact which is interesting to note in connection with Michaelsen's suggestion that the family of Eudrilinæ has descended from Ocnerodrilide ancestors.

A perusal of the key shows that these subgenera are not all of the same value. *Ocnerodrilus* (sens. str.) differs from all others in its peculiar sperm-sacs and in the absence of spermathecæ. *Enicmodrilus* and *Ilyogenia*, on the contrary, are more closely related. *Nematogenia* and *Haplodrilus* are quite distinct and had best be considered as distinct genera. *Nematogenia* is especially remarkable on account of its nematocytes or thread-cells, structures found in no other oligochæta.

Ocnerodrilus *Eisen.*

Definition.—Small terrestrial or aquatic worms. Setæ eight, paired. Clitellum includes the male pore in XVII. Pharyngeal and septal glands. A pair of intestinal diverticles in IX. With or without spermathecæ. One or two pairs of testes. Ovaries in XIII. With or without racemose sperm-sacs. With or without prostates, which, when present, open with the sperm-ducts, or, when more than one pair, in the somite immediately behind. Prostate contains only one layer of cells. No penial setæ. Two pairs of hearts. Lateral blood-vessels pass through the intestinal diverticles. Meganephridia paired, present also in the anterior somites, generally with cœlomic cell-mantle, sparsely traversed by blood-vessels.

Key to the Subgenera and Species of *Ocnerodrilus*.

Ocnerodrilus, *Leiodrilus*, *Pygmæodrilus*, *Ilyogenia*, *Enicmodrilus*, *Nematogenia* and *Haplodrilus*.

I. Prostates present. Two pairs of testes. No racemose sperm-sacs. Small, simple sperm-sacs capping the testes. No spermathecæ.

Ocnerodrilus Eisen, (sens. str.)

1. *occidentalis* Eisen.
2. *occidentalis* var. *sinensis* var. nov.
3. *occidentalis* var. *arizonæ* var. nov.

II. Prostates present. Two pairs of testes. Racemose sperm-sacs. No sperm-sacs capping the testes. Spermathecæ in IX, without diverticles.

Enicmodrilus, subgen. nov.

4. Sperm-ducts with a thick muscular investment near the pore. Spermathecæ large and globular. Prostates of medium size. *agricola* Eisen.
5. Sperm-ducts with a thick muscular investment near the pore. Spermathecæ long, cylindrical. Prostates thin, below medium size. Sperm-sacs in IX very diminutive.........*Rosæ* Eisen.

6. Sperm-ducts with a thick muscular investment near the pore. Spermathecæ medium, narrow, cylindrical. Sperm-sacs in IX large, exteriorly hardly lobed. Prostates thick.
contractus EISEN.

7. Sperm-ducts not thicker at the pore. No setæ *ab* in XVII. One pair of very diminutive prostates. Spermathecæ small, pear-shaped, without distinct stalk. Sperm-sacs in IX and XII. Septal glands in V the largest, those in VII and VIII very small. Margins of setæ undulating............*Hendriei* EISEN.

8. Sperm-ducts no thicker at the pores. No setæ *ab* in XVII. One pair of medium size prostates. Spermathecæ large, with short stalk. Racemose sperm-sacs in IX and XII. Septal glands in VI the longest. Margins of setæ undulating.
comondui, sp. nov.

9. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. One pair of diminutive prostates. Spermathecæ large, with distinct stalk. Racemose sperm-sacs in IX and XII. Septal glands in VII the longest. Margins of setæ smooth.
santi xavieri, sp. nov.

10. Sperm-ducts not thicker at the pore. No setæ *ab* in XVII. One pair of prostates in XVII, and one pair in XVIII. Margins of setæ undulating...........................*limicola* EISEN.

11. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. One pair of large prostates in XVII. Setæ with even margin, but with a lunate cavity at apex. Spermathecæ medium sized, constricted transversely at centre. Racemose sperm-sacs in IX and XII............................*paraguayensis* ROSA (40).

12. Sperm-ducts not thicker at pores. No setæ *ab* in XVII. Setæ with even margin. One pair of small prostates. Racemose sperm-sacs in XII only. Septal glands in VI the largest.
mexicanus, sp. nov.

13. *mexicanus* var. *hawaiiensis* var. nov.

14. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. Setæ with even margin. One pair of large prostates open on a very large pair of papillæ. Racemose sperm-sacs in IX and XII. Septal glands in V the largest. Spermathecæ stalked, sac large, globular, and as wide as two ordinary somites.
tuberculatus, sp. nov.

15. Sperm-ducts not thicker at the pores. No setæ *ab* in XVII. Male papillæ large, surrounded by glandular protuberances projecting beyond XVII. Prostates large, extending to XXX. Spermathecæ stalked, the stalk with a slight local, lopsided bulging out of the lumen. Racemose sperm-sacs in IX and XII...............................*Calwoodi* MICHAELSEN (27).

16. Sperm-ducts not thicker at the pores. Setæ *a* absent in XVII. Spermathecæ as well as prostates are very large.
Beddardi EISEN.

17. Sperm-ducts not thicker at the pores. Setæ *b* absent in XVII. Spermathecæ and prostates are very minute.
guatemalæ EISEN.
18. Sperm-ducts not thickened at the pores. Setæ *b* absent in XVII. Spermathecæ minute. Prostates large.........*sonoræ* EISEN.

III. No prostates. Spermathecæ in IX, without diverticles. Racemose sperm-sacs. No sperm-sacs capping the testes. Two pairs of testes.

Ilyogenia BEDDARD, (57).

19. No trace of the muscular part of the prostates remaining.
taste (EISEN, 17).
20. A trace of the muscular part of the prostates remains as a small atrial chamber at the male pore.........*tepicensis* (EISEN, 18).
21. No trace of the prostates remains. Ovaries fused in the median line...................................*africana* (BEDDARD, 57).

IV. Prostates present. Two pairs of testes. Spermathecæ in VIII, without diverticles. Sperm-sacs present in X, XI, XII, not racemose.

Leiodrilus, subgen. nov.

22. *Eiseni* BEDDARD (20).

V. Prostates present. Spermathecæ in IX, with two or more diverticles. Racemose sperm-sacs. Male pores more or less approximated. Two pairs of testes.

Pygmæodrilus MICHAELSEN, (12).

23. Male pores close to the median line. Sperm-ducts thickened near the pores. Spermathecæ stalked, with 2 to 4 diverticles each.........................*bucobensis* (MICHAELSEN 11, 16).
24. Male pores distant from median line. Sperm-ducts with a muscular, globular enlargement at the pore. Spermathecæ with a row of diverticles at the base.
quilimanensis (MICHAELSEN 12).
25. Male pores close to the median line. One single median spermatheca in IX, with four diverticles.
affinis (MICHAELSEN 11, 16).
26. Male pores not far from median line. One pair of spermathecæ in IX, with three diverticles.
bipunctatus MICHAELSEN (16).

VI. Prostates present. Spermathecæ in IX, without diverticles. Racemose sperm-sacs. No sperm-sacs capping the testes. Dorsal pores. One pair of testes. Rudimentary gizzards in VI and VII.

Nematogenia, subgen. nov.

27. *lacuum* BEDDARD (39).
28. *lacuum*, var. *panamaënsis* var. nov.

VII. Prostates present. Spermathecæ in IX, without diverticles. No racemose sperm-sacs. One pair of testes. No gizzard. No dorsal pores.

Haplodrilus, subgen. nov.

29. *Borelli* ROSA (40).

Subgenus **Ocnerodrilus** *Eisen.*

Structure of Sperm-sacs.—The structure of the sperm-sacs in *Ocnerodrilus* (sens. str.) is of considerable interest. In the author's description of the type-species of the genus no mention is made of the sperm-sacs, nor indeed were they discovered at that time, an oversight explained by the fact that in *O. occidentalis* the sperm-sacs do not project from the septa, but are mere small caps at the end of the testes. They are so small, even in fully adult specimens, that it is only in sections that they can be studied. The structure will be described under the species *O. occidentalis*, but I will here mention that it is identical with that of the sperm-sacs of the genus *Pachydrilus* which I have lately had occasion to investigate (fig. 132.)

Although always described as being void of sperm-sacs, *Pachydrilus* really possesses them. In this genus the sperm-sacs are also mere caps of the testes, the latter being multi-lobed, each lobe carrying its own sperm-sac. This character in *Ocnerodrilus occidentalis*—the lowest species in the genus—may be an ancestral character retained from its Pachydrilide ancestors. It is, however, hazardous to place too much importance on the structure of the sperm-sacs in a phylogenetic study of a genus, as even in closely related species they differ widely. Thus in *O. Eiseni* the sperm-sacs are not racemose, while in the majority of other species these sacs are racemose and traversed by trabeculæ. In this instance, however, I think that the small cap-shaped sperm-sacs of *O. occidentalis* and of *Pachydrilus* point to a close phylogenetic relationship. Another Enchytræide character is found in the diverticles of the intestine, a character also seen in Eudrilidæ, which family Michaelsen (21, p. 18) claims has descended from Ocnerodrilide ancestors.

Ocnerodrilus occidentalis *Eisen.*

PLATE XII, FIG. 123.

Definition.—Size 15 mm. Setæ *ab* are present in somite XVII and situated ventrally to the male pore. No spermathecæ. No racemose sperm-sacs, but small sperm-sacs capping the testes. Two pairs of testes in X and XI.

Sperm-ducts are not enlarged near the pore. Ovipores in front of and somewhat dorsal to setæ *b*. Septal glands of about equal size. Sacculated intestine in XII. Diverticles of the œsophagus are not divided into chambers. Prostates, one pair, very thick and large.

Habitat.—The type is from Fresno, California. In the collection there are also a number of specimens from Durango, Mexico, collected by Mr. James Ainsa in the parks of the city, in January, 1899.

It is interesting to note that the specimens from Durango resemble those from California rather than those from Arizona.

My former description of this interesting species was based on dissections and not upon sections, and, therefore, some characteristics escaped observation. Having since sectioned specimens from the original locality as well as from Durango, a more detailed description can now be given.

DETAILED DESCRIPTION.

Setæ.—The ventral setæ in the clitellum are a little farther apart than the corresponding setæ anterior and posterior to the clitellum, the distance *a–b* being a trifle greater than the distance *c–d*. This arrangement is more pronounced in the Durango specimens.

Sexual Zone.—The specimens from Durango which had been placed directly in alcohol have in the centre of XVII a markedly depressed sexual zone, which encloses the two male papillæ. This depression is much less pronounced in the specimens from Fresno. In the middle of the zone the two male papillæ stand out boldly. The papillæ are oblong-rounded, with a narrow wedge-shaped prolongation towards the median line. The main part of the papillæ is situated immediately dorsal to the ventral setæ *ab*, which are both present.

Septal Glands.—The septal glands, in V to VIII, are all of about the same size. The species differs in this from the var. *arizonæ*, in which the posterior glands, in VIII, are much smaller than those anterior. The dorsal part of the suprapharyngeal glands is continuous with the dorsal part of the septal glands in V.

Septal formula:—

$$\overline{\text{V/VI}},\ \overline{\overline{\overline{\overline{\text{VI/VII}}}}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\text{VIII/IX}}}},\ \overline{\overline{\overline{\text{IX/X}}}},\ \overline{\overline{\text{X/XI}}},\ \overline{\text{XI/XII}}.$$

Diverticles of the Intestine.—The diverticles are not divided by septa as in some of the other species, but possess interiorly only a few more or less projecting lobes. In this respect the species resembles the variety.

Testes and Sperm-sacs.—As has been previously stated, there are really two pairs of testes in X and XI, each testis being directly connected with a minute, narrow sperm-sac which does not extend beyond the somite of the testes. The sperm-sacs project straight upwards and the testes are very thin, in cross-section only one or two cells thick. The sperm-sacs are simple and sac-like, covered by peritoneum. They are nowhere connected with the septa, but appear to be simply extensions of the testes. There are no racemose sperm-sacs as in most of the other species. The sperm-funnels lie quite free behind the testes in X and XI and do not stand in direct communication with the sperm-sacs (figs. 123, 132).

Ocnerodrilus occidentalis *Eisen*, **sinensis**, var. nov.

Definition.—Length 25–30 mm., width 1 mm. Setæ *ab* in somite XVII are both absent. Sperm-ducts are separated though surrounded by a common muscular investment, their lumens remaining distinct till they reach the pore. The muscular investment is not thicker at or near the pore. The prostates are carried forwards (constant ?) as far as somite XIII, and show a slight bulbous enlargement at the pore. Clitellum, dorsally, XIII–XX; ventrally, XIV–XIX. Septal glands in V, VI and VII are of equal size; those in VIII are somewhat smaller. In other respects the variety resembles the species.

Habitat.—Several specimens collected by Mr. Alexander Craw from pots containing plants brought from China. The variations from the type which characterize this variety are slight, but as the specimens come from China it seems best to describe them as a distinct variety. The most characteristic features, such as the absence of spermathecæ and the peculiar sperm-sac caps which cover the testes, in connection with the absence of other sperm-sacs, show this variety to be merely a form of *Ocnerodrilus occidentalis*. The septal glands in VII are larger than in the variety *arizonæ*.

Septal formula:—

$\overline{\text{V/VI}}$, $\overline{\text{VI/VII}}$, $\overline{\text{VII/VIII}}$, $\overline{\overline{\text{VIII/IX}}}$, $\overline{\overline{\text{IX/X}}}$, $\overline{\overline{\text{X/XI}}}$, $\overline{\overline{\text{XI/XII}}}$, $\overline{\text{XII/XIII}}$.

Ocnerodrilus occidentalis *Eisen*, **arizonæ**, var. nov.

Plate XII, Figs. 124–134.

Definition.—Size 15–25 mm. Clitellum 1/3 XIII–1/2 XX. Setæ *ab* in somite XVII both present. No spermathecæ. Testes, two pairs in X and XI, directly capped by two small sac-like sperm-sacs in X and XI. No racemose sperm-sacs. Sperm-ducts not greatly enlarged near the male pore, but with a slight swelling of the lumen. Prostate and sperm-ducts joining in the same pore between the longitudinal layer and the epithelium. Prostates small, not extending beyond the clitellum. Septal glands of unequal size, the posterior ones much smaller. Diverticles of the œsophagus not divided into chambers. Sacculated intestine in XII.

Habitat.—Phœnix, Arizona, near irrigation ditches. Obtained through the kindness of Mr. Geo. A. Treadwell, October 19, 1896. A number of specimens have since been received from the same locality, collected by Master Grant, in January, 1897.

The variety differs but slightly from the species, but I believe the differences are worthy of being recorded, especially those concerning the size of the suprapharyngeal glands.

Ocnerodrilus occidentalis.	*Ocnerodrilus occidentalis*, var. nov. *arizonæ*.
Septal Glands.	
Of about the same size. The most posterior pair of glands not smaller than those anterior to it.	Of different sizes. The posterior pair of glands is very much smaller than those anterior to it.
Prostates.	
Long, extending backward through several somites behind clitellum.	Short, confined to the clitellar somites.

Both species and variety differ from all other species of *Ocnerodrilus* in the absence of spermathecæ and racemose sperm-sacs.

EXTERNAL CHARACTERS.

Somites.—They increase slightly in size towards XI; XII and XIII are smaller, and XIII is smaller than XII; XIV is larger and from it the clitellar somites slightly increase in size towards XIX; XX is smaller.

The *prostomium* slightly divides somite I. It is furnished with a deep transverse groove in line with the upper margin of somite I.

The *clitellum* extends from the anterior 1/3 XIII–1/2 XX. It is equally developed on dorsal and ventral sides.

Male pores are situated on two small round papillæ in XVII, not connected by any special zone. In each papilla is seen a sac-like lumen, into which open the sperm-duct and the prostate, which thus unite but do not fuse just before reaching the exterior. Both setæ *a* and *b* are present at the male papilla, setæ *a* being situated on the side of the papilla.

INTERNAL CHARACTERS.

Genital Zone.—There are no tubercula pubertatis like those found in Lumbricidæ; but I find in the posterior part of somite XV and in the anterior part of XVII, as well as in XVIII, a zone in which the glandular cells of the clitellum are absent. Instead of these we find here a continuous row (in longitudinal sections) of very short and broad epithelial cells, characterized by having their frayed distal ends terminating in a number of long and pointed processes. Some of them project beyond the muscular layers and can even be followed to a point where I think they connect with the ventral ganglion.

The long tubular glands of the clitellum end at the beginning of the genital zone, though the long narrow ducts of many of these cells are seen to bend inwardly and pass through the zone. The zone possesses a stratum of longitudinally arranged glands running parallel to the body-wall, in somewhat the same manner as the spermathecal setæ-glands of *Diplocardia Udei.* None of these glands open into a special chamber, as in the last mentioned species; but probably all open into the clitellar region outside of the zone.

There is an abundance of capillaries in the zone, and I have no doubt but that the zone is of sexual importance. Its structure reminds us in some respects of tubercula pubertatis, though there is an absence of true tubercula pubertatis glands. I could not find any regular sense-cells, though these occur in bunches in the epidermis of other somites.

Septal Glands.—There are four pairs of septal glands in somites V, VI, VII and VIII, the dorsal parts of which gradually diminish in size posteriorly. The dorsal part of each gland is much the largest, being broad and square in longitudinal section, while the ventral part is narrow and elongated. The glands in V, VI and VII are developed dorsally and ventrally, but the one in VIII is developed only on the ventral side of the intestine. These glands are only about one-fourth as large as the corresponding part of any of the anterior glands. The ventral parts of the anterior glands are of about equal size.

The *pharynx* is sac-like and in the form of a single dorsal pocket.

The *œsophagus* is narrow and straight and enters directly into the tubular intestine, which is also straight and only slightly widens between the septa. The diverticles of the intestine originate in the posterior part of IX. They are swollen and the part connecting with the intestine is very broad. The widest part of each diverticle is wider than the intestine in that somite. The folds in the walls of the diverticles are quite simple and resemble those of the intestine. Each diverticle has but one cavity, there being no separate chambers as in *Ocnerodrilus Beddardi* and in *O. taste.*

Septa.—Beginning with septum V/VI the ventral parts of the septa are a trifle thicker than the dorsal parts. The first considerably thickened septum is VII/VIII; X/XI is the thickest. None of the septa are thickened close to the body-wall or near the intestine.

Septal formula:—

$\overline{\mathrm{V/VI}}$; $\overline{\mathrm{VI/VII}}$; $\overline{\mathrm{VII/VIII}}$; $\overline{\overline{\overline{\mathrm{VIII/IX}}}}$; $\overline{\overline{\overline{\mathrm{IX/X}}}}$; $\overline{\overline{\overline{\mathrm{X/XI}}}}$; $\overline{\overline{\mathrm{XI/XII}}}$.

Testes.—The testes are slender and short, and connect directly with the minute, sac-like sperm-sacs, which are only slightly wider than the testes. Each testes has a central core of connective tissue, or muscular strands projecting from the septum, which I once mistook for a duct.

Sperm-ducts and Prostates.—The ducts join in the anterior part of the clitellum, but their lumens do not fuse until reaching the anterior third of XVII. After fusing, the ducts are slightly widened and increase gradually but very slightly in size until the body-wall is reached, where quite a little swelling is seen at the point of junction with the ducts. The sperm-duct joins the prostate before the two have fully penetrated the wall of the papilla. The prostates do not extend beyond the clitellum. The prostate cells are of two kinds: those most numerous are composed of glandular cells with very fine granulations taking the eosin stain; the others, which are fewer in number, consist of thin, rather irregular supporting cells, extending from the peritoneum to the lumen. The latter are probably the phylogenetic ancestors of the inner layer of cells which is characteristic of the prostate of the higher Terricolæ (fig. 133).

Ovisacs.—The oviducts are long and slender, opening in front of setæ *ab*. There are two small ovisacs in line between the oviductal funnels projecting into somite XIV.

Subgenus **Enicmodrilus**, subgen. nov.

The various species of the subgenus *Enicmodrilus* may be arranged as follows:—

I. Sperm-ducts with a thick muscular investment near the pores.
O. agricola EISEN.
O. Rosæ EISEN.
O. contractus EISEN.

I′ Sperm-ducts without thick muscular investment near the pores.
II. Setæ *ab* wanting in XVII.
a. Sperm-sacs only in XII. *O. mexicanus*, sp. nov.

a'. Sperm-sacs in IX and XII.
b. Margins of setæ undulating. No tubercle at male pore.
One pair of prostates. *O. Hendriei* EISEN.
O. comondui, sp. nov.
Two pairs of prostates. *O. limicola* EISEN.
b'. Setæ with even margins, but with a lunate cavity at apex. *O. paraguayensis* ROSA.
b''. Setæ with even margins. Male pores on large tubercles. *O. tuberculatus*, sp. nov.
b'''. Setæ with even margins. Sexual zone sunk. *O. santi xavieri*, sp. nov.
II' Setæ *a* absent in XVII. *O. Beddardi* EISEN.
II'' Setæ *b* absent in XVII.
Prostate minute. *O. guatemalæ* EISEN.
Prostate large. *O. sonoræ* EISEN.

Ocnerodrilus (Enicmodrilus) santi xavieri, sp. nov.

Definition.—Length 35-40 mm., width 1¼ mm. Somites about 80. Prostomium divides somite I about one-half. Somite I about twice as wide as somite II. Setæ paired, ventral and dorso-lateral, with smooth margins. No setæ *ab* in XVII. Clitellum saddle-shaped, XIV-½ XIX. Somite IX only a little wider than any other near somite. Sexual zone sunk below the general surface of the body. Male pores on two, hardly elevated, papillæ, in line with setæ *ab*, rounded. The two anterior septal glands of about equal length and thickness; the third pair, in VII, is longer, but narrower; the fourth pair is much the shortest, or about half as short as the third pair. Spermathecæ large, with distinct duct and a pouch with undulating outline. Two pairs of testes and sperm-funnels. A pair of anteseptal, racemose sperm-sacs in IX, and a postseptal, racemose pair, in XI. Sperm-ducts, not thickened near the pores, opening in the same pores as the prostates. The prostates are hardly wider than the sperm-ducts, straight, and not extending beyond the centre of XVIII. No dorsal pores. Meganephridia thickly covered with capillaries; a large cœlomic mantle.

Habitat.—This is the most common earthworm and the only Ocnerodrilide found in Baja California in the vicinity of Loreto and San Xavier. It occurs there in the moist soil in every garden and along every irrigation ditch. Collected June 22, 1899.

Characteristics.—Most of the species of the subgenus *Enicmodrilus* are closely related and only the nicest distinctions serve to distinguish them. *O. santi xavieri* differs from *O. Hendriei* in its spermathecæ, which are much larger, being furnished with a comparatively long, muscular stalk, which is almost wanting in the latter species.

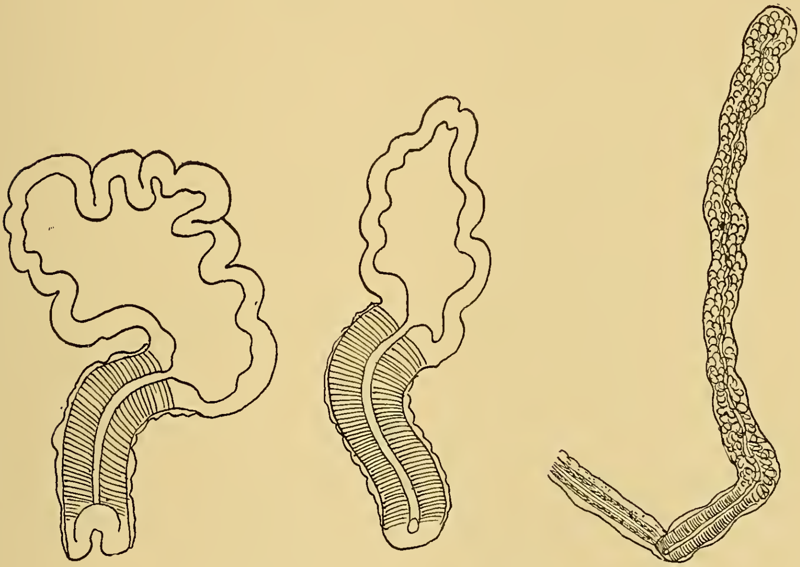
From *O. guatemalæ* the species is distinguished by the absence of setæ *a* in XVII. *O. mexicanus* has no sperm-sacs in IX. The diverticles of the intestine are large and subdivided into longitudinal chambers.

Septal formula:—

$$\text{IV/V, V/VI, } \overline{\text{VI/VII}}, \overline{\overline{\overline{\text{VII/VIII}}}}, \overline{\overline{\overline{\overline{\overline{\overline{\text{VIII/IX}}}}}}}, \overline{\overline{\text{IX/X}}}, \overline{\overline{\text{X/XI}}}.$$

The *sperm-sacs* in IX project from the body-wall near the septum IX/X.

No *ovisacs* are present.



Ocnerodrilus santi xavieri, spermatheca and prostate.

Ocnerodrilus (Enicmodrilus) comondui, sp. nov.

Definition.—Length about 60 mm., width 1¾ mm. Somites 80 to 90. Prostomium divides somite I about one-third. Somite I wider than II or III. Setæ paired, with undulating margins and five to six direct, transverse lines. No setæ *ab* in XVII. Clitellum saddle-shaped, in XIV-XIX. Somite XIX not wider than the other somites. Sexual zone not sunk, except a trifle between the papillæ. Male pores hardly elevated, round, in line with setæ *ab*. Septal glands in VII and VIII of about equal width, those in VI the longest, those in VII a little longer than in VIII. Spermathecæ large, broad and with distinct stalk; the pouch with undulating margins. Two pairs of testes and sperm-funnels. Racemose sperm-sacs in IX and XII; the former preseptal, the latter postseptal. Sperm-ducts not thickened at the pores; prostates greatly varying in size. In some specimens the glandular part is only knob-like, while in others it is much longer and folded, but does not extend beyond somite XIX. Meganephridia very large, as wide as the somites, the posterior ones with cœlomic mantle.

Habitat.—This species is abundant in the valley of Comondú in the central part of Baja California, Mexico. It is the only Ocnerodrilide found there in the irrigation ditches and in wet soil generally. Collected June 25, 1899.

Characteristics.—The absence of setæ *ab* in XVII and the undulating margins of the setæ bring *O. comondui* near to *O. Hendriei*, from which it differs in having the sperm-sacs in somite IX strongly racemose, and in the form of the spermathecæ and the sizes of the respective septal glands.

The difference between *O. comondui* and *O. santi xavieri* is in the undulating margins of the former and in the nephridia, which are relatively larger than those in the latter form, as may be seen by examining the specimens exteriorly. It is also a larger and especially a thicker worm.

The septal formula, differing from that of *O. santi xavieri*, is as follows:—

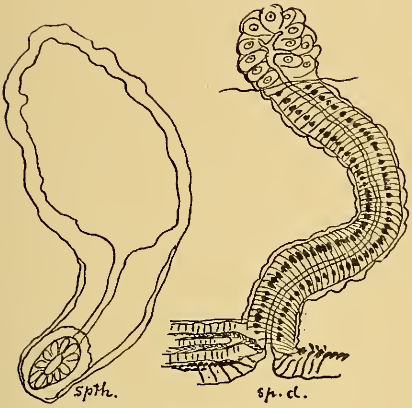
IV/V, V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII.

Sperm-sacs.—The racemose sperm-sacs in IX do not project from the septum forwards, but spring from the body-wall a little in front of the septum on the dorsal side of the body. This is also the case in *Ocnerodrilus santi xavieri*, and perhaps in other species.

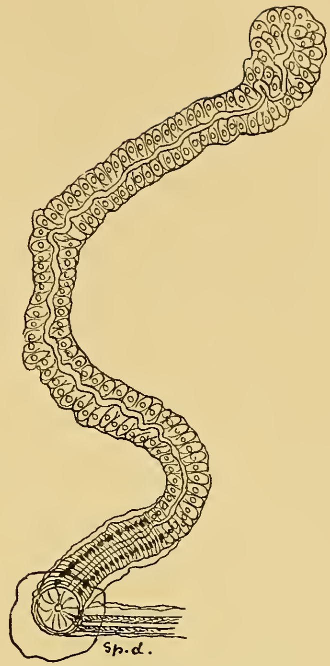
The *sperm-ducts* open in the same pore as the prostates, but do not enter them.

The *prostates* vary more in size than in any other species so far known. In some specimens the glandular part consists merely of a knob-like body, while in others the glandular part is several times as long as the muscular part and extends through somites XVII and XVIII. But as I could see no other differences, both these forms are for the present referred to one species.

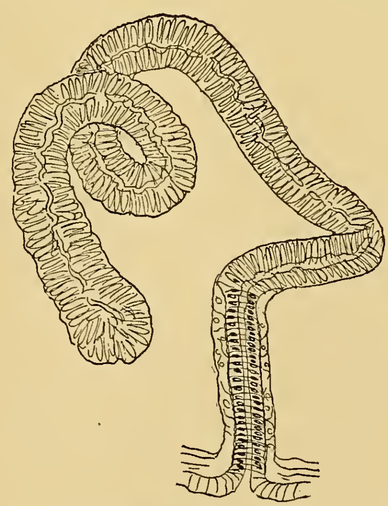
No *ovisacs* are present.



Ocnerodrilus comondui,
spermatheca and prostate.



Ocnerodrilus santi xavieri,
prostate.



Ocnerodrilus comondui, prostate.

Ocnerodrilus (Enicmodrilus) limicola *Eisen.*

Ocnerodrilus limicola EISEN, Proc. Cal. Acad. Sci., 2d Ser., Vol. III, 1893, p. 254.

Setæ.—As Beddard has expressed doubt as to the existence of setæ *ab* in somite XVII, I have re-examined the type and find these setæ to be really absent.

Ocnerodrilus (Enicmodrilus) mexicanus, sp. nov.

PLATE XIV, FIG. 159.

Definition.—Length 45 mm., width 1 mm. No specialized genital zone. The prostates and sperm-ducts open on a pair of small papillæ in XVII, in line with setæ *ab*. Setæ *ab* in XVII are absent. Setæ strictly paired and smooth. Clitellum complete. Spermathecæ, one pair in IX, small, with warty and wavey apex and without diverticle. Sperm-sacs in XII, large and racemose. Sperm-tanks in X and XI. No racemose sperm-sacs in IX. Testes in X and XI. One pair of prostates in XVII confined to one somite; they are small and slender, the glandular part hardly thicker than the muscular part. The sperm-ducts open in the same pore as the prostates. The sperm-ducts are slender and not enlarged at the vicinity of the pores. Septal glands in V to VIII; the glands in VI are the largest; those in VIII the smallest. Sacculated intestine commences in XII. The diverticles of the intestine are long, extending through the whole somite. The nephridia are all furnished with a cœlomic mantle; they are larger from somite XIII posteriorly. The cœlomic mantle consists of two large flat folds overlapping each other in such a way as to appear as one single square mantle occupying the whole width of the somite.

Habitat.—Mazatlan, Mexico, in garden soil.

This species belongs to the group in which the lower part of the sperm-ducts is not enlarged. It differs from *O. Hendriei* in having the septal gland in VI by far the largest, and in the absence of racemose sperm-sacs in IX. It differs from *O. limicola* in having a larger gland in VIII and only one pair of prostates.

Ocnerodrilus (Enicmodrilus) mexicanus *Eisen*, hawaiiensis, var. nov.

PLATE XIV, FIGS. 170, 171.

Definition.—Characters similar to those of the species except in the following: The sperm-sacs in XII are very large, filling the whole cœlom, but they are only very slightly racemose. The spermathecæ are very large; they extend to the dorsal wall of the cœlom and there is a deep constriction at the center; otherwise the shape is that of the variety. The prostates are very long, extending through ten somites beyond the male pores. Septal formula:

$\overline{\overline{\mathrm{V/VI}}}$, $\overline{\overline{\overline{\mathrm{VI/VII}}}}$, $\overline{\overline{\overline{\overline{\mathrm{VII/VIII}}}}}$, $\overline{\overline{\overline{\overline{\mathrm{VIII/IX}}}}}$, $\overline{\overline{\mathrm{IX/X}}}$, $\overline{\overline{\mathrm{X/XI}}}$, $\overline{\mathrm{XI/XII}}$, $\overline{\mathrm{XII/XIII}}$, XIII/XIV.

Habitat.—Honolulu, Hawaii; from soil in pots of plants from the island. Collected by Mr. Alexander Craw.

The nephridia also differ somewhat from those of the species. The cœlomic mantel has the form of a very thick S with the dorsal lobe much thicker than the lower lobe.

Ocnerodrilus (Enicmodrilus) tuberculatus, sp. nov.

PLATE XIV, FIGS. 155 and 156.

Definition.—Length 30 mm., width 2 mm. Somites 104. Prostomium divides somite I into halves; the somite is broader than those behind. Setæ paired, ventral and dorso-lateral with smooth margin. No setæ *ab* in XVII. Clitellum saddle-shaped, in XIII–XIX. Somite IX twice as wide as any other somite. Male pores open on a pair of very large papillæ in line with setæ *ab* in XVII; papillæ with the body-wall about one-third as long as the body is wide. The three anterior septal glands of nearly equal size, slightly diminishing in depth posteriorly; those in VIII the smallest. Spermathecæ, one pair, postseptal in IX, stalked, with a very large globular free apical part. Two pairs of testes and sperm-funnels. Sperm-ducts not thickened at the male pores. Prostates large, extending as far as XXIV. Sperm-sacs large, racemose in IX and XII. No dorsal pores. Meganephridia covered with a few cœlomic, glandular cells which, however, are not in sufficient quantity to constitute a mantle. Anterior nephridia without such cells.

Habitat.—The City of Guatemala, Central America.

This species is readily distinguished externally by the two very large male papillæ which are much more prominent than those in any of the other Central American or Mexican species described so far. The incomplete clitellum and the large size of the worm is also characteristic. The single specimen had become discolored and resembles an Acanthodrilid in the shape of the body.

DETAILED DESCRIPTION.

The most prominent feature exteriorly is the two *male papillæ* replacing the ventral pairs of setæ in XVII. The base of the papilla is much sunk below the general surface, causing it to protrude from a cavity. The apex of the papilla is furnished with a small pit into which open the sperm-ducts and the prostate, immediately adjoining each other. The spermathecal pores and the ovipores appear to be in line with the ventral setæ.

Septal formula:—

$\overline{\text{V/VI}}$, $\overline{\overline{\text{VI/VII}}}$, $\overline{\overline{\overline{\text{VII/VIII}}}}$, $\overline{\overline{\overline{\text{VIII/IX}}}}$, $\overline{\text{IX/X}}$, $\overline{\text{X/XI}}$, XI/XII, XII/XIII.

Septal Glands.—The glands in V are the thickest, the others diminish in thickness posteriorly, so that those in VIII are thinnest. The length (in the direction of the short diameter of the body) of the respective sperm-sacs is, however, very nearly the same.

Intestine.—The tubular intestine is narrow and tubular, its outer walls being parallel where they pass the septa. Between the septa the respective parts of the intestine are greatly bulged out or beaded. The chylus diverticles in IX are long and slender; they originate in the posterior part near the posterior septum. Sacculated intestine commences in XII.

Spermathecæ.—The spermathecæ are postseptal, opening half-way between the setæ and the septum VIII/IX. Their lower or muscular part is cylindrical and very thick, occupying the whole width between the setæ and the septum. The length of each is about one-fourth the diameter of the cœlom. The upper sac is irregularly globular and hangs down over the posterior side of the muscular part, giving the organ somewhat the shape of a smoking pipe. This greatly inflated sac is as wide as two ordinary somites and reaches to the center of the cœlum. The large size of the spermathecæ so increases the size of somite IX that its width is that of two ordinary somites. There is no diverticle.

Sperm-sacs.—The racemose sperm-sacs in IX and XII are of the regulation type and very large, filling the whole of the somites. They have comparatively few lobes, these being correspondingly large. Large sperm-masses in X and XI.

Sperm-ducts and Prostates.—The sperm-ducts are thick but without any thickened muscular investment. When the ducts enter the papilla they actually narrow down. The prostates are thick and rather straight, the glandular part running back some eight somites. The sperm-ducts and the prostates open at the very apex of the papilla, side by side, the sperm-ducts immediately in front of the prostates. Just before the ducts enter the papilla they do not quite equal in width the muscular part of the prostate. The ducts may be seen running close together within their common investment and do not fuse until they reach the most external pore.

Subgenus **Nematogenia,** subgen. nov.

Ocnerodrilus (Nematogenia) lacuum *Beddard*, **panamaënsis,** var. nov.

PLATE IX, FIGS. 55–65, 114–116.

Definition.—Length 55 mm., width at clitellum 2 mm. Somites 110–120. Setæ strictly paired. Dorsal pores present, those in the clitellum surrounded by a wider depression. No setæ *ab* in XVII. Clitellum in 1/2 XV–1/2 XXII. Septa V–X thickened. The two anterior septal glands well developed, the three posterior ones minute. Gizzards two, very small, in VI and VII; sacculated intestine begins in XIII. Nephridia commence in III, those posterior to the clitellum with cœlomic mantle. Spermathecæ very large in IX. One pair of tests in XI. One pair of sperm-funnels in XI. Racemose sperm-sacs in XII. Ovaries in XIII. Oviducts in XIV. Sperm-ducts, one pair open in XVII jointly with the prostates. One pair of prostates, extending from XVII to XXXIII; in the last three or four somites they are folded.

Habitat.—Four mature and an equal number of immature specimens from Panama, Central America. Collected February, 1896, by Professor Charles H. Gilbert. The specimens were preserved in a five per cent. solution of formalin.

Affinity.—The variety differs from the species from Lagos, Africa, as described by Beddard, in the following particulars:—

Ocnerodrilus lacuum *Beddard*, **panamaënsis**, var. nov.	**Ocnerodrilus lacuum** *Beddard.*
DORSAL PORES	
begin X/XI.	begin at least VI/VII.
CLITELLUM	
1/2 XV–1/2 XXII.	1/2 XIII–1/2 XXVI.
SACCULATED INTESTINE	
commences in XIII.	commences in XII.
SPERM-DUCT	
not wider at the pore.	slightly wider at the pore.
PROSTATES	
extremely long and folded, extending through 16 somites.	not so long, extending only through 6–7 somites.
LYMPHOCYTES.	
No crenate cells. Nematocytes.	Crenate cells. No nematocytes. (?)
	(All after Beddard.)

DETAILED DESCRIPTION.

Septa.—The septum farthest anterior is IV/V and is very narrow. There are five specially thickened septa.

Septal formula:—

$$\overline{\overline{\overline{V/VI}}},\ \overline{\overline{\overline{\overline{VI/VII}}}},\ \overline{\overline{\overline{\overline{VII/VIII}}}},\ \overline{\overline{\overline{\overline{VIII/IX}}}},\ \overline{\overline{\overline{IX/X}}}.$$

The three central septa are of about equal size and somewhat thicker than the ventral body-wall in their somites.

Septal Glands.—Septal glands are found in somites V, VI, VII, VIII and IX. Those in V are very large, much larger than the suprapharyngeal glands in IV, and about as wide as the muscular part of the pharynx. The glandular mass in V is principally dorsal, ventrally it is very narrow and thin. The septal glands in VI–IX are exceedingly diminutive and cannot be made out by dissection; they are imbedded in lymphatic tissue and amongst agglomerations of lymph-cells; they are confined entirely to the region nearest the intestinal wall and are nowhere as thick as the septa.

Nephridia.—The anterior nephridia do not possess any cœlomic mantles. The posterior nephridia are partly covered by such mantles, the latter being divided in two lobes. One of these lobes is more ventral, consisting of very large cells of a radiating arrangement, the other and more dorsal lobe is much larger, and consists of smaller cells which contain minute opaque globular granules. The lobes are long, narrow and bent backwards. The whole nephridium has the shape of a figure 5. Nephropores in line with and in front of setæ *d*.

Alimentary Canal.—The prostomial lips are small but well defined. The mouth is narrow and may be said to correspond to somites I and II. In line with somite III there is a circular lip, much folded and composed of broad clear epithelial cells, somewhat like the area of taste-cells in *Benhamia*. The pharynx is developed only dorsally. It is very short and its superposed glands are very small and compressed, with their narrow ends projecting forwards. It does not occupy the whole of somite IV but leaves a place for a short piece of the œsophagus at its posterior end. The *œsophagus* turns upwards and occupies one-half of IV and V. The *gizzards* (fig. 56) are in VI and VII; they are very minute, but still perfectly differentiated. The one in VI is a little larger and occupies about one-half of the diameter of the somite. Its muscular layer is slightly wider than the epithelial layer of the intestine. The gizzard in VII is longer and narrower than the anterior one. Its muscular layer tapers gradually towards the septa, and the thickest part of the layer does not extend over one-third of the length of the somite. The gizzards are so narrow that they cannot be distinguished except through sections. They are not wider than the intestine and rather narrower than the œsophagus in V. The *tubular intestine* may be said to extend from VIII to XII. It tapers gradually towards the *sacculated intestine*, which commences in XIII. At the entrance to the sacculated intestine it is furnished with the usual large epithelial folds projecting backwards.

Spermathecæ.—(fig. 57.) The two spermathecæ open in front of the ventral setæ, half-way between them and the septum in somite IX. The muscular duct is somewhat less in length than the pouch. The walls of the latter consist of an inner epithelium of very narrow glandular cells, in which we can distinguish a very large ciliated discharge-pocket adjoining the nucleus. The spermatheca contains not only spermatozoa but also spermatocytes and spermatogonia, having one, two and four nuclei, together with a fine granular secretion.

Testes.—There is only one pair in XI. In longitudinal sections the tests are slightly racemose.

Sperm-sacs.—There is one pair of elongated, well defined sperm-masses in XI, projecting forwards in that somite. They are not surrounded by peritoneum. The real racemose sperm-sacs are in XII. They project from the posterior surface of septum XI/XII, closely surrounding the intestine.

Sperm-ducts and Funnels.—Only one pair of ciliated sperm-funnels and one pair of sperm-ducts. The funnels are large, situated in XI. The sperm-ducts run directly backwards to the male pore in XVII, where they open close to the prostate pores and on the same elevated papillæ.

Prostates.—These organs are larger than in any other species of the genus known. They extend through some sixteen somites and are folded on themselves at the distal end, and would if stretched out extend through three or four more somites. They increase slightly in width from the pore to somite XXXIII; but decrease from that point to the apex. There is a muscular and a glandular part. The muscular part consists of a row of glandular cells, a narrow muscular layer of a few strands, a connective tissue layer with rather large nuclei, and a narrow peritoneal layer of small cup-shaped cells. The nuclei of the latter are small and stain very dark. Towards the distal end of the muscular part the connective tissue layer decreases in size, while the glandular layer increases. Hence the muscular duct is composed of two sections, each section occupying two somites. The part which is most glandular contains two different kinds of alternating glandular cells. The narrow cells are similar to those in the muscular prostates; the larger ones resemble those in the glandular part. In the glandular part there is only a single row of glandular cells, commencing with somite XXI.

Lymphocytes.—(figs. 114–116.) The free cœlomic cells of this variety are of more than usual interest, one kind being a most extraordinary structure. The following kinds are distinguished.

Nematocytes.—This name is proposed for a highly specialized lymphocyte found in great numbers in the lymphatic fluid of this species. These cells are erythrophile, staining intensely with eosin and fuchsin. *The whole cytoplasm is filiform and takes the shape of a single, continuous, narrow strand wound regularly like a coil of rope.* Seen from the flat side these cells are irregularly rounded. The winding of the strand begins at one end or surface and continues regularly, ending at the other surface-end or pole. Where the cells had been torn, it was frequently found that a portion of the nematocyte had been carried some distance away without any break in the cytoplasmic thread, part of which could be seen more or less uncoiled, connecting the two portions of the cell. In many instances the beginning and the end of the thread could be clearly seen. The first coils nearest the pole are narrow, but they gradually widen until they reach their greatest diameter, which is that of the cell; then again they gradually diminish and finally end as they began. The thread does not contain any microsomes of unequal size, but there is some differentiation, so that alternating divisions stain darker. These alternate divisions appear to be of the same size, but are so minute as to be but indistinctly seen. In optical section the thread is round. The nematocyte is not covered by an exterior membrane (cytotheca), but the boundary of the cell consists always of the margins of the cytoplasmic rope. There is no cytoplasm visible either inside or outside of the cytoplasmic rope. The latter did not fill the centre of the cell, there being always more or less space not occupied by the thread and the nucleus.

The nucleus is oval, slightly irregular, with a central contraction.

A cœlomic cell somewhat resembling the nematocyte has recently been described by Edwin S. Goodrich from the lymph of *Enchytræus hortensis*.[1] Mr. Goodrich has figured a number of these cells and demonstrated their minute structure in detail. They differ from the nematocyte of *Nematogenia lacuum* var. *panamaënsis* in having a distinct cell-wall and in having the nucleus placed outside instead of inside of the rope-coil, which is much less regularly coiled.

In the *Enchytræus* cells the rope appears as a secondary structure in the cytoplasm, while in the *Nematogenia* cells the rope itself is the cytoplasm and *all* the cytoplasm there is in the cell. The rope may, perhaps, serve to catch bacteria, sperm-fragments and other foreign substances in the lymph. The function of the rope in the *Enchytræus* cells is unexplainable, unless we presume that it is now and then ejected outside of the cell-wall, serving as a lasso for catching microbes, or for attachment. Cells corresponding to the supposed early stages of the *Enchytræus* cells as figured by Goodrich are nowhere to be seen in our *Nematogenia*. Goodrich has also figured (figs. 13 *e* and 14) cells which greatly resemble the amœbocytes from the *Ocnerodrilus* lymph; these cells he describes as thread-cells under the action of water and caustic potash. Similar cells are found in our *Nematogenia*, but I do not believe that they are stages of the nematocytes. They are comparatively few in number and are much smaller than the nematocytes; they also possess a centrally located nucleus, while the amœbocytes figured by Goodrich have no nucleus, but are evidently structures separated from it. No suggestions offer themselves as to the origin of the nematocytes.

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[1] Quart. Journ., Mic. Sci., Vol. XXXIX, Pt. 1, May, 1896.

Mucocytes.—The round cyanophile cells found in great numbers in the lymph are probably referable to the class called by Dr. Rosa mucocytes. They are, however, perfectly round and have not the projections figured by Rosa. They are of the same size as the nematocytes but are spherical and even in outline, and furnished with a cell-wall. The nucleus is round with a central nucleolus. The mucocytes are more numerous than any of the other cells and appear to originate in a special lymphatic tissue intimately connected with the septal glands in VII, VIII and IX. It is not found surrounding the glands in IV, V or VI. The real septal glands in VII–IX are small, but appear much larger than they are on account of this lymphatic layer, which closely and intensely surrounds the cellular tissue of the glands. The differentiation is best brought out by a double stain of Rubin S. and Toluidine blue, the gland staining dark blue and the lymphatic tissue pink with blue nuclei. The cells composing this lymphatic tissue are not as round as the mucocytes. There are large numbers of the latter embedded in the tissue, especially at the edges, where probably they originate, though I have not seen any of them in mitosis.

Amœbocytes.—These are small star-shaped bodies with minute and numerous thread-like pseudopodia. These rods or threads are probably the amœboid projections of the cell itself, but the whole structure is too small to be studied in detail. They stain but poorly, and are less readily studied than the nematocytes.

Subgenus **Ilyogenia** *Beddard.*

Ocnerodrilus (Ilyogenia) taste *Eisen.*

PLATE XIV, FIGS. 157, 158.

Phœnicodrilus taste EISEN, Mem. Cal. Acad. Sci., Vol. II, 1895–96, Nos. 4 and 5.

Habitat.—In the immediate vicinity of the city of Tepic, Mexico, at an altitude of 4,000 feet. Also numerous specimens collected by Prof. Albert Koebele in the vicinity of the City of Mexico and at Morelos, Mexico. In the latter district they were found in the pine timber at an altitude of 6,000 to 7,000 feet.

Notes on the Tepic Specimens.

Upon dissection, one of the specimens which had previously been overlooked and referred to *Ocnerodrilus tepicencis* was found to agree in all the principal points with *O. taste* from the Cape Region of Baja California. Both species are characterized by the absence of the ovisac, the small clitellum in XIV–½ XIX, and by the short, thick, and warty spermathecæ, although in *O. tepicencis* they are very small and do not occupy more than one-fourth the width of the somite, while in the type-specimens from El Taste they are larger, extending fully to the posterior part of the somite (fig. 135). In *O. taste* there is not the distinct, star-like, radiating zone found in somite XIV of the other species. The specimens are large and fully mature, and it is therefore not probable that the spermathecæ are undeveloped.

Notes on the Specimens from the City of Mexico.

The specimens from the City of Mexico differ in some respects from those from the type-locality—the mountains of Baja California. There is no star-shaped papilla in somite XIV, in line with setæ *cd*. The spermathecæ are a little smaller and the outline of the sac-like part is more even, the undulating margin being confined to the apex of the sac. The sperm-sac in IX is furnished with some six to eight lobes, which are less minutely racemose than in the type. In X and XI sperm-masses only are found. This seems to be a common characteristic of most of the species. The sperm-sacs in XII are also racemose, long and narrow, and postseptal. There is absolutely no trace of any prostates. The two sperm-ducts run close together until they reach a point just above the male pore, when they fuse and become invested with a heavier coat of muscles. They then dip down through the muscular layers and form a small atrium about half as wide again as the sperm-ducts and equaling in thickness that of the epithelium of the clitellum at that place.

Kerria *Beddard.*

Kerria McDonaldi *Eisen.*

Habitat.—A pond near Santa Ana, Cape Region, Baja California, Mexico.

The specimens resemble very closely those found at Miraflores, Baja California. One of the specimens was sectioned, enabling me to add a few particulars to the former description. The intestine possesses a very rudimentary gizzard in somite VII. The circular muscular layer is here about twice as thick as in the somites preceding and following, and altogether the intestine in that somite is about one-third thicker than elsewhere. The single pair of sperm-funnels is in X. There are no sperm-sacs in any of the somites, only sperm-masses in X and XI.

EUDRILINÆ.

Eudrilus *Perrier.*

Eudrilus Eugeniæ *(Kinberg).*

PLATE VII, FIGS. 27–34; PLATE VIII, FIGS. 40–48; PLATE IX, FIGS. 49–50.

Habitat.—The specimens upon which my investigations are based are all from Panama, where they were collected in January, 1896, by Professor Charles H. Gilbert. They were preserved in a five per cent. solution of formalin, and were in very good state of preservation, suitable for histological purposes. Judging from the number of specimens in the collection, this species must be the most common of the large terrestrial earthworms in Panama.

Nomenclature.—For convenience sake I have here adopted the definition by Beddard and referred the present species to *Eudrilus Eugeniæ* (Kinberg), though I am satisfied that there are differences sufficient to warrant the making of at least a new variety. In a species so widely distributed as *Eudrilus Eugeniæ* we may expect to find interesting variations. In the following pages I have noted down the principal anatomical differences between my specimens from Panama and those upon which Beddard bases his definition; there are also added some observations on the finer anatomical and morphological structure.

EXTERNAL CHARACTERS.

Body.—(figs. 27–34). The body of the worm tapers gradually towards the tail which is very thin and pointed. Length from 120 to 150 mm. Color reddish to violet brown above, with fine and strong violet iridescence. Below yellowish white with some iridescence.

Somites.—(figs. 27, 28). The prostomium divides somite I about one-half to two-thirds. Somite II is about one-fourth smaller than I or III; somite III is about one-third smaller than IV; and IV is somewhat smaller than II and III combined. Somites III, IV and V are somewhat longer.

Nephropores.—The most anterior pore is in VI, in front of setæ *cd*. The pores in X to XIII are surrounded by an elevated glandular ring.

The *ovipores* are in front of *cd* in XIV.

Copulatory Organ.—(figs. 29–33). The male pores are found in the posterior part of somite XVII in line with setæ *ab*. There is a very large eversible bursa-copulatrix into which open the penis and the copulatory papilla. On this papilla we find the external pore of the Y-gland, while at the apex of the penis we find the opening of the prostate duct. When the bursa-copulatrix is retracted, the end of the penis projects through the opening of the male pore. When this bursa is everted the whole penis, as well as the very large papilla of the Y-gland, is free. Owing to contractions and contortions of the worm, it is difficult to illustrate the true position of these exterior organs (figs. 29–33). The papilla of the Y-gland is very large, filling nearly the whole of the bursa-copulatrix. It possesses only one pore, the one which communicates directly with the duct from the Y-gland. The penis is variable in regard to its curvature, but it is always so situated that its exterior groove can be readily brought opposite and close to the opening pore of the Y-gland. When viewing the papilla of this gland from the exterior there appear to exist two external pores of the gland, the papilla being pointed at both ends and quite symmetrical. Sections show, however, that there is only a single pore, which is always situated on the side nearest the exterior groove in the penis. This groove in the penis does not extend to the base of that organ, but only about half-way down its length. The groove is connected with the lumen of the penis near its apex only and not at the base also, as described by Beddard.

INTERNAL CHARACTERS.

Nephridia.—The nephridia are very thin, slender, and even, occupying a narrow zone along the septa. Those posterior to the clitellum are long and covered for their entire length with a thick but even agglomeration of round granular secretions of different sizes. These globules stain intensely with aniline colors. The granules are confined in a sac-like tissue, the surface of which is racemose. It extends from top to base of the nephridium, but only along one of its sides. The nephridial cœlomic sac, which follows the almost parallel lobes, is narrow and even, and occupies about one-fourth of the width of the somite.

Suprapharyngeal Gland.—The usual suprapharyngeal glands are present and well developed. When viewed in longitudinal sections they are seen to consist of five distinct lobes, one posterior to the other. The most anterior lobe is the smallest and the most posterior lobe the largest. Each lobe contains a central muscular bundle connecting the pharynx with the body-wall. Glandular cells surround these muscular strands on all sides. The muscles to which the most posterior lobe is attached run backwards to the junction of somites VII and VIII.

Subintestinal Vessel.—(figs. 39, 42). Beddard describes and figures this vessel as being double in somites X and XI. In my *Eudrilus* from Panama the vessel is single, judging from an examination of an unbroken series of transverse sections. It is surrounded by a zone of lymphatic tissues (fig. 41) in which are seen a number of lymphocytes. Immediately surrounding this vessel the tissue forms a thick, even coating, which ventrally spreads out as a lamella on either side (fig. 42). Under high power the tissue is seen to be highly vacuoled, with two kinds of nuclei and here and there a lymphocyte. The vessel connects directly with the blood sinus in the median diverticle of the intestine. The ventral side of the diverticle consists similarly of a spongy tissue with numerous vacuoles separating the epithelial linings. In this tissue we also find two kinds of cells, some with much smaller nuclei than the others.

The last hearts are in XI. The hearts in IX, X, XI are of about equal size; those in VII and VIII are smaller, the former being the smallest.

Diverticles of the Intestine.—These hearts are well developed, as has already been mentioned by several investigators, especially Beddard. There is one point in which the specimens from Panama differ from those of Beddard. He describes the entrance of the diverticle into the intestine as very wide, while in my specimens this duct is very narrow (figs. 39, 40). In both of the median diverticles I find large agglomerations of lime, a few of which are shown in fig. 41. In the paired diverticles in somite XII neither crystals nor any lime globules are to be found.

Female Generative Apparatus.—(figs. 49, 50). This complicated apparatus differs considerably in details from the wood-cuts and descriptions given by Beddard. The oviducal pore is situated in front of setæ *cd* in XIV. Into this pore opens a very large, somewhat coiled spermathecæ, which is bent on itself. The part which is nearest the pore is situated in XIV, but the largest part is found in XIII. Into this spermatheca open three different ducts, within a short distance of each other. The place where these ducts open into the spermatheca is found about one-third the distance from the pore to the inner apex. The ducts which open into the spermatheca are those of the oviducal gland, the anterior oviduct and the posterior oviduct (figs. 49, 50, *ov.* 1; *ovd. gl.* and *ov.* 2 and *ov. s.*). The anterior and posterior oviducts differ in size and function. While the anterior oviduct conducts the undeveloped egg-cells, the posterior oviduct conducts not only the undeveloped egg-cells of the anterior ovary into the ovisac, but also the ripe ova from the ovisac to the spermatheca. The posterior ovaries, which are situated much higher up, are also the largest. As Beddard has pointed out, these ovaries serve also as ovisacs. The ovaries in XIII are rudimentary and furnish only immature ova. The young egg-cells from these ovaries slough off in bunches and are carried through the narrow anterior oviduct (figs. 49, *ovd. ov.* 1) to the base of the spermatheca; thence they are probably carried to the posterior ovisacs, there to go through maturation. In the ovisacs we find ova in all stages of development. There are free bunches of egg-cells, as well as cells attached to the walls of the ovisacs, and it seems there can be no doubt as to the double nature of the ovisac, it being both ovary and an ovisac. The long coiled oviduct is not ciliated, but we find cilia in the funnel of the oviduct, which connects directly with the ovisac. The funnel and the coiled oviduct are entirely in XIII, but the part of the spermatheca into which it opens is in XIV. Beddard states that the oviduct penetrates the septum XIV/XIII twice. This is not the case in the *Eudrilus Eugeniæ* from Panama, as has just been shown. The egg-cells in the posterior ovary and ovisac are not placed as in Beddard's figure (Pl. XX, fig. 53), but they are found all along the inner margins of the walls of the ovisac, in the manner figured (fig. 49, *ov.* 2).

The lower part of the spermatheca is much wider in my specimens than in Beddard's, judging from his figure referred to above. The figures representing the female reproductive system were drawn from a number of sections, (fig. 49 from longitudinal, fig. 50 from cross-sections). They are, of course, partly diagrammatic, but it was the endeavor to reproduce the relative proportions as faithfully as possible.

As regards septum XIII/XIV, it was found to be perfect all along the body-wall and between it and the female organs. In the center, however, it is defective or entirely absent.

Male Apparatus.—(figs. 44, 48). This very complicated set of organs differs somewhat from the description and figures of *Eudrilus sylvicola (Eugeniæ)* as given by Beddard. In a general way, Beddard's description fits the specimens in question, but the positions of various parts is different. In one respect, however, Beddard is in error, provided, of course, that we have studied the same species. Beddard states (62) that the longitudinal groove of the penis opens into the lumen of that organ. This is not the case in the *Eudrilus Eugeniæ* from Panama. The penis possesses a groove just as stated by Beddard, but it does not open into the canal of the penis at the junction with the bursa, it simply ends bluntly at the base, while at the apex it joins with, and ends at, the exterior opening of the canal of the penis. The groove is therefore entirely an exterior structure along its whole length. Its object is not difficult to perceive. Because of its peculiar position the groove can readily be brought close to the pore of the Y-gland, as shown in figs. 44 and 46 at X. Any discharge from the gland at any point from the base to the apex will therefore be caught in the groove and conducted to the orifice of the penial canal, there to be mixed with the exuding contents of the prostates.

Four specimens were sectioned in order to ascertain the structure of this organ and all were found to closely agree. In every instance the pore of the Y-gland was found to be situated close to the groove in the penis. At times the pore was found near the base, this always being the case when the muscular cushion was retracted. When the latter was more or less extended, the pore was found nearer to the apex of the groove. The secretion of the Y-gland when coagulated is tough and resembles, superficially at least, the secretion from the silk glands of a caterpillar. In many of the specimens the secretion of this gland has been ejected, forming a very thin flattened string several inches long, either hanging down along the side of the body or twisted and rolled into a ball around the copulatory cushion. Quite a little force is required to break this thread. The thread stains but poorly with hæmatoxylin and methylene blue, and cannot therefore be of a strictly mucous nature. It shows a fine longitudinal striation, as if consisting of innumerable fine strands. The pore of the Y-gland is round and possesses but a single opening. The pore is also connected with a tiny groove which runs parallel (and opposite) to the groove in the penis, but which is much shorter. The upper end of the Y-gland is muscular, the two forks are separate as regards their lumens, but they are surrounded by a common muscular covering of great thickness. According to Beddard's figures the prongs of the gland are longer than the canal, the prongs joining close to the wall of the bursa. In my specimens the Y-gland possesses a longer duct, as shown in fig. 44, *y gl.* This duct is very much curved and enters the bursa from the ventral side of that organ, while Beddard's figures indicate that the Y-gland enters the bursa from its dorsal side.

Prostates.—In my specimens the longer prostate is about twice as long as the shorter one and must, I think, be the main prostate, while the shorter part may be called a diverticle of the other. These two parts cannot well be considered as two distinct prostates joined together, on account of the difference in structure, which, though slight, seems of sufficient importance to be considered.

Thin sections of the two parts of the prostates are found to stain differently, one taking the stain much more readily than the other. The contents of the diverticle also stains intensely with red stains, but I have found no such dark staining secretion in the larger part of the prostate. There is also a difference in the structure of the glandular cells in the two parts. Those of the diverticle are larger, more twisted and bent, while those of the main prostate are smaller and straighter. In the main prostate the epithelial layer is surrounded by a narrow muscular layer which winds in and out between the glandular cells, but in the diverticle this muscular layer is reduced to a very few strands not readily perceived.

The muscular coat surrounding the prostates is exceedingly powerful. It consists of three layers of which two are entirely distinct. The outer longitudinal layer surrounds a narrower transverse muscular layer, and this is lined interiorly by another very narrow, but still recognizable longitudinal layer, which here and there runs off to the prostates, separating the diverticle from the main gland. The two inner muscular layers are not always to be distinguished one from the other and are probably only differentiated parts of one layer. The width of the diverticle is greater than that of the inner prostate. In cross-sections it will be seen that the diverticle embraces the main prostate like a crescent and occupies the largest space inside the common muscular coat.

The secretion from the diverticle appears to be of a twofold nature. There is a thin cyanophile mucous secretion and a thicker erythrophile one. The latter is generally found in the shape of irregular rounded granules or globules surrounded by the cyanophile secretion.

Judging from Beddard's figure (62, fig. 10), the difference in the size of the two glands is not great. In my specimens the longer part of the prostate is much narrower, occupying a comparatively small space within the muscular coat.

The globular enlargement of the sperm-duct at the ciliated funnel resembles exactly the figures given by Beddard, but the funnel itself is somewhat different. In Beddard's figure we see broad and narrow lobes alternating, while in my specimens all are of the same size, the lobes being broader and regular.

Sperm-ducts.—These are very thick, and are separated to the junction by the prostate. They enter the prostate covering in the vicinity of the apex of the diverticle, run for a short distance inside the covering, and then pierce the main prostate, just in line with the apex of the diverticle. The ducts curve inwardly and enter the prostate in the center of the organ, as seen in a section represented in fig. 47. The two ducts unite only in the glandular part of the prostate. Anteriorly the ducts run forward in a straight line, curving only over the large muscular bursa.

Epidermal Sense-cells.—(figs. 95–97). As is well known, many and perhaps all species of the genera of Eudrilidæ are characterized by the possession of large epidermal sense-cells, which Beddard has compared to the pacinian bodies of higher animals. He has figured and described these cells (54) in *Eudrilus*, and any further description would seem to be superflous. But the sense-cells found in the *Eudrilus* from Panama differ so much from those Beddard describes that it seems likely that we have investigated two different species. Judging from Beddard's papers (54, figs. 2 and 3; and 62, fig. 14) it appears as though the structures of the various cells composing the so-called pacinian body do not differ much from each other. In fig. 14 we find a large central nucleus surrounded by a rather small cell, around which are seen a number of thin concentric cells with nuclei of much smaller size than the central one. This is the case in Beddard's species from Guiana. In my Panama specimens, the sense-cells are situated exactly as described by Beddard, at the base of the epidermis; they never reach more than about half-way up to the cuticle. The sense-corpuscle is surrounded by ordinary glandular and supporting cells, which shut off the former from the cuticle. In a general way the sense-corpuscles may be described as consisting of a very large central cell, which is capped and partly surrounded by from three to twelve very thin but wide cells superposing each other (figs. 95, 96). A characteristic feature of each one of these upper cells is the situation of the nucleus, which is found on or near a line passing perpendicularly from the cuticle through the large central cell. There is no constancy in the size of the nuclei. Beddard states that the central nucleus is very large and that the other nuclei are small. While I have found corpuscles in which the central nucleus was much larger than the upper ones, in many instances the reverse has been the case. The upper nuclei are generally of very even size.

When seen in a cross-section of the body of the worm the sense-corpuscle is sac-like, generally higher than broad (fig. 95). In longitudinal sections (fig. 97) the sense-corpuscle is longer than high. The most interesting feature of the sense-corpuscle is the structure of the large central cell. Its size varies considerably, as may be seen by the figures, but it is always larger than all the upper cells combined. There are two very prominent characteristics of this cell: the nucleus is situated in, and suspended by, a diaphragm which forms a constant acute angle with the base of the cell and the cuticle of the deric epithelium; secondly the cytoplasm of the cell is laminated in a certain and distinct manner (figs. 95–97).

The central nucleus is evidently capable of extention and contraction, as in some cells it is found to be much elongated in the direction of the diaphragm, while in others it is quite round. In some cells the diaphragm has the form of a simple bar, dividing the vacuole into two equal parts; but in reality this diaphragm consists of a number of narrow lamella which in the figure are only seen in cross-section. The other ends extend to the opposite side of the vacuole somewhat in the manner of a membrane stretched on a drum. More strictly speaking, there are two central vacuoles separated by a diaphragm, and surrounding them is a dense mass of peculiarly laminated cytoplasm. Cross-sections show that this lamination does not extend all around the cell, but is discontinued in the direction of the diaphragm both upwards and downwards. The lamellæ are very distinct and of even thickness throughout until a certain zone is reached, where they spread and thin out, each lamella continuing towards the cell-wall as a thin, wavy, cytoplasmic thread. In several cells there could be distinctly perceived a thinner continuation of the central cell downwards into the muscular layers, probably indicating a connection with nerve-fibers.

Beddard has given a diagrammatic drawing of a "pacinian corpuscle" of *Hyperiodrilus* (No. 54, Pl. XVI, fig. 4) from which it appears there were a large number of nuclei in the central core. In the sense-corpuscles of *Eudrilus Eugeniæ* from Panama there certainly does not exist any structure similar to that just described. On the other hand, I find some resemblance between these cells and the supposed auditory cells of *Pontoscolex* described elsewhere in the paper. In both of these cells the cytoplasm shows a very high degree of differentiation. There is in each cell a central nucleus and a diaphragm, the latter being of different structure in the two cells. In *Eudrilus Eugeniæ* there is no body comparable to the otosome; but still there is enough resemblance to suggest a possible or even probable similarity of function. Since the manuscript of the first paper (Eisen 19) on *Pontoscolex* passed out of my hands, Dr. R. Hesse (2) has described a most interesting type of sense-cells from the epidermis and nerve-ganglia of Lumbricidæ. Dr. Hesse recognizes in these cells organs for the perception of light.

In *Pontoscolex* and *Eudrilus* the sense-corpuscles are not found in increased numbers in the anterior and posterior somites, but on the contrary are more numerous in the central parts of the body, or in parts much less exposed to light. If the sense-corpuscles in *Eudrilus* and *Pontoscolex* are organs for light, we should expect to find them more numerous in parts of the body most readily exposed to the light, such as the tail and the prostomium; but in these parts they are, on the contrary, very rare or absent. Sense-cells in the central part of the body are likely to serve some other purpose.

We have seen that Oligochæta possess cells perceptive of light, taste, smell, and touch, and unless we assume the existence of a sixth sense not present in the higher animals, the only remaining sense not yet fully recognized in Oligochæta is that of hearing. The nature of the structure of the sense-cells in *Pontoscolex* and *Eudrilus* is such as not to oppose the assumption that in these cells may be recognized primitive auditory organs. In *Pontoscolex* the characteristic parts of the auditory cell are the otosome and the diaphragm. In *Eudrilus* the diaphragm only is present, but it does not seem improbable that the almost vertical column of nuclei superposed on the large lower cell may serve as a row of otosomes, aiding materially in carrying along the sound-waves to the diaphragm of the more sensitive cell below. It is of the utmost importance that the worms be enabled to perceive sounds caused by the feet of birds, the working of moles and other animals,—sounds which must be transmitted through the soil in order to reach the worms.

The situation of the sense-corpuscles in the projecting equatorial of each of the more central somites in those parts of the body which come into closest contact with the soil, seems to me to especially favor the theory that these cells and corpuscles are really organs for the perception of sound. Not only are these cells more numerous in the equatorial of the central somites, but they are nearly exclusively found on the dorsal and lateral sides of each somitic equatorial, and are almost absent on the ventral side. In other words, they are most numerous in parts most accessible to sound-waves passing through the soil, and are singularly scarce in parts which are least accessible to these sound-waves. These cells in *Eudrilus Eugeniæ*, as well as in *Pontoscolex*, are found several rows abreast in each equatorial, and are never found outside of the equatorial.

ACANTHODRILINÆ.

Notiodrilus *Michaelsen.*

With Dr. Michaelsen (30) I agree to place the American species of the old genus *Acanthodrilus* in a separate genus. As Dr. Michaelsen's paper (30) arrived just as this manuscript was going to press, there was no time to discuss the subject; I can merely state that in most respects Dr. Michaelsen's re-arrangement of the genera of this family seems admirable.

Notiodrilus Whitmani, sp. nov.

PLATE XIV, FIGS. 163–167.

Definition.—Length 60 mm., width 2½ mm. Somites about 115. Setæ paired. Penial setæ very large, smooth, with end knob. No spermathecal sexual setæ. Clitellum small, saddle-shaped, XIII–XVI. Prostomium divides somite I, about one-half. Genital zone not prominent. Groups of four to six small papillæ in the intersegmental grooves of IX/X, X/XI, XI/XII, in line with the lateral intervals on each side. Intestine without any diverticles. Gizzard in VI. Sacculated intestine commences in XIV. Two pairs of spermathecæ, the anterior pair smallest, each with a single diverticle of large size. The spermathecal pores are postseptal. Sperm-sacs racemose, in IX, XI and XII. Loose sperm-mass in X. Testes in X, XI; sperm-funnels in X, XI. Ovaries in XIII, oviducts in XIV. Prostates long, narrow, tubular, much coiled in one plane, each covering two somites. Sperm-ducts do not fuse until the male pore in XVIII. Meganephridia; no peptonephridia. Last hearts in XII. Color pale flesh, without pigment.

Septal formula:—

$$\overline{\overline{\overline{\text{VI/VII}}}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\text{VIII/IX}}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\overline{\text{X/XI}}},\ \overline{\text{XI/XII}}.$$

Habitat.—Coban, Guatemala, Central America.

This species is very abundant in the river near the city of Coban, in the highlands of Guatemala. I found it in the banks of the river, among the roots of plants, etc. It is not strictly an aquatic form. The species is named in honor of Professor C. O. Whitman, to whom the author is indebted for many courtesies.

Detailed Description.

Glands.—There is a pair of small septal glands in VI and VII, about as long as the spermatheca is wide. There is a tiny subpharyngeal gland. There is no septum anterior to that separating VI and VII.

The *gizzard* is strongly developed, but confined to somite VI. There are very few and only very small chloragogen cells anywhere.

The *sperm-sacs* are all racemose, but the anterior pair is less racemose than the two posterior pairs. All three pairs are postseptal.

The *spermathecæ* are of somewhat less height than the diameter of the body. The anterior pair is considerably narrower than the posterior pair; this is true of both the main sac and the diverticle. In the anterior pair the diverticle is of the same length as the main sac, but a trifle straighter and a little thinner. This diverticle is divided up into imperfect chambers, due to some parts of the epithelium being longer than others. The posterior diverticle is less marked in this respect. The main sac of the spermatheca contains a much narrower epithelium, which is smooth and even. The diverticle joins the main sac at the base of the muscular duct. The diverticle of the posterior spermatheca is about two-thirds as large as the main sac of that organ.

The *prostates* are thin and tubular, but greatly coiled, principally in one plane. The glandular part is perhaps ten times as long as the muscular duct. There are two kinds of cells in the glandular part, but they do not form two distinct layers as in so many other species. The larger, very glandular cells reach from the outer to the inner wall and are only one layer thick. Similarly, the thinner supporting cells which separate the glandular cells reach from the inner lumen to the outer surface of the organ, very much in the same way as in some species of *Diplocardia.* The prostates open slightly dorsal to the penial setæ.

The sacs with *penial setæ* are very large, about as long as three somites. The two sacs at each pore are joined along their entire length; they consist of a larger sac-like part which encloses the setæ, and a shorter, narrower, and tubular part, serving as a duct for the guidance of the seta when it is projected. This duct is about one-third as long as the main seta-sac, towards which it is sharply bent or even closely folded. The two ducts of the respective setæ are closely joined, but not fused, and remain thus to the very pore. The setæ are of different forms. The longer is a little more curved, and its apex, which is much narrower, is bent towards the main part like a fish-hook. The shorter seta is only a trifle shorter. It is less curved and the tip is narrower and only slightly bent. Both setæ are smooth and have a small knob at the apex. The knob is not quite smooth, being furnished with a few depressions and elevations.

The *common setæ* are strictly paired, and measured with a micromillimeter scale give the following comparative values:—

a–a=110; a–b=12; b–c=90; c-d=10.

Notiodrilus cristalifer, sp. nov.

PLATE XIV, FIGS. 160–162.

Definition.—Length 20 mm., width 1 mm. The anterior seven somites smoother than those posterior. The genital zone is sunk as in *Benhamia*. The prostates in XVII and XIX open on prominent papillæ. Setæ strictly and closely paired, all ventral. Penial setæ slender, not ornamented. Nephropores in front of setæ *d*. Diverticles of the intestine in VII, VIII, IX. Sacculated intestine in XII; gizzard in V. Spermathecæ in VIII and IX. Testes in X and XI. Racemose sperm-sacs in XII, very minute and ventral. Plain sperm-sacs in IX. Sperm-funnels in X, XI; sperm-ducts not fused until the male pore. Prostates confined to their own somites. Meganephridia, with numerous lime crystals. No typhlosole. Septal formula:—

V/VI, VI/VII, $\overline{\text{VII/VIII}}$, $\overline{\overline{\overline{\text{VIII/IX}}}}$, $\overline{\overline{\text{IX/X}}}$, $\underline{\underline{\overline{\text{X/XI}}}}$, $\underline{\underline{\overline{\text{XI/XII}}}}$, $\underline{\underline{\overline{\text{XII/XIII}}}}$, $\underline{\underline{\overline{\text{XIII/XIV}}}}$.

Habitat.—Tactic, near Coban, in Guatemala. One specimen, July 4, 1882.

This little species of *Notiodrilus* is well characterized by the position of the diverticles of the intestine in somites VII, VIII and IX. Nearly all other species of this genus have the diverticles much farther back, generally posterior to XIII. *N. cristalifer* is readily distinguished by the form of its spermatheca from *N. tamajusi*, also from Guatemala, the only other species so far known which has the intestinal diverticles in the same somites. *N. tamajusi* has the penial setæ ornamented at apex. *N. Whitmani* has no intestinal diverticles.

DETAILED DESCRIPTION.

Dorsal pores present; the most anterior one IX/X (?).

Glands.—The suprapharyngeal glands are in six lobes, the most anterior one being very minute. There is no trace of any septal glands.

Calciferous Diverticles.—The calciferous diverticles of the intestine occupy the ventral or latero-ventral part of the intestine in somites VII to IX, and constitute merely thickened folds or swellings of the intestine. They possess, however, the same internal structure as diverticles of other species, that is, their interior cavity is divided by numerous, more or less parallel, folds of the inner epithelium. In a vertical section of the intestine it is seen that these folds are confined to the ventral part, gradually diminishing laterally, and entirely absent on the dorsal side, where the walls of the intestine are characterized by large blood-sinuses.

The *spermathecæ* in VIII and IX are medium sized, slender sacs, each with a small tubular diverticle pointing forwards, but confined to the somite of the spermatheca.

The *sperm-sacs* in IX are large, filling the whole somite. They are surrounded by a peritoneal membrane but are without trabecula. The racemose sperm-sacs are in XII; they are very small and confined to the lateral and ventral sides of the cœlom.

The glandular part of the prostate is large and bent zigzag, but is confined to the somite into which it opens. There are two distinct layers of cells.

The *clitellum* was not developed in the immature specimen at my disposal.

The *penial setæ* are without ornamentation, except for a small fin-like flare at the very apex. The apex of one of the setæ is furnished with a tiny hook, below which on the curved side is situated the flare. The other setæ is without the hook but possesses the flare.

Tne *nephridia* are large meganephridia opening in front of setæ *d*. They are characterized by numerous—from 30 to 60—minute crystals, probably of lime, strung out along the whole length of the nephridium. Similar crystals, but twice the size, are found in the sacculated intestine. None are in the diverticles of the tubular intestine. The dorsal part of each nephridium is covered by a cœlomic mantle extending about one-third down the nephridium.

The *septa* between VII and X are thickened both dorsally and ventrally, but the septa between X and XIII are thickened principally ventrally.

MICROSCOLECINÆ.

Key to the Species of *Microscolex*, *Yagansia* and *Rhododrilus*.

A. Two pairs of testes.

Microscolex *Rosa*.

I. Two pairs of testes. No spermathecæ.

1. No gizzard. Nephridia commence in V. Sperm-ducts join the center of the muscular part of the prostate.
Microscolex dubius (Fletcher, 3).
2. No gizzard. Nephridia commence in II. No septal glands; suprapharyngeal glands small. Sperm-sacs in XI and XII. Sperm-ducts join the prostate at the exterior pore.
Microscolex Poultoni Beddard (38).
3. Gizzard rudimentary. Nephridia commence in II. Septal glands small; suprapharyngeal glands large. Sperm-sacs in XI and XII. Sperm-ducts join the prostate in the body-wall, previous to entering exterior pore. Nephropores with sphincter.
Microscolex elegans (Eisen, 16).

4. Gizzard rudimentary. Nephridia commence in II. Racemose sperm-sacs in XI and XII. Anterior setæ not converging; posterior converging. Sperm-ducts join prostate before they enter the body-wall, half-way up the muscular part. Nephropores without sphincter.
Microscolex carolinæ, sp. nov.

II. Two pairs of testes. Spermathecæ present, with one diverticle each.

5. No gizzard. No penial setæ. Sperm-ducts join the prostates in the body-wall.
Microscolex algeriensis BEDDARD (38).

6. Gizzard rudimentary. Penial setæ present. Sperm-ducts open on segment behind the prostates.
Microscolex phosphoreus (DUGÈS) MICHAELSEN (30).

7. Gizzard rudimentary. Setæ convergent. Penial setæ smooth, with end knob. Sperm-ducts open into the prostates.
Microscolex Horstii, sp. nov.

III. Two pairs of testes. Spermathecæ present, with two diverticles each.

8. No gizzard. Distance *a–b* several times smaller than *c–d*.
Microscolex Benhami (EISEN, 16).

9. No gizzard. Distance *a–b* about equal to *c–d*.
Microscolex Troyeri (EISEN, 16).

10. Gizzard rudimentary, in V. Setæ not converging. All nephropores in front of setæ *c*. Prostates and sperm-ducts open together in the same pore.
Microscolex novæ-zelandiæ BEDDARD (25).

11. Gizzard rudimentary, in V. Setæ converging. Sperm-ducts open into the muscular prostate. Nephropores II–IV in front of setæ *d*............*Microscolex parvus*, sp. nov.

12. Gizzard rudimentary, in V. Setæ converging. Nephropores II–IV in front of setæ *d*. Prostates and sperm-ducts open in separate pores.
Microscolex Hempeli SMITH (3).

13. Gizzard in VIII. Sperm-sacs in XII. Prostomium complete............*Microscolex monticola* BEDDARD (86).

B. One pair of testes.

Yagansia *Michaelsen* (30).

I. Spermatheca with one diverticle each.

1. Gizzard in V. Prostomium incomplete. Setæ paired; penial setæ long. No dorsal pores. Spermathecæ in IX. Sperm-sacs in IX and XI. Prostates extend back many somites.............. *Yagansia papillosa* (BEDDARD, 87).

2. Gizzard in VI. Prostomium incomplete. Setæ paired. Penial setæ long. Dorsal pores present. Spermathecæ in IX. Sperm-sacs in XI.
Yagansia longiseta (BEDDARD, 87).

3. Gizzard in VI. Prostomium complete. Setæ paired; penial setæ curved, without exterior sculpture. Sperm-sacs in XI.
Yagansia pallida MICHAELSEN (28).

4. Gizzard in VI. Setæ paired; penial setæ with crenate ridges. Sperm-sacs in XI.
Yagansia spatulifer MICHAELSEN (13).

5. Gizzard in VI. Prostomium complete. Setæ paired; penial setæ with spinelets. Sperm-sacs in IX and XI. Spermathecal diverticle forked.
Yagansia grisea (BEDDARD, 87).

6. Gizzards in VI and VII. Prostomium complete. Setæ separated; penial setæ smooth. Dorsal pores present. Sperm-sacs in IX and XI. Sperm-ducts open separately from the prostates.
Yagansia diversicolor (BEDDARD, 87).

7. Gizzards in VI and VII. Prostomium complete. Setæ paired; penial setæ with transverse ridges, flattened and wider at apex. Dorsal pores present. Sperm-sacs in XI.
Yagansia corralensis (BEDDARD, 87).

8. Gizzard in VII. Prostomium complete. Setæ separated; penial setæ smooth. No dorsal pores. Sperm-sacs in XI.
Yagansia robusta (BEDDARD, 87).

9. Gizzard in VIII. Prostomium complete. Setæ separated; penial setæ smooth. No dorsal pores. Sperm-sacs in XI and XII.
Yagansia gracilis (BEDDARD, 87).

II. Spermathecæ with two diverticles each.

10. Gizzards rudimentary. Sperm-ducts open behind the prostates in a groove. Penial setæ with spinelets.
Yagansia Michaelseni (BEDDARD, 87).

C. Two pairs of testes; four pairs of spermathecæ, in VI–IX.

Rhododrilus *Beddard.*

Rhododrilus minutus BEDDARD (37).

Microscolex *Rosa.*

Microscolex elegans *(Eisen).*

Deltania elegans EISEN, Mem. Cal. Acad. Sci., Vol. II, No. 5, 1896.

The following additional characteristics not mentioned in the former description are of considerable interest:—

Gizzard.—There is a small rudimentary gizzard in somite V. The transverse muscular layer is increased some three or four times, but still is not sufficiently thick to form a perfect gizzard. The intestine widens but little in this somite and cannot be seen well except in sections.

Spermathecæ.—There are no real spermathecæ and the peculiar sacs filled with spermatozoa found in the specimens first described are of doubtful character; they do not open exteriorly. Similar structures have not been found in any specimens dissected or sectioned recently.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

Habitat.—This species was found to be common in southern California where I have collected it on Santa Rosa Island and at Santa Barbara. On the island it appears to be the most common species and there can be no doubt but that it is indigenous.

M. elegans is represented in the eastern United States by *M. carolinæ*, the main difference between the two being the manner in which the sperm-ducts join the prostates. In *M. elegans* the junction is in the body-wall, while in *M. carolinæ* the sperm-ducts join the prostate half-way between the body-wall and the glandular part. The former species is much more delicate than the latter, which may be readily transported long distances without injury.

Microscolex carolinæ, sp. nov.

Definition.—Length 90–110 mm., width below clitellum 4 mm. Prostomium incomplete. Dorsal pores posterior to clitellum. Clitellum perfect, XIII–XVII. Setæ rather distant; those in the ventral couples and posterior to clitellum converging towards the male pores, but those in front of the clitellum not converging. Oviducal pores in line with setæ *a*. Spermiducal pores in XVII. Penial setæ present. Testes in X and XI. Sperm-sacs small and very racemose in XI, XII. Rudimentary gizzard in V. No spermathecæ. Sacculated intestine in XVII. Nephridia without sphincter. Color flesh with a brick red clitellum.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV.

Habitat.—The specimens were collected in the uplands near Raleigh, North Carolina, by Messrs. Brimley.

This species is more robust and of a deeper color than *M. elegans*. The principal differences appear to be the following: The sperm-ducts join the muscular part of the prostate half-way between the body-wall and the glandular part. The nephridia do not seem to possess the sphincter, and the sperm-sacs are much more racemose and the lobes narrower than in *M. elegans*.

DETAILED DESCRIPTION.

Somites.—The somites anterior to the clitellum are of about the same width.

Setæ.—Only those setæ anterior to the male pores converge towards these pores. The setæ are distant as follows:—Interval a–a=b–c, but is slightly narrower than c–d; a–b is about two-thirds that of a–a. Setæ c and d are slightly dorsal. The penial setæ are not unusually long. They are of medium size; the apex is almost straight, ornamented with about twelve rows of faint, short, transverse, wavey depressions or lines, of which there are about three abreast, running somewhat diagonally in the direction of the short diameter.

Intestine.—The gizzard is rather imperfectly developed and very small. It is hardly wider than the balance of the intestine, is principally developed inwardly and does not cause the intestine to bulge out. It is entirely confined to somite V. The somites following are strongly nipped by the septa. The sacculated intestine, commencing in XVII, possesses very thin walls. No large chloragogen cells are found on any of the divisions of the intestine.

The *septa* are all very narrow and those slightly thickened are not more than twice as thick as the others. All the anterior septa are attached half-way between the grooves.

Glands.—The suprapharyngeal glands are well developed and show a succession of lobes increasing in size posteriorly. The septal glands are very minute and are found in somites V, VI, VII, VIII and IX; in the latter somite they are entirely ventral and exceedingly small, as seen in longitudinal sections of the body.

Sexual Organs.—The testes are found in somites X and XI, the spermiducal funnels in the same somite, while the sperm-sacs are in XI and XII. The latter are small, strongly racemose and entirely confined to the ventral part of the body, not rising above the intestine. The ovaries are as usual in XIII. They are strongly fringed, the individual strands not being more than one ovum thick.

The sperm-ducts are separate to the very point where they enter the prostate glands. The prostates are confined to one somite. They are very nearly straight, with the top slightly bent over. They consist of two distinct parts, of which the lower is narrower and strongly muscular. The larger, glandular part is club-shaped, the inner or distal part being the thickest. The sperm-ducts enter the muscular part at a point situated half-way between the body-wall and the glandular part of the prostate. The glandular cells are not arranged in two distinct layers; there are, however, two kinds of glandular cells. The inner layer, consisting of the narrowest cells, projects everywhere into the outer layer, making the boundary between the two layers very indistinct.

The *nephridia* commence in somite II, but the body of the first nephridium is situated mainly in III. Each nephridium is furnished with a large terminal vesicle which opens directly through the body-wall. There is no urinary bladder, nor is the exterior pore furnished with large sphincter cells, as in *Microscolex elegans* (Eisen 16). At the point in the clitellum where the vesicle opens into the pore, the clitellar cells suddenly narrow down, thus allowing the vesicle to connect directly with the pore. The nephropores are slightly ventral and anterior to setæ *c*.

Microscolex parvus, sp. nov.

Plate XIV, Figs. 183, 184.

Definition.—Length 35–45 mm., width 1–1½ mm. Somites 85. Prostomium does not encroach on somite I. The ventral part of somite I is half as wide as its dorsal part; the somite is narrower than somite II. Dorsal pores begin about VIII–IX, a very large one between XIII/XIV. Setæ posterior as well as anterior to the male pore converging towards that pore. Penial setæ sigmoid at apex. Spermiducal pores in XVII. Oviducal pores separate, in line with setæ I. Spermathecal pores in line with setæ I, in VIII/IX. Spermatheca with two diverticles. Testes, two pairs in X and XI. Sperm-sacs small, racemose, in XI and XII. A small ovisac in XIV. Gizzard very rudimentary. Sacculated intestine commences in XVI. Sperm-ducts open into the prostate. Muscular part of the prostate half as long again as the glandular part. Color very pale flesh with pale, yellowish clitellum.

Habitat.—Santa Rosa Island, and Santa Barbara, California. The writer collected some ten or fifteen specimens in moist garden soil in May and June. I have no hesitation in pronouncing this species indigenous to California. Its geographical distribution eastward is probably quite extensive.

Outwardly this species resembles *M. Troyeri*, but differs in the size of somite I and in having ventral papillæ and a rudimentary gizzard. It differs from *M. Hempeli* in having the sperm-ducts open into the prostate; while the deltoid arrangement of the ventral setæ is different from that of *M. novæ-zœlandiæ*.

Detailed Description.

Somites.—The somites in front of the clitellum are of about the same size, excepting somite I, which is smaller, its ventral part being only one-half as wide as the dorsal part. Somite X is slightly smaller than somites IX and XI.

Papillæ.—A pair of papillæ surrounds setæ *a* in somite XI, and a single median papilla which, however, is sometimes missing, is found in XII.

Setæ.—The deltoid arrangement of the setæ is found both anterior and posterior to the male pores. This arrangement of the setæ in *M. parvus* resembles that in *M. Troyeri*, except that the anterior ventral setæ are closer together in the latter species, although not so close as in *M. Benhami*. If we assume that in somite IX the interval between the setæ *a* is equivalent to 11, we get the following ratios:—

Somite IX:	a–a=11, a–b=8, b–c=15, c–d=14.
Somite XIV:	a–a=14, a–b=7; setæ *c*, *d* missing.
Somite XVIII:	a–a=17, a–b=4, b–c=35; setæ *d* missing.
Somite XXV:	a–a=20, a–b=15, b–c=30, c–d=18.
Somite XXXIV:	a–a=20, a–b=17, b–c=30, c–d=18.

The deltoid arrangement begins posteriorly with somite XIII, or thereabout, and ends with somite XVIII. In somite XVIII the distance between setæ *a* and *b* is only half that between the corresponding setæ in somite IX. Setæ *c* and *d* are as a rule absent in the clitellum. The common setæ are faintly ornamented with six or eight rows of short transverse wavey lines running obliquely across the seta from apex to center.

Penial Setæ.—The penial setæ are slightly sigmoid at the very apex. The one I dissected was smooth except for two or three deep creases in the concave part just below the apex, but I am not certain whether these creases were natural or accidental.

Septa.—The septa are all narrow and those thickened are only slightly so.

Intestine.—The *pharynx* is developed only dorsally; it forms a deep fold or sinus.

The *gizzard* in V is very rudimentary, the thickened muscular layer being not more than twice as thick as the same muscular layer in the following somites. It does not cause the least swelling of the intestine in somite V, and is hardly noticeable. The tubular part of the intestine is very straight and only slightly nipped by the septa. This part of the intestine is ciliated in somite XVI and in the posterior part of XV. In XVI it connects with the sacculated intestine which begins in XVI. The intestine is covered with small chloragogen cells in XV to XXIV.

Sexual Organs.—These offer few characteristics. There are two pairs of testes, two pairs of sperm-sacs, and one pair of short ovisacs in XIV, projecting from the anterior septum backwards.

The *sperm-ducts* run singly until they join the prostate at a point just before it enters the body-wall; therefore the ducts actually enter the prostate. The prostate consists of a glandular and a muscular part, the former being from three to four times as wide as the latter, which equals it in length, or may be even longer. In one specimen the muscular part is half as long again as the glandular; in another they are of about the same length. The glandular part consists of two layers of cells, but the inner layer is made up of very narrow cells. The glandular part is slightly folded and is confined to somites XVIII and XIX, or to XVIII alone. The spermathecæ consist of one pair of sac-like bodies of oblong shape and irregular outline. The two diverticles are of unequal size. They are about one-third the length of the spermatheca. The nephridia commence in somite II. The four most anterior pores are in line with setæ *d*, those following are in a line with setæ *c*, slightly ventral to them. The nephropores in the clitellar somites are much larger and more transparent than the others; they are surrounded by a ring of very large cells.

Microscolex parvus, var. **carolinianus,** var. nov.

Definition.—Length 45 mm., width 2 mm. Clitellum ½ XIII–½ XVII. Papillæ: two on the ventral surface of XI and one median and ventral in XII; also a single ventral, median one on the boundary between XVII and XVIII, posterior to the male pores. Setæ deltoid in their position towards the male pore, the same as in the species. Dorsal pore between III and IV but the first plain one between VII and VIII. A very large dorsal pore between XIII and XIV. Spermathecæ larger than in the species and the diverticles almost as long as the main sac. The muscular part of the prostate is somewhat smaller than the glandular part. The gizzard is less rudimentary, the muscular layer being about three to four times larger than the corresponding layer in somite VI. The septal glands in somites V to IX are less developed than in the species.

Habitat.—Raleigh, North Carolina. Two specimens collected by Messrs. Brimley.

As is seen, the variety differs from the species only in the greater development of various interior organs. The principal difference is in the spermathecæ with their large diverticles, those of the species being particularly small. Intermediate forms with the species will no doubt be found.

Microscolex Troyeri *(Eisen).*

Deltania Troyeri EISEN, Mem. Cal. Acad. Sci., Vol. II, No. 3, 1894.

This species is widely distributed. Specimens are represented from the following localities: Coulterville, Calif., twelve miles east of the town in the region of the yellow pine in the Sierra Nevada mountains; Redding, Calif., collected by Mr. Richard C. McGregor; San Francisco, Calif., collected from flower pots by Mr. Charles Fuchs; Orizaba, Mexico, collected by Mr. Albert Koebele.

The species resembles *M. parvus* in the arrangement of the setæ, but differs externally, somite I being broader. In *M. parvus* somite I is much narrower on the ventral side than on the dorsal, and the whole somite is much narrower than somite II. In *M. Troyeri* somite I is wider than somite II, and is not narrower on the ventral side. *M. Troyeri* possesses no ventral papillæ on any of the somites.

Microscolex Horsti, sp. nov.

Plate XIV, Fig. 185.

Definition.—Length 20 mm., width 1½ mm. Somites 45. Setæ, beginning with XXI, deltoid in arrangement both posterior and anterior to the male pore. Small ventral paired tubercles in XI; two large ventral tubercles in XIV adjoining and dorsal to the ovipores, which are in line with setæ *a*. The male pores are so close together that they appear to be situated on the same papilla, between setæ *a*, in XVII. Somite I is narrower than II, and its dorsal side is half as wide as the ventral. Somites I–VI are a third narrower than those following. Clitellum perfect in XIII–XVII. Penial setæ unequal, the longer curved, the shorter straight; both with the apex knob-like and smooth. Testes in X and XI. Sperm-sacs small, racemose, in XI and XII. Sperm-ducts open into the muscular prostate. Prostate thick and bent, confined to one somite. Spermathecæ, one pair in IX, each with one diverticle. A small rudimentary gizzard in V.

Habitat.—One specimen found among roots of plants in a flower pot brought from Honolulu, Hawaii. Taken in April, 1898, by Mr. Alexander Craw, State Horticultural Quarantine Officer of California.

This species is well characterized. The close proximity of the male pores, the single diverticle of the spermathecæ, the rudimentary gizzard, and the knob-like apex of the penial setæ serve to place it in the group formed by *Microscolex algeriensis* and *Microscolex modestus*.

Unfortunately the specimen is badly twisted and all the points could not be determined, but enough was shown to entirely separate it from the two nearest allied species.

The most anterior *nephridia* are probably in II, beyond doubt in III. The *intestine* which is unusually narrow, is nipped by the septa, and the *gizzard* is very rudimentary; its muscular layer is of about the same thickness as the muscular layer of the body-wall—not thick enough to cause the intestine to bulge out. The sacculated intestine commences in somite XVI. The *pharynx* also is developed ventrally and furnished with subpharyngeal glands. Strong *septal glands* extend back to somite VIII, there being none in somite IX. The *spermathecæ* are strong, each with a single, rather large diverticle pointed backwards. The diverticle joins the muscular part of the spermatheca close to the body-wall. The *sperm-ducts* join the muscular part of the *prostate* in the body-wall. Septa VIII to XIV are somewhat thickened. The *septa* on all the anterior somites are attached to the body-wall half way between the intersegmental grooves, in line with the setæ. The interval between setæ *a* and *b* is slightly less than that between *c* and *d*. In a general way the arrangement of the setæ resembles that of *M. Troyeri*.

PLUTELLINÆ.

Nomenclature.

In his Monograph on Oligochæta Beddard refers all the species of *Plutellus* and *Argilophilus* to the genus *Megascolides*. The genus *Plutellus* was created for a worm with alternating nephropores, meganephridia, five pairs of spermathecæ and with calciferous diverticles in X, XI, XII. The genus *Megascolides* was established by McCoy for a worm with plectonephridia, two pairs of spermathecæ, one diverticle of the intestine, etc. My genus *Argilophilus* was made for species with meganephridia, two pairs of spermathecæ, no calciferous diverticles, alternating nephropores. If the various species are to be bunched under one genus, then there can be no doubt but that the genus *Plutellus* must be retained. But I think that we are not yet ready to join plectonephric species with meganephric ones in one genus.

There are other reasons why I do not think that *Plutellus* and *Argilophilus* are generically connected. Benham's species *Plutellus Perrieri* possesses only one pair of testes and one pair of sperm-funnels, and the funnels are enclosed with the testes in a special sac. Scrutinizing Perrier's description of his *Plutellus heteroporus*, it seems to me probable that his species agrees with Benham's in some very important points. May not Perrier have mistaken the sperm-funnel for oviduct and the testes in X for ovaries? If such is the case, his species would resemble Benham's in having one pair of testes and one pair of funnels, which character I think will be sufficient to relegate the two species to separate genera. In the only other American species, *Megascolides americanus* Smith, related to these species of Benham and Perrier we find plectonephridia and two pairs of spermathecæ. This species is thus undoubtedly more related to the Australian species than to the American ones, and I think Professor Smith is right in referring it to *Megascolides*. It possesses plectonephridia and two pairs of testes and sperm-funnels. As for *Argilophilus*, I propose the genus for species with two pairs of testes and funnels and with meganephridia.

American Species of *Plutellinæ*.

A. Meganephridia, one pair of testes and one pair of sperm-funnels, more than two pairs (four or five) of spermathecæ.

Plutellus *Perrier.*

1. Three pairs calciferous glands.

Plutellus heteroporus Perrier.

2. No calciferous glands.

Plutellus Perrieri Benham.

B. Meganephridia, two pairs of testes and two pairs of sperm-funnels, no calciferous diverticles.

Argilophilus *Eisen.*

Argilophilus marmoratus Eisen.
Argilophilus hyalinus, sp. nov.

C. Plectonephridia, two pairs of testes and two pairs of funnels, no distinct calciferous diverticles.

Megascolides *McCoy.*

Megascolides americanus Smith.

A revision of the species belonging to the above genera is highly desirable, but until it is done nothing is gained by lumping together the species under one genus.

Argilophilus *Eisen.*

Argilophilus hyalinus, sp. nov.

Definition.—Length of contracted specimen 90 mm., width 4 mm. Setæ paired. Penial setæ present. Clitellum saddle-shaped, in XIII–XIX. Gizzard in V, very large. Spermathecæ three pairs, without diverticles, in VII, VIII, IX. Spermathecal pores are postseptal, in front of setæ *b*. Testes in X, XI. Sperm-funnels in X, XI. Ovaries in XIII. Oviducts in XIV, opening in front of setæ *a*. Sperm-ducts join in XVIII. One pair of tubular, coiled prostates in XVIII. The intestine without diverticles. Nephridia are meganephric. Color hyaline, without any pigment.

Septal formula:—

$$\overline{\text{V/VI}},\ \overline{\overline{\overline{\overline{\text{VI/VII}}}}},\ \overline{\overline{\overline{\overline{\text{VII/VIII}}}}},\ \overline{\overline{\overline{\overline{\text{VIII/IX}}}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\text{X/XI}},\ \overline{\text{XI/XII}}.$$

Habitat.—Coban, Guatemala, Central America. A single specimen.

To the above short definition I can add only a very few details on account of the maceration of the single specimen. The definition is, however, sufficient, as the three pairs of spermathecæ without diverticles serve to fully characterize the species. The form of the *spermatheca* is that of an unopened toadstool. In size the spermathecæ are small, not reaching much above half the diameter of the worm. The *prostate* is flattened and coiled in one plane, spreading over two or three somites. The muscular part is thickest near the base. The *sperm-ducts* probably enter the prostate at the junction of the glandular and muscular parts. The *setæ* are almost smooth except for a few small notches on the inner side near the apex. The penial setæ are of medium size, slightly curved, with some shallow corrugations along the free end.

Argilophilus marmoratus collinus, subsp. nov.

PLATE XII, FIGS. 118–121.

Definition.—Male pores situated on lunate papillæ, which are somewhat sunk and entirely enclosed by a continuous oval ridge. The two ridges are connected by a median elevated band running in the direction of the long diameter of the body. Puberty-papillæ varying in number, single, median, never paired. The ventral interval between setæ *a–a* slightly diminishing from about somite XXIV to somite XVII. Penial setæ with a few large spines near apex. No dorsal pores. Prostomium divides somite I from one-half to nine-tenths, and is furnished with two cross grooves.

Habitat.—California: Calistoga, Napa County; Mill Valley, Marin County; also at Duncan Mills, Sonoma County; on rather dry hill sides among manzanita bushes and other native vegetation. My attention was first called to this interesting form by Dr. H. W. Harkness, to whom my thanks are due for many fine specimens.

AFFINITIES AND CHARACTERISTICS.

Although this worm differs considerably from the other Californian forms of the genus I do not consider it to be an independent, well defined species—no more so than *A. ornatus* and *A. papillifer*. These three forms are only externally distinct, and so far as I can see agree in internal structure. They appear to me as the beginning of species branching from a common stock. With these exterior differences are connected differences in habitat. *A. papillifer* is only found in comparatively very moist places, generally in heavy adobe soil, such as near streams, along ditches, under logs, in flooded places. *A. ornatus* is found in less moist places, in ordinary adobe soil, while *A. collinus* is found only on dry hill sides, which are never exposed to excessive moisture. I have nowhere found these forms intermingling with each other in the same locality, and it appears as if their external structure was due, in part at least, to their different habitats.

A. papillifer resembles *A. collinus* in possessing only unpaired median puberty papillæ, while *A. ornatus* possesses pairs of such papillæ in the intersegmental grooves. In *A. ornatus* and *A. papillifer* the structure of the genital zone is the same, the male papillæ being connected by a thin transverse band, running in the short diameter of the body.

In *A. collinus* this band is broad and runs in the long diameter of the body. In *A. ornatus* and *A. papillifer* the ventral interval between setæ *a–a* does not narrow towards the male pore, while in *A. collinus* this distance becomes less towards the male pore. There is also a slight divergence between the setæ *a–a* anterior of the male pore (fig. 119).

Another slight difference is seen in the prostomium. In *A. collinus* the prostomium divides somite I very deeply, sometimes almost entirely, while in *A. papillifer* and *A. ornatus* the posterior prolongation of the prostomium never exceeds the middle of somite I.

As the triple nomenclature has been objected to by some, it may be advisable to retain the name *A. marmoratus* for the form without papillæ, making those with papillæ varieties under this species.

DIPLOCARDINÆ.

General Remarks on Affinity.

Michaelsen's (30) suggestion that the genus *Diplocardia* be referred to a family of its own is, I think, a good one. But I do not agree with him in regard to the distinguishing feature of the family. The genus *Trigaster* and my new genus *Zapotecia* are the disturbing factors in a perfectly satisfactory arrangement of the genera and species of this family and those of *Benhaminæ*. The question arises, which character should be given more weight, the nephridia or the calciferous diverticles? Whichever is adopted, we meet with difficulties. On the whole, I think that in this instance the calciferous diverticles are of more systematic importance than the nephridia. Accordingly, I place in this family the genera *Trigaster* and *Zapotecia*. The latter genus is created for a species with meganephridia and without calciferous diverticles. To join this species with *Diplocardia* is, according to present ideas, impossible, and I think it is best to keep species with three gizzards out of that genus. The completely hidden nature of the sperm-ducts is also an interesting feature of the genus, which character it shares with *Trigaster*. To join *Zapotecia* with *Benhamia* is even less natural. With the genus *Trigaster* there is a greater affinity and at first I had arranged the species under that genus; but it now seems to me more proper to keep meganephric and plectonephric species apart, except in cases where we know with certainty that great variation exists in their structure, as for instance, in *Dichogaster*.

In a preliminary paper (Eisen 22) have been noted in a general way the characteristics of various species of *Diplocardia* which have been examined critically. Through the kindness of Professor Frank Smith of the State Biological Laboratory of Champaign, Illinois, I have been enabled to study the specimens of all the *Diplocardia* species in his possession, and have made observations on some points which previously had been either overlooked or misunderstood.

Professor Smith has also had the kindness to call my attention to a couple of errors in the above mentioned paper. The species of *Diplocardia* so far known are remarkably well characterized for identification, differing strikingly in the external genital zones as well as in their inner organization. The median ventral zone around the prostates is well marked, but I think too much significance should not be placed on the presence or absence of papillæ, there being considerable variation in different specimens. Of more importance is the form and size of the zone, the curvature and shape of the sexual grooves between the prostates, the size and ornamentation of the penial and spermathecal setæ, the location of the spermathecal pores, etc.

By courtesy of Professor Albert Koebele I add the description of a new species, characterized by the position of the male pores in somite XVIII. This raises the number of known species of *Diplocardia* to nine, which is probably but a small fraction of what will be found in the future.

MORPHOLOGICAL FEATURES.

There are several structural details in the finer anatomy of *Diplocardia* which are of more than common interest, for example, the glandular crop in somites XIV and XV, which is found in at least one of the species, *Diplocardia Michaelseni*, and which may exist in others. In another species, *Diplocardia Eiseni*, Michaelsen found lime-secreting tissues in the same somites. This structure is said by him to resemble that of the calciferous diverticles without partaking of the diverticular nature.

Another interesting morphological feature of this genus is the structure of the prostate. I have investigated the prostates of *D. singularis caroliniana*, *D. Udei* and *D. Michaelseni*. In all these species the prostates are exteriorly more or less tubular, but the surface is rough, warty, wavey and uneven. Longitudinal sections show the lumen of the glandular part in *D. caroliniana* to be rather wide and straight, continuing regular from one end to the other. It is lined by large columnar epithelial cells as is usual in all higher terrestrial Oligochæta except the Ocnerodrilini.

In the glandular prostate of *D. Michaelseni* the lumen is very narrow, being no wider than the lumen of the muscular part; and instead of being unbroken it sends out along its entire course numerous large or small side branches into which open the glandular prostate cells, though some also open in the main canal. The main lumen, as well as the branches, is lined by what appears to be a membrane consisting of thin, narrow strands of connective tissue, in which no nuclei are seen. In other words, the inner epethelial layer of cells, which is supposed to be characteristic of the higher Terricolæ, is wanting.

In *D. Udei* the main lumen of the glandular prostate is so irregular and branching that none of the sections show more than a very short piece of it. Everywhere in the mass were seen numerous minute lumens, so small that they could barely be studied with the highest lens systems. The lumen system in this species is racemose, very similar to the stem of a bunch of grapes. The main lumen and the branches are lined by narrow strands, the same as in *D. Michaelseni.* In addition to these, the main lumen has here and there minute epithelial cells; these, however, are absent in the branches. Thus, *D. Udei* takes an intermediate position between the two other species mentioned above. The variations in the position of the spermiducal pores, ranging from XVIII to XXI, are also of the greatest interest. It seems probable that when more species are known, the genus *Diplocardia* will prove to be of great morphological interest.

Diplocardia *Garman.*

Definition.—Setæ, eight, in four couples, lateral and ventral. Penial setæ, present or absent. Spermathecal setæ, present or absent. Prostomium divides somite I more or less. Clitellum saddle- or ring-like, generally XIII-XVIII. Oviducal pores XIV. Spermathecal pores, two or three pairs, either postseptal or preseptal. Spermiducal pores on XVIII, XIX, XX, or XXI, according to species. Prostate pores on somites next anterior and posterior to the spermiducal pores. The pores on each side connected by a groove. A genital zone generally present, with or without papillæ. Intestine with two gizzards, generally in V, VI. Œsophagus either with or without folds containing calcic concretions. Tubular intestine never with calciferous diverticles, as in *Benhamia.* A glandular crop sometimes in XIV and XV. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Two pairs testes in X and XI. Two pairs sperm-funnels in X and XI. Prostates, two pairs opening anteriorly and posteriorly to the sperm-ducts. Spermathecæ, two or three pairs, each one with a diverticle near the center. Dorsal vessel double or single. Nephridia and meganephridia generally without cœlomic mantle.

Habitat.—As far as known, the genus is confined to the United States and to northern Mexico.

The following subdivision of *Diplocardia* is based on the location of the spermiducal pores:—

KEY TO THE SUBGENERA AND SPECIES OF *Diplocardia*.

I. Spermiducal pores in somite XXI. No penial setæ.

Aleodrilus EISEN.

1. *Keyesi* (EISEN).

II. Spermiducal pores in somite XX.

Omahania, subgen. nov.

2. *verrucosa* UDE.

III. Spermiducal pores in XIX.

Diplocardia GARMAN (sens. str.).

a. Spermathecæ two pairs.

3. Both pairs of spermathecal pores are posterior to setæ or preseptal; sexual spermathecal setæ in VIII and IX. *Eiseni* (MICHAELSEN).

4. The pair of spermathecal pores in VIII is postseptal; the pair in IX is preseptal; sexual spermathecal setæ in VIII and IX. *Michaelseni* EISEN.

5. Both pairs of spermathecal pores are postseptal; sexual spermathecal setæ in VIII, IX and X.................... *Udei* EISEN.

6. Both pairs of spermathecal pores are postseptal; no sexual spermathecal setæ.................................. *riparia* SMITH.

b. Spermathecæ three pairs.

7. Penial setæ straight, about one-half longer than ordinary setæ. Sperm-ducts are hidden in the body-wall. *communis* GARMAN.

8. Penial setæ sigmoid, several times longer than ordinary setæ.
   a. Penial setæ not ornamented. Color dark brown. *singularis* (UDE).
   b. Penial setæ ornamented. Color pink. *singularis caroliniana*, subsp. nov.

IV. Spermiducal pores in XVIII.

Naillenia, subgen. nov.

9. Spermathecæ two pairs. Their pores postseptal, in VIII and IX. Sexual spermathecal setæ in IX. *Koebeli*, sp. nov.

DIAGRAM SHOWING LOCATION OF GIZZARDS, SPERMATHECÆ, SPERM-SACS, SPERM-DUCTS, PROSTATES AND THE NATURE OF THE NEPHRIDIA.

Diplocardia (Aleodrilus) Keyesi *(Eisen).*

PLATE XIII, FIG. 136.

Aleodrilus Keyesi EISEN, Mem. Cal. Acad. Sci., Vol. II, No. 5, 1896.
Diplocardia Keyesi EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, flesh, marbled violet, no pigment. Size, 70 mm. by 5 mm. Somites, 150. Prostomium divides somite I about one-half. Dorsal pores, the most anterior one in I, VIII/IX. Spermiducal pores in XXI. Spermathecal pores, two pairs, in VIII and IX, in front of setæ *ab*. Prostate pores in XX and XXII. Oviducal pores in front of setæ *a*. Setæ all ventral; *a–b* slightly larger than *c–d*; *a–a* larger than *b–c*. No sculpture. Penial setæ none. Spermathecal setæ not differentiated. Clitellum ring-like anteriorly, posteriorly saddle-shaped. Genital zone not distinct; two parallel grooves in ½ XX–½ XXII; groove almost straight, with a knob at each apex; concavity turned ventrally. Œsophagus without calcic concretions. Gizzards in V and VI. Sacculated intestine in XV. Dorsal vessel single, not covered with chloragogen cells. Hearts in X, XI, XII, with large pulsating divisions; no chloragogen cells. Nephridia, meganephridia, no cœlomic mantle. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts, which join at XII/XIII in a common muscular sheath; fuse in XX/XXI. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Sperm-masses in X and XI. Oviducts in XIV. Prostates confined to one somite each, small, tubular, thicker at apex. Spermathecæ, two pairs in VIII and IX; distal end knob-like; the duct is very slender and long, with a minute wart-like and ear-shaped diverticle situated about the middle.

Septal formula:—

$$\overline{\text{VI/VII}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\text{VIII/IX}}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\text{X/XI}}.$$

Habitat.—Ensenada de Todos Santos, Baja California, Mexico.

DETAILED DESCRIPTION.

Spermathecæ.—(fig. 136). The form of the spermathecæ is the same as was figured in a previous paper (Eisen 18). The duct is very long and slender, though confined to one somite. It carries a small wart-like and ear-shaped diverticle, situated about half-way from the globular knob to the base. In this respect the species agrees with the other known species of the genus. The diverticle is no wider than the duct and resembles an agglomeration of three or four minute warty protuberances. In the former paper these protuberances were noted but were then considered accidental. I am now satisfied that they constitute a true though minute spermathecal diverticle, being constant both in position and size, as I afterwards ascertained by examination of another specimen.

Sperm-sacs.—There are two pairs of sperm-sacs. One pair is preseptal and slightly racemose in IX, protruding into the somite from septum IX/X. It is situated laterally and rather ventrally. A pair of strongly racemose sperm-sacs is also found in XII, but these are postseptal, protruding backward into XII from septum XI/XII. These latter sperm-sacs are much larger and much more racemose than those in IX. Hence it will be seen that *D. Keyesi* even in this respect agrees with the other species of the genus.

Subgenus **Omahania**, subgen. nov.

Diplocardia (Omahania) verrucosa (*Ude*).

Diplocardia verrucosa UDE, Zeitschr. wiss. Zool. Bd. LXI, 1895, p. 133; EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, pink. Size, 65 to 75 mm. by 2.5 to 3 mm. Somites, 100 to 125, body round, of even thickness. Prostomium divides somite I by one-half. Dorsal pores, most anterior one VIII/IX (or X/XI). Spermiducal pores on XX. Spermathecal pores on anterior third of somites IX and X, somewhat dorsal to setæ *d*. Prostate pores on XIX and XXI. Oviducal pores interior to setæ *a*; no glandular ridge. Setæ sigmoid, very faintly ornamented. Distance *d–d* more than half the periphery; *c–d* somewhat greater than *a–b*; *a–a* three times, and *b–b* two and a half times greater than *a–b*, no setæ *ab* in XX. Penial setæ curved, not ornamented. Spermathecal setæ not differentiated. Clitellum saddle-shaped, XIII–XVIII. Genital zone a rectangular field from posterior ⅓ XVIII–½ XXII, extending laterally to center between *b–c*. Two deep grooves from ½ XIX–½ XXI, the convexity of which is outwards, except in the center of XX, where it is turned towards the median line; one median papillæ on XXII; one pair papillæ on XIX in line with setæ *b*; one pair papillæ on XIX and XXI, interior to grooves; one pair papillæ exterior to grooves on each of XIX, XXI, XXII (two pairs papillæ on each of XIX, XXI, and three papillæ on XXII). Œsophagus, no calciferous folds or thickenings. Gizzards in V and VI. Sacculated intestine commences in XVI. Dorsal vessel single. Hearts, three pairs in X, XI, XII. Nephridia, meganephridia, commence in II, pores intersegmental in front of setæ *d*. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts open in central part of groove in XX. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Oviducts open in front of and interior to setæ *a*. Prostates very thin, even, bent in four folds, confined to one somite each.

Spermathecæ, two pairs in VIII and IX, retort-like, with a small, short-stalked, ear-like diverticle below the center. No specialized spermathecal setæ.

Septal formula:—

$$\overline{\overline{\mathrm{VI/VII}}},\ \overline{\overline{\mathrm{VII/VIII}}},\ \overline{\overline{\mathrm{VIII/IX}}},\ \overline{\mathrm{IX/X}},\ \overline{\mathrm{X/XI}},\ \overline{\mathrm{XI/XII}}.$$

Habitat.—Omaha, Nebraska.

The above definition is taken from Ude's description. There is in my mind some doubt about the position of the spermathecal pores in *Diplocardia verrucosa.* Ude says that the pores are situated on the anterior third of IX and X, and between the setæ *d.* In specimens sent me by Dr. Frank Smith labeled *D. verrucosa*, the spermathecal pores are situated in IX and X, as described by Ude, but the pores are a little dorsal to setæ *a.* However, we must for the present accept Ude's statement, twice repeated (pp. 133 and 135), and will therefore assume that the specimen sent by Dr. Smith belongs to a different species, also belonging to the subgenus *Omahania.* What throws a doubt on the position of the spermathecal pores is the fact that Ude (5, p. 135) states that the ovipores also open between setæ *d.* His fig. 14, however, shows that these pores open normally, that is, ventral to setæ *a.* The references to setæ *d* may be a misprint in both instances. *D. verrucosa*, as well as the species sent me by Dr. Smith, differs also from all of the *Diplocardias* in the position of the spermathecal pores in IX and X. In no other species is a spermathecal pore found in X. This may possibly be a characteristic of the subgenus *Omahania.*

Subgenus **Diplocardia** *Garman.*

Diplocardia Eiseni *(Michaelsen).*

Geodrilus Eiseni MICHAELSEN, Zool. Jahr., Abth. Syst. Bd. VIII, 1894, p. 177.
Diplocardia Eiseni (MICHAELSEN) EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, dorsally dark brown, pigmented, clitellum violet gray. Size, 150 mm. by 2 mm. Somites 165; VIII–XIII smoother and wider than the others. Prostomium divides somite I about one-half, with the lateral margins strongly converging. Dorsal pores, most anterior one on XI, first distinct one on XIII. Spermiducal pores on XIX in line with setæ *a*. Spermathecal pores on VIII and IX, posterior to setæ *a*, in line with *a–b*. Prostate pores on XVIII and XX, in line with setæ *b*. Oviducal pores near median line, surrounded by a zone. Setæ, sigmoid, with numerous fine bars; *a–a* about one-twelfth, *d–d*, five-ninths the whole periphery; *b–c* is shorter than *a–a*; *ab* shorter than *c–d; a–b*, half as long as *b–c; ab*, slightly shorter than *c–d*. Setæ *b* in XIX is present, *a* is absent or present. Penial setæ rudimentary or very small, in the body-wall of XVIII and XX. Spermathecal setæ differentiated and ornamented in VIII and IX. Clitellum ring-shaped in XIII–XVII, saddle-shaped in XVIII. Genital zone, a quadrangular, glandular, ventral zone in XVIII–XX, in the corners of which lie the prostate pores. The two grooves are curved ventrally. No depressed area and no papillæ. Gizzards in V and VI. Sacculated intestine commences in XVIII; a dorsal typhlosole. Dorsal vessel alternatingly double and single in VI–XV. Hearts, four pairs in X–XIII. Nephridia, meganephridia, commence in II. Testes in X and XI. Sperm-funnels in X and XIX. Sperm-ducts join, but do not fuse until at the male pore in XIX. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Oviducts large. Spermathecæ, two pairs in VIII and IX. A large sac-like part and a thinner, irregularly bent, muscular duct; a small, stalk-like diverticle with a knob-like apex.

Septal formula:—

VI/VII, VII/VIII, VIII–IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV, XIV/XV, XV/XVI.

Habitat.—Orange County, Florida. Specimens received from Professor Frank Smith.

Detailed Description.

Body.—The somites of this species are much more distinctly set than those of any of the other species. The grooves are deep, the equatorials of the somites standing out boldly. None of the specimens possess a depressed genital zone. The copulatory grooves connecting the prostates and male pore are, on the contrary, situated on two elevated ridges, the whole zone being raised above the sexual surface of the body and more prominent than the clitellum.

The prostomium divides somite I about one-half. Somites II to IX increase gradually in width posteriorly. Somites VIII and IX are of about equal width. Somites X, XI, XII are about of the same width as somites VIII and IX. The papillæ on which are situated the spermathecal setæ are not very prominent.

The color of alcoholic specimens is grayish with a tint of brown on the dorsal anterior parts, undoubtedly due to pigment. According to Professor Smith the color is dark brown in life.

The tail of the worm is very characteristic. The last few somites are not only much narrower, but are also much shorter than any of the others. In three of the specimens the last seven or eight somites are half as long and a fifth as wide as the somites next anterior. They are of a pale whitish color prominently marked off from the deep gray of the other somites. In the fourth specimen only the last two somites are smaller and whiter. By width of the somite is meant the extension from head to tail; the length is the diameter across the body. These last somites appear as if they had been regenerated, but as all the specimens agree, I am inclined to consider this diminution in size a constant character.

Diplocardia riparia *Smith.*

PLATE XIII, FIGS. 143, 144.

Diplocardia riparia SMITH, Bull. Ill. State Lab. Nat. Hist., Vol. IV, 1895, p. 285.

Definition.—Color brown anteriorly and dorsally, clitellum dull coppery colored. Size 220–250 mm. Somites, 136–157. Prostomium divides somite I by one-half. Dorsal pores, most anterior one on anterior margin of XI, near X/XI. Spermiducal pores in XIX. Spermathecal pores, two pairs in VIII and IX, anterior to setæ *ab*. Prostate pores in XVIII and XX. Oviducal pores in XIV. Setæ as in *D. communis*, no ventral setæ *ab* in XIX. Distance *a–a*=*b–c*; *a–b* very little larger than *c–d*. Penial setæ in XVIII and XX. Spermathecal setæ not differentiated. Clitellum saddle-shaped, in XIII–XVIII. Genital zone, no rectangular ventral zone; a ventral depression in XVII–XXI, deepest in XVIII and XX. A pair of crescent-shaped grooves curved ventrally from center of XVIII–XX. Two papillæ very close to median line, between XXI/XX. One median papilla XVI/XVII, one pair papillæ XVII/XVIII, one pair papillæ XX/XXI, one pair papillæ XVII/XVIII. Gizzards in V, VI. Sacculated intestine commences in XVIII. Dorsal vessel single. Nephridia, meganephridia, a small pair in II. Testes in X and XI. Sperm-funnels in X and XI. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Prostates in XVIII and XX. Spermathecæ, two pairs in VIII and IX, with a large ear-like diverticle pointing forward, which is very prominent and exteriorly slightly racemose. Anterior and posterior spermathecæ are of the same size. Septa (according to a section placed at my disposal by Professor Frank Smith):—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Habitat.—Havana, Illinois. Professor Frank Smith kindly furnished me several specimens.

Detailed Description.

Genital Zone.—The genital zone is slightly sunken, very much as in Smith's specimens of *D. communis*, but to a lesser extent. The centre of the zone in XIX is higher, while the depression exists in XVIII and XX. But even the depressions are slightly elevated in the centre, so that there appear to be four separate depressions, one in each corner of the zone. The ridge surrounding the zone is very low. There is one pair of papillæ in the posterior part of XVII and one smaller pair in XX. One specimen possesses a large median papilla in XVI/XVII. In this papilla are seen two distinct depressions, giving it the appearance of being double. The papilla is strictly median and not in line with the papillæ of the zone, which latter are all in line with setæ *ab*.

Spermathecæ.—As these organs have not been figured, and as their shape is of considerable importance, I have thought best to give two figures (143, 144) of the two spermathecæ from the same side of a specimen.

Sperm-ducts.—According to longitudinal sections lent me by Professor Frank Smith, the sperm-ducts generally run between the cœlomic epithelium and the longitudinal muscular layer. Here and there, however, they are covered by a single strand of muscles. The same characteristic is also found in *D. communis*. According to a private communication to me by Professor Smith, the statement by Garman, that the ducts in *D. communis* run entirely in the muscular layer, is considerably misleading. Even in this species the ducts are merely covered by the cœlomic epithelium and not by muscular strands as in *Trigaster*.

Diplocardia Michaelseni *Eisen.*

Diplocardia Michaelseni EISEN, Zool. Bull., Vol. II, No. 4, 1899.

Definition.—Color, flesh. Size, 45 mm. by 2 mm., hardly tapering posteriorly. Somites, 63. Prostomium divides somite I completely. Dorsal pores, most anterior IV/V. Spermiducal pores XIX. Spermathecal pores, one pair preseptal in IX, one pair postseptal and almost central or median in VIII. Prostate pores XVIII, XX. Oviducal pores XIV, in front of and anterior to setæ *a*, close together. Setæ all ventral; *a–a*=3 *a–b*; *a–a* about one-third larger than *b–c*; *b–c*=about 2 *a–b*. Penial setæ present at spermiducal pore. Spermathecal setæ present in VIII, IX; setæ *a* and *b* being differentiated and sculptured. Clitellum ring-like, dorsally XIII–½ XVIII; ventrally XIV–XVII. Genital zone, a deep central, oval pit in XVIII–XX, surrounded by an elevated ridge. A pear-shaped ventral and median papilla in XXI and ½ XXII, and a similar papilla in ½ XXII and XXIII. Grooves between prostate pores are straight. A pair of deep, round pits in posterior part of XVII. No paired papillæ. Œsophagus straight or bent, not widening in any somite. Gizzards VI, VII. A large, thick glandular crop in XIV, XV. Sacculated intestine commences in XVIII. Dorsal vessel single (?), swollen in XVI, XVII. Hearts X, XI. Nephridia, meganephridia. Testes very large in X, XI. Ovaries are digitate. Sperm-funnels in X, XI. Sperm-sacs, three pairs, in IX, X, XII. Those in IX are preseptal, those in X and XII are postseptal, in IX only sperm-masses. Oviducts in XIV. Prostates occupy somites XVII–XXI, glandular part contains only one layer of cells, muscular duct folded, glandular part thick. Spermathecal duct muscular, long, folded, pouch large in two divisions; a large, oval, exterior diverticle, pointed forwards. The spermathecæ in VIII open anterior to setæ, those in IX open posterior to setæ.

Septal formula:—

$$\overline{\overline{\text{VI/VII}}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\text{VIII/IX}}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\overline{\text{X/XI}}},\ \overline{\text{XI/XII}}.$$

Habitat.—I possess a dozen specimens of this very interesting species, from Raleigh, North Carolina. Collected by Messrs. Brimley.

Occurs in swamps and in water under logs together with *D. Udei* and *D. singularis caroliniana.*

In this species, as in *D. Udei*, there are bundles of glands opening jointly in a pair of circular orifices in VIII and IX, between the sexual spermathecal setæ. These glands are interposed between the layers of the body-wall and the epithelial cells, and run parallel with the longitudinal axis of the body. Their structure is described more in detail in a memoir soon to be published by the California Academy of Sciences, San Francisco.

Affinity.—*Diplocardia Michaelseni* resembles *D. Udei* and *D. Eiseni* in possessing spermathecal sexual setæ accompanied by interior glandular structures in the body-wall. It differs from all other species so far described in the position of the spermathecal pores, which in somite IX are preseptal, while in somite VIII they are postseptal. As far as we know it also differs in the possession of a glandular crop in two of the clitellar somites similar to the one described in *Pontodrilus Michaelseni* (Eisen, 17).

External Characters.

Body.—The body is cylindrical, and does not taper either to head or end. The somites are not well marked off. The width is about the same at any point of the body, except at the clitellum, which widens a very little.

Somites.—The three anterior somites are much narrower than the others, and of about equal width, being about three-fourths as wide as IV, and one-half as wide as V. Somites V, VI, VII are of about the same width. The clitellar somites XIII to XVII are of about the same width or slightly wider and longer than the others.

The *prostomium* divides somite I entirely, reaching the intersegmental groove I/II.

Dorsal Pores.—Most anterior dorsal pore is between IV/V. Between II/III and III/IV there are slight depressions.

Spermathecal Genital Zone.—There is one pair of closely approximated papillæ in VIII and IX occupying about three-fourths of the ventral side of these somites. The papillæ are rosette-like, each with a central depression from which apparently protrude the sexual spermathecal setæ. In the posterior margin of IX, in line with setæ *ab*, are two preseptal spermathecal pores. In VIII no such pores are visible.

Postclitellar Genital Zone.—There is an oval sunk field in the ventral side of somites XVIII–XX, surrounded by a swollen margin protruding beyond the body line. This field is connected anteriorly with two deep pits in the posterior margin of XVII. Somites XXI, XXII, XXIII are occupied by two large ventral pear-shaped swellings, as wide as the zone in XVII–XX. Each one of these pear-shaped swellings occupies one and a half somites. There are no other papillæ.

The *clitellum* appears ring-shaped and perfect, except for a V-shaped ventral depression in XIII and XIV. The clitellar somites are of even size and form and quite smooth. The intersegmental grooves are perfect.

Spermathecal Sexual Setæ and Glands. Setæ *ab* in VIII and IX are differentiated sexual setæ. They are strongly sculptured in about the same way as those of *Diplocardia Udei*, but the anterior part of the ridges are drawn out into short spines.

The setæ are accompanied by glandular structures in the body-wall, as far as I can see exactly like those in *Diplocardia Udei*, only not quite so numerous. They all open into a common globular chamber, there being no side chambers as in *D. Udei*.

INTERNAL CHARACTERS.

Septa.—The enlargement of the septa is principally dorsal. This refers especially to the septa separating VII/VIII, VIII/IX, in which the dorsal part is two or three times wider than the ventral part.

Septal and Pharyngeal Glands.—The suprapharyngeal glands are well developed. There appear to be at least seven dorsal lobes. There are three pairs of very minute septal glands in VI, VII and VIII, situated close to the intestine and suspended by muscular strands. The one in VIII is the largest, and is at the widest part as wide as the wall of the intestine. Those in VI and VII are much thinner and one to three cells thick. A very interesting fact is that throughout the intestine in somites VII, VIII and IX are seen isolated dark-staining streaks, which upon examination are found to consist of glandular cells, exactly like the septal glands. They are found between the epithelial cells and the muscular layers, the same as the septal glands, and differ from the cells of the glandular crop by their intense staining, and by their shape, which is also similar to the septal glands. They do not appear to discharge into the intestine. The glandular cells are apparently of the same nature as the septal glands. The glands in the crop in somites XIV and XV do not stain deeper than the epithelial cells, but rather more faintly, and not at all with the blue colors, as do the septal glands.

Spermathecæ.—In *Diplocardia Eiseni* both spermathecæ open immediately in front of the septa, and in the majority of the other species so far known the spermathecæ open posterior to the septa. The present species occupies an intermediate position in that one pair of spermathecæ are preseptal, while the other is postseptal. The preseptal pores are situated very close to the septum, but the postseptal pores are situated very near the center of the somite, in line with and immediately in front of setæ *ab*, —so near that the pores appear actually in the place where setæ *ab* are generally found, while these setæ have been pushed slightly backward. Setæ *ab* in somites VIII and IX are differentiated sexual setæ. In the only specimen sectioned the posterior spermathecæ are the longest, pushing backwards to the posterior end of X, but still confined in IX. Each spermathecæ consists of a folded muscular duct and a sac-like part, the latter strongly constricted at the centre. Each division is oval or semioval, in width about equal to one-fourth the diameter of the body cavity. The length of the sac-like parts of the spermathecæ in IX is equal to or even greater than the diameter of the body, or equal to the two somites IX and X. The spermathecæ in VIII are a little smaller, which probably is due to want of space to develop, they being crowded on one side by the gizzards and on the other by the spermathecæ in IX.

As regards structure the spermathecæ resemble those of *D. Udei.* The lower part, at least, of the muscular duct is surrounded by glandular cells and these again by stray muscular strands. The diverticle of the spermathecæ in VIII is so large that it projects through the septum VII/VIII into VII. It does not seem to contain any trabeculæ.

Reproductive Organs.—Testes are large, in X, XI. Ovaries are strongly digitate, longitudinal sections showing six or eight narrow lobes starting from the septum.

Sperm-sacs.—There are three pairs of sperm-sacs surrounded by a peritoneal membrane. The pair in IX is slightly racemose and preseptal. The pair in X is not racemose, but still traversed by trabeculæ starting out from septum IX/X. They are thus postseptal. In XI there is a large sperm-mass like the pair in X, but there are no trabeculæ and there is no peritoneal membrane. The sacs in XII are strongly racemose and postseptal.

Prostates.—The prostates are large and thick, each one folded once. The outline is rough, wavy and warty. The muscular duct is well marked and folded two or three times. Each prostate occupies about two somites. They open as usual near sacs with penial setæ, but I am unable to say whether these are sculptured or smooth. The structure of the glandular part of the prostate is peculiar. The lumen is not wider than the lumen of the muscular part. This lumen is along its entire length ramified with tapering branches into which open the glandular cells. The lumen appears, both in the main canal as well as in the branches, to be lined by a thin membrane only, which probably must be considered as a reduction of the regular columnar epithelial cells which characterize the prostates of all higher Oligochæta except the Ocnerodrilini. This membrane contains, so far as I can see, no nuclei. The glandular part of the prostates is thus only one layer thick, all the cells being of the same quality. Around each branch of the lumen the glandular cells are arranged as around the lumen of a common prostate. They also open in the main lumen. Compared to the prostate of *D. Udei*, the parts of the present species are yet more reduced as regards the inner epithelium. In *D. Udei* I could now and then find a nucleated cell in the lining epithelium, while in *D. Michaelseni* there are neither distinct cells nor nuclei. The branching of the lumen is more simple and regular in *D. Michaelseni* than in *D. Udei.*

Vascular System.—I find muscular connecting vessels or hearts in X and XI only. There is no supraintestinal dilatation of the dorsal vessel, as in some other species. The dorsal vessel appears to be single.

Intestine.—The gizzards are very short and thick and the connection between them is not thin, being about one-third as wide as the widest part. Œsophagus is straight. Tubular intestine is straight, slightly and gradually widening posteriorly. In XIV and XV we find the most characteristic part of the intestine. It consists of an oblong thick *glandular crop* of the same general structure as the one I have previously described in *Pontodrilus Michaelseni.* The crop consists of a thick glandular layer of cells which appears between the inner epithelium and the muscular layer. This layer consists of a great number of small cubical cells without any apparent ducts. But unlike *Pontodrilus Michaelseni*, no vascular blood loops are found penetrating the cell-layer, which appears homogeneous throughout. The part of the tubular intestine situated between the crop and the sacculated intestine, that is, from the posterior one-third of XV to the beginning of XVII, is strongly ciliated. The sacculated intestine is only very slightly wider than the tubular intestine.

Diplocardia Udei *Eisen.*

PLATE XI, FIG. 117; PLATE XIII, FIGS. 145–154.

Diplocardia Udei EISEN, Zool. Bull. Vol. II, No. 4, 1899.

Definition.—Color flesh, without any pigment; an even tint all around the body. Size, 70–90 mm. by 2 mm. at the widest part. Somites, 200–220. Prostomium divides somite I about two-thirds. Dorsal pores, most anterior one in anterior part of XI. Spermiducal pores in XIX. Spermathecal pores, two pairs, in front of setæ *b* on anterior part of VIII and IX. Prostate pores in XVIII and XX. Oviducal pore in XIV. Setæ: *a–a*=3 *a–b*; *a–a* slightly smaller than *b–c*; *b–c*=4 *a–b* (about); *c–d* not quite twice as wide as *a–b*; *d–d* greater than half the periphery. In VIII, IX and X, $a–a=1\frac{1}{2}\ a–b$. Penial setæ present, ornamented. Spermathecal setæ differentiated in VIII–X, highly ornamented, accompanied by glands in the body-wall. Clitellum dorsally XIII–½ XVIII, ventrally XIII–⅔ XXI. Genital zone a narrow, deep, rectangular depression, deeper than in any of the other species, surrounded by a thick, elevated ridge. Tubercula pubertatis in XIX–XXI, a pair of papillæ in XVIII. Most anterior septum III/IV. Œsophagus, no dilations containing calcic concretions. Gizzards in V and VI. Sacculated intestine commences in XVII. Dorsal vessel single, thickly covered with chloragogen cells. Hearts in X–XII, with chloragogen cells. Meganephridia, no cœlomic mantle. Testes in X and XI. Sperm-funnels in X and XI. Sperm-sacs, one preseptal in IX, one postseptal in XII, both racemose. Oviducts small. Prostates very short and thick, occupying two somites each. Spermathecæ with a diverticle hidden in the wall of the spermathecæ, not perceptible except in sections. Anterior spermathecæ largest.

Septal formula:—

$$\overline{\text{VI/VII}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\text{VIII/IX}}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\overline{\text{X/XI}}},\ \overline{\text{XI/XII}}.$$

Habitat.—Raleigh, North Carolina. Collected by Messrs. Brimley.

This species comes nearest to *D. Eiseni* and *D. riparia*, without exactly being intermediate between the two. From *D. Eiseni* it differs in the position of the spermathecal pores and in the number of somites containing sexually differentiated spermathecal setæ, there being two such somites in the former and three in the latter species. There is also a pronounced difference in the genital zone, which in *D. Udei* is very deep, with straight fossæ. The species is smaller than *D. riparia*, its color is much lighter generally, being without pigment, and it possesses the sexual spermathecal setæ which are lacking in *D. riparia*. With those species possessing three pairs of spermathecæ *D. Udei* need not be confounded.

DETAILED DESCRIPTION.

Somites.—(figs. 145, 146.) The anterior somites increase in size towards the clitellum, with the exception of somites VIII, IX and X, which are much larger than the other somites. These somites also contain the genital setæ described elsewhere. Those somites anterior to VIII are all distinctly 3-ringed. Somites VIII, IX, X are perfectly smooth; somites XI–XVI are 3- or 4-ringed. The clitellar somites are smooth, while those posterior to the clitellum are distinctly 5-ringed. The prostomium divides somite I by fully two-thirds. The clitellar somites are not very prominent and evidently not fully developed. Sections show that the clitellar glands are thin, extending dorsally from XIII–½ XVIII, while ventrally they could be traced to XXI. This posterior extension of the ventral part of the clitellum is due to the high glandular ridge surrounding the genital zone (fig. 146).

Genital Zone.—(figs. 145, 146.) This zone consists of a deeply sunk rectangular field in XVIII–XX, surrounded by a very high and swollen ridge of oval form, extending across the largest part of the ventral surface in somites XVII–XXI, where it connects with a low, median, ventral ridge of the body-wall. There are generally no papillæ, but in one specimen there was a trace of a pair of papillæ in XVII. The prostate pores are strongly elevated. The fossæ connecting them are straight, and not curved as in some other specimens. There are three pairs of small, rather pellucid fields in XVIII, XIX and XX, which I take to be tubercula pubertatis. Longitudinal sections show an arrangement of glands in these places similar to those found in tubercula pubertatis generally.

Setæ.—The distances between the setæ are not prominently characteristic. Distance *a–a* is about three times that of *a–b*. The ventral interval or *a–a* is only slightly larger than the lateral interval or *b–c*. The latter, *b–c*, is about four times as wide as *a–b*. The distance between setæ *c–d* is not quite twice that between *a–b*. The dorsal interval or *d–d* is greater than half the periphery of the equatorial.

In somites VIII, IX and X the ventral interval, *a–a*, is only about once and a half that of *a–b*, instead of being three times as great as in the other somites. This is due to the setæ *ab* being slightly more ventral in these three somites.

Spermathecal Sexual Setæ.—(figs. 50, 51.) Michaelsen was the first to discover the sexual spermathecal setæ in *Diplocardia*. These setæ have been found in *D. Eiseni*, *D. Udei*, and *D. Michaelseni*. In the former species they occur in two somites, VIII and IX, while in *D. Udei* they are found in three somites, VIII, IX and X. It is interesting to note that in the latter species somite X, which does not contain any spermathecæ, still possesses these sexual setæ. It is only setæ *ab* which are replaced by sexual setæ. The form of these is similar to curved penial setæ; they are much longer than ordinary setæ and quite slender (fig. 150). The apex is strongly and beautifully sculptured, as shown in figs. 151, A and B. Under a low power the sculpture appears like bristles, but under a good apochromat we see that what appears to be bristles are but short curved ridges, each one enclosing a flat oval field with a granular sculpture. There is no difference between these setæ in IX and X. Each one of the setæ protrudes through a pore surrounded by a pale elevated ring or circular ridge and the body-wall surrounding the two setæ is elevated, appearing as if strongly glandular. This causes the ventral side of somites VIII, IX and X to appear much swollen and also wider than the other surrounding somites.

Glands of the Sexual Setæ.—(fig. 154.) The external elevation of the body-wall around the spermathecal setæ is connected with an interior differentiation of structure. Michaelsen has described somewhat similar structures in *D. Eiseni*, but judging from Michaelsen's description they differ considerably from those found in *D. Udei*. Unfortunately Michaelsen does not give any figures, so that a minute comparison is not possible. He described them as structures without distinct cell-walls, but with numerous nuclei. I suspect that this absence of cell-walls may be due to degeneration.

In *Diplocardia Udei* I find that an extra layer of glandular cells has made its appearance between the muscular layer and the epithelium (fig. 154). Some of these cells protrude between the muscular fibres, but the majority are pushed in between the epithelial cells. These glandular cells bear a strong resemblance to the tubercula pubertatis cells described from *Dichogaster Crawi*, but they have the peculiarity of opening into a chamber surrounding the apex of the seta. This chamber opens to the exterior through the setal external pore, which, as before stated, is surrounded by a slightly elevated ring. Thus the glandular cells extend from the various ventral parts of the somite, their ducts leading to this pore. The distal ends of the cells are all bent upwards or downwards, but the long narrow ducts run parallel and close together until they reach the pore. The secretion in these cells stains but faintly, and in this respect resembles that of the tubercula pubertatis. Figure 154 represents a longitudinal section of this glandular zone. The seta comes in from above, but has been cut off obliquely. The chamber into which the glands open is furnished with side pockets into which some of the glandular cells open. The walls of all the cells are very distinct. The cœlomic epithelium in somites VIII, IX and X is granular and resembles chloragogen cells. The cell-contents consists of small and numerous round, dark-staining granules. The cells themselves are of different sizes, protruding more or less freely and independently into the cœlomic cavity, while their thin ends lose themselves among the muscular layers.

Another interesting feature of this glandular structure is a double row of cells as in a prostate. The long glandular cells may readily be compared to and are perhaps homologous with the long glandular cells of a common prostate, while the narrow cells lining the chamber into which the former cells open are similar to the inner layer of cells of the prostate. If the whole structure had been free in the cœlom instead of being enclosed by the layers of the body-wall, its similarity to a prostate would have been almost complete. This fact gives great probability to the opinion of Michaelsen, that the prostates are differentiated cell-structures originally connected with setæ.

Penial Setæ.—(figs. 152, 153.) These setæ are present and not rudimentary; they are very minute, curved, and of unequal length. The longer seta is very slender, several times longer than ordinary setæ. The shorter seta is thicker and undoubtedly not yet developed. The apex of the longer seta is hooked and sculptured. The sculpture is different from that of the spermathecal setæ and less elaborate. There are rows of spine-like elevations combined with depressions difficult to describe.

Septal and Pharyngeal Glands.—Besides the usual mass of suprapharyngeal glands there is also a row of subpharyngeal glands of small size, on the ventral side of the pharynx, opening into its posterior part. There are very small septal glands in VII, VIII and IX, attached to muscular strands coming forwards. The longitudinal diameter of these glands is no greater than the diameter of the dorsal vessel, and in longitudinal sections they appear to be of the same size as the isolated subpharyngeal glands.

Intestine.—The œsophagus is very narrow and tubular; it curves upwards from the pharynx. The tubular intestine runs straight on from the gizzards to the sacculated intestine and is thickly surrounded by chloragogen cells. It is only slightly nipped by the septa. The sacculated intestine commences in XVII.

Spermathecæ.—(figs. 147, 148.) The two pairs of spermathecæ occur in VIII and IX. In the specimen dissected, as well as in the one sectioned, the anterior spermathecæ are much longer and narrower than the posterior ones. I have observed this to be the case also in *D. singularis* subsp. *caroliniana*, and it may possibly be characteristic. The diverticle is hardly, if at all, perceivable from the exterior. In one spermatheca no exterior diverticle could be detected, in the other there is only the slightest swelling. In sections the spermathecal diverticle is distinct enough, forming a cavity in the spermathecal wall. It is divided into several chambers by trabeculæ. Figures 147 and 148 represent one of the anterior and one of the posterior spermathecæ from the same specimen. The figures were drawn from three sections. There is a muscular duct not perceived from the exterior, being hidden by the other spermathecal tissue.

Sperm-sacs.—There are two pairs of sperm-sacs, both strongly racemose, resembling those of *Diplocardia caroliniana*. The pair in IX is preseptal, that in XII postseptal.

Prostates.—(fig. 149.) The four prostates are very compact and when dissected appear as square irregular masses. One of the prostates possesses a thin distal end doubled on the main body of the prostate. The muscular duct is narrow, slender, and coiled. The prostates do not project dorsally and are confined respectively to one and two somites. The penial setæ opening with the prostates are not half as long as the muscular part of the prostate.

The structure of the glandular part of the prostate is interesting as it shows a reduction of the inner epithelium. The lumen is very narrow, narrower than the lumen of the muscular part. It is numerously and irregularly branched, the glandular cells opening into the branches as well as into the main lumen. The whole prostate forms a single system of glands, the secretions of which all flow into the common narrow lumen. This lumen is lined, not by the regular columnar epithelial cells, but by a thin nucleated membrane, with here and there a few very small, distinct cells. The prostate is in reality racemose, appearing tubular exteriorly. See also the description of *D. Michaelseni*.

Nephridia.—The nephropores are in line with setæ *d*. In form the nephridia closely resemble those of *A. Keyesi* which have been figured elsewhere (Eisen 18). The windings and the spur are more folded and twisted. There is no cœlomic mantle.

Vascular System.—So far as can be judged from longitudinal sections the dorsal vessel is single. There is a peculiarity in the intestinal blood-sinus of some of the sexual somites. The blood-sinus suddenly leaves the intestine on the dorsal side and assumes the form of an independent blood-vessel, running close to the intestine, and parallel with the dorsal vessel. This supraintestinal vessel exists only in somites XI and XII. It begins near the posterior fourth of XII and extends forwards to the septum separating X/XI. In the posterior of these two somites the supra-intestinal vessel lies entirely free above the intestine except where it is nipped by the septa. In somite XI it is superposed on the intestine and merely connected by mesenteric tissues with the dorsal vessel in those somites. It is not covered by chloragogen cells; these, however, cover the dorsal vessel, the hearts, and the intestine. The hearts are not much dilated, but appear as tubular vessels of even thickness, without valves. The lateral vessels posterior to the clitellum are covered thickly with chloragogen cells. As in *A. Keyesi*, each lateral vessel possesses a small diverticle, situated in the centre of the vessel. The present species is more pronounced than in *A. Keyesi*, being narrower and often twisted around the lateral from which it starts. In *A. Keyesi* two such diverticles are found, but they are smaller and more knob-like.

Diplocardia communis *Garman.*

Diplocardia communis GARMAN, Bull. Ill. Lab. Nat. Hist., Vol. III, 1888, p. 47.

Definitiön.—Color, flesh; clitellum dull yellow or flesh. Size, 300 mm. Somites, 123–165. Prostomium divides I by one-half. Dorsal pores, most anterior one X/XI. Spermiducal pores in XIX. Spermathecal pores, three pairs in VII–IX, in line with *a–b*. Prostate pores in XVIII and XX. Oviducal pores close together in front of and interior to setæ *a–b*. Setæ, ventral, *a–a* slightly larger than *b–c*, not ornamented; no setæ *a–b* in XIX. Penial setæ in XVIII and XX, only slightly curved, smooth, one-third longer than ordinary setæ. Spermathecal setæ not differentiated. Clitellum saddle-shaped, in XIII–XVIII. Genital zone, copulatory papillæ: one pair on XVII, one pair on XX. Copulatory grooves on XVIII–XX, curved towards the ventral median line. With or without a depressed zone. Œsophagus, no calciferous folds. Gizzards in V and VI. Sacculated intestine commences in XVII, a low typhlosole from XXIII–XL. Dorsal vessel alternately double and single from VII backwards. Hearts in X–XII.

Meganephridia, most anterior one in III. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts run on top of muscular layer, between it and the cœlomic epithelium. They join only at the pore. Sperm-sacs in IX preseptal, in XII postseptal. Prostates long, slender, tubular, abruptly bent at the pore, sometimes extending over more than one somite. Spermathecæ, three pairs in VII–IX, club-like, with an ear-shaped diverticle below the center.

Septal formula (approximately correct):—

$$\overline{\mathrm{VI/VII}},\ \overline{\mathrm{VII/VIII}},\ \overline{\overline{\overline{\mathrm{VIII/IX}}}},\ \overline{\overline{\mathrm{IX/X}}},\ \overline{\overline{\mathrm{X/XI}}}.$$

Habitat.—Champaign, Illinois. Collected by Professor Garman. Through the kindness of Professor Frank Smith, I have in my possession four specimens collected by Professor Garman, and three specimens collected by Professor Smith himself. The former differ from the latter in the character of the genital zone. It is well worth the while to examine a large number of specimens in order to ascertain if there are not two distinct species now joined under the name of *D. communis.*

Genital Zone.—Specimens collected by Professor Garman: No. 1. No signs of a depressed genital area. There is one pair of comparatively large papillæ in the posterior part of XVII, just clearing the groove of XVII/XVIII, with their bases slightly encroaching on XVIII. Besides this pair there are three pairs of smaller papillæ in the posterior parts of XX, XXI and XXII, similarly very slightly projecting across the intersegmental grooves posteriorly. No. 2. One pair of papilla in XVII, and one pair in XX, situated as in No. 1. No. 3, similar to No. 2. In all these specimens the papillæ of the anterior pair are the largest.

In each one of the specimens collected by Professor Smith there is a depressed genital zone not existing in Garman's specimens. This zone is oblong and almost rectangular. It is surrounded by an elevated ridge similar in shape to that found in *D. Udei*, but it is not so high. This ridge extends from ½ XVII–⅓ XXI, while the depressed zone extends from XVIII–⅓ XXI. Inside the ridge there is in specimen No. 1 a pair of papillæ in the posterior part of each of somites XVII and XX and one pair in XXI. No. 2. One pair of papillæ in XVII, one pair in XX similarly situated. Besides there is one pair of papillæ in the posterior part of XIV, in line with the papillæ of the zone and of the same size or slightly larger. These two papillæ are situated on an elevated zone, or, in other words, are surrounded by an elevated ridge which is closed in front but open behind; it extends to the center of XV. No. 3 is similar to No. 2 but has no papillæ in XIV. In the three specimens the papillæ in XVII are larger than the posterior papillæ.

The depressed zone is not of uniform depth in the three somites, being much deeper at the anterior and posterior ends. In the part occupied by somite XIX the zone is hardly deeper than the main part of the somite, while in XVIII and XX–⅓ XXI the zone is deeper at the end and appears like two separate cavities, separated by a central bar in XIX. There are tubercula pubertatis swellings in XIV to XVII, but with no decided external characteristics.

Diplocardia singularis *Ude.*

Geodrilus singularis UDE, Zeit. f. wiss. Zool. Bd. LVII, 1894, p. 69.

Definition.—Color dark brown. Size 65 mm. by 3 mm. Prostomium divides somite I about one-half. Dorsal pores, most anterior one VII/VIII. Spermiducal pores in XIX. Spermathecal pores, three pairs in VI/VII, VII/VIII, VIII/IX. Prostate pores in XVIII and XX. Oviducal pore in XIV, interior to setæ *a*, surrounded by a glandular ridge. Setæ, ventral, lateral; *d–d* greater than half the periphery; *a–a* larger than *b–c*; *c–d* somewhat larger than *a–b*; *a–b* about one-half as large as *b–c*; *l. i.* shorter than *v. i.*; *a–b* half as long as *l. i.*, and three times shorter than *v. i.*; faintly ornamented at apex. No setæ *a–b* in XIX. Penial setæ three times as long as the ordinary setæ, curved, not ornamented. Spermathecal setæ not differentiated. Clitellum, ring-like, XIII–½ XVII, saddle-shaped, ½ XVII–XVIII. Genital zone, no rectangular field, two lunate grooves on ½ XVIII–½ XX, convexity towards ventral median line. One pair papillæ in XVII. One pair in XX. Sometimes with a deep oval zone in XVII–½ XXI (Smith's specimens). Œsophagus strongly twisted, bead-like in X–XIII, narrower in XIV–XVI, no calciferous folds. Gizzards in V and VI. Sacculated intestine commences in XVII. Dorsal vessel single. Hearts, three pairs in X–XII; in VI–IX narrow vessels. Meganephridia, first pair, in II, small; pores ventral to setæ *d.* Testes in X and XI. Sperm-funnels in X and XI. Sperm-sacs, one pair in

IX preseptal, one pair in XII postseptal. Prostates with many folds at right angles. Spermathecæ, three pairs in VII–IX, sac-like, gradually narrowing duct, oblong diverticle.

Habitat.—Havana, Illinois. Four specimens (size 90x2 mm.) from this locality, kindly sent me by Professor Frank Smith of Champaign, Illinois. Three of the specimens are adult.

No attempt was made to section and dissect the specimens. They were labeled by Professor Frank Smith and determined by him. They are much longer than Ude's specimens and also narrower. In the table of species I have retained the description given by Ude, as future investigation of the Havana specimens may reveal differences.

Genital Zone.—The genital zone agrees in a general way with the figure given by Ude, but differs in one point. There is a very marked depressed area of oval shape occupying the ventral side of somites XVIII to ½ XXI, just posterior to the clitellum. When the worm is viewed from the ventral side this area is seen to occupy about one-half the width of the somite; that is, there is left on either side of the depression about one-quarter of the width of the somite. There is a very slight ridge bordering the depression, which is well defined and sufficiently deep to appear quite dark. There are two pairs of papillæ, one pair in XX/XXI, the other in the groove separating XVII/XVIII.

Anterior Somites.—The prostomium divides somite I about three-fourths. Somites I and II are about one-half as wide—in direction of head to tail—as somite IV. Somite III two-thirds as long as IV. These anterior three somites are thus distinctly shorter than the following ones. The anterior nine somites are more or less corrugated; the others are smooth. The clitellum occupies dorsally ½ XIII–½ XVIII, ventrally ½ XIII–¾ XVII. In XVII the clitellum leaves a ventral space occupied by the anterior pair of the papillæ. One specimen does not possess any papillæ.

Diplocardia singularis *Ude*, subsp. **caroliniana** *Eisen.*

PLATE XIII, FIGS. 137–142.

Diplocardia singularis UDE, subsp. *caroliniana* EISEN, Zool. Bull. Vol. II, No. 4, 1899.

Definition.—Color flesh, without pigmentation. Size, 40–50 mm. by 1.5 mm. Somites, 64, 98–136. The prostomium divides somite I about one-half. Dorsal pores, most anterior on the front part of IX. Spermiducal pores in XIX. Spermathecal pores in VII–IX. Prostate pores in XVIII and XX. Oviducal pores in XIV, on a small glandular area. Setæ as in the species, but *a–b* is about twice as long as *a–a* ; *a–b* is less than one-half as wide as *b–c*, all faintly sculptured. No setæ *a–b* in XIX. Penial setæ curved, pointed, and ornamented. Spermathecal setæ not differentiated. Clitellum ring-like, except in anterior part of XVIII, where it is saddle-shaped, XIII–½ XVIII. Genital zone not much differentiated. Two curved grooves, with the convexity turned to the ventral median line. In XVII two large circular areas, like depressed papillæ. In XXI two similar areas. In XXII one median oblong area. Œsophagus without calciferous folds. Gizzards in V and VI. Sacculated intestine commences in XVII. Dorsal vessel single, with chloragogen cells. Hearts, muscular vessels in X–XII, with chloragogen cells. Meganephridia. Testes in XXI. Sperm-funnels in X and XI, compact. Sperm-sacs, one pair in IX preseptal, one pair in XII postseptal. Oviducts, very large protruding funnels in XIII. Prostates large, tubular, almost straight, one-third as wide as the body-cavity. Spermathecæ, three pairs in VII–IX; the anterior pair the smallest; the two posterior pairs the largest. Each of the latter extends through two somites backwards. The diverticle is longitudinally oblong, with a distinct stalk or duct, and divided into several chambers by trabecula.

Septal formula:—

$$\overline{\overline{\overline{\overline{\mathrm{VII/VIII}}}}},\ \overline{\overline{\overline{\overline{\mathrm{VIII/IX}}}}},\ \overline{\overline{\overline{\mathrm{IX/X}}}},\ \overline{\overline{\overline{\mathrm{X/XI}}}}.$$

Habitat.—Raleigh, North Carolina, U. S. A. Found under logs and in rotten wood in swamps in the vicinity of the city. Fifty odd specimens were received alive during the first half of January, 1897, from Messrs. Brimley.

In the location and number of the various organs this form does not apparently differ from *Diplocardia singularis* Ude, but the size and shape of the spermathecæ and prostates, and the form and ornamentation of the penial setæ are so at variance with the description and figures of *D. singularis* given by Ude that it seems advisable to classify the specimens from Raleigh, North Carolina, under a separate subspecies. To the differences referred to above we may also add absence or scarcity of papillæ on the clitellum, four of which occur in *D. singularis*.

The following description will be confined to the points of difference between the species and subspecies. A closer comparison can only be made through a study of type specimens of the species.

EXTERNAL CHARACTERS.

Color.—The whole worm is semi-transparent, of a delicate flesh-color, with blood-vessels appearing through the skin. The spermathecæ and prostates appear as white masses through the skin.

Somites.—The somites are all faintly three-ringed. The clitellar somites XIII–½ XVIII are much more distinct and wider than the somites posterior to them. According to the figure given by Ude the clitellar somites of *D. singularis* are of about the same width as the somites posterior to them. The clitellum ends posteriorly and dorsally with the centre of XVIII, but ventrally with the posterior margin of XVII. In *D. singularis* the clitellum appears to extend to the posterior part of XVIII, while ventrally it does not cover the whole of XVII.

The *prostomium* (fig. 137) divides somite I by almost two-thirds. It is bounded posteriorly by a deep transverse groove which extends across the whole somite in the direction of the short diameter of the body.

The *dorsal pores* begin in IX. The pores increase gradually in size posteriorly, those immediately in front of the clitellum are larger. The pores in the clitellar somites are also distinct. The most anterior pore is situated on the anterior part of IX. In several somites anterior to the first dorsal pore there are deep depressions which appear, when viewed from the surface, as narrow pores. Longitudinal sections show that these depressions do not penetrate the body-wall. Undoubtedly such depressions have sometimes been mistaken for true pores.

Genital Zone.—(fig. 137B.) There are two slightly curved grooves with the convexity towards the median line. They are slightly wavy and surrounded by a slight swelling. Of these swellings those surrounding the prostate pores and penial setæ are the largest and sometimes appear as elevated papillæ. There are no real elevated papillæ in the surrounding somites in any of the specimens; in their place are small, round fields, semitransparent and undoubtedly of a nature similar to the papillæ. Of these fields there are two very closely joining in XVII, posterior to the setæ and occupying the continuation of the ventral interval *a–a*. Two similar areas are in XXI, while in XXII there is a more oblong area, median in position, covering the whole ventral interval *a–a* posterior to the setæ. Only the specimens most fully developed possess these flat papillæ.

Setæ.—The common setæ are like those of *D. singularis*, but the ventral interval *a–b* is less than half that of the lateral interval *b–c*. According to Ude, in *D. singularis* *a–b* is equal to one-half of *b–c*. The setæ are all sculptured, but the sculpturing is more in the shape of notches than that represented in Ude's figure 11. The shape of the setæ is also different, the posterior part being much heavier in *D. caroliniana*.

The penial setæ (figs. 139, 140) differ somewhat from those of *D. singularis*. They are about three times as long as the common setæ. They are more pointed than those of *D. singularis* as figured by Ude and the apex is more twisted. The most important difference is found in the sculpturing of the setæ, which are not smooth as in *D. singularis*. The sculpture is represented in fig. 140. It does not begin at the apex, but some distance below it. There are from eleven to fourteen small distinct notches on either side. The two setæ in each bundle are practically alike.

INTERNAL CHARACTERS.

Spermathecæ.—(figs. 141 A and B.) There are three pairs of spermathecæ as in *D. singularis*, situated in somites VII, VIII and IX, with the pores in front of the setæ. They differ in shape from those of *D. singularis*, being much longer and narrower, and with the exception of those in VII, extending through two somites instead of being confined to one as in that species. This difference in size would, however, be of less importance were it not coupled with a change in the form of the diverticle. Ude describes and figures the diverticle of *D. singularis* as being transversely oval with a short shaft. In the subspecies *caroliniana* the diverticle is longitudinally oblong and the apex knob-like. This was found to be constant in the three specimens opened.

Septal and Pharyngeal Glands.—The pharyngeal glands are also developed ventrally, though they are here much smaller than on the dorsal side. Dorsally they are long and in cross-sections present a row of about seven glandular masses attached to as many muscular strands. On the under side of the pharynx, just above the ventral nerve-cord, there is a row of narrow and short glands, also attached to muscular strands, one following the other, just as on the dorsal side. These ventral glands open into the ventral part of the pharynx near its posterior margin. There are also small septal glands close to the œsophagus in somites VII and VIII.

Prostates.—(fig. 142). The prostates are much larger and of different form from those of *D. singularis.* Ude's figure does not show the muscular duct, and his description does not mention its relative size to the glandular part; but the glandular part which he figures is certainly very much narrower in proportion to its length than what we find in the subspecies. In the former the glandular part is five or six times the width of the duct. This glandular part was the same shape and size in the three specimens examined by me. In width it equals about one-third or more of the body-cavity of the worm; it is scarcely folded, slightly irregular and nipped, and extends through three or four somites. The posterior prostates appear to be a trifle more folded and extend backwards. Thus the prostates opening in XVIII occupy XVI, XVII, XVIII and XIX, while those opening in XX occupy XX and XXI and sometimes part of XIX. Two figures are given of two prostates on one side in the same specimen.

Blood-vessels and Hearts.—The dorsal vessel is single. There are three pairs of muscular vessels in somites X, XI and XII, which probably serve as hearts. They are not greatly extended, nor are they divided into pulsating chambers separated by valves, as in *D. Keyesi.* The hearts are covered by chloragogen cells. The dorsal vessel is similarly covered. The blood-sinus in the dorsal part of the intestine in X, XI and XII rises above the muscular layers of the intestine and forms a kind of supraintestinal vessel. In none of these somites is this vessel so free as in *D. Udei*, being everywhere attached to the intestine, though elevated above it. In *D. Udei* the part in XII is entirely separated, while the one in XI is only superposed on the intestine.

Intestine.—There are no dilations of the œsophagus. The sacculated intestine commences in XVII. There is a typhlosole in XX–XIV.

Subgenus **Naillenia,** subgen. nov.

Diplocardia (Naillenia) Koebeli, sp. nov.

PLATE XIV, FIGS. 177, 178.

Definition.—Size 80–100 mm. by 2 mm. Somites about 100. Prostomium divides somite I about one-half. Dorsal pores, VII/VIII. Spermiducal pores in XVIII. Spermathecal pores in VIII and IX, both pairs postseptal. Spermathecal sexual setæ in IX. Penial setæ large, curved in XVII and XIX; sculptured, with spines. Exterior papillæ, one pair on IX, one large median papilla covering posterior part of X and anterior part of XI; a large median papilla on XIV and XV; a large median papilla between XIII and XXIV. Sacculated intestine commences in XIV, thence to XXIII it possesses an interior thick and greatly folded epithelium. Spermathecæ large, with a very large and thick diverticle directed forwards. Prostates thick and long, each occupying at least two somites, opening into XVII and XIX.

Septal formula:—

$$\overline{\text{V/VI}},\ \overline{\overline{\text{VI/VII}}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\overline{\text{VIII/IX}}}}},\ \overline{\overline{\overline{\text{IX/X}}}},\ \overline{\overline{\text{X/XI}}},\ \overline{\text{XI/XII}},\ \text{XII/XIII}.$$

Habitat.—About a dozen specimens, of which five were adult, taken by Professor Albert Koebele at Morelos, Mexico, at an altitude of 6,000 to 7,000 feet, in the region of the pines, September, 1897. Though otherwise fully developed sexually, none of the specimens possess a clitellum.

The subgenus is named for Professor A. Van der Naillen of San Francisco. This very interesting form differs from all other members of the genus in the position of the spermiducal pores, in XVIII, showing the extent of the variation of these pores in the same genus. It stands at one end of the series, while *Diplocardia Keyesi* stands at the other, giving an extreme variation of four somites in which are located the male pores. *D. Koebelei* differs from all other species of *Diplocardia* in not possessing racemose, preseptal sperm-sacs in IX, a character which seems to join it more closely to the *Benhamia* group, and perhaps to *Trigaster*.

Detailed Description.

Somites.—Somite I is dorsally as wide as somite III, ventrally as wide as somite II. Somites II and III are narrower than those following, which slightly increase in size posteriorly, at least as far as X or XII.

Clitellum.—The clitellum is not developed in any of the specimens, and it is possible that it is altogether absent. The large papillæ surrounding the prostate pores may serve as a substitute for a clitellum. These papillæ show the same structure as that described in the tubercula pubertatis of *Pontoscolex*, except that the glandular cells are much larger and extend not only into the muscular layers, but far beyond them into the cœlomic cavity of the body. These glandular masses form a continuous stratum on the ventral side of somites XVII, XVIII and XIX, but are especially developed back of the prostate pores, where they extend to the centre of the cœlomic cavity, touching the sides of the intestine. These glands do not open into any special pore, as is the case in some other species where, for instance, they open into the papillæ of the spermathecæ. They open on the surface in exactly the same manner as the large glandular cells of the clitellum. The glands do not occur singly, but in bunches. I am inclined to regard them as modified clitellar cells.

The *genital zone* in somites XVII–XIX is square, the grooves being straight and parallel, bounded by ridges connecting the papillæ around the prostate pores.

Papillæ.—The papillæ surrounding the spermathecal pores, as well as the single median papillæ on X/XI and XIV/XV, show a structure similar to that of the spermathecal papillæ figured for *D. Udei*, except that the cells are much narrower, though fully as long. In the papillæ on XIV/XV these long horizontal cells open into two pores situated in line with the ventral couples of setæ, in the intersegmental groove between these two somites.

Setæ.—The *penial setæ*, opening at the prostate pores, are very long and much curved, like a sickle with a reflexed, sharply pointed apex. Along the whole length the seta is ornamented with some twenty or more rows of short scale-like spines, hardly projecting from the main body, except at the recurved part of the apex, where the spines are a little longer. One specimen has curved penial setæ in somite XVIII. They are much smaller than those in the prostate papillæ, but much larger than the ordinary setæ. The specimen sectioned did not have these setæ, and I suppose their presence is abnormal.

Spermathecal setæ are present in the two papillæ in somite IX. There are two setæ in each papilla, pointing forwards; they are about twice as long as the common setæ, almost straight, with the apex slightly spatulate, and appear to be somewhat ornamented, in the same manner as the penial setæ. A description of the exact structure cannot be given, as it was desired not to mutilate the specimen.

The *common setæ* are sigmoid as usual. Their position posterior to the clitellum may be expressed as follows:—

d–c=15; c–b=85; b–a=20; a–a=85; a–b=20; b–c=85; c–d=15.

d–c=20; c–b=80; b–a=15; a–a=90; a–b=15; b–c=80; c–d=20.

d–c=20; c–b=85; b–a=20; a–a=90; a–b=20; b–c=85; c–d=20.

The above shows a slight variation, partly actual and partly due, perhaps, to unequal stretching of the body-wall.

Anterior to the male pores the distance between setæ *c* and *d* is somewhat greater. The arrangement may be given as follows:—

d–c=20; c–b=55; b–a=12; a–a=45; a–b=12; b–c=55; c–d=20.

As regards the size of the setæ, it is interesting to note that while those posterior to the male pores are all of about the same size, those between the male pores and the front part of the body vary in such a way that the ventral setæ are about twice as large as the lateral. The apices of these setæ are slightly ornamented with five to six rows of shallow notches, resembling the undeveloped eyes of a potato.

Gizzards.—The two gizzards are well developed and situated in somites V and VI.

Intestine.—The tubular intestine offers nothing characteristic. It is straight and only slightly nipped by the septa. The sacculated intestine commences in XIV. It is of characteristic structure. The outer wall of this part of the intestine in somites XIV to XXI is straight, but the inner layer comprising the villi is much folded, being besides very thick. This inner epithelial layer is thicker and more folded than any other epithelial layer of the intestine, and is probably of the nature of a typhlosole. In somite XX the sacculated intestine assumes the usual shape, with thin walls not folded.

Generative Organs.—The testes are in somites X and XI. There are two pairs of large racemose sperm-sacs projecting from the anterior septum, in somites XI and XII. The sperm-funnels are in X and XI. The ovaries in XIII. The ovipores are separated. The spermathecæ are very large, each being furnished with a large forward pointing diverticle, originating near the base of the main sac, the junction of the two being very wide and the diverticle within a neck. The spermatozoa are collected in small pockets in the wall of the sac, in the same way as in *Argilophilus*, the pockets being somewhat smaller than in that genus (Eisen 16).

The spermathecal pores are found on the anterior face of the somite, about half-way between the setæ and the bottom of the intersegmental grooves. The glandular prostate contains two layers of cells.

Septa.—The septa do not strictly correspond to the intersegmental grooves, but start out almost from the centre of the somites.

The *septal glands* are very diminutive in somites IV to VII and in X. They are attached to the blood vessels. The suprapharyngeal glands are of medium size.

The *brain* is situated in somite II.

The *tubular intestine* and the anterior segments of the sacculated intestine are furnished with chloragogen cells. Similar cells also surround the dorsal vessel. Sections show that the most anterior dorsal pore is between somites VII and VIII.

The *nephridia* commence in somite IV. Their structure has not been studied, but it appears to be similar to that of the nephridia of the other species, that is meganephridia, resembling those of *Diplocardia Keyesi.*

The *dorsal vessel* is double. In XI and XII it is narrow and tubular; in XIII to XVI it is much wider.

Color.—As far as could be judged from specimens preserved in formalin, the color is pale flesh without any trace of pigment.

The species is named for Mr. Albert Koebele, Horticultural Entomologist of the Hawaiian Government, to whom I am greatly indebted for a number of most interesting species which he collected in Mexico.

Trigaster *Benham.*

Definition.—Setæ paired, eight in each somite. Clitellum long or short. Gizzards two or three. Nephridia plectonephric. Spermathecæ two pairs, in VIII and IX, with or without diverticle. No diverticles of the intestine. Prostates two pairs, open in the somites anterior and posterior to the male pores, which are in XVIII. Penial setæ present or absent. Sperm-ducts are completely hidden in the muscular layer of the body-wall.

General Remarks on Affinity.

It is not without some hesitation that I have modified the generic definition of this genus as given by Benham, in order to be able to arrange in it the new species to be described hereafter. On the other hand, if a new generic name is to be made for our new species, its characterization would rest mainly on negative characteristics, viz., the possession of two gizzards instead of three, and on the lesser extent of the clitellum. For the present, it seems preferable to refer the new species to the old genus *Trigaster*, and to modify the definition of the genus rather than to create an uncertain one. The hidden nature of the sperm-ducts is probably characteristic of all the species.

The question will undoubtedly arise as to why this genus has been made to include a species with only two gizzards, when the genus was founded upon a species characterized by three gizzards. The answer is found in the fact that *T. tolteca* more closely resembles Benham's (3 and 13) species *T. Lankesteri* than any other species or genus known. It possesses all the important features of Benham's species, the only great difference being in the number of gizzards. Perhaps the most important character of *Trigaster* will be found in the hidden course of the sperm-ducts. While this is not demonstrated in *T. Lankesteri*, it is more than probable that it will be found to be the case even in this species. Benham did not find the sperm-ducts and the probable reason for this is that they are hidden in the body-wall.

If the want of a gizzard should exclude *T. tolteca* from the genus *Trigaster*, then a new genus must be created. The species cannot be united with *Benhamia*, differing, as it does, in too many important points. It possesses plectonephridia instead of micronephridia; it has no diverticles of the intestine; and finally, its sperm-ducts are hidden in the body-wall. *Zapotecia ameca-mecæ* resembles Benham's original *Trigaster* species in most particulars, but differs in having meganephridia instead of plectonephridia.

The hidden nature of the sperm-ducts is characteristic of both species of *Trigaster.* This character is also found in two species of *Diplocardia* but to a lesser degree, the ducts being merely covered by the peritoneum or by a strand or two of muscles. In the absence of diverticles of the intestine *Trigaster* resembles the other genera of this family. This character seems to me to be of the greatest importance and I consider it to be the distinguishing feature between Diplocardinæ and Benhaminæ.

The two species of *Trigaster* may be distinguished as follows:—

Trigaster tolteca, two gizzards, in V and VI.

Trigaster Lankesteri, three gizzards, in VII, VIII and IX.

Trigaster tolteca, sp. nov.

PLATE XIV, FIG. 179.

Definition.—Length over 120 mm., width below clitellum 5 mm., at the tail 9 mm. Somites 190. Setæ in couples, the ventral ones closer than the dorsal. Penial setæ at the prostates curved and smooth. Prostomium barely indentates somite I. Dorsal pores posterior to clitellum. Clitellum in XIII–XIX. Genital zone almost square, sunk, with two parallel fossæ. A small median papilla on XX. Two gizzards in V and VI. No diverticles of the intestine. Very small septal glands extending to somite IX. Small subpharyngeal glands present. Racemose sperm-sacs in XII growing out from the dorsal vessel. Spermathecæ without diverticles, in VIII and IX; the pores in the intersegmental grooves VII/VIII, VIII/IX, postseptal. Testes and sperm-funnels in X and XI. Ovaries in XIII. Sperm-ducts hidden in the longitudinal muscular layer of the body-wall, fusing at the pores in XVIII. Prostates tubular, in XVII and XIX. Nephridia consist of many isolated tufts, commencing in III. Dorsal vessel double in X, XI, XII (?). Hearts very muscular, the last one in XIII. Color pale; no pigment.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, X/XI, XI/XII, XII/XIII, XIII/XIV.

Habitat.—Toluca, Mexico, in the pine-region at an altitude of 8,000. Collected by Professor Albert Koebele.

Of the single specimen one-half of the anterior end was sectioned lengthwise, the other half crosswise. The part sectioned longitudinally exhibits the following anomaly:

The anterior prostate, in XVII, is double, as regards both the glandular and the muscular part. A single large prostate opens with the sperm-ducts in the equator of somite XVIII. With this prostate opens also a pair of penial setæ exactly similar to those in XVII and XIX. The other side of the worm does not exhibit these peculiarities.

Detailed Description.

Owing to the indifferent state of preservation of the single specimen, but few details can be given. The spermathecæ are very large and have the form of elongated sacs without diverticles. The upper end of the sac is somewhat wider than the lower half near the pore. The walls are very thick. The upper, larger chamber is lined by very long columnar epithelium. The lower part exhibits a very peculiar structure. The lumen is narrow and the walls are enormously thick. These walls are made up of large, globular, glandular cells of various sizes. The cells are separated into groups by trabecula, thus having the appearance of closely packed composite glands. Around this glandular part of the prostate is seen the usual muscular layer. The epithelial cells of the upper chamber are arranged in groups like villi and are fully as large as the epithelial cells of the intestine. The pores of the spermathecæ are postseptal, though opening into the angle of the intersegmental grooves.

There is a pair of racemose sperm-sacs in XII, but instead of projecting from the septum they are seen to grow around the hearts in that somite, the connection with the septum probably having been separated.

The glandular part of the *prostate* is by far the longest, extending to the dorsal part of the somite. The muscular duct is very short and narrow, extending only a little way above the body-wall. Outwardly the glandular part is entire, but sections show it to be composed of numerous separate though closely packed lobes of glandular cells. In the part nearest the lower lumen two distinct layers of cells can be distinguished, but in the upper part there is only one.

In the specimen sectioned, the sperm-ducts on one side of the body fuse together just in front of the pore. On the other side they open through two distinct pores. The sperm-ducts after leaving the funnels dip directly into the body-wall. The testes and ovaries are attached rather high up, or in line with the sperm-funnels.

There is no typhlosole. The sacculated intestine seems to begin in XIII. The nephridia consist of minute tufts of tubules irregularly scattered over the body-wall and especially numerous near the septa. Neither nephrostomes nor nephropores could be found.

Setæ.—The penial setæ are narrower than the ordinary setæ, slightly curved at the apex, and smooth. The ordinary setæ are all ventral and not ornamented. They show the following arrangement according to measurement with the micromillimeter: $d\text{–}c=30$; $c\text{–}b=40$; $b\text{–}a=13$; $a\text{–}a=35$. The distance between the ventral setæ is thus considerably less than that between the lateral setæ.

The body-wall is very thick, the arrangement of the muscular layers being like that in *Notiodrilus*.

Zapotecia, gen. nov.

Definition.—Setæ paired, eight in each somite. Clitellum short. Gizzards three, in V, VI and VII. Meganephridia. Spermathecæ, two pairs in VIII and IX, with imperfect diverticle. No calciferous diverticles of the intestine. Prostates, two pairs, open on somites anterior and posterior to the male pores, which are in XVIII. Penial setæ present. Sperm-ducts hidden in the muscles of the body-wall.

Affinity.—The genus differs from *Trigaster* in the possession of meganephridia instead of plectonephridia. From *Diplocardia* it differs in having three gizzards instead of two.

Zapotecia ameca-mecæ, sp. nov.

PLATE XIV, FIG. 180.

Definition. — Length, 120 mm., width 8 mm. (specimen contracted). Somites 200. Prostomium divides somite I about one-half. First dorsal pore XV/XVI; first large pore XX/XXI. Clitellum saddle-shaped, in XIII–XIX. Setæ all ventral, paired, but not closely so. Penial setæ present at the prostates, curved and smooth. Genital zone large, square, not deeply sunk. No papillæ or ridges. Gizzards three, in V, VI and VII. No calciferous diverticles. Small subpharyngeal gland. Very small septal glands in VII–IX. Large racemose sperm-sacs in XI and XII, both postseptal, projecting from the septa. Spermathecæ in VIII and IX opening into the intersegmental grooves VII/VIII and VIII/IX, but considerably posterior to the septa. Testes and sperm-funnels in X and XI. Ovaries in XIII. No ovisacs. Sperm-ducts run entirely hidden in the body-wall, fusing at the pore, in XVIII. Prostates in XVII and XIX. One pair of meganephridia in each somite. Nephropores in line with setæ *b*. Last heart in XII. Sacculated intestine commences in XIII. Color pale flesh without any prominent pigment.

Septal formula :—

$$\mathrm{IV/V},\ \overline{\overline{\overline{\mathrm{V/VI}}}},\ \overline{\overline{\overline{\overline{\mathrm{VI/VII}}}}},\ \overline{\overline{\overline{\overline{\overline{\mathrm{VIII/IX}}}}}},\ \overline{\overline{\overline{\overline{\overline{\mathrm{IX/X}}}}}},\ \overline{\overline{\overline{\overline{\mathrm{X/XI}}}}},\ \overline{\overline{\overline{\overline{\mathrm{XI/XII}}}}},\ \mathrm{XII/XIII}.$$

Habitat.—Ameca-meca, Mexico. One adult specimen collected by Professor Albert Koebele, in August, 1897, at an altitude of 8,000 feet.

Affinity.—As far as can be judged from Professor Benham's description of his immature specimen of *Trigaster Lankesteri* (Benham, 3), *Z. ameca-mecæ* besides having meganephridia instead of plectonephridia, differs in the location of the three gizzards and of the spermathecal pores. In *Trigaster Lankesteri* these pores are figured by Benham as being in the posterior part of the somite, thus making them preseptal, while in *Zapotecia ameca-mecæ* they are postseptal.

DETAILED DESCRIPTION.

Setæ.—The setæ are paired, but not very closely. By measurement with a micromillimeter ocular the intervals were found to be as follows:—

$d–c=35$; $c–b=92$; $b–a=35$; $a–a=115$; $a–b=30$; $b–c=90$; $c–d=35$.

The distance between setæ *ab* and *cd* is almost the same.

The *penial setæ*, of which there are two in each sac, are much narrower than the ordinary setæ. A good view of the tips was not obtained, but they appear to be smooth and slightly curved.

Somites.—The segments of the body increase in length gradually towards the front end. The clitellar somites are very narrow. The specimen being in a poor state of preservation the genital zone is less distinct than it would have been in well preserved specimens. The zone is large but not deep, and is bounded by the edges of the saddle-shaped clitellum, which barely reaches the ventral side of the body. The two longitudinal fossæ could hardly be distinguished.

Gizzards.—The gizzards are fully developed but shorter than in *Trigaster Lankesteri*, as described by Benham. The thick part is situated in the posterior part of the somites. From the thick posterior part the gizzard tapers anteriorly into a very thin wall.

The *tubular intestine* is much nipped by the septa. There are no traces of any calciferous or other diverticles of the intestine and there appears to be no typhlosole. The walls are deeply plicated and strongly vascular.

Glands.—There is a row of narrow but rather long sub-pharyngeal glands opening into the ventral part of the pharynx. This row extends all along the ventral side to the œsophagus. The septal glands are very small and easily overlooked.

Nervous System.—The brain is in somite III. The ventral nerve-cord is very large. Its muscular outer layer is enormously developed, its diameter being thicker than the inner cellular part.

Nephridia.—There is a pair of perfect meganephridia in each somite. The nephropores are in line with setæ *b*. Judging from sections the nephridia seem to resemble those of *Notiodrilus*.

Spermathecæ.—There are two pairs of large spermathecæ in VIII and IX, each possessing a large sac-like diverticle of peculiar structure. This diverticle is directed forwards and is situated in the same somite as the main sac. In one spermatheca the diverticle is formed by the bulging out of the whole anterior wall of the lower, narrower part of the spermatheca; in the other the diverticle is attached to the narrow part of the spermatheca proper, at its junction with the body-wall. The diverticle and the distal sac proper are of about the same size. The distal sac is of the usual structure, with columnar epithelium. The narrow, lower part of the spermatheca, as well as the diverticle, is of a different structure, the walls consisting of a continuous row of small pockets separated by long, narrow cells. In these pockets are packed bundles of spermatozoa, the heads of which are attached to the bottom wall of the pockets. At the junction of the narrow and the sac-like parts of the main diverticle are found a few cells of the same peculiar, globular form as those found to be so numerous in *Trigaster tolteca*. It is evident that the structure of the lower parts of the spermatheca is similar in *Trigaster Lankesteri* and *Z. ameca-mecæ*, as Benham also describes the spermatozoa as being attached to the lower part of the diverticle. The pores of the spermathecæ are situated half-way between the setæ and the anterior septum, but in the intersegmental grooves. The septa are not connected with the grooves, but are situated much farther forward.

The *sperm-sacs* are very large and extend all around the intestine.

The *testes* and *sperm-funnels* offer nothing characteristic.

The *sperm-ducts* are completely hidden in the longitudinal layer of the body-wall, just as in *T. tolteca*. As Benham did not find any sperm-ducts in *T. Lankesteri*, it is probable that in that species also the sperm-ducts are hidden in the body-wall.

The *prostates* are very thin and folded repeatedly. Their glandular part is many times longer than the muscular duct which appears to be unusually short. The prostates are confined to one somite each, and are composed of two distinct layers of cells.

BENHAMINÆ.

Benhamia *Michaelsen.*

Of the species and varieties described under this genus none equals in interest *Benhamia viridis*. This species seems to be a native of Mexico and not an imported worm.

It is found in the pine region at Toluca, at an altitude of 8,000 feet, and has every indication of being an indigenous form. Its most interesting character is the abnormal position of the sperm-ducts, which makes the species a connecting link between *Benhamia* and *Dichogaster*.

Benhamia Bolavi *Michaelsen*, pacifica, var. nov.

PLATE X, FIGS. 68–73.

Definition.—Length 30 mm.; number of somites about 95. First dorsal pore V/VI. Clitellum incomplete, in XIII–XX. Penial setæ, the longer with six sharp-pointed notches, the shorter spoon-like but with no prongs. Common setæ couples equidistant. Oviducts open in a single pore on a median papilla in line between setæ *a*, in center of somite XIV. Gizzards in VIII. Calciferous diverticles, three pairs, in XV, XVI, XVII; the two anterior pairs connected as one. Sperm-sacs in XI and XII. Sperm-masses in X. Micronephridia in three rows on either side. Spermatheca, basal part with small stalked diverticle pointed forwards, apical part much narrower than the basal part. Sacculated intestine begins in XIX. Color pink.

Habitat.—Honolulu, Hawaii. Presented by Mr. Alexander Craw.

Affinity.—This form comes so very near *B. Bolavi* that it seems best to refer to it only as a variety under that species. There are a number of minor differences which appear constant and which are of considerable interest. In order to facilitate a comparison of the three forms of *B. Bolavi* so far recognized, a table is given of the principal differences noted.

TABLE OF *Benhamia Bolavi* AND VARIETIES.

Benhamia Bolavi.	**Benhamia Bolavi,** var. **pacifica.**	**Benhamia Bolavi,** var. **palmicola.**
Length.	*Length.*	*Length.*
40 to 60 mm.	30 mm.	50–60 mm.
Penial Setæ.	*Penial Setæ.*	*Penial Setæ.*
The largest with 5 to 8 notches, the smaller spoon-like, slightly forked.	The largest with 6 spine-like notches, the smaller spoon-like, not forked.	The largest with 4 blunt notches, the smaller spoon-like.
Gizzards.	*Gizzards.*	*Gizzards.*
Situated in VII.	Distinctly in VIII.	Distinctly in VIII.

Calciferous Diverticles.	*Calciferous Diverticles.*	*Calciferous Diverticles.*
Three distinct and separate pairs.	The two anterior ones connected.	The two anterior ones connected.
Spermathecæ.	*Spermathecæ.*	*Spermathecæ.*
The basal and apical parts of about equal width. Diverticle not sessile.	The basal and apical parts of unequal width, apical part much smaller. Diverticle sessile.	The basal part not much wider than the apical part, both globular and of almost equal size. Diverticle sessile, longer than in var. *pacifica.*
Nephridia.	*Nephridia.*	*Nephridia.*
The ventral ones, or I, are considerably narrower than the lateral ones, and furnished with two separate cœlomic mantles.	The ventral ones, or I, not much narrower and furnished with only one cœlomic mantle.	The ventral ones, or I, consist of two unequal parts, each covered with a cœlomic mantle. They are larger than the other nephridia.

DETAILED DESCRIPTION.

Size.—All the specimens are fully mature, with a large clitellum; still none are over 30 mm. in length, while several are less than 20 mm. Variety *pacifica* is therefore the smallest of the *B. Bolavi* group.

Dorsal Pores.—The variety agrees with *B. Bolavi*, but differs from *B. palmicola* in which the most anterior dorsal pore is IV/V.

Penial Setæ.—The smaller seta shows no forking but is distinctly spoon-like. The figure (Eisen 18) of the smaller seta of var. *palmicola* is probably incomplete and figured from a side view, as a side view of the corresponding seta of var. *pacifica* shows a somewhat similar shape; but seen from the face it is distinctly spoon-like (fig. 72). The notches of the larger seta are much more pointed and look like spines, while in var. *palmicola* they are very blunt.

Genital Zone.—The genital zone is not greatly depressed but is rather flat. There is a slight elevation around the prostate pores, and the groove connecting them is curved towards the ventral median line of the body.

Suprapharyngeal Glands.—When seen in a longitudinal section passing through the centre of the body, the posterior lobe is much thicker than the three anterior lobes. There are only four lobes in all, as usual diminishing in size forwards. These lobes are much shorter than in the var. *palmicola.* Small septal glands are present in VIII, IX, X, XI and XII, situated close to the intestine.

Intestine.—The pharynx is furnished with a long dorsal pocket below the suprapharyngeal glands. The sense-organ zone in the palate is much smaller than in var. *palmicola.* In the specimens sectioned the gizzards are short and thick, much more so than in the other varieties. The sacculated intestine commences in XIX, as in var. *palmicola*, but in *B. Bolavi* it commences in XXI.

The *typhlosole* is either very small or absent. In longitudinal sections it did not show distinctly.

The *calciferous diverticles* resemble those of var. *palmicola* in every particular. I have re-examined my sections of the latter form and find that in this, also, the two anterior diverticles on either side are connected in such a manner that they appear as a single diverticle extending through somites XV and XVI. The diverticle in XV does not have a separate connection with the intestine, but is simply an anterior lobe or projection of the diverticle in XVI.

Spermathecæ.—The basal part is much wider than in the other varieties, and the diverticle is more stalked. The size of the basal and apical parts is much greater than in either *B. Bolavi* or the var. *palmicola.*

The *prostates* are upright and the glandular part is folded on itself, reaching down below the beginning of the narrow muscular duct.

The *hearts* are less pronounced and much narrower than in the var. *palmicola.* The last pair is in XIII. The one in XII is much the largest.

The *nephridia* vary considerably but they are always separated and do not overlap or touch each other. Number 2 is generally the largest; it is oblong and round. Number 1 is hardly smaller than 2, and there is no separate cœlomic mantle for the ducts nearest the nephrostome.

Benhamia papillata *Eisen*, **hawaiiensis,** var. nov.

Plate X, Figs. 77-79; Plate XIV, 170, 171.

Definition.—Length 40 to 50 mm. Somites 114. First dorsal pore IV/V. Prostate pores on small papillæ. Penial setæ largest, with four sharp spines and slightly wider tip; smaller seta with a very thin, slightly sigmoid tip. Diverticle of the spermatheca at the junction of the muscular and glandular part, or in the muscular part. Nephridia in three pairs; No. 1 consists of two lobes of the cœlomic mantle; the ventral lobe is the smallest. Color pale flesh, with yellowish clitellum.

Habitat.—Honolulu, Hawaii. Eight specimens presented by Mr. Alexander Craw. One specimen from Samoa.

The differences between *B. papillata* and the variety *hawaiiensis* while slight are of sufficient interest to warrant their being recorded. It is not necessary to repeat the characters of the species, but only to mention those in which the species and variety differ from each other.

The specimen from Samoa differs in having the diverticle of the spermatheca start from the muscular part instead of from the junction of the glandular and muscular parts, as in the specimens from Hawaii. Unfortunately the penial setæ could not be distinguished in the single specimen from Samoa. I have, however, little hesitation in placing all these forms together in one variety.

External Characters.—Variety *hawaiiensis* is smaller in size and the somites are fewer in number than in the species. The papillæ on which the prostates open are not as prominent as those of the species. The clitellum is very rough and considerably overlaps the genital pit. The smaller penial setæ are less sigmoidal at the tip, which is somewhat shorter than in the species. The largest seta is furnished with four short spines instead of blunt notches as in the species. The first dorsal pore is VI/V.

INTERNAL CHARACTERS.—The diverticle of the spermatheca joins the latter at the junction of the muscular and glandular part or in the muscular part (specimen from Samoa). In the species the junction is much higher up and on the glandular part. The muscular duct in both the species and the variety is comparatively long. The ventral ganglion in the specimen dissected is greatly enlarged in somite X. Of the constancy of this enlargement I am not certain. The nephridia differ considerably from those of the species. They are shorter and do not extend as far dorsally. The ventral nephridium possesses only two cœlomic mantles, while in the species it has three or four. Two figures (figs. 77 and 81) are given, illustrating their comparative size and form.

Diverticles of the Intestine.—The pair in XVII is the largest, and opens separately into the intestine. The pair in XVI is next in size. The pair in XV is the smallest and being connected with the pair in XVI can only be regarded as a projection of the latter, the two opening through one pore on either side into the intestine.

Benhamia nana *Eisen.*

PLATE X, FIG. 76.

Calciferous Diverticles.—A re-examination of my slides of this species has been made in order to compare its calciferous diverticles with those of the species described in this paper. These glands are shaped very much as are those in *Benhamia Bolavi*, var. *pacifica*, and there is a very small lobe projecting forward from the diverticle in XVI into somite XV. This lobe is connected with the diverticle in XVI by a ciliated duct which joins the ciliated duct of the diverticle in XV, which enters the intestine at the same point as the duct from the diverticle in XVII. The septa from the surrounding somites bunch together at this point and are besides very thin and difficult to separate. The figure of the diverticle of *B. Bolavi*, var. *pacifica*, given in this paper, would also illustrate the structure of this organ in *B. nana*, provided the anterior lobe was the smaller, instead of *vice versa* as in the above mentioned variety.

I have also re-examined *Benhamia B.*, var. *papillata*, and *Benhamia B.*, var. *palmicola*, and find that even in these forms the two anterior calciferous diverticles are more or less connected and that the posterior diverticle is separated. In var. *papillata* the two anterior diverticles open together into one ciliated tube or fold, while the diverticle in XVII is separated (fig. 76*c*). In *Benhamia nana* the anterior diverticle is very small (fig. 76*d*).

Benhamia viridis, sp. nov.

PLATE XIV, FIGS. 175, 176.

Definition.—Length 110 mm., width 4 mm. Somites 120 to 140. Prostomium divides somite I completely, but the projection is a mere groove or line often extending as far as somite III. Setæ closely paired. Penial setæ present, not ornamented. Anterior dorsal pore XI/XII. Genital zone is a square field formed by two elevated ridges interior to which are two more or less parallel grooves. Six pairs of tubercles in somites XIV–XIX. Spermathecal pores VII/VIII, VIII/IX. Spermiducal pores in the intersegmental groove XVII/XVIII. Prostate pores in the equator of XVII and XIX. Clitellum saddle-shaped, in XIII–XX. Gizzards in V and VI. Calciferous diverticles in XV, XVI and XVII. Sacculated intestine in XVIII. Typhlosole in XVIII and XIX. No sperm-sacs. Spermathecæ in VIII and IX; large apical sac tapering towards the base; a small wart-like, plurilobed diverticle at the base. Hearts in VII–XII. Micronephridia in eight lobes on each side of the median line. Color bright bluish green; clitellum a yellowish brown.

Habitat.—The type is from Toluca, Mexico, at an altitude of 8,000 feet. One other specimen from the City of Mexico. Collected by Professor A. Koebele.

The most interesting character of this *Benhamia* is the position of the spermiducal pores in the intersegmental groove of somites XVII/XVIII, instead of in the equatorial of XVIII as in all the other species. It thus forms a connecting link between the two genera *Benhamia* and *Dichogaster*. If the spermiducal pores in *Benhamia viridis* had been moved forward just one-half of a somite the species would have been a typical *Dichogaster*.

The single specimen from the City of Mexico differs in some interesting particulars from the specimens from Toluca. The ventral part of somite VIII possesses a genital zone consisting of a small rectangular depression surrounded by two parallel ridges which are flanked by two small papillæ, the whole structure occupying the space of the ventral rows of setæ. Sections of this specimen show a pair of prostates situated with the sperm-ducts in somite XVIII. These prostates, which have the same size and shape as those in XVII and XIX, open into the posterior part of the somite, between the equator and the intersegmental groove. The sperm-ducts seem to fuse in somite XVI, opening as is usual in this species into the intersegmental groove between XVII and XVIII. Adjoining these prostates in XVIII are small penial setæ of the same structure as those opening with the regular prostates in XVII and XIX.

It is interesting to note that an exactly similar proliferation of prostates in the somite of the spermiducal pores was found in a specimen of *Trigaster tolteca* previously described in this paper; it is also found constant in some species of *Dichogaster*.

DETAILED DESCRIPTION.

The limited number of specimens and their indifferent preservation makes it impossible to enter as fully into details as could be wished. This refers principally to points of histological interest.

The *prostomium* divides somite I completely, and a deep crease is projected as far backwards as the anterior half of III.

The *somites* are of even size and smooth. Those containing the spermathecæ are, however, furnished with a deep crease on the ventral side on the posterior half of the somite. The genital zone in the most perfect of the specimens consists of a rectangular depression bounded interiorly by the two more or less parallel grooves. Immediately adjoining these grooves are two elevated ridges, one on either side. Exterior to each of these ridges is a line of papillæ, of which a pair of each is on somites XIV–XIX. Interior to this outer row there are two inner pairs occupying the places of the ventral setæ in somites XV and XVI. These papillæ are absent in some specimens. The spermathecal region in somite VIII is marked by a pair of ventral median papillæ on the anterior half of the somite. The papillæ are situated close together, in line with the ventral setæ.

Setæ.—The ventral setæ as well as the lateral are absent on somite XVIII. The common setæ are strictly paired and all ventral. The tips of the setæ are indistinctly sculptured with small wavy depressions. The penial setæ are short and very slender, about one-third or one-fourth as thick as the ordinary setæ. One seta is straight, of the shape of a knife suddenly contracted at the point. The other is sigmoid and curved at the apex, neither being ornamented exteriorly. Interiorly they are seen to be composed of numerous rings, one following the other as in a coil of wires.

Calciferous Diverticles.—Only the anterior contains lime crystal. The three diverticles open separately into the intestine. There are minute septal glands in VII–XIII.

The *typhlosole* is very small and confined to two somites.

The *clitellum* is not well developed and it is impossible to state whether it is saddle-shaped or ring-like.

The *spermathecæ* consist each of a broad, rather flat spear-head-shaped sac. At the base is a single flat round diverticle with the form of a rosette. Upon closer examination this rosette is seen to be composed of four to ten interior chambers, only slightly set off exteriorly.

The *diverticle* is situated on the anterior side of the septum, while the main sac projects backwards into the posterior somite. The diverticle is about one-third the length of the main sac. There are no sperm-sacs. Spermtanks in X and XI.

The *sperm-ducts* fuse and become invested with a strong muscular covering in XVII. They penetrate the septum separating XVII and XVIII at some little distance from the body-wall, and then bend downwards and penetrate the body-wall immediately under the septum in the intersegmental groove of XVII/XVIII. The anterior prostate and bundle of penial setæ, however, open into the equator of somite XVII, while the posterior prostates and setæ open similarly into the equator of XIX. On account of this arrangement the distance between the anterior prostate and the spermiducal pore is only from one-third to one-fourth that between the spermiducal pore and the posterior prostate.

The *anterior prostate* opens immediately behind the penial setæ. The muscular part of the prostate is long and strong. The glandular part is much folded, but confined to one somite. The testes and sperm-funnels in X and XI and the ovaries in XIII are normal.

The body-wall does not contain a row of the sense organs, found in some other species of this genus.

The following septa are thickened, principally in the dorsal parts:

$\overline{\text{V/VI}}$, $\overline{\overline{\text{VI/VII}}}$, $\overline{\overline{\text{VII/VIII}}}$, $\overline{\overline{\text{VIII/IX}}}$, $\overline{\overline{\overline{\text{IX/X}}}}$, $\overline{\overline{\overline{\text{X/XI}}}}$, $\overline{\overline{\overline{\text{XI/XII}}}}$, $\overline{\overline{\overline{\text{XII/XIII}}}}$, $\overline{\overline{\text{XIII/XIV}}}$, $\overline{\text{XIV/XV}}$.

The *nephridia* are the most complicated of any which I have observed in this genus. There are about eight rows of sacs on either side of the ventral ganglion, but instead of being regular they vary greatly in size and form, some being almost entire, while others are deeply lobed. The different lobes are more connected than, for example, in *Benhamia Bolavi*, var. *papillata*. The ventral micronephridium is as usual the most compound.

The beautiful color of this species is an unusual one in Oligochæta. Beddard in his large monograph mentions that he has seen a species of *Benhamia* from Trinidad of a bright green color. It is, of course, impossible to say whether Beddard's species is identical with mine, as circumstances did not allow him to describe it.

Benhamia jamaicæ, sp. nov.

PLATE XIV, FIGS. 168, 169.

Definition.—Length 40 mm., width 4 mm. Somites 130. Setæ closely paired, the lateral interval slightly greater than the median. Penial setæ present, smooth with hook-like apex. Male pores in the equator of XVIII. Anterior prostate pores in the posterior part of XVII; posterior prostate pores in the equator of XIX. Prostomium large, divides somite I completely. Somite II larger than those following. First dorsal pore in VI/VII. Clitellum complete but ventrally thin, in XIII–XX. Gizzards two, in VI and VII. Diverticles of the intestine, three pairs in XV, XVI, XVII, not connected with each other and opening independently into the intestine. Sacculated intestine in XIX. Dorsally and ventrally enlarged intestinal epithelium in XXI to XXIV. Suprapharyngeal glands with four tiers of lobes. Septal glands thin but almost continuous from VIII to XIV. Spermathecæ: pores postseptal, VII/VIII, VIII/IX, main sac in VIII and IX, tubular, with a minute, wart-like diverticle at the base and a larger diverticle higher up. Testes in X and XI. Sperm-funnels in X and XI. Sperm-masses in X and XI. Ovaries in XIII. Ovisacs in XIV. Oviducts in XIV. Prostates large and thick, confined to somites XVII to XIX. Sperm-ducts fused, in XVII, a horseshoe-like loop in XVI. Micronephridia, posterior ones, with cœlomic mantles. Color reddish.

Habitat.—Island of Jamaica. One specimen collected by Professor C. H. Tyler-Townsend.

DETAILED DESCRIPTION.

Owing to the want of specimens for dissection, the description of some of the interior organs, especially that of the spermathecæ, is not as full as is desirable.

Somites I, II and III are set off from the balance. Somite III is the largest. The intersegmental groove between I and II is hardly distinguishable.

The common *setæ* are smooth and not characteristic. The larger of the penial setæ is a little more curved than the smaller. The apex of both is furnished with a small close, helix-like hook, which in the larger seta is a trifle more distinct than in the other.

Sense-cells.—There is a zone of hyaline cells with sense-cells in the equator of every somite, also similar cells in the anterior parts of the pharynx.

The *septa* are only very slightly thickened in some places. The septal formula is as follows:—

VI/VII, VII/VIII, VIII/IX, IX/X, $\overline{\text{X/XI}}$, $\overline{\text{XI/XII}}$, $\overline{\text{XII/XIII}}$, XIII/XIV.

The *dorsal pores* are large and distinct even to the last somite of the tail.

The *diverticles* of the intestine are large, rounded and oblong, without indentations. Each diverticle opens independently into the intestine and is not connected with the other. The posterior ones are the largest. All are of the same structure, containing no crystals, only lime globules.

The *spermatheca* consists of a main sac, tubular in form and much twisted. There is a small wart-like diverticle at the base of the posterior spermathecæ, but this diverticle is not seen in the anterior pair. In both pairs there is a large diverticle inserted below the centre of the main tubular sac. The diverticle is enlarged at the apex. The apex of the main tubular sac is enlarged, with an outer, irregular outline and with an interior racemose chamber.

The *prostates* are thick and the glandular part is composed of two layers of cells. They open in the equator of their respective somites. The sperm-ducts are fused in XVII and covered with a strong muscular investment. There are no sperm-sacs, only sperm-masses.

The last *hearts* are in XII.

The *genital zone* is rather indifferently preserved in the single specimen. It is square and considerably depressed. In each of the depressed somites is seen an elevated ridge connecting the setæ, but somewhat broken in the median line. The ovipores could not be distinguished.

Benhamia guatemalæ, sp. nov.

PLATE XIV, FIGS. 172–174.

Definition.—Length 40 mm., width 2 mm. Somites 127. Prostomium divides somite I about one-third. Most anterior dorsal pore XII/XIII. Clitellum in XIII–XX. Genital zone a round depression, with four small papillæ marking the prostate pores. A zone of pellucid cells in the equator of each somite. Setæ paired. Penial setæ present, but not ornamented. Gizzards in V and VI. Tubular intestine ciliated. Diverticles of the intestine in XV, XVI, XVII, each opening independently into the intestine. The two anterior with crystals. Sacculated intestine in XIX. Spermathecæ in VII and VIII; their pores VI/VII, VII/VIII; each with a rosette-like pluri-chambered diverticle near the base. Sperm-sacs racemose, two pairs, in XI and XII. Sperm-masses in X and XI. Testes and funnels in X and XI. Ovaries in XIII. No ovisac. Prostates open in the equator of XVII and XIX. Sperm-ducts open in the equator of XVIII. A dorsal typhlosole beginning in XXVI. Last heart in XII; a trace of septal, but no subpharyngeal glands. Suprapharyngeal glands slender, in four lobes. Micronephridia in five rows on either side.

Septal formula:—

VI/VII, VII/VIII, VIII/IX, $\overline{\text{IX/X}}$, $\overline{\text{X/XI}}$, $\overline{\overline{\text{XI/XII}}}$, $\overline{\overline{\text{XII/XIII}}}$, $\overline{\text{XIII/XIV}}$, XIV/XV.

Habitat.—Found in garden soil in the City of Guatemala, Central America.

This species differs from *B. mexicana* in several particulars. The setæ are closely paired and the distance *a–b* is equal to the distance *c–d*. The nephridia are in five rows, while in *B. mexicana* they are in three rows.

DETAILED DESCRIPTION.

The *setæ* are closely paired and the ventral interval is about one-fourth larger than the lateral. The penial setæ are almost straight and their apex is straight, smooth and without ornaments. The prostates terminate on small papillæ.

The *septal glands*, situated close to the intestine in VII–XIII, are hardly perceptible and only one or two cells thick.

The *nephridia* are highly developed micronephridia in all the posterior somites. They are arranged in five rows on each side of the median line. Of these rows the most ventral is the largest. It is also much more branched than the others and occupies the whole lateral interval between setæ *b–c*. Of the remaining micronephridia those in rows 2 and 4 are considerably smaller than those in rows 3 and 5.

There is a *dorsal pore* between XII and XIII but no other anterior dorsal pore. The postclitellar pores begin between XX and XXI.

The *diverticles* of the intestine are not connected with each other, but open independently into the intestine in their respective somites. The posterior pair is the largest, the anterior the smallest. The two anterior pairs contain large crystals. The posterior pair did not contain any secretions.

Spermathecæ.—These organs are large and sac-like, each being furnished with a large rosette-like diverticle containing several pear-shaped chambers strongly marked on the exterior of the diverticle. The diverticle projects through the anterior septum into the somite next anterior to the pore. The pores open into the intersegmental grooves. The specimen sectioned contains an additional spermatheca on one side of the body. It opens into the intersegmental groove between V and VI. It is quite rudimentary. The two main pairs of spermathecæ are in somites VII and VIII.

The *testes* in X and XI, and the two pairs of sperm-funnels in the same somites, offer nothing characteristic. There are two pairs of very minute, racemose *sperm-sacs* in XI and XII, situated on the lateral and ventral sides of the cœlom. The two *sperm-ducts* fuse in XVII, and in XVIII are invested with a muscular coat as thick as the muscular part of the prostates. Both the prostates and the sperm-ducts open into the equator of their respective somites.

Dichogaster *Beddard.*

General Remarks on Affinity.

The three new species which I am enabled to describe tend to further cement together the various species of this genus, as well as to confirm the views held by Dr. Michaelsen in regard to the affinity of the genus. He explains the striking similarity between some species of *Benhamia* and

Dichogaster by supposing that the latter genus has descended from the former through a process of reduction of the prostates and through a displacement of the male pore. That such reduction and displacement has actually taken place is evident from the fact that some of the species now described offer characteristics which are intermediate between the two genera. A perfect series is had from the typical *Benhamia* with its male pores in the equator of XVIII to the typical *Dichogaster* with its male pores opening with the prostates in the equator of XVII.

Benhamia viridis forms the first link in this chain. In this species the pore of the sperm-ducts has advanced more than one quarter of a somite, being found in the anterior part of XVIII near the intersegmental groove. The next link is seen in *Dichogaster Ribaucourti*, where we find the pore of the sperm-ducts in the intersegmental groove between XVII and XVIII. In this species the prostates have remained. The next link is *Dichogaster Townsendi*, in which the pore of the sperm-ducts is in the equator of XVII, together with the prostate pore, but the remains of the former spermiducal somite are yet recognizable in an accessory septum found in somite XVII. This accessory septum is situated immediately posterior to the sperm-ducts, lying between them and the septum separating somite XVII from the fully developed somite next posteriorly. As might be expected, somite XVII is slightly larger than either of the adjoining somites, but otherwise there is no exterior sign that two somites have been fused together.

The development of *Dichogaster* from its *Benhamia*-like ancestors has thus comprised two distinct processes: one consisting of a displacement of the male pore forward, the other in a reduction in size and the disappearance in part of the male pore-bearing somite, XVIII.

As regards the reduction of the prostates, we find this to be more or less complete and not subjected to any general rule. While in some species the prostates have disappeared from the somites posterior to the male pores, in others they have remained, and in some species—*D. Townsendi* and *D. Damonis*—an increase in the number of prostates has taken place.

It is superfluous to state that the author fully agrees with Dr. Michaelsen's theory of the derivation of *Dichogaster* from ancestral *Benhamias;* also in the derivation of Cryptodrilini from Acanthodrilide ancestors. It is impossible with our present knowledge of the structure of the various species of *Dichogaster* and *Benhamia* to keep the families separate as proposed by Beddard.

It may be of some interest to recapitulate and review the similarities between the genera *Benhamia* and *Dichogaster*. These similarities are so many and so important that they can not possibly be accounted for by chance. The following characters are found in some of the species of both genera:—

1. A pellucid zone of sense-cells in the pharyngeal region.
2. A zone of sense-cells in the equator of each somite.
3. Micronephridia covered with a cœlomic mantle.
4. A great variation in the nephridia in the different species.
5. Intestinal posterior cœca *(Millsonia* and *Benhamia cœcifera).*
6. A very characteristic arrangement and structure of calciferous diverticles in XV, XVI and XVII.
7. The form of the spermathecæ.
8. A depressed genital zone, below the general surface of the body.
9. Two forward gizzards.
10. A tendency to variation in the position of the spermiducal pore.

In the following, Dr. Michaelsen's view as to the limits of the genus has been accepted to the extent of placing in it the genus *Millsonia;* but in addition, in concurrence with the suggestion of Beddard, the genus *Microdrilus* has also been included. This I know will clash with Dr. Michaelsen's view as to the reduction of the prostates and their relation to the spermathecæ. Dr. Michaelsen holds that the reduction of the posterior prostates and the forward movement of the sperm-ducts has been necessarily accompanied by a reduction of the *anterior* pair of spermathecæ. So far as we know, this has been the case in four only of the *Dichogaster* species, *Dichogaster Damonis*, for instance, being an exception.

On examination, *D. Townsendi* is found to greatly resemble *D. Damonis* in almost every particular, except that the former possesses two pairs of spermathecæ. It is impossible to separate these two species and refer them to different genera. Among the other species, *Microdrilus saliens* differs from *D. Braunsi* principally in the possession of two pair of spermathecæ, but in other respects the reduction of the prostates and the forward movement of the sperm-ducts have been completed. In another species, *D. Ribaucourti*, the forward movement of the sperm-ducts has alone been accomplished, the two pairs of prostates and the two pairs of spermathecæ remaining.

As the genus *Dichogaster* is now presented, it is impossible to segregate any one of the species without destroying the whole genus. If, for instance, we begin by assigning *D. Ribaucourti* to the genus *Benhamia*, on account of its two pairs of prostates and its two pairs of spermathecæ, then we must, to be consistent, refer *D. Townsendi* also to this genus; but if *D. Townsendi* is placed in the genus *Benhamia*, *D. Damonis* must likewise be placed there, as these two species differ only in the presence or absence of the anterior pair of spermathecæ. Similarly, if we transfer *D. saliens* and *D. Crawi* to the genus *Microdrilus*, then, also, must be referred to this genus several other species which do not possess posterior prostates.

As will be seen from the above, it is impossible to segregate any of the species and place them in other genera without destroying the whole genus. At the same time, we see that the most constant character is the position of the sperm-ducts in the center of somite XVII; but even this constancy of character is shaken by the position of the sperm-ducts in the intersegmental groove in *D. Ribaucourti.* It may further be seen that the reduction of the prostates is often but not always accompanied by a corresponding reduction in the anterior pair of spermathecæ. In one species the anterior pair of spermathecæ has been reduced but the prostates have been increased.

In *D. Damonis,* for which species the genus *Dichogaster* was created by Beddard, the only pair of spermathecæ is found in somite VIII and not in IX, the reduction in this species having taken place in the posterior pair of spermathecæ and not in the anterior pair. Under these circumstances, the validity of the theory advocated by Dr. Michaelsen, that the reduction of the posterior prostates is accompanied by a reduction of the anterior spermathecæ, is questionable. Should we eliminate from the genus *Dichogaster* any species with spermathecæ in somite VIII, then we would have to drop from the genus the very species for which the genus was created.

Since the above was written, the author has received from Dr. Michaelsen his interesting paper on *Balanta* (29). In this paper Dr. Michaelsen enlarges yet further upon his views in regard to the reduction of the anterior spermathecæ and the posterior prostates. If we consider all the known species of *Dichogaster*, it will be seen that the theory does not hold good in all instances, and cannot, therefore, be considered of universal importance. The accompanying diagram, arranged in accordance with that constructed by Dr. Michaelsen, will, I think, show the variations in the reduction of the prostates and spermathecæ. Here it will be seen that while in *Dichogaster Crawi* the posterior prostates have been reduced, the anterior and corresponding spermathecæ remain; and also that although the posterior spermathecæ have been eliminated in *D. Damonis*, the anterior prostates still remain. Moreover, the diagram shows that while in some species the sperm-ducts have been moved forward, no corresponding elimination of prostates and spermathecæ has taken place. In order to make the diagram more useful I have included the gizzards and diverticles and also endeavored to show the three kinds of nephridia. The diagram of *D. nigra* will serve also for *D. mimus*, *D. Braunsi* and *D. Hupferi.* In *D. mimus* the sperm-sacs are in XI and XII. In the other two species they are unknown.

KEY TO THE SPECIES OF *Dichogaster*.

I. Two pairs of spermathecæ.

1. One pair of prostates in XVII. Somite I reduced. Penial setæ present . . . . *D. Crawi*, sp. nov.
2. One pair of prostates in XII. Somite I normal. Penial setæ present . . . . *D. saliens* BEDDARD.
3. Two pairs of prostates in XVII and XIX. No penial setæ. Male pores in the intersegmental groove, but in XVII. *D. Ribaucourti*, sp. nov.
4. Three pairs of prostates in XVII, XVIII and XIX. No penial setæ. Male pore in the equator of XVII. *D. Townsendi*, sp. nov.

II. One pair of spermathecæ. No penial setæ.

5. Three pairs of prostates in XVII, XVIII and XIX. A wart-like spermathecal diverticle. Spermathecal pores VII/VIII. *D. Damonis* BEDDARD.
6. One pair of prostates in XVII. Male pores open in a copulatory bursa. Spermathecal pores VIII/IX. No spermathecal diverticle . . . . *D. nigra* BEDDARD.
7. One pair of prostates in XVII. Male pores separated. Spermathecal pores VIII/IX. A wart-like spermathecal diverticle. *D. mimus* MICHAELSEN (10).

III. One pair of spermathecæ. Penial setæ present; one pair of prostates in XVII.

8. Differentiated spermathecal sexual setæ. *D. Hupferi* MICHAELSEN (6).
9. No differentiated spermathecal sexual setæ. *D. Braunsi* MICHAELSEN (18).

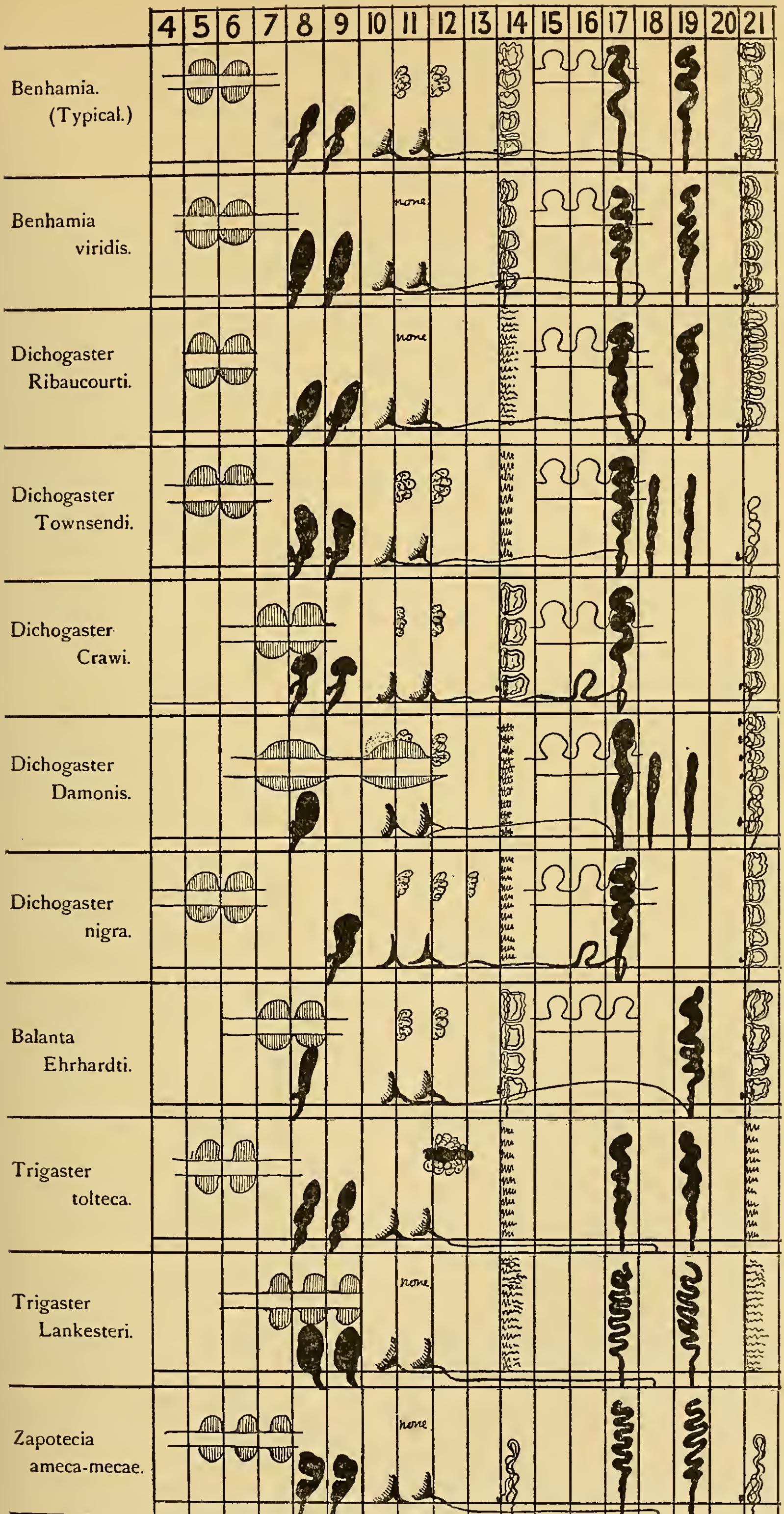


DIAGRAM SHOWING LOCATION OF GIZZARD, SPERMATHECÆ, SPERM-SACS, PROSTATES, SPERM-DUCTS, DIVERTICLES AND THE NATURE OF THE NEPHRIDIA.

Dichogaster Crawi, sp. nov.

PLATE VI, FIGS. 82–94B, 112, 113.

Definition.—Length 40 mm. Somites 120. Prostomium and somite I are reduced. Clitellum complete, in ½ XIII–½ XX. Genital zone sunk, narrow, from XVI–XVIII. Male pore on papillæ in XVII, in line with setæ *ab*. Setæ strictly paired, faintly ornamented. Setæ *ab* absent in XVII. Penial setæ straight with seven knees on each side. Dorsal pores begin III/IV. Spermathecal pores VII/VIII, VIII/IX, in front of setæ *ab*. Testes in X and XI. Ovaries in XIII. Racemose sperm-sacs in XI and XII, postseptal. Ovisacs, one pair in XIV. Oviducts in XIV, opening into separate pores, situated close to and interior to setæ *ab*. Gizzards two, in VII and VIII. Tubular intestine begins in XII. Sacculated intestine begins in XIX. Typhlosole large, commences in XXIII, zigzags on dorsal side. Calciferous diverticles in XV, XVI, XVII, with one duct in XVI. Last heart in XIV. Prostates confined to somite XVII. Sperm-ducts open immediately behind prostates in the same papilla. Micronephridia in four rows on each side of the median line.

Habitat.—Honolulu, Hawaii. Found among the roots of plants received at San Francisco. Collected and presented by Mr. Alexander Craw, State Horticultural Quarantine Officer of California, after whom I take pleasure in naming the species. One specimen was also received from the plant-house at Del Monte, California, taken in June, 1897. The worms when alive showed great activity, jumping several inches into the air when touched.

The specimen from Del Monte differed from the Hawaiian specimens in the disposition of the nephridia and in having a little longer spermathecæ. *Dichogaster Crawi* is nearest related to *Dichogaster saliens.* Judging from Beddard's rather short description, the two species differ from each other in the following particulars:—

Dichogaster Crawi.	*Dichogaster saliens.*
Somite I reduced.	Somite I normal.
Penial setæ with a fine hair tip furnished with a knob.	Penial setæ without fine hair tip.
The posterior calciferous diverticle connected by a ciliated duct with the duct of the anterior diverticle.	The posterior calciferous diverticle connected with the upper part of the anterior diverticle, and without any ciliated duct.

External Characters.

Somites.—The prostomium (fig. 84) is very small and causes only a small indentation in somite I, which is the narrowest, being about one-third the width of II. The somites following increase slightly in width up to somite VI and VII, both of which are of equal size, and about twice as wide as I. Somites VIII to XII gradually decrease in size towards the clitellum, which commences in the center of XII and continues to the center of XIX. The somites posterior to the clitellum are much narrower but more distinctly three-ringed. Somite I is narrowest on the ventral side.

Dorsal pores.—First pore III/IV. The first very distinct pore, viewed exteriorly, is V/VI.

Setæ.—The setæ are strictly paired and ventral, not reaching the lateral line. The couples are nearly equidistant from each other, except in the somites where a deltoid arrangement is found, similar to that which is seen in some species of *Microscolex (Deltania)*. The distance *a–a* increases from about somite XXVIII to XVII, in which is the male pore; and from XVII the distance increases forwards to somite XI, then decreases towards VIII and VII, the spermathecal somites. From VII forwards there is first a slight increase, then a narrowing towards I.

All the setæ are slightly sigmoid, with four or more slight notches or spines near the apex. There are two bunches of penial setæ in XVII, at each male pore. The projecting part of the setæ is either slightly curved or perfectly straight, tapering to a fine point, which is bent in a right angle and furnished with a knob. The outline is strongly wavy, showing about seven sharp knees on either side, but with no other ornamentation. The smaller seta has the knees less prominent and the bent apex longer, and the knob fully as large as that of the larger seta. The third seta appears to be undeveloped. In one sac this seta was very strongly curved.

Genital Zone.—(fig. 83.) This zone is small but distinct. It commences with somite XVI and ends with somite XVIII. It is very narrow, of about the width of a somite, except in the centre, where it is about twice as wide. The whole zone is sunk as in *Benhamia* and surrounded by an elevated ridge of clitellar cells. There are no distinct markings of the somites in the zone, except at the boundaries. There are two male papillæ in the centre of the zone, from each one of which protrudes the large, almost straight apex of a penial seta.

Lymphocytes and Cells of the Body-wall.—(figs. 91, 113.) The prostomium is well developed and its epithelial cells are taller than the cells of the nearest somites, tapering towards the interior and ending in a fine hair-point. Such cells are also, though more sparingly, found in the epidermis of the other somites, interspersed among ordinary supporting cells. They stain differently from the latter, being more erythophile, while the supporting cells are decidedly cyanophile. In the former pages of this paper it has been pointed out that similar cells are found in large numbers in the caudal zone of *Pontoscolex*, and it is stated as my opinion that they are probably sense-cells, especially responding to vibrations transmitted through the soil.

On the inner side of the prostomium, but especially on the two inner lips or ridges separating the mouth from the palate, we find groups of regular taste-cells, each with a fine hair-point. They occur in bunches of twenty or more, and the hair-points frequently project through the cuticle in such numbers as to give the cells the appearance of being ciliated. These cells stain much deeper than the other sense-cells. They have the same general form.

Dr. R. Hesse in a most admirable paper (2) has described a number of cells of very distinct construction, which he supposes, and as it appears with very good reason, to be cells sensitive to light. Cells of a similar nature are found in considerable numbers in the prostomium of *Dichogaster Crawi*. Their structure is similar to that of the light-cells of *Allolobophora arborea*, as figured by Hesse. They vary

Table of Species of *Dichogaster*.

	Dichogaster Crawi *Eisen.*	**Dichogaster saliens** (*Beddard*). *Microdrilus saliens* Beddard (57).	**Dichogaster Ribaucourti** *Eisen.*	**Dichogaster Townsendi** *Eisen.*	**Dichogaster Damonis** *Beddard* (45).	**Dichogaster nigra** (*Beddard*). *Millsonia nigra* Beddard (85).	**Dichogaster mimus** *Michaelsen* (10). *Millsonia rubens* Beddard (85).	**Dichogaster Hupferi** *Michaelsen* (6).	**Dichogaster Braunsi** *Michaelsen* (18).
Size and Somites.	40 mm. by 2 mm. Somites 120.	25 mm.	80 mm. to 100 mm. by 3 mm. Somites 150.	90 mm. by 5 mm. Somites 165.	1000 mm.	230 mm. by 7 mm.	4000 mm. by 13 mm. Somites 350.	180 mm. by 6 mm. Somites 250.	38 mm. by 3 mm. Somites 158.
Anterior Somites.	Prostomium well developed; somite I very diminutive; somite II with setæ.		Prostomium divides somite I completely.	Prostomium as well as somite I well developed.		Prostomium not encroaching on I, which is normal.	Prostomium does not encroach on I.	Somite I is normal. Intersegmental grooves distinct only anteriorly, posteriorly smooth.	Somite I normal.
Clitellum.	Complete ½ XIII–½ XX, very thin ventrally.	Complete except on XIX. Extends over XIII–XIX.		Unknown.	Incomplete, covering XIII–XX.		Incomplete in XVI–XIX, covering XIII–XXII (XXIII).	Not developed in the specimen described.	Covering XIII–½ XIX, not quite complete.
Dorsal Pores.	Commence III/IV.	Commence IV/V.	No dorsal pores anterior to clitellum.	Present, only posterior to clitellum.	Present.	Commence X/XI.	Most anterior IV/V. Pores on the clitellum.	Commence XVIII/XIX.	Not recognizable.
Genital Zone.	A central median depression in XVI–XVIII. One pair closely approached papillæ in line with ventral setæ. Male pore double, more ventral than setæ *ab*.	Two semicircular papillæ, with their straight sides opposed to each other.	Two lunate ridges, with the concavity ventral.	A central, median, square depression, with one pair of small papillæ in XVII. No setæ *ab* in XVII and XVIII.	Not depressed. Three pairs of distinct pores; those in XVII on a tumid area between the ventral setæ. Similar areas in XVIII and XIX more distinctly marked off.	Male pores consist of a single copulatory bursa, which is surrounded by a smooth area.	A round field between XVI–XIX. A pair of large male pores in line with setæ *ab*. No copulatory bursa.	Male pores in line with setæ *ab*.	A narrow transverse zone surrounding two rounded, protruding papillæ in line with setæ *ab*. Male pore double.
Setæ.	Strictly paired, all ventral, converging towards the male and spermathecal pores, all faintly sculptured at apex. Distance *a–a* only in places greater than *b–c*.	Paired.	Strictly paired, all ventral.	Strictly paired, all ventral, not converging towards the male pores. Not sculptured. Distance *a–a* one-third larger than *b–c*.	Strictly paired. Distance *a–a* somewhat smaller than *b–c*. Ventral setæ absent on XVII to XIX.	Strictly paired, ventral distance *a–a* somewhat greater than *b–c*. No setæ on somites I–V.	Strictly paired, all ventral. Distance *a–a* is slightly greater than *b–c*.	Strictly paired, all ventral, on small white papillæ. Distance *a–a* slightly greater than *b–c*.	Strictly paired, all ventral, not converging towards the sexual pores.
Penial Setæ.	Three at each prostate pore. Apex undulating, tips hair-like and bent, with a minute knob.	Undulating at apex, with fine notches at each bend.	No penial setæ.	No specialized penial setæ.	No penial setæ.	No penial setæ.	None present.	Several in each sac. Apex is a regular curve; tip on inside pinched. Apex, but not tip, ornamented with minute and closely set teeth.	Slightly curved, undulating at apex, the latter with a knob-like enlargement. No hair-like tip.
Sperm-ducts.	A horseshoe-like loop in XVI, heavy muscular investment near the pore. Pore immediately behind prostates but on the same papilla.	A muscular investment near the pore; open immediately behind the prostates.	Straight, join in XVII and open into intersegmental groove XVII/XVIII.	No horseshoe-like loop in XVI. A heavy muscular investment near the pore. Opens in the same pore as the prostate and immediately behind this organ, in the equator or in somite XVII.	Without muscular investment near the pore.	A muscular investment near the male pore. Open separately in a copulatory bursa.	A horseshoe-like loop in XVI. Open with a folded prostate.		
Prostates.	One pair, tubular, straight, confined to somite XVII.	One pair, straight and tubular.	Two pairs: the anterior pair opens close to the sperm-ducts in XVII; the posterior pair opens into the equator of XIX.	Three pairs, tubular, each one confined to one somite, open in the equator of the somites, in XVII, XVIII and XIX.	Three pairs, in XVII, XVIII and XIX; their pores correspond to the ventral setæ; those in XVII are largest.	One pair, tubular, slender, the glandular part coiled. Open in the posterior margin of a median central bursa.	One pair, in XVII, tubular.	One pair, irregularly rolled together in XVII.	One pair in XVII, the glandular part folded into a squarish rounded body.
Spermathecæ.	Two pairs, pores separate, VII/VIII, VIII/IX, in front of setæ *ab*; toadstool-like, a single diverticle. No modified sexual setæ.	Two pairs, each with a single diverticle.	Two pairs, in VIII and IX; their pores VII/VIII, VIII/IX. Several small wart-like diverticles pointing forwards.	Two pairs, pores separate in the intersegmental grooves VII/VIII, VIII/IX. A single composite diverticle. No modified sexual setæ.	One pair in VIII, the pores of which are close to the median ventral line near anterior margin of VIII (VII/VIII). A mulberry-like, composite diverticle directed forwards.	One pair in VII. Pores VIII/IX, close together, corresponding to ventral setæ. Has the form of a short foot with toe pointing backwards. No diverticle.	One pair, sac-like. Pores VIII/IX, in line with setæ *c–d*. One wart-like diverticle. No differentiated sexual setæ.	One pair in IX, sac-like. Pores in line with setæ *ab* VIII/IX. Differentiated sexual setæ in large numbers, in four sacs. Exterior part with broad rows of teeth.	One pair in IX. Pores VIII/IX. Sac-like, each with two twisted, tubular diverticles. No sexual spermathecal setæ.
Sperm-sacs.	Racemose sacs in XI and XII, postseptal.		Not developed in the immature specimens.	In XI and XII, both pairs racemose and postseptal.	One median, sac-like, in X; one pair partly racemose in XI; one pair racemose in XII.	In XI, XII and XIII, the latter the largest, all postseptal.	In XI and XII, small, postseptal.		
Oviducts.	Open upon a large median papilla, but through separate pores in line with *ab*.	Pores ventral to setæ *ab*.	Separated.	Unknown.	Open on two separate pores, closely approximated, within the ventral setæ and in line with the prostate pores.		Open separately in line with setæ *ab*, connected by a fold curved backwards, in the body-wall.		Open in a transverse slit.
Ovisacs.	One pair in XIV.		No ovisacs developed.	Unknown.					
Septa.	Thickened are VIII to XIV.		Thickened are VIII to XV.	Thickened XI/XII–XIV/XV, only ventrally and dorsally.		Thickened are IV/V–XIII/XIV.	Thickened are IX–XVII.		
Intestine.	Straight, no posterior appendices. Large typhlosole commencing in XXIII.	No posterior appendices (?). Sacculated intestine commences in XVIII.	No intestinal cœca. No typhlosole. Sacculated intestine in XIX.	No posterior appendices.		About thirty pairs of cœca. Typhlosole.	Sacculated intestine commences in XVIII. Cœca in XXVIII–LX.	Intestine without cœca.	No posterior cœca.
Gizzards.	Two in VII and VIII.	Two.	Two in V and VI.	Two in V and VI.	Two in VII to X, each one occupying two somites.	Two in V and VI.	Two in V and VI.	Two.	Two, in VIII and IX.
Calciferous Diverticles.	Three pairs in XV, XVI, XVII, opening through one pore in XV/XVI. The anterior diverticle is a fold of the one in XVI.	Three pairs in XV, XVI, and XVII, only the middle pair opens in the gut XV/XVI. The connecting passage is high up, away from the intestine.	Three pairs in XV, XVI and XVII, opening through three separate pores into the intestine.	Three pairs in XV, XVI and XVII, opening separately into the intestine.	Three pairs in XV, XVI and XVII, the anterior pair the largest.	Three pairs in XV, XVI and XVII.	Three pairs in XV, XVI and XVII.		Two pairs, in XIV and XV (?), of equal size.
Last Hearts.	In XIV. Dorsal vessel dilated in XIII and XIV.		In XIV.	In XII.			In XII. Dorsal vessel dilated in XVI and XVII.		
Nephridia.	Micronephridia, in four rows on each side, the posterior ones with cœlomic mantle, equidistant. Peptonephridia in IV.	Probably micronephridia posteriorly.	Micronephridia, posteriorly in ten rows on each side and with cœlomic mantles. Anteriorly plectonephridia.	Anterior to clitellum, micronephridia without cœlomic mantle; posterior to clitellum, meganephridia	The first five are peptonephridia. The following anterior ones consist of small tufts—plectonephridia. Posteriorly, micronephridia, in six rows; one nephridium of these being larger and perfect.	Posteriorly micronephridia with cœlomic mantles; anteriorly plectonephridia.	Plectonephridia anteriorly; micronephridia posteriorly.	Plectonephridia.	Plectonephridia.
Color.	Pink; clitellum yellowish gray.		Reddish brown, strongly pigmented and iridescent on dorsal side.	Superiorly, reddish brown, pigmented. Ventrally, pale without pigment.		Dark brown, almost black.	Anteriorly pale violet gray, clitellum brown; posteriorly brick-red.	Dorsal side brownish; ventral side yellowish.	Grayish brown with violet clitellum.
Habitat.	Honolulu, Hawaiian Islands.	Singapore, Java, Penang.	City of Mexico.	The Island of Jamaica, West Indies.	Fiji.	Lagos, West Africa.	Lagos and Accra, West Africa.	West Africa.	Sierra Leone, West Africa.

in size and shape, but the central core in the cytoplasm is always rounded or ovoid. The cytoplasm of the core (fig. 113) is always coarsely vacuoled or foam-like, while that outside of the core is much more finely granulated. The distinction between the two is always great and well marked, the central core staining paler than the surrounding cytoplasm. The best differentiation was effected with eosin and thionin. With hæmatoxylin the foamy structure of the cytoplasm becomes clouded and indistinct.

These light-cells were not found outside of the prostomium. There were none in the brain or in other ganglia. Beddard described in *Microdrilus saliens* a zone of clear cells in the pharynx, similar to the corresponding zone in *Benhamia*, and he calls attention to the astonishing resemblance between these two genera in this respect. In *Dichogaster* such a zone exists in the two circular lips or ridges of the mouth, next to the prostomium, but it is less well defined than in *Benhamia*, common supporting cells appearing between the clear cells. At one end of this zone there is an area consisting of glandular cells. In the central median line of each somite there is a continuous row of glandular cells, six to ten cells deep, staining more intensely than the regular goblet cells of the epidermis. In the center are a few sense-cells, but as far as I can see with no sense-hairs. This zone resembles the sense-zone found in the equator of the somites of *Benhamia*, but it is less differentiated and defined.

Mucocytes.—(fig. 12.) There are several kinds of lymphocytes in the cœlomic cavity. The large majority consist of very large mucocytes, each with a nearly central nucleus and foam-like cytoplasm, radiating towards the nucleus. These call for no special description.

Morocytes.—This name is proposed for a certain kind of lymphocyte with peculiar characteristics. The nucleus is nearly always situated close to the cell-wall. The cytoplasm is separated into two distinct parts. One of these is central, extending from one end of the cell to the other;

this part is generally sausage-like, curved or rounded, and appears quite solid. One of its long ends touches the nucleus while the other reaches the cell-wall on the opposite side. This large central body is connected by a few very thin cytoplasmic strands with the cell-periphery. It is composed of a number of hyaline globules of various sizes, around which the cytoplasm is crowded. The central cytoplasmic core resembles a mulberry; hence the name.

Eosinophiles.—These cells are small and round, of the same size as the morocytes, but less numerous. The diameter of the nucleus, which is frequently slightly polymorphous, is twice the diameter of the morocyte. The cytoplasm is coarse and fills the cell outside of the nucleus.

INTERNAL CHARACTERS.

Septa.—Some of the septa are slightly thickened. The most anterior thickened septum is that separating somites IV and V; it passes behind the suprapharyngeal glands. This septum is quite as thick as the longitudinal muscular layer of the body-wall. There is an exceedingly thin strand separating V and VI. Posterior to this there are no distinct septa until VIII/IX. The following septa are all very thin, but XI/XII, XII/XIII, XIII/XIV are thickened, principally nearest the body-wall on the dorsal side. The last three septa mentioned are as thick as the muscular layer of the body-wall. The septum separating XI and XII is connected by muscular straps with the posterior parietes on the dorsal side. This structure has been described by Beddard as also belonging to *Dichogaster rubens* and *D. nigra*, though occurring in different somites in those species.

The specimen of *Dichogaster Crawi* which I sectioned longitudinally is peculiar in that each of somites XI and XII has two septa, one at a little distance from the other and running somewhat irregularly. The septum X/XI corresponds to the intersegmental groove X/XI. In septum XI/XII, the anterior part is situated in the center of XI, the posterior part in the intersegmental groove XI/XII; there is also a septum extending from the posterior intersegmental groove on the ventral side of XII to the center of the dorsal side of XII. The formula for the septa would be as follows:

$\overline{\text{IV/V}}$, V/VI, O, O, O, O, X/XI, $\overline{\text{XI/XII}}$, $\overline{\text{XII/XIII}}$, $\overline{\text{XIII/XIV}}$, disregarding the double septa in XI and XII, the constancy of which is not proven.

Intestine.—(fig. 91.) The prostomium is quite large and furnished with an epithelium much wider than that of the body-wall, consisting almost exclusively of taste-cells interspersed with a few light-cells. At the inner base of the prostomium there runs all around the mouth the usual pair of lip-valves capable of closing the intestinal tract against the exterior. Between the lips and the pharynx there is a space as wide as the lips themselves, occupied by a common epithelium. The pharynx is developed only dorsally and is sac-like. The pharyngeal glands are large, especially the posterior lobe. The anterior lobes are hardly perceptible in longitudinal median sections. In slightly extra-median sections we see that the anterior lobes are present, but small. There are five lobes, respectively diminishing in size forwards, but the anterior lobe is very much smaller than the one next to it—so small that it readily escapes observation.

The *œsophagus* extends a considerable distance behind the pharynx. It is at first narrow, widening out to about three times the original width and then joining the gizzards.

The *gizzards* are in VII and VIII, joined by a narrow bridge. Behind the gizzards the intestinal walls are furnished with a thick, folded epithelium extending through somites IX–XII inclusive. In XIII the intestine becomes tubular, the epithelium not being folded and the walls being narrow. This part of the intestine is perfectly straight throughout, there being no bend either before or behind the gizzards.

Calciferous Diverticles.—(figs. 92, 93.) There are three pairs, the same as in *Benhamia*, and they are of the same general structure. There is only one entrance from the diverticles, on either side, to the intestine. This entrance is situated on the dorsal side of the intestine, just below the septum XV/XVI. But the connection between the diverticles on each side is not such as is figured by Beddard in his *Microdrilus saliens*. There we see that the connection is high up and the posterior diverticle appears to be merely a fold or projection of the middle one. In *Dichogaster Crawi* the posterior diverticle is connected with the main duct by a long duct which runs parallel to the intestinal wall. The anterior pair of diverticles is in reality only lobes of the second pair, and only slightly set off from it. The posterior pair is well set off from the middle pair.

Sexual Apparatus.—(figs. 89, 94.) As far as can be judged from Beddard's descriptions, these organs resemble those of *Microdrilus saliens*. The two pairs of spermathecæ are of toadstool shape, each with a short diverticle pointing forwards. The ciliated sperm-funnels are short, compact, and not folded, much the same as in *Benhamia*. The sperm-sacs are small, racemose, and postseptal in XI and XII. The ovaries in XIII are just inside of the clitellum. There are two ovisacs protruding from the septum XIII/XIV into XIV.

The *sperm-ducts* are separate till they reach the pore. With the commencement of somite XV they are comparatively narrow, but in that somite their muscular layer begins to widen and at the end of it is more than twice as thick as in XIV. From somite XIV to the pore the combined ducts are of even thickness, and as wide as the muscular duct of the prostate. The sperm-duct at this point is as thick as the two muscular layers of the body-wall combined. It lies entirely free and on the top of the cœlomic epithelium.

The *prostate* is tubular and confined to one somite, XVII. The muscular part is quite long. The glandular part is tubular and consists of two layers of cells. The papilla on which the pores are situated is strongly convex, but hardly extends above the line of the general body-wall. The prostate opens in the centre of the papilla, and the sperm-duct immediately behind in the posterior part of the pore.

The *oviducts* open separately, each one on a papilla occupying the whole width of the somite. The cells of this papilla are very thin and stain less deeply than the clitellar cells.

Nephridia.—(fig. 90.) The nephridia are strikingly like those of a *Benhamia*. There are only micronephridia arranged in four rows on each side, extending from the ventral to the dorsal side, almost uniting with each other at the dorsal line of the body. Each one of the four micronephridia consists of a cœlomic rounded mantle, with ducts along its anterior margin. Nephridium 1 consists of one larger and two smaller mantles, the latter covering part of the ducts nearest the nephrostome. I could only find nephrostome belonging to nephridia 1; they are in line with setæ *ab*. There is a pair of peptonephridia in somite IV. In the specimens from Hawaii the nephridia are arranged as in fig. 90. In the specimen from Del Monte the fourth and most dorsal nephridium is situated much nearer the dorsal line, there being a space between the third and fourth nephridium as wide or wider than the largest micronephridium.

Vascular System.—The last hearts or connecting vessels are in XII. Commencing with XIV the dorsal vessel is greatly enlarged, forming out of the main median trunk a large median heart separated from the one in somite XIII by valves. The corresponding enlargement in XIII is almost as large, but the one in XII is several times smaller, and hardly larger than the normal size of the vessel. A similar enlargement of the dorsal vessel has been described by Beddard in *Millsonia rubens*.

Dichogaster Ribaucourti, sp. nov.

PLATE XIV, FIG. 181.

Definition.—Length 80 to 100 mm., width 3 mm. Somites 150. Prostomium very narrow, divides somite I completely. No dorsal pores anterior to clitellum. Genital zone consists of two elevated crescent ridges, with the concavity ventral, in somites XVII to XIX. Setæ strictly paired. No penial setæ. Sperm-ducts straight, joining in XVII, opening into the intersegmental groove between XVII and XVIII. Prostates, two pairs; the anterior pair opens immediately ventral to the sperm-ducts in XVII, the posterior pair opens in the center of XIX. Spermathecæ, two pairs; one pair in VIII, one pair in IX, their pores in line with setæ *ab* in the intersegmental grooves between VII/VIII, VIII/IX; several diverticles near the base. Oviducts separate. Sacculated intestine commences in XIX. No typhlosole. No intestinal cœca. Gizzards, two in V and VI. Calciferous diverticles, three pairs in XV, XVI, XVII, opening into the intestine through three pairs of pores. Last hearts in XIII. Nephridia are micronephridia, ten on each side, each one with a cœlomic mantle. Testes and sperm-funnels in X and XI. Ovaries in XIII. Color reddish brown, pigmented, strongly iridescent on dorsal side.

The following septa are thickened:—

$$\overline{\text{VIII/IX}},\ \overline{\text{IX/X}},\ \overline{\overline{\overline{\text{X/XI}}}},\ \overline{\overline{\overline{\text{XI/XII}}}},\ \overline{\overline{\overline{\text{XII/XIII}}}},\ \overline{\overline{\overline{\text{XIII/XIV}}}},\ \overline{\text{XIV/XV}}.$$

Habitat.—City of Mexico, Mexico. Collected by Professor Albert Koebele, September, 1897. Five specimens preserved in formalin, only three of which possess an exterior genital zone. The clitellum is not differentiated in any of the specimens.

Every species of this interesting genus proves conclusively that the genus cannot be far removed from *Benhamia*, and that with Michaelsen we must consider *Dichogaster* as a reduced *Benhamia*. The present species demonstrates also that this genus is not as incongruous as Beddard supposes, and that the species with separate prostates posterior to the male pores are not sufficiently distinct to warrant assigning them to a separate genus. In the species under consideration one pair of accessory prostates is found in XIX, making the species intermediate between those species without accessory prostates and those with three accessory pairs (*D. Damonis* and *D. Townsendi*).

Detailed Description.

The *prostomium* is exceedingly narrow, the posterior projection being merely a furrow completely dividing somite I. The somites offer nothing especially characteristic. The clitellum is not developed in any of the five specimens, but there is no reason to suppose that it is wanting in fully mature individuals.

The *genital zone*, on account of the absence of a clitellum, is less developed than in fully matured specimens. The two lunate ridges covering the three somites XVII to XIX are of even thickness throughout their length, and so curved that they enclose between them a zone oval in the center. The specimens not being in the very best condition, it was impossible to observe any of the exterior pores.

The *setæ* are strictly paired and all ventral. Their tips are slightly scalloped. The absence of penial setæ brings this species into close relation with *Dichogaster Damonis*, which species it also resembles on account of its accessory prostates.

The *sperm-ducts* are straight, without the horseshoe-like bend found in *D. Crawi*. The two sperm-ducts are separate until they reach somite XVII, where they fuse into one just before entering the male pore, which is intersegmental and not equatorial.

The absence of *sperm-sacs* may be due to the immature state of the specimens.

The *sperm-funnels* lie immediately behind the testes in X and XI. In line with the testes, but in somite XII, is found a pair of structures resembling ovaries. They are somewhat smaller than the regular ovaries in XIII and less divided than the testes. These structures are probably accidental.

The *prostates* have the normal structure. There is a long muscular duct and a thicker glandular upper part. The latter, which is confined to one somite, contains two layers of cells, the inner of which is very minute.

There are no ovisacs developed. The spermathecæ are large and sac-like, pointing forward. There are several small wart-like diverticles pointing forward and penetrating the anterior septum, the diverticles thus being on one side of the septum, while the main sac is on the other. The pores are in the intersegmental grooves.

The *calciferous diverticles* are arranged three on each side. The two anterior pairs contain lime crystals. The posterior pair is of a different structure, the inner lining consisting of globular cells like those figured from *Benhamia nana*. In this posterior pair there are no lime crystals. Each diverticle opens into the intestine by a separate pore, and they bear no relation to each other. There is no typhlosole and there are no intestinal cœca.

The *nephridia* resemble in a general way those of the genus *Benhamia*. There are ten rows of micronephridia on either side of the ventral ganglion. The pair nearest the ganglion is split up into three small lobes, and the one nearest this consists of two lobes, but all the others consist of but a single lobe. Each lobe is surrounded by a cœlomic glandular mantle. No nephrostomes were observed. There is no specialized zone of sense-organs in the epidermis.

Dichogaster Townsendi, sp. nov.

Plate XIV, Fig. 182.

Definition.—Length 90 mm., width 5 mm. Somites about 165. Prostomium divides somite I about one-half. Dorsal pores present. Genital zone, a flat, square field on the ventral side of XVI–XIX (immature specimen). Setæ paired, absent on somites XVI and XVII. No specialized penial setæ. Spermathecæ two pairs, in VIII and IX; pores postseptal; a medium sized diverticle pointing forwards. Testes, two pairs in X and XI. Sperm-funnels in X and XI. Sperm-sacs racemose, in XI and XII, both postseptal. Three pairs of prostates. Anterior prostates opening with the sperm-ducts into XVII, one pair in XVIII and one pair in XIX. Two gizzards in V and VI. Diverticles of the intestine in XV, XVI, XVII. Sacculated intestine commences in XIX. Last hearts in XII. Nephridia: anteriorly plectonephridia, posteriorly meganephridia. No subpharyngeal glands and no septal glands. Color, above brownish and pigmented, below pale, uncolored.

Septal formula:—

V/VI, VI/VII, VII/VIII, VIII/IX, IX/X, $\overline{\text{X/XI}}$, $\overline{\overline{\overline{\text{XI/XII}}}}$, $\overline{\overline{\overline{\text{XII/XIII}}}}$, $\overline{\overline{\overline{\text{XIII/XIV}}}}$, $\overline{\overline{\overline{\text{XIV/XV}}}}$, XV/XVI.

Habitat.—Jamaica. Collected by Professor C. H. Tyler-Townsend, for whom the species is named.

This species is readily distinguished by its two pairs of spermathecæ and three pairs of prostates, as well as by the absence of specialized penial setæ. The arrangement of the nephridia is also characteristic. The male pore is equatorial, while, in *D. Ribaucourti* it is intersegmental.

DETAILED DESCRIPTION.

The single specimen at my disposal was poorly preserved in alcohol and contained much sand. It was first halved and washed free from sand, after which one half was sectioned lengthwise. The specimen is not adult and the clitellum is not indicated. All other organs were, however, fully developed, with perhaps the exception of the prostates, mention of which will be made later.

Somites.—The prostomium and somite I are small but normal. From somite XI anteriorly the somites are much smaller. Somite XVII is somewhat larger than those adjoining.

Setæ.—The common setæ are rather slender and straight and without ornamentation. There are no setæ *ab* in XVII and XVIII, but there is at least one seta at the prostate pores in XIX. These setæ are possibly a trifle more slender than the ordinary ones but cannot be considered as penial setæ. All the setæ are closely paired and all ventral. The ventral interval is one-third greater than the interval *b–c*.

Septa.—The septa are remarkable for their thinness. In no other earthworm have I found the septa so thin, most of them being only one or two strands thick. The thickened septa are thickened principally along the dorsal and ventral sides. There is no trace of septal glands nor of any subpharyngeal glands, but the suprapharyngeal glands are fully developed.

Intestine.—The two gizzards are powerfully developed and are not particularly characteristic. The tubular intestine is straight. In somites XV to XVI there are as usual three pairs of diverticles, which in this species are much developed. Each diverticle opens independently into the intestine.

Spermathecæ.—The spermathecæ are of large size, each one consisting of a large distal sac and a narrower duct. The pores are in the anterior part of the somite and accordingly postseptal. They open into the intersegmental grooves of VII/VIII and VIII/IX. I am unable to state whether the diverticle penetrates the anterior septum. The upper sac-like part has a remarkably thin wall, as thin as the thinnest septum and entirely without columnar epithelium. The muscular duct, however, is thick and furnished with a somewhat pear-shaped diverticle containing from three to several longitudinal chambers which seem to open separately into the muscular duct.

The *testes* and *ovaries* are minutely lobate.

The *sperm-sacs* are strongly racemose. The *sperm-ducts* run side by side but do not fuse until they reach somite XVII. Here the duct is seen to be strongly muscular and as wide as the prostate, behind which it passes, opening into the same pore. Of the three pairs of *prostates*, the anterior pair, which opens with the sperm-ducts, is the largest, being of the usual size. It is confined to somite XVII. The upper, glandular part is no thicker than the muscular part and has no distinct glandular cells, though there are two distinct layers of cells. The outer cells are very minute, resembling connective tissue. This unusual structure of the prostate may be due to degeneration. The prostates in XVIII and XIX are about one-half as wide as those in XVII. They open into the equator of their respective somites. The one in XIX opens immediately in front of a common setæ. These posterior prostates are present on both sides of the worm and possibly are characteristic of the species and not accidental proliferations.

Nephridia.—The nephridia of this species are interesting. There are no micronephridia, as in some other species, at least none covered with a cœlomic mantle. Anterior to the clitellum the nephridia show a plectonephric condition, as in most other species; but posteriorly, where it would be expected that micronephridia would be found, are large and apparently typical meganephridia. Typical is used advisedly, as the condition of the specimen did not allow of any very minute investigation.

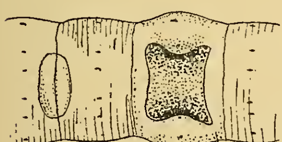
PERICHÆTINÆ.

Pontodrilus *Perrier.*

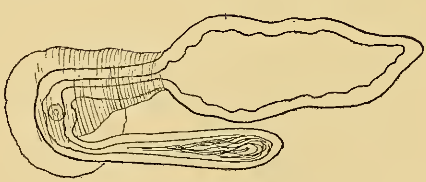
Pontodrilus Michaelseni *Eisen*, **hortensis**, var. nov.

Definition. — Length 75 mm., width 3 mm. Prostomium encroaches slightly on somite I. Setæ with exceedingly faint transverse furrows. Sexual zone depressed, with two parallel pits separated by a slight longitudinal ridge. Anterior to this zone the clitellum is saddle-shaped. Spermathecæ large, pear-shaped, with narrow duct and a narrow, club-shaped diverticle. Prostate with the muscular duct about two-thirds as wide as the glandular part. The sperm-duct enters the glandular part near the muscular part and enters the lumen at once. Intestine with a vascular crop in XIV and XV which is strongly contracted at the septa. In other respects similar to the species.

Habitat.—In garden soil, along sewers in the gardens of Loreto, Baja California, Mexico, June 20, 1899. Many specimens fully adult and with well developed clitellum and sexual zone. The soil in the gardens is slightly saline, but not to such an extent as to prevent the cultivation of oranges, limes and bananas. The date palm thrives especially well. No specimens were found near the shore.



Sexual zone.



Spermatheca.

DETAILED DESCRIPTION.

Characteristics.—The principal differences between the species and the variety are found in the sexual zone, the form of the spermathecæ, the faint ornamentation of the setæ, and the relative size of the muscular and glandular parts of the prostates.

The septal formula is as follows:

$$\mathrm{IV/V},\ \overline{\mathrm{V/VI}},\ \overline{\overline{\overline{\overline{\mathrm{VI/VII}}}}},\ \overline{\overline{\overline{\overline{\overline{\mathrm{VII/VIII}}}}}},\ \overline{\overline{\overline{\overline{\overline{\overline{\mathrm{VIII/IX}}}}}}},\ \overline{\overline{\overline{\overline{\overline{\mathrm{IX/X}}}}}},\ \overline{\overline{\overline{\overline{\overline{\mathrm{X/XI}}}}}},\ \overline{\overline{\overline{\overline{\overline{\mathrm{XI/XII}}}}}},\ \overline{\overline{\overline{\overline{\mathrm{XII/XIII}}}}},\ \mathrm{XIII/XIV}.$$

Intestine.—The tubular part is narrow and even and joins a vascular crop in XIV. This crop is more vascular than that of the species and is shorter and narrower. It is also strongly contracted at the septa, which is not the case in the species.

Sperm-duct.—In a recent paper Michaelsen (30) has given great importance to the assertion of A. Iizuka, that the sperm-duct in *Pontodrilus matsushimensis* Iizuka traverses the wall of the whole glandular prostate in order to enter it at its distal free end. Iizuka assumes that this peculiarity is a common characteristic of all species of the genus. A re-examination of the type specimens of *P. Michaelseni*, as well as a careful study of two sets of serial sections of the variety in question, shows conclusively that the sperm-duct enters at once and directly into the glandular prostate at a little distance above its junction with the muscular part. There is, however, a long and thick blood-vessel which takes the same course as the sperm-duct figured by Iizuka. Michaelsen (30, p. 221, line 10), who has described a variety of the Japanese species (*P. masushimensis* var. *chatamianus*), appears to be somewhat uncertain about the exact point of entrance of the sperm-duct. Under these circumstances it seems to be premature to place any great importance on the possibly aberrant structure of the sexual apparatus of the Japanese species.

Spermathecæ.—The spermathecæ are much larger than in the species. They occupy the largest part of their respective somites. The form of the main sac is also different from that of the species.

Nephridia.—As in the species these organs begin in somite XIII. The nephridia anterior to the clitellum are furnished with only a few accessory cells, while those posterior to the clitellum are covered with a thick cœlomic mantle, which seems more uneven and more rugose than that of the species.

Setæ.—The ornamentation of the setæ is exceedingly faint. The tip of the setæ at first glance appears to be perfectly smooth, and it is only with a good homogeneous immersion lens that the faintest of marginal impressions—too faint to be illustrated in a drawing without being exaggerated—can be perceived.

The various species of *Pontodrilus* are closely related and a careful reconsideration of all the forms would prove of great interest.

LIMNODRILIDÆ.

Telmatodrilus *Eisen.*

A second species of this genus is not uncommon in California, and it is not improbable that the two species were at first confounded. The following definition will distinguish the two species thus far known:

Telmatodrilus Vejdovskyi *Eisen.*

Definition.—Body stiff, sluggish, slightly tapering. Spermathecæ opening in front of and between the ventral fascicles of setæ in X. The setæ are indistinctly uncinate.

Habitat.—Sierra Nevada Mountains, in the medium dry soil of marshes and meadows, or in rotten logs in wet places.

This definition is drawn from my first description, the type-specimens not being accessible. Beddard, in his Monograph of Oligochæta, page 263, gives a definition of *T. Vejdovskyi*, differing in some respects from that originally given by the author. His description is probably partly based on specimens which I sent him in 1892. Beddard states that the spermathecal pores open between the dorsal and ventral bundles of setæ, making it evident that he had before him not *T. Vejdovskyi*, but *T. McGregori*. The specimens sent to Professor Beddard at his request were not closely examined, hence the error.

Telmatodrilus McGregori, sp. nov.

Definition.—Body not stiff, less sluggish, and more tapering towards the tail than in the former species. Spermathecæ opening in front of and between the ventral and lateral fascicles of setæ in X. Setæ distinctly uncinate, especially those of the ventral fascicles.

Habitat.—California, in the Sierra Nevada Mountains, generally at high altitudes, lower in the northern part of the State than in the southern. Specimens are in the collection from the following localities: Castle Crag, Shasta County, in an irrigation ditch close to the hotel; Phil Hope Spring, about six miles east of the town of Coulterville, Mariposa County, and a few miles north of Dog Town, at the top of the gulch: 3—Spring Meadow, on the east side of the North Fork of King's River, Fresno County, at an altitude of about 8,000 feet; in springs on the east side of Dinkey Creek, Fresno County, a mile or so from Frank Dusey Camp, near the head-waters of the creek, at an altitude of 6,000 feet.

The species is named for Richard C. McGregor, to whom the author is indebted for many new species of Oligochæta.

DETAILED DESCRIPTION.

As will be seen, the principal character concerns the spermathecal pores, which in *T. McGregori* are situated in front of the lateral intervals, while in *T. Vejdovskyi* they are found in front of the ventral interval.

Body.—Length in fully extended specimens 40 to 60 mm., width about 1 mm. Body strongly tapering towards the tail. More slender and more active than *T. Vejdovskyi*.

Setæ.—Beginning with somite II, there are four fascicles in every somite, each containing from 6 to 14 setæ. The setæ of the lateral fascicles are indistinctly uncinate, while those of the ventral fascicles are distinctly so. The anterior setæ, or those in somites II to IX inclusive, are larger than those following. The anterior fascicles have more setæ than the posterior ones, somite II having about 14 setæ in the lateral fascicles and from 10 to 12 in the ventral ones. This number gradually diminishes posteriorly, until in somite IX there are about eight setæ in the lateral fascicles and six in the ventral. In somite XI and following the setæ are considerably smaller. The setæ are more sigmoid and more thickened in the middle than those in the former species.

Pores.—The male pores are situated in somite XI, immediately lateral and dorsal to the ventral fascicles of setæ, and in such close proximity that the setæ just clear the male pore, the pores and the fascicles thus being in the equatorial of the somite. The spermathecal pores are situated half-way between the anterior margin of the somite and the equatorial line between the ventral and lateral fascicles of setæ. The pores of the nephridia are in line with the ventral fascicles of setæ and near to the anterior margin of the somite.

Intestine.—There is a strong muscular pharynx but it does not carry any suprapharyngeal gland. There is, however, a row of septal-pharyngeal glands opening into the pharynx. These glands extend posteriorly to and include somite VII. The most anterior gland is in IV, attached to the anterior face of the septum III/IV. These glands are principally developed ventrally and laterally, that in VII ventrally only. The individual cells in these glands are much separated, similar to those in *Enchytræidæ*. The tubular intestine is narrow, nipped by the septa, and extends to somite XI. In XII it enlarges into a sacculated intestine, which is generally very large in XII, XIII and XIV, gradually narrowing down. The tubular intestine and the sacculated intestine from somite XIV, posteriorly, are covered with small chloragogen cells which are lacking in XII and XIII.

Blood-vessels.—The perivisceral vessels in the anterior somites gradually increase in size posteriorly, but the pairs in X and XI are considerably larger, serving as hearts.

There is no heart-body. The dorsal vessel is generally, but not always, situated on one side of the body. It is much larger in XII and XIII.

Testes.—There is one pair of testes in somite X, occupying the usual position. They extend backwards and connect with a median, dorsal sperm-sac, which extends to the middle of somite XII.

Ovaries.—There is one pair of ovaries in somite XI, extending from the anterior septum backwards, and filling a large part of the somite. The oviducts are very small; the ovipores are in front of and in line with the ventral fascicles of setæ in XII.

Spermathecæ.—The spermathecæ are simple sacs, one-half shorter than those figured for *T. Vejdovskyi.* They are strongly muscular from the apex to the pore. There are no spermatophores.

Sperm-ducts and Penis.—These organs, which open on XI, resemble those figured for *T. Vejdovskyi.* There is no chitinous sheath in the penis, and I have reason to think that there is none in the other species of this genus. The atrium, into which open the many prostates, is always strongly bent, either sideways, forwards or backwards. It is strongly muscular, the muscular layer being circular. The sperm-duct joins the atrium abruptly, and is about one-third narrower. It descends downwards at once, with a few slight folds, and then widens out to a flaring funnel which is invested in the septum X/XI. The penis itself projects alongside of a rather strong copulatory cushion situated immediately dorsal to the male pore. Between it and the ventral fascicle of setæ there is a deep pit, through which the penis is protruded. There are ten to fifteen prostate glands of about the same diameter as the atrium.

Nephridia.—There are no nephridia in the genital somites. Posterior to the clitellum the nephridia commence in somite XVI. Only the posterior nephridia are covered with large bladder-like peritoneal cells.

APPENDIX.

METHODS OF COLLECTING.

It is often inconvenient to dig for worms, the holes and casts of which can be seen in abundance over the top of the ground. In such instances the author has had recourse to one of two methods, either of which will cause the worms to rapidly seek the surface of the soil. The first of these methods was used by the Indians of California years ago, when *Argilophilus* species were used for food. A long crowbar is driven vertically into the soil and worked sideways for a few minutes, when the worms will leave their holes and come to the surface, where they may easily be gathered up. They may also be forced to come out of the ground by wetting the soil with a weak solution of sulphate of iron in water. A teaspoonful of the sulphate dissolved in a bucket of water and poured over the ground will soon cause the worms to make their appearance. As the epidermis is irritated by this means, the specimens should be preserved as soon as possible.

CARE OF THE WORMS.

Oligochæta may be safely transported alive for thousands of miles even in tropical climates, providing sufficient care be taken. They can best be sent in a closed box which is entirely filled with soil, thus preventing movement from side to side. The soil must be moist, but never wet. The box with soil should always be enclosed in a larger box, and the space between filled in with wood shavings or "excelsior."

A better way is to use moss, especially sphagnum moss, instead of soil. The moss should be soaked in water, then squeezed by hand until no more water can be gotten from it. The box in which the worms are to be placed should be packed full of the moss and placed in a larger box with damp moss around it. Any water in the box will cause the worms to die. No broken or injured worms must ever be placed among the lot. Upon being received the worms should be washed in clean water; they are then ready to be cleaned from sand.

The author finds the quickest and most satisfactory way of freeing specimens from sand is to place them in a wet handkerchief or other cloth of cotton or linen. The cloth should be slightly wet and the worms wrapped up in it and placed in a glass jar closely covered. If the jar be now placed in a perfectly dark place the worms will crawl about and free themselves from sand. This method was found to be more satisfactory than the use of blotting paper.

NARCOTIZING.

A good way of narcotizing the worms previous to killing them is to use chloroform as recommended by Perrier. A few precautions are nesessary. Only a couple of drops should be used, and must not be mixed with the water. A disregard of these precautions will cause the worms to become distorted and to burst open in places. The direct influence of the chloroform vapors also has the same effect. It is best to place the specimens in a flat dish and cover them well with water. In the center of the dish is placed a heavy but short vial containing only a few drops of chloroform. The whole is covered with a bell-jar. The chloroform may also be dropped on a piece of cotton or blotting paper and placed on a large piece of cork floating on the surface of the water, or simply left on the table. It must, however, never come in direct contact with the water. In from fifteen minutes to two hours, or when the worms are fully stretched out, they are ready to be killed with the fixative.

A method to be recommended in handling delicate and thin-skinned worms is to place them in water to which from time to time are added a few drops of a saturated solution of bichloride of mercury in water. In half an hour the worms should be fully stretched out and ready to be fixed.

Fixatives and Imbedding.

The best and most practical fixative for Oligochæta the author finds to be a solution of bichromate of potassium with acetic acid, according to the following formula:—

Bichromate of potassium 3 parts.
Glacial acetic acid 6 parts.
Water 100 parts.

The worms are fixed in this solution for about twenty-four hours and afterwards washed in running water for several hours until no trace is left of the yellow color.

This fixative is cheap and easily carried on collecting trips; it has an advantage over sublimate in being non-poisonous and requiring no iodification; it allows of excellent staining and fixes better than sublimate-acetic.

A cheap fixative and preservative for the use of traveling collectors consists of two per cent. of formaldehyde in 33 per cent. of alcohol. This preservative allows of good staining and does not make the specimens brittle. It is, however, inferior to the sublimate-acetic and the bichromate-acetic fixatives. The worms are dropped into the solution, which should be replaced by fresh after twenty-four hours.

Worms which are to be sectioned lengthwise should not be as straight as those which are to be sectioned transversely. If they are slightly curved it is much easier to orientate their ventral and dorsal sides when placing them in the paraffin imbedding. The worms curve either ventrally or dorsally, and even the slightest curve will enable one to place them so that the sections will pass directly through the dorsal and ventral line. Sections destined for transvere sectioning should be perfectly straight. This is best accomplished by placing them between thin glass rods.

As soon as the worms are dead and before they become stiffened place them in a dry, shallow dish with a flat bottom. After straightening each worm out place along side of it a round glass rod, as thick or slightly thicker than the worm. By alternating worms and glass rods, the whole bottom of the dish may be covered and the worms kept perfectly straight.

The fixative is at first applied slowly, drop by drop, so as not to disturb the specimens; but as soon as they are sufficiently hardened they should be entirely covered with the fixative. If the worms are large it may be necessary to replace the liquid by fresh. More than four hours immersion is not advisable.

The after treatment offers no peculiarities and is understood by every biologist accustomed to laboratory work. The worms are preserved in alcohol which should be changed as soon as it becomes yellow, or in a solution of formaldehyde in water, or in a one per cent. solution of formaldehyde in thirty per cent. of alcohol. Specimens should on no account be kept any length of time in strong formaldehyde, as it greatly injures them.

Some worms contain sand or other hard substances, which must be gotten rid of before sectioning. An easy method is to cut the specimen lengthwise with a pair of fine scissors, and then to wash the sand from the intestine. In this way one-half of the body may be sectioned lengthwise and the other half transversely.

The sections are best mounted on slides by the alcoholic method (Eisen 23).

When the worms are removed to vials, they should be placed head downwards, in order to prevent this part from becoming accidentally dried. Do not place too many specimens in one vial, as they will macerate and become useless. If, however, space is limited and it is desirable to crowd the specimens, the formalin solution may be changed several times until it remains perfectly clear after standing for several days. The worms must be hard and solid when stored away. It is very important that the vials should be full of the solution, so that when turned about the worms will not move. A piece of paper placed in the top of the vial will also prevent any shaking up. Fill the vial full of liquid, drop a string down into the neck of the vial and then insert a cork. Press down the cork and at the same time pull out the string. The air in the bottle will escape and the cork can be pushed down to the very liquid, thus leaving no room for air. Even comparatively small air bubbles will allow the contents of the bottle to shake about, causing the ruin of the specimens. The best paper to place in the bottles is soft white tissue paper. Toilet paper will not do as it dissolves.

When glass vials are to be sent away they should always be packed in a box which is enclosed in another box, with soft packing between the two. A label of stiff paper on which is written in lead pencil the date and locality, and whether collected in soil, in the mud of rivers, in moss, etc., should always be placed inside the vial.

Disappearance of Native Species.

It is not my intention to enumerate here all the localities in which native worms abide; indeed, they are to be found almost everywhere in the soil, and in the banks and bottoms of rivers and streams. In collections received from generous friends and donors it has often been a great disappointment to find the large majority of the specimens to be worms imported from Europe, instead of native species, which are the only ones of real interest to us.

Collectors generally hunt for earthworms in manure piles or in gardens, and it is in just such places that the accidentally imported European worms flourish to the exclusion of the native species. In California and in the southern States generally, it is now almost impossible to find in rich garden soil and in manure piles any other than common, European varieties.

Native Oligochæta are to be found in the virgin soil of the country, far from gardens and manure heaps; in the moist soil of gulches and mountain meadows;

under native trees and shrubbery; in the mud of streams; under rotten and decaying stumps and leaves in the forest; under moss and the rotting seaweeds on the coast. It is in such localities that we must search for our native Oligochæta.

The large worms are generally the best known; the smallest have been neglected, and it is principally among these latter that we may hope to find new and interesting species. The small white worms so common in the north are but little known; so also are the forms found in the mud of rivers and springs. On the Pacific Coast the native worms are generally of a pale gray or flesh color. The European species are as a rule darker, the reddish or brownish color being due to heavy pigments.

The reason for the European species supplanting the native forms is probably due to several causes. The former are much hardier and may be easily transported from one locality to another without injury. They are less sensitive to heat and light, which is probably due to their pigmentation. As a rule they are adult all the year round, while the native species are adult only in the first half of the rainy season; therefore the European species have a longer breeding season and can better adapt themselves to climatic conditions. The European worms seem to have grown up in the vicinity of man and have accommodated themselves to his cultivation of the soil, which cultivation drives the native worms away. While this refers especially to the worms in our temperate regions, it is also the case in the highlands of Mexico and to some extent in the tropics. The encroachment of the European Terricolæ is such that in time there will be few if any native species left. Of the smaller foreign *Limicolide* worms, but few seem as yet to have spread in this country.

It is of the greatest importance when collecting to remember the fact that nearly all earthworms when adult possess a different colored band—the clitellum—on the anterior part of the body. If this band is not present the species cannot be identified.

Methods of Indicating the Thickened Septa.

Many investigators satisfy themselves with simply describing some septa as thickened. This, of course, does not indicate the relative thickness, and if it be given in the text much time is consumed in committing it to memory. The following method of indicating the relative thickness of the septa is suggested by the author. Septa are to be indicated by Roman numerals, a bar on top indicates that the whole septum is thickened, a bar below indicates that it is thickened only below. One bar indicates twice the thickness of the ordinary septum, and two or more bars indicate increased thickness. "O" in place of the Roman numeral indicates that the septum is wanting. A fraction in front of a numeral indicates that the septum is attached to the center of the somite and does not correspond to the intersegmental groove. For examples of this method the reader is referred to the descriptions under species. A single bar may indicate that the septum is as thick as two ordinary septa, a bar and a half (————═══) may indicate that the septum in question is one and one-half times thicker than an ordinary septum. If the septum is thickest in the center, this may be indicated by diminishing the bars toward both ends.

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INDEX TO AMERICAN OLIGOCHÆTA.

New genera and species in **full face**, synonyms in *italics*.

SIGNIFICANCE OF REFERENCE LETTERS.

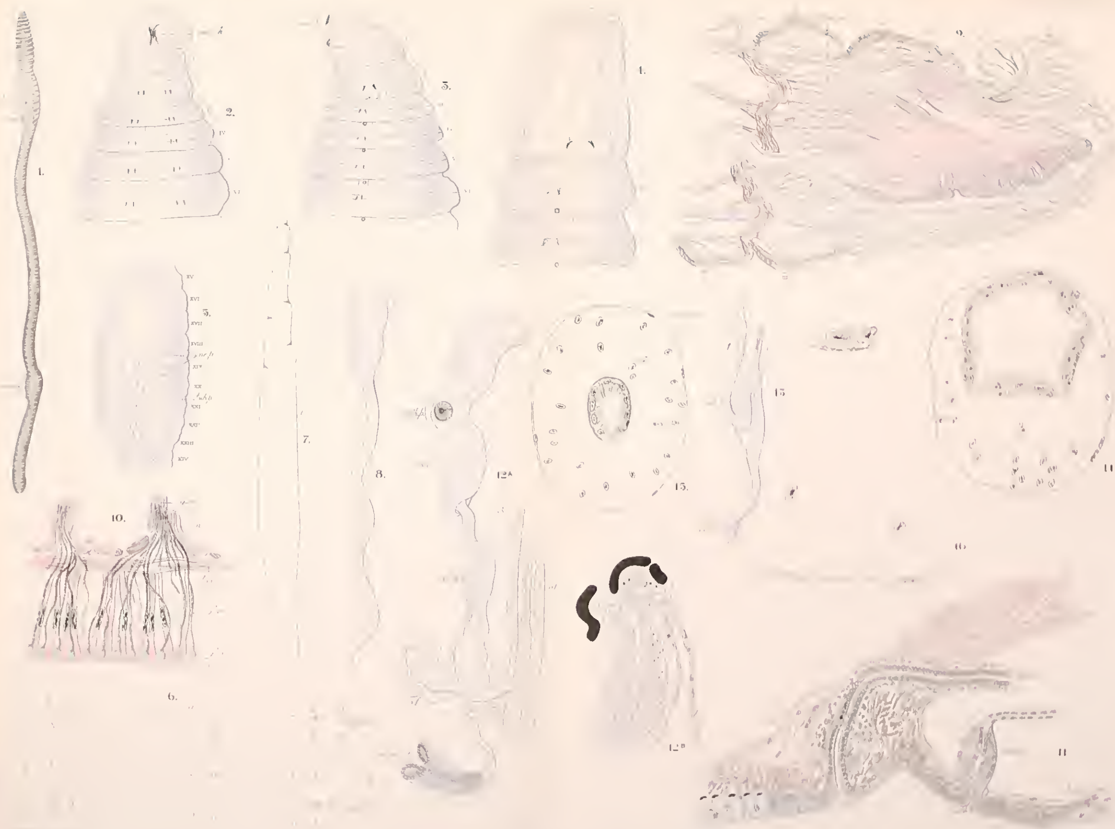
a. ep. — epithelium in the anterior part of the somite.
a. f. — anterior fold of nephridia.
am. cy. — amœbocytic chloragogen cells.
arch. s. — archosomal structures
bd. — body-wall.
bd. w. — body-wall.
bl. — blood-sinus.
bl. cap. — capillaries.
bl. m. — membrane of blood-sinus.
bl. s. — blood-sinus.
bl. v. — blood-vessel.
br. — brain.
bu. c. — copulatory bursa.
cal. — calcic concretions.
cal. div. — calciferous diverticle.
cal. gl. — calciferous glands.
cap. — capillaries.
caud. reg. — caudal region.
caud. z. — caudal zone.
c. b. c. — cushion copulatory bursa.
c. c. — copulatory cushion.
cen. c. — central cell.
c. ep. — ciliated epithelial cells.
cham.sex.gl. — discharge chamber of sexual glands.
chlo. — chloragogen cells.
cl. c. — clitellar cells.
cl. gl. — clitellar glands.
clit. — clitellum.
clit. c. — clitellar cells.
c. m. — circular muscles.
co. bu. — copulatory bursa.
cœ. — cœcum.
cœc. — cœcal pouch of nephridium.
cœl. ep. — cœlomic epithelium.
con. t. c. — connective tissue cells
co. p. — copulatory papilla.
cp. — capillaries.
c. p. — copulatory cushion.
c. p. — copulatory papilla.
cr. — circular muscles.
cr. — sperm-funnels.
cr. m. — circular muscles.
cu. — cuticle.
c. va. — vacuole in cytoplasm.
cy. di. — cytoplasmic diaphragm.
d. — diverticles of intestine
d. c. d. — duct of calcic diverticle.
div. pr. — diverticle of prostate.
d. pr. — duct of prostate.
ducts.sex.gl.—ducts sexual glands.
d. v. — dorsal vessel.
d. y. gl. — duct of y-gland.
eg. c. — egg-cell.
ep. — epithelium.
epd. — epidermis.
e. sp. d. — entrance of sperm-ducts.
f. — duct of funnel.
f. — folds.
gl. — ganglion.
gl. c. — glandular cells.
gl. d. — ducts of glands.
gl. p. — discharge pockets of glands.
gr. — groove.
h. — heart.
h. b. — horseshoe-like bend.
i. li. — interior lips.
int. — intestine.
int. cr. m. — intestinal circular muscles.
int. ep. — interior epithelium.
int. seg. — intersegmental groove
int. ty. ca. — intra-typhlosolar canals.
lam. cy. — cytoplasmic lamella.
l. c. — lymphocytes.
l. div. pr. — lumen of diverticle of prostate.
l. gro. — longitudinal groove.
l. m. — longitudinal muscles.
l. n. — nuclei of lymphatics.
l. p. — lumen of penis.
l. pr. — lumen of prostate.
ly. — lymphatic tissue.
lyc. — lymphocytes.

ly. t. — lymphatic tissue, or lymphatic glands.
m. — muscles.
m. c. — cell-cap.
m. c. — muscular cushion.
mes. — mesenteries.
m. l. — muscular layers.
ms. — muscular layer.
m. ty. ca. — intra-typhlosolar canals.
n. d. — nephridial duct.
neph. — nephridium, or part of nephridium.
neph. p. — nephropore.
nephr. st. — nephrostome.
n. gl. — nerve ganglion.
n. st. — nephrostome.
o. bu. c. — orifice copulatory bursa.
oe. — œsophagus.
oes. — œsophagus.
or. — orifice of diverticle.
or. cal. div. — orifice calcic diverticle
or. sex. gl. & setæ. — orifice of sexual glands, etc.
or. y. gl. — orifice of y-gland.
otos. — otosome.
o. ov. — orifice of ovary.
ov. — ovary.
ov. 1. — anterior ovary.
ov. 2. & ovs. — posterior ovary with ovicells.
ovd. — oviduct.
ovd. gl. — oviducal gland.
ovd. ov. 1. — oviduct of anterior ovary.
ovd. ov. 2. — oviduct of posterior ovary.
ov. f. — oviducal funnel.
p. — penis.
pa. — papilla.
pa. y. gl. — papilla of y-gland.
pe. — penis.
p. ep. — epithelium in the posterior part of the somite.
per. — peritoneum.
pert. — peritoneum.
p. f. — posterior fold of nephridium.
p. f. — posterior fold.
phx. — pharynx.
phx. gl. — pharyngeal glands.
po. b. c. — pore copulatory bursa.
p. p. — papillæ.
pr. — prostate and diverticle.
pr. — prostomium.
pr. b. c. — pore of copulatory bursa.
pr. d. — duct of prostate.
pr. pr. — prostate pore.
pr. st. d. — dorsal part of prostomium.
pr. st. v. — ventral part of prostomium.
pr. y. gl. — pore of y-gland.
p. s. — penial setæ.
s. — septum.
sa. b. — setæ *ab.*
sac. int. — sacculated intestine.
s. c. — sense-cells.
s. c. tub. pub. — supporting cells of t. p.
sept. — septum.
sex. gl. — sexual glands.
sex. set. — sexual setæ.
s. gl. — septal glands.
s. h. — sense-hairs.
s. int. — sacculated intestine.
s. int. v. — supraintestinal vessel.
sp. d. — sperm-duct.
s. pha. gl. — suprapharyngeal glands.
spr. — spur.
sp. s. — sperm-sacs.
spth. — spermatheca.
spth. d. — spermathecal duct.
spth. p. — spermathecal pore.
spz. — spermatozoa.
sub. in. v. — subintestinal vessel.
su. c. — supporting cells.
sup. c. — supporting cells.
su. ph. gl. — suprapharyngeal glands.
t. — testes.
t. c. — taste cells.
t. gr. — t-shaped groove.
t. int. — tubular intestine.
t. m. — transverse muscular layer.
tr. m. — transverse muscles.
tub. — tubular intestine.
tub. in. — tubular intestine.
tub. p. — tubercula pubertatis.
tub. p. c. — tubercula pubertatis cells.
typh. — typhlosole.
v. gl. — ventral ganglion.
w. — windings of nephridia ducts.
w. bl. v. — wall of blood-vessel.
y. gl. — y-gland.

EXPLANATION OF PLATE V.

Pontoscolex corethrurus (FR. MÜLLER) *mexicanus*, subsp. nov.

Fig. 1. Specimen natural size.
Fig. 2. Anterior somites, ventral view.
Fig. 3. Anterior somites, side view. The nephropores are seen to be in front of the setæ *cd*. Setæ *cd* in II are further apart, larger and also more dorsal than the corresponding setæ in other somites.
Fig. 4. Anterior somites, side view. Prostomium retracted. More magnified than figs. 2 and 3.
Fig. 5. Clitellar somites, side view, showing the tubercula pubertatis and the enlarged glandular area around the setæ.
Fig. 6. Part of the body-wall of the anterior somites spread out, showing the location of anterior setæ. There is no nephridium in III. Setæ *cd* in II are further apart, larger and more dorsal than those in III, IV, etc.
Fig. 7. A penial seta from clitellum.
Fig. 8. One of the spermathecæ.
Fig. 9. Longitudinal section of the anterior somites. Zeiss *a* 2, Oc. 12. (*s*) Much enlarged septum III/IV; (*m*) muscles to which are attached the suprapharyngeal glands and muscles connecting this septum with the body-wall. The former are fastened to the very large septum separating III/IV.
Fig. 10. Part of the pharynx, showing the discharge-pockets of the unicellular glands.
Fig. 11. Longitudinal section of the body-wall of somites VII and VIII, passing through the spermathecal and nephridial pores, showing the opening of the former in the posterior part of the somite, in front of the septum separating VII/VIII. Zeiss D., Oc. 2.
Fig. 12. A nephridium dissected out, from a somite next posterior to clitellum; *gl. p.*, glandular pouch; *br.*, bridge of nephridium.
Fig. 13. The part surrounding the glandular pouch of another nephridium; *gl. p.*, glandular pouch; *f.*, duct to the folds; *n. d.*, narrow duct connecting with the nephrostome.
Fig. 14. Section of the nephridial sphinxter at its interior end.
Fig. 15. Section of the nephridial sphinxter at its outer end, showing a ciliated inner epithelial lining.
Fig. 16. A part of the former figure more highly magnified.



EXPLANATION OF PLATE VI.

Pontoscolex corethrurus (FR. MÜLLER), *mexicanus*, subsp. nov.

Fig. 17. Longitudinal section of the body-wall in somite IV, showing the arrangement of the muscular layers.

Fig. 18. Cross-section of part of the body-wall in somite IV. Zeiss D., Oc. 4. The letters indicate the same as in fig. 17.

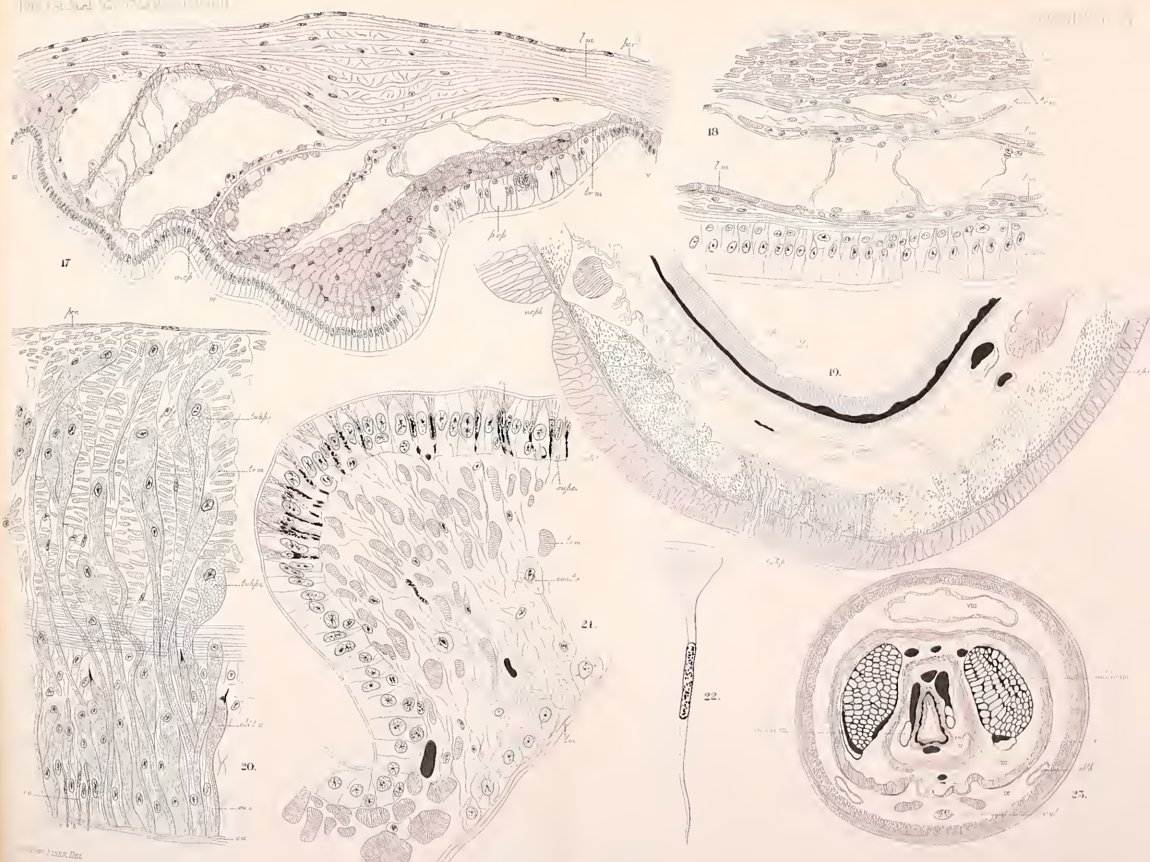
Fig. 19. Cross-section of the body-wall in one of the clitellar somites, showing tubercula pubertatis.

Fig. 20. A highly magnified part of the tubercula pubertatis, Zeiss $\frac{1}{12}$, Oc. 2.

Fig. 21. Part of the body-wall from the caudal zone, showing the various epidermal cells.

Fig. 22. An isolated vibratory sense-cell.

Fig. 23. Cross-section of the worm, one of the somites containing calciferous diverticles.



PONTOSCOLEX MEXICA[illegible]

EXPLANATION OF PLATE VII.

Pontoscolex corethrurus (FR. MÜLLER) *mexicanus*, subsp. nov.

Fig. 24. Cross-section of a calciferous diverticle. Zeiss Apo. 2 mm., 1.40, Oc. 4.

Fig. 25. Cross-section of a calciferous diverticle at its connection with the intestine.

Fig. 26. Longitudinal section of the tubular intestine, where it opens into the sacculated intestine, showing the thickened transverse muscular layer in somites XVI and XVII; *ep.*, epithelial cells; those in XVII ciliated.

Eudrilus Eugeniæ (KINBERG).

Fig. 27. Specimen natural size.

Fig. 28. Anterior somites, dorsal view.

Fig. 29. Clitellar somites, ventral view.

Fig. 30. Exterior male apparatus, the copulatory bursa everted (side view). The narrow crescent-shaped penis is seen to encircle the large papilla on which opens the Y-gland. This papilla is contracted at the middle and pointed at each end.

Fig. 31. Male copulatory apparatus with the bursa everted (front view). Letters same as in fig. 30.

Fig. 32. A male copulatory apparatus with only partly everted bursa (front view).

Fig. 33. The same as above, side view, showing the groove, beginning about half-way between apex and base. The pore of the prostate is near the apex.

Fig. 34. Apex of penis showing groove and pore of prostate.

Pontoscolex corethrurus (FR. MÜLLER) *mexicanus*, subsp. nov.

Fig. 35. Lacking.

Fig. 36*a*. Section of intestine showing typhlosole.

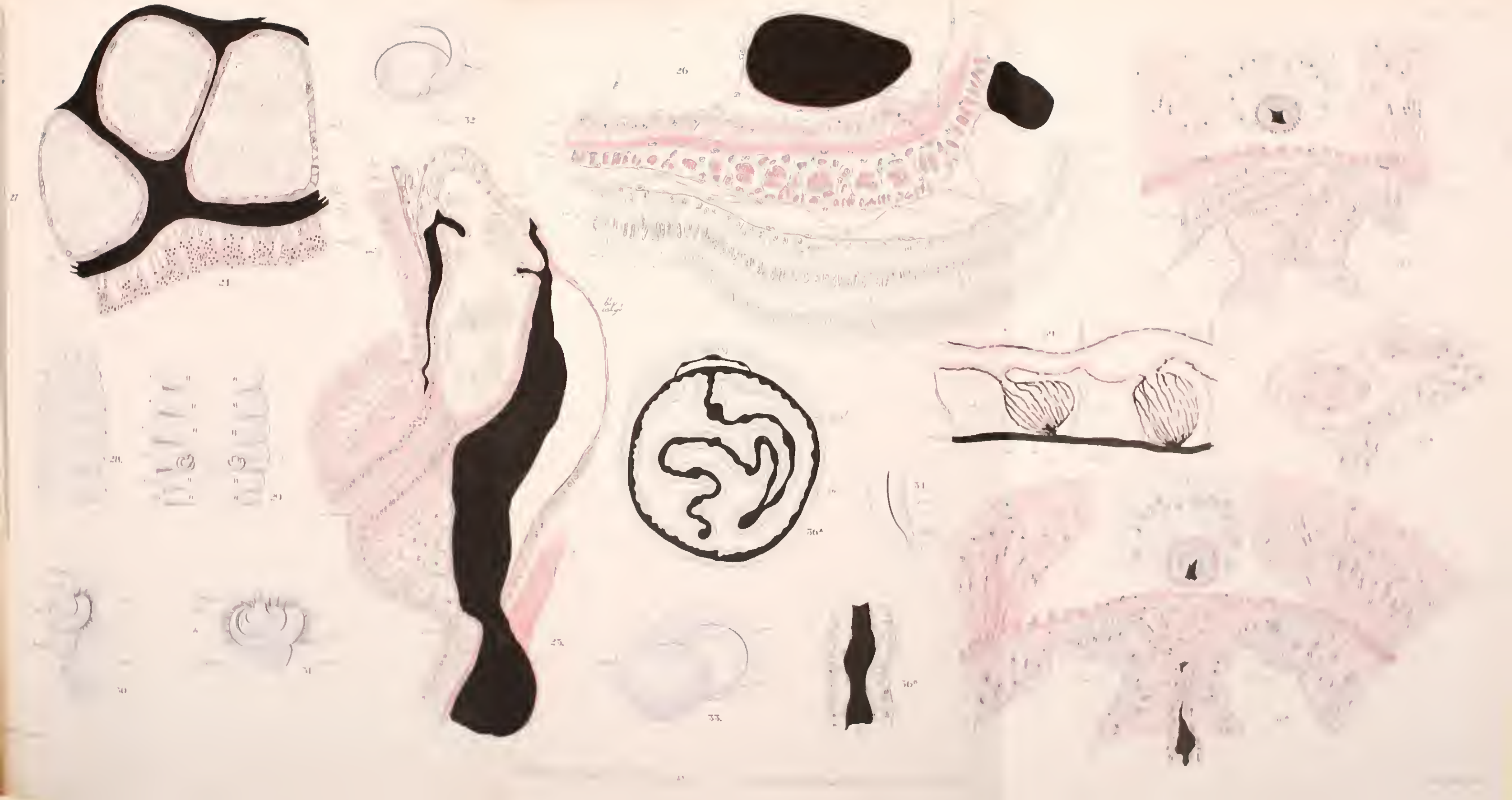
Fig. 36*b*. Detail of the typhlosole.

Fig. 37. Transverse section of the upper part of the typhlosolar region, including dorsal vessel, the chloragogen cells and intra-typhlosolar canals; Zeiss Apo. 2 mm., Oc. 4; (*a*), the whole upper region with a single central intra-typhlosolar canal; (*b*), a section of the same region, but with two canals of unequal size; (*c*), a section where an intra-typhlosolar canal opens into the upper part of the intestine. Only part of the details are carried out, the indicated parts being similar to those of fig. 37*a; in. ty. ca.*, intra-typhlosolar canals; *inv. cr. m.*, invagination of circular muscular layer around the typhlosole.

Fig. 38. Lacking.

Eudrilus Eugeniæ (KINBERG).

Fig. 39. The two median diverticles of the intestine in somites X, XI, showing the very narrow connection with the intestine as well as their relative size (longitudinal section); *sub. in. v.* subintestinal vessel, not divided in any part of the somite.



EXPLANATION OF PLATE VIII.

Eudrilus Eugeniæ (KINBERG).

Fig. 40. Transverse section of a median calciferous diverticle of the intestine. The section passes through the junction with the intestine.

Fig. 41. Transverse section of the median diverticle of the intestine. Only a few of the numerous calcic crystals figured.

Fig. 42. Subintestinal vessel surrounded by lymphatic tissue. The dark dots represent nuclei. Zeiss *AA.*, Comp. Oc. 6.

Fig. 43. A highly magnified detail of the former. The solid black represents blood. Zeiss, Apo. 2 mm. Comp. Oc. 4.

Fig. 44. Male apparatus, in longitudinal section. The figure is constructed from a number of sections and is to some degree diagrammatic. The section does not show the free, external parts of the organ; *div. pr.*, diverticle of the prostate joining the main prostate at the point ×; *e. sp. d.*, entrance of sperm-ducts into the main prostate; *m. s.*, muscular layers of prostate enclosing both the main prostate and its diverticle; *p.*, section of penis. The large central lumen is the duct from the prostate. Below this is seen a T-shaped groove. The Y-gland opens out just opposite this groove at ×. The junction of the central canal in the penis and the T-shaped groove is found much nearer the apex of the penis, and is not shown in the figure; *co. m. c.*, copulatory muscular cushion, the inner wall of the lumen.

Fig. 45. A transverse and sagittal section through the copulatory male pore, showing the ducts. The figure is constructed from three sections. The details are diagrammatic; *pr. d.*, duct from prostate below junction of the diverticle and the main prostate; *pr.*, section of the prostate above its junction with the diverticle. The dotted lines indicate the outlines of the prostate between the two sections; *l. gro.*, lumen of groove running along the exterior of the penis. This groove connects with the lumen of the penis nearer its apex, which is twisted. The section has passed through an apparent, but not a real opening in the wall. A real opening does not exist; *or. y. gl.*, pore of the Y-gland, opposite the external penial groove.

Fig. 46. A more highly magnified detail of fig. 44, representing the pore of the Y-gland and the groove of the penis; *t. gr.*, T-shaped groove in the penis, on the side of the papilla; *c. c.*, copulatory cushion following the inner wall of the bursa; *bu. c.*, copulatory bursa; *o. bu. c.*, opening of copulatory bursa.

Fig. 47. Cross-section of the prostate at the point where the sperm-ducts enter the prostate.

Fig. 48. A cross-section of the body in somite XVII, passing through the pore of the copulatory bursa; *c. b. c.*, cushion of bursa, strongly muscular; *po. b. c.*, pore of bursa, the latter retracted below the outline of the body; *gr.*, exterior groove in penis, cut through in such a way as to appear a single pocket; *d. y. gl.*, duct of Y-gland, near the pore; *or. y. gl.*, pore of Y-gland, the dots indicate its appearance in succeeding sections.


12.
10.
11.
17.
18.

EXPLANATION OF PLATE IX.

Eudrilus Eugeniæ (Kinberg).

Fig. 49. Longitudinal section of the female apparatus, constructed from a number of longitudinal sections of the body; *ov. 2*, posterior ovary in XIII; *ov. 1*, anterior ovary in XIII; *ovd. ov. 2*, oviduct from posterior ovary, connecting at × with the spermatheca; *ovd. ov. 1*, oviduct from anterior ovary.

Fig. 50. A transverse section of the body, constructed from small sections passing through the female apparatus. Letters as in fig. 49.

Figs. 51–54. Lacking.

Ocnerodrilus (Nematogenia) lacuum Beddard, *panamaënsis* var. nov.

Fig. 55. A specimen natural size, fixed in formalin.

Fig. 56. The anterior somites, constructed from several longitudinal sections. Details only indicated; *ly. gl.* lymphatic tissue; *i. li.*, inner lips of pharynx.

Fig. 57. Spermatheca.

Fig. 58. Section of the wall of the pouch of the spermatheca, showing the wide terminal pockets of the secreting cells; Zeiss, Apo. 2 mm., Oc. 4.

Fig. 59. Surface view of the two prostates and part of the sperm-ducts, illustrating the muscular and glandular parts, their size and position.

Fig. 60. A dissected prostate, showing copulatory papilla, with pores of sperm-duct and prostate, the former opening posterior to the prostate.

Fig. 61. Surface view of one of the male papillæ, showing the openings of the sperm-ducts and prostates close to each other.

Fig. 62. Detail of a transverse section of the body-wall through the male and prostate pores. The former is dotted.

Fig. 63. Section of the prostate in somite nearest the male pore; muscular and connective tissue layers as well as epithelial glandular cells, with large discharge pockets.

Fig. 64. Section through prostate in the fourth segment from the male pore. Two kinds of glandular cells, some very large, others quite narrow. The latter resemble those found in the glandular part of the prostate. The part through which this section passes does not belong to the glandular part of the prostate, but to the muscular part. The large glandular cells are absent from the strictly glandular part, in which all the cells are columnar and narrow.

Fig. 65. Part of the septal gland in somite VIII, with lymphatic tissue and lymphocytes along the margin; Zeiss D., Oc. 6.

Fig. 66. Lacking.

Fig. 67. Nephridium.

EXPLANATION OF PLATE X.

Benhamia Bolavi MICHAELSEN, *pacifica*, var. nov.

Fig. 68. The ventral sexual zone, showing the fossæ, the prostate pores with penial setæ, and the oviduct pores in the center of XIV.
Fig. 69. A spermatheca, rare form.
Fig. 70. A spermatheca, common form.
Fig. 71. Apex of the longer penial seta.
Fig. 72. Shorter penial seta front view *a;* side views *b* and *c*.
Fig. 73. Section through the junction of the calciferous diverticles with the intestine. The section is tangential to the intestine.

Benhamia Bolavi MICHAELSEN, var. *palmicola* EISEN.

Fig. 74. Section through calciferous diverticle.

Benhamia papillata EISEN.

Fig. 75. Section through calciferous diverticle.

Benhamia nana EISEN.

Fig. 76. Section through calciferous diverticles.

Benhamia papillata EISEN, *hawaiiensis*, var. nov.

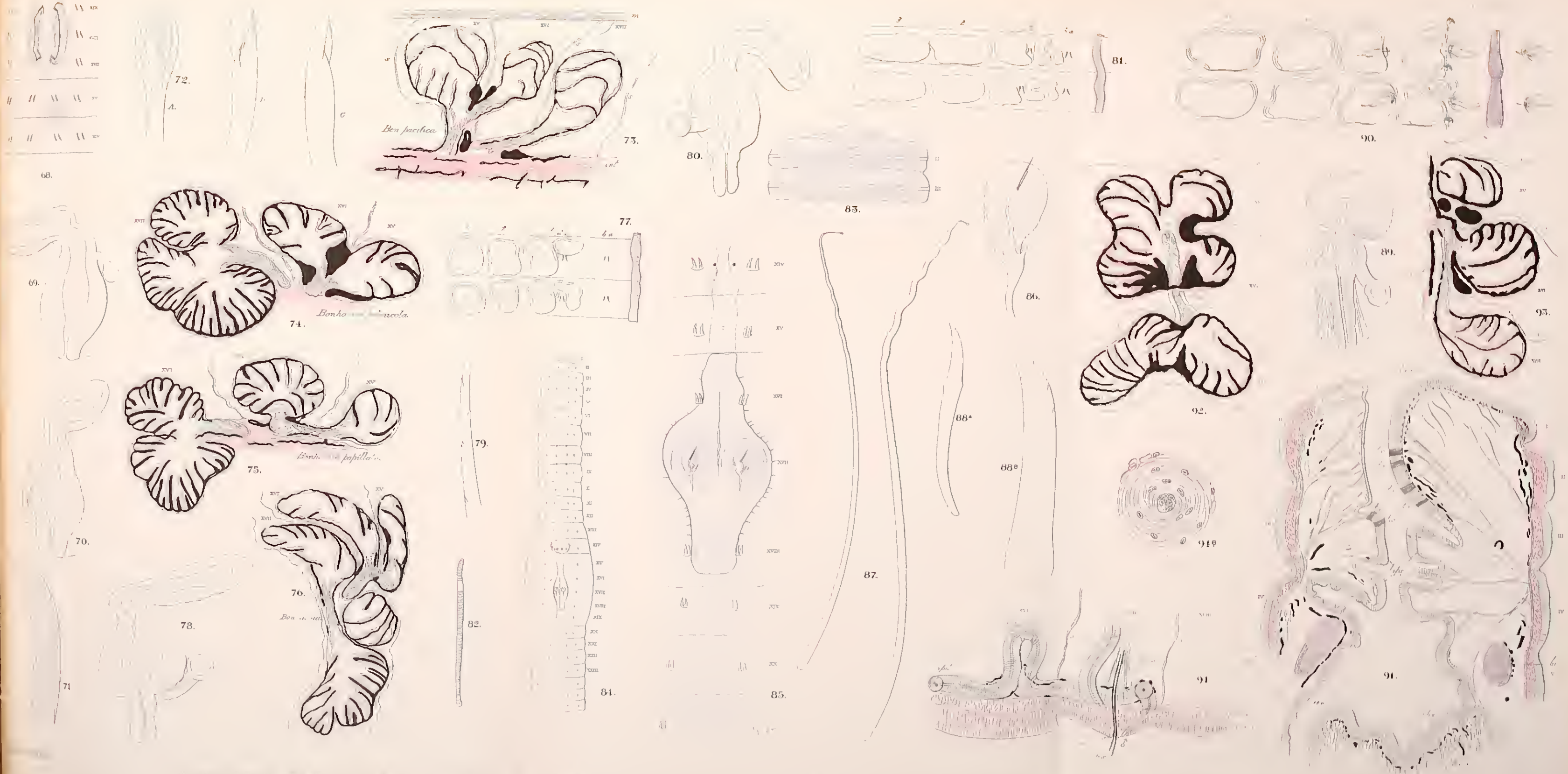
Fig. 77. Nephridia in two succeeding somites, showing the outlines of the cœlomic mantles.
Fig. 78. A spermatheca.
Fig. 79. Apex of larger penial seta.

Benhamia papillata EISEN.

Fig. 80. Nephridia of two succeeding somites, showing outlines of the cœlomic mantles.
Fig. 81. Spermatheca.

Dichogaster Crawi, sp. nov.

Fig. 82. A specimen natural size.
Fig. 83. The three anterior somites and prostomium (dorsal view). The very diminutive somite I is entirely hidden between prostomium and somite II. It can be clearly demonstrated in sections only.
Fig. 84. Anterior somites, ventral view. Genital region and the deltoid arrangement of the setæ.
Fig. 85. Genital region, more magnified. The zone is sunk, but the two central papillæ project as high as the body-wall surrounding the zone.
Fig. 86. A more magnified view of one of the genital papillæ, showing the branched deep groove, in the upper end of which open the prostate and sperm-ducts.
Fig. 87. Two of the largest penial setæ, from one sac. The largest seta is more wavy at the apex and the spur is shorter.
Fig. 88. One of the common setæ, showing the general outline *a;* the ornamented apex *b*.
Fig. 89. A spermatheca, the diverticle pointed forwards.
Fig. 90. Two somites on one side of the ventral ganglion, showing the micro-nephridia arranged as four flaps.
Fig. 91. Anterior somites (longitudinal section); corrosive sublimate. Zeiss AA., Oc. 4; *t. c.*, taste-cells in the epithelium. The small, round dots at the base of the narrow epithelial cells represent light-cells *lips*, inner circular lips, with clear sac-like cells. At the anterior end of the lips are seen bunches of taste-cells.
Fig. 92. Longitudinal section of the calciferous diverticles, parallel to the surface of the intestine. The two anterior diverticles are seen to be only folds of one sac, while the posterior diverticle is connected with the former by a narrow ciliated duct, which also serves as a duct for the anterior diverticular folds; *d. c. d.*, duct of calciferous diverticle.
Fig. 93. Longitudinal section passing through the duct of the calciferous diverticle, just cutting into the intestine; *or.*, orifice of diverticles.
Fig. 94. Longitudinal section of the body-wall in the genital somites XVI–XVIII. Genital papilla in XVII, constructed from two sections.



Benhamia papillata — Benhamia nana, Fig 76

EXPLANATION OF PLATE XI.

Eudrilus Eugeniæ (KINBERG).

Figs. 95–97. Sense-cells from the epidermis of the body-wall representing types of the most common variations of those cells. Figs. 95 and 96 from transverse sections of the body, fig. 97 from longitudinal section. In fig. 95 the narrow ventral protoplasmic diaphragm is contracted, in fig. 96 it is released. In figs. 95 and 96 this diaphragm points diagonally upwards to the right, but it often points to the left. It is never horizontal, nor vertical. The number of marginal cells, *m. c.*, forming the cap varies with the cell.

Pontoscolex corethrurus (FR. MÜLLER), *mexicanus* subsp. nov.

All the figures are drawn with Zeiss Apo., 2 mm., 1.40, Comp. Ocs. 4, 6 and 8, from preparations fixed in corrosive sublimate solution. Benda Iron-hæmatoxylin, Eosin-thionin, or Eosin-toluidine were used in staining.

Fig. 98. Auditory cell supported by two smaller surface cells, which separate it from the cuticle.

Fig. 99. Same.

Fig. 100. Part of the auditory cell in which the archosome (spheres) has the shape of a long sausage-like body. No star-shaped archosome in this cell.

Fig. 101, *a* and *b*. Two auditory cells. The archosomes differ greatly in size. All structures except the archosomes are merely indicated. Oc. 4.

Fig. 102. Part of auditory cell. Two large archosomes, each with two centrosomes. Oc. 8.

Fig. 103. Part of auditory cell, only the archosomes are delineated in detail. They differ greatly in size. Oc. 6.

Fig. 104. Two archosomes from an auditory cell. Oc. 8.

Fig. 105. Two archosomes from an auditory cell, one with two centrosomes, the other with a somosphere and three centrosomes.

Fig. 106. Two archosomes from an auditory cell. In one *(a)* there is a star-like somosphere with centrosome, while *b* has a rounded somosphere with at least two centrosomes. Oc. 4.

Fig. 107. Two archosomes from an auditory cell. One *(a)* has two separate somospheres, one with one centrosome, the other with two centrosomes, connected by a narrow dark-staining band. Oc. 8.

Fig. 108. Two centrosomes from different cells; one stained with Benda iron-hæmatoxylin, the other with eosin-thionin. Oc. 8.

Fig. 109. Part of an auditory cell with two archosomes.

Fig. 110, *a–k*. Amœbocytes from cœlom. Specimen from Tahiti.

Fig. 111. Microcytes from the cœlomic fluid, same specimen as above.

Dichogaster Crawi, sp. nov.

Fig. 112. Lymphocytes from cœlom. *A* and *B* typical forms, which constitute the majority of cells; *C*, *D*, *E*, rare forms for comparison of size with the other cells. *A*, *B*, *C*, Oc. 4; *D*, Oc. 6; *E*, Oc. 8; Zeiss, Apo. 2 mm.; Eosin-Thionin, corrosive sublimate; sections.

Fig. 113. Cells from the prostomium, showing a bunch of common sense-cells, also a single light-cell. Zeiss Apo., 2 mm., Oc. 6.

Ocnerodrilus (Nematogenia) lacuum BEDDARD, *panamaënsis*, var. nov.

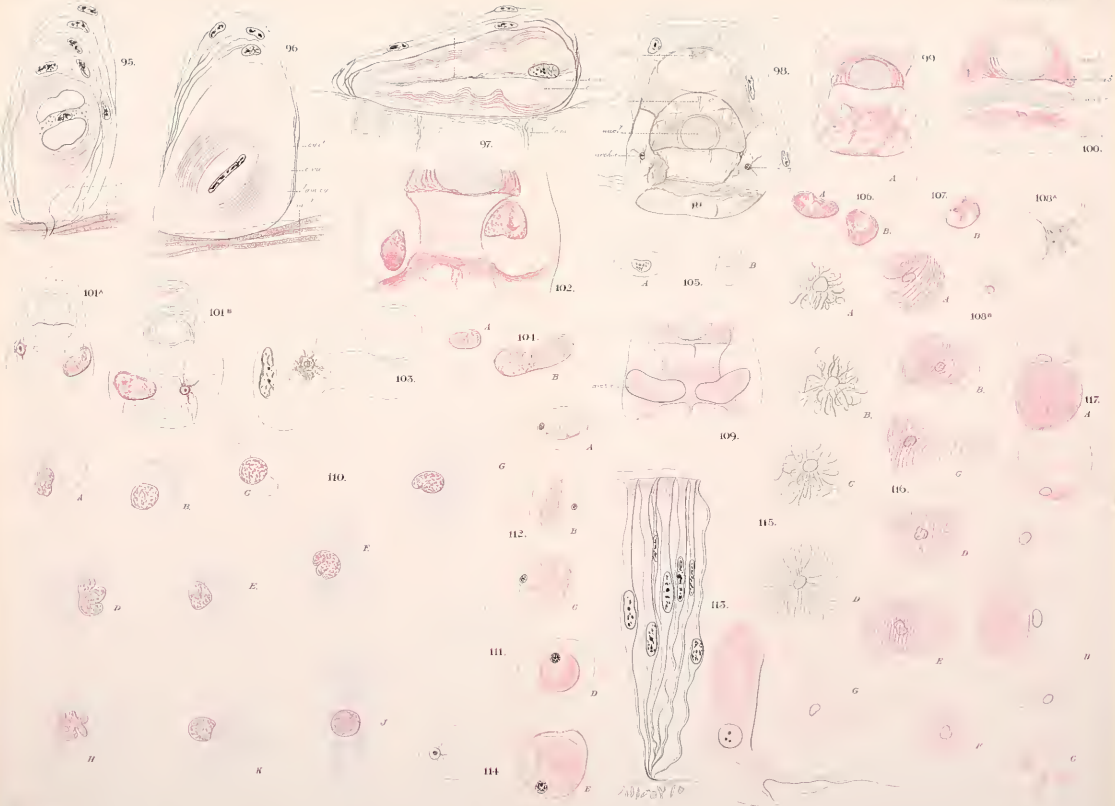
Fig. 114. A common mucocyte.

Fig. 115. Several amœbocytes, cover glass preparation.

Fig. 116. Nematocytes; the cytoplasm consists of a single thread coiled like rope. Zeiss 2 mm., Apo., Oc. 8. Sections in paraffin.

Diplocardia Udei EISEN.

Fig. 117. *A*, *B*, lymphocytes; *C*, microcytes.



[illegible] Fig's 95 to 97 [illegible] 98 [illegible] Fig's [illegible] & 115 [illegible]
Diplo[illegible] Fig [illegible]

EXPLANATION OF PLATE XII.

Argilophilus marmoratus collinus, subsp. nov.

Fig. 118. Apex of penial seta.
Fig. 119. Anterior somites, ventral view.
Fig. 120. Genital somites, ventral view.
Fig. 121. Prostomium and somite II.

Argilophilus marmoratus papillifer EISEN.

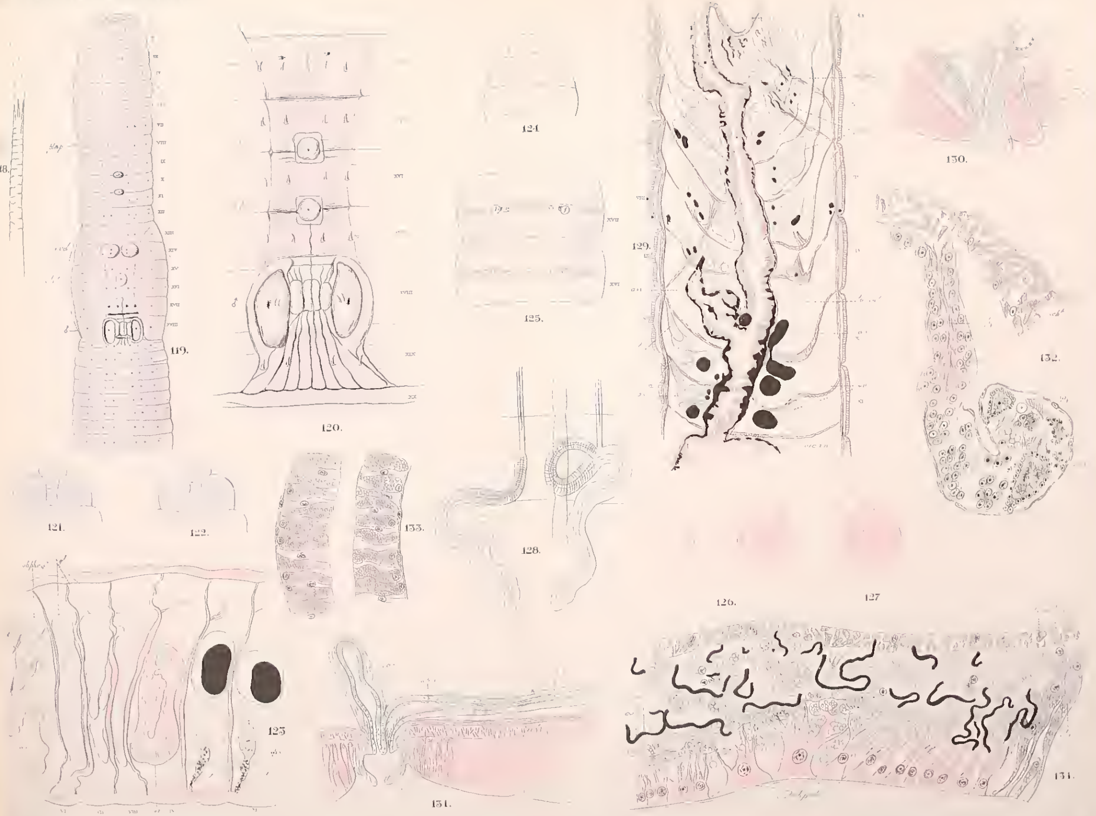
Fig. 122. Prostomium and anterior somites.

Ocnerodrilus occidentalis EISEN.

Fig. 123. Anterior somites in longitudinal section, showing form and size of septal glands and testes. No details are attempted. The section passes through the centre of the pharyngeal part, but misses the intestine, except at its junction with the diverticle.

Ocnerodrilus occidentalis EISEN, *arizonæ*, var. nov.

Fig. 124. Anterior somites, dorsal view.
Fig. 125. Genital somites, ventral view, showing male pores and papillæ and setæ *ab* in somites XVI and XVII.
Fig. 126. A male papilla with setæ pores.
Fig. 127. The same papilla, side view, inner sac-like lumen, into which open prostate and sperm-duct.
Fig. 128. Outline of prostates and sperm-ducts at the male pore; dissected. The ventral nerve-cord is twice as wide as the sperm-duct.
Fig. 129. Anterior somites, longitudinal section. The details are diagrammatic.
Fig. 130. Cross-section of the male pore; junction of prostate and sperm-duct; slight widening of the sperm-duct near the male pore. No details attempted. Zeiss D., Oc. 2.
Fig. 131. Longitudinal section through the male pore; *sp. d.*, the wider lumem of the two joined sperm-ducts. The fusion of the ducts takes place at the point marked ×; *c. p.*, copulatory papilla.
Fig. 132. One of the testes and sperm-sacs, longitudinal section. The part of the sperm-sacs shown represents about one-half of the whole sac as seen in succeeding sections.
Fig. 133. Section of prostate, showing the two different kinds of cells in the same row or layer.
Fig. 134. Genital zone, longitudinal section in XV and XVI; *gl. c.*, glandular, horizontal cells. The epithelium is chiefly composed of broad, posteriorly frayed cells, the ends of which project through the muscular layers. Probably a sense-zone.



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EXPLANATION OF PLATE XIII.

Ocnerodrilus (Ilyogenia) taste (EISEN).

Fig. 135. Spermatheca. This organ is smaller than in the type from El Taste, Baja California. The specimen described is from Tepic, Mexico.

Diplocardia (Aleodrilus) Keyesi (EISEN).

Fig. 136. One of the spermathecæ.

Diplocardia singularis UDE, *caroliniana* var. nov.

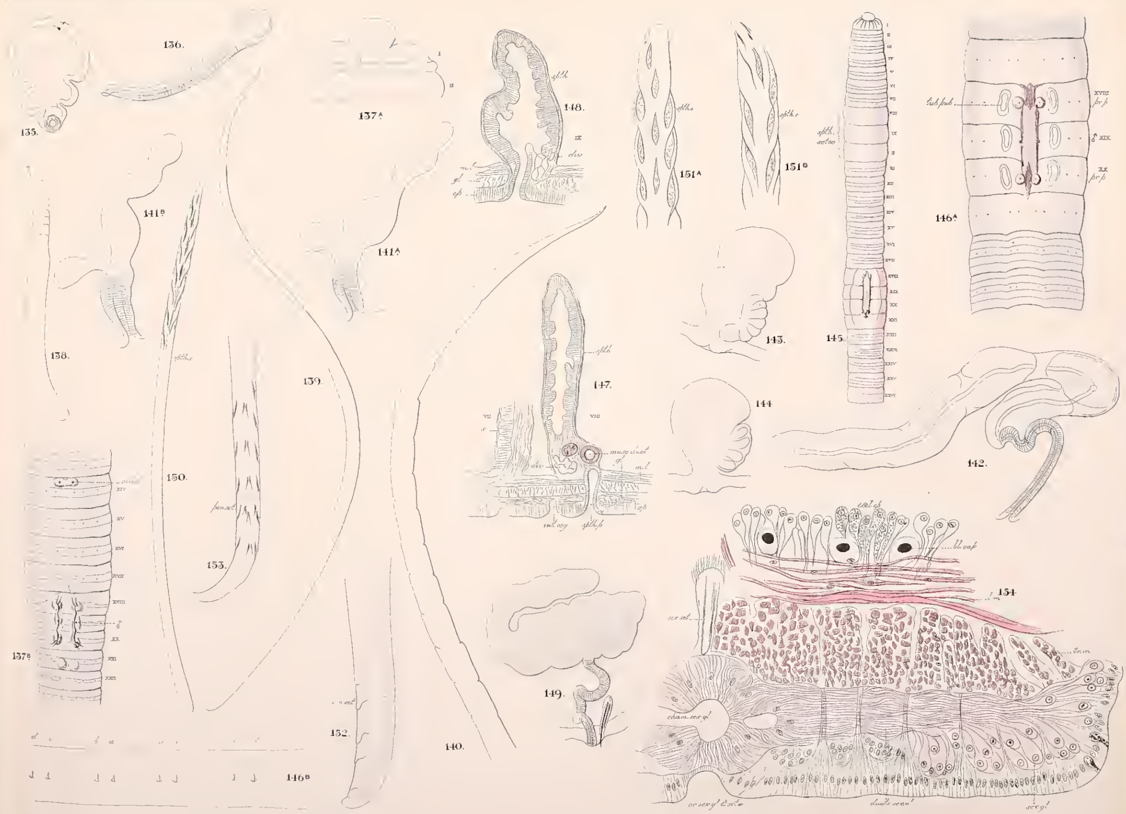
Fig. 137. Clitellar and genital somites, ventral view.
Fig. 138. A common seta.
Fig. 139. A penial seta; same magnification as in 138.
Fig. 140. Apex of penial seta.
Fig. 141, *a* and *b*. Two spermathecæ from somites VIII and IX.
Fig. 142. A prostate.

Diplocardia riparia SMITH.

Fig. 143. A spermatheca, somite IX.
Fig. 144. The other spermatheca from the same somite.

Diplocardia Udei EISEN.

Fig. 145. Anterior somites, ventral view. The ventral parts of somites VIII-X are swollen and furnished with spermathecal sexual setæ.
Fig. 146. Sexual zone in somites XVII-XXI.
Fig. 147. Somite VIII, longitudinal section of body-wall, showing spermatheca and its diverticle; *gl.*, glands leading to the spermathecal sexual setæ.
Fig. 148. Spermatheca from IX, with a hidden diverticle.
Fig. 149. A prostate with muscular duct and bundle of penial setæ.
Fig. 150. Spermathecal sexual seta.
Fig. 151. Apex of spermathecal sexual seta; side view and front view.
Fig. 152. Apex of common seta.
Fig. 153. Apex of penial seta, same magnification as fig. 151. Zeiss Apo. 2 mm., Oc. 4.
Fig. 154. Longitudinal section of body-wall passing through the pore of sexual seta and showing the glandular structure combined with it; *sex. gl.*, sexual glands, the ducts of which lead to the pore, and to the chambers opening in the pore; *cham. sex. gl.*, chambers into which open the ducts of the sexual glands; *sex. set.*, sexual seta cut off obliquely, just before it enters the pore; *ducts. sex. gl.*, ducts of the glands leading to the pore.



Lith. Britton & Rey, S.F.

Phœnicodrilus taste, Fig 135 Diplocardia keyesi, Fig 136 Diplocardia s. caroliniana Fig's. 137 to 142. Diplocardia riparia, Fig's; 143 & 144

Diplocardia udei, Fig's 145 to 154.

EXPLANATION OF PLATE XIV.

Ocnerodrilus (Enicmodrilus) tuberculatus, sp. nov.

Fig. 155. Spermatheca.
Fig. 156. The penial tubercle in somite XVII, showing the junction of the sperm-ducts and the prostate.

Ocnerodrilus (Ilyogenia) taste (Eisen).

Fig. 157. One of the spermathecæ. Partly in optical section but showing the irregular swelling at the apex.
Fig. 158. Section of the body-wall passing through the male pore, showing the total absence of prostates.

Ocnerodrilus (Enicmodrilus) mexicanus, sp. nov.

Fig. 159. Spermatheca.

Notiodrilus cristalifer, sp. nov.

Fig. 160. Spermatheca.
Fig. 161. The longer penial seta.
Fig. 162. The apex of the shorter penial seta.

Notiodrilus Whitmani, sp. nov.

Fig. 163. The prostate and the sacs of penial setæ.
Fig. 163*a*. Apex of a penial setæ.
Figs. 164, 165. The two anterior spermathecæ.
Figs. 166, 167. The two anterior spermathecæ from the same specimen as the last.

Benhamia jamaicæ, sp. nov.

Fig. 168. Spermatheca.
Fig. 169. Apex of two penial setæ from the same sac.

Benhamia papillata Eisen, *hawaiiensis*, var. nov.

Fig. 170. A spermatheca.
Fig. 171. Another spermatheca from the same specimen as the last.

Benhamia guatemalæ, sp. nov.

Fig. 172. Spermatheca.
Fig. 173. Another spermatheca from the same specimen as the last.
Fig. 174. Apex of a penial setæ.

Benhamia viridis, sp. nov.

Figs. 175, 176. Two spermathecæ. The former from a specimen from the city of Mexico, the latter from Morelos.

Diplocardia (Naillenia) Koebeli, sp. nov.

Fig. 177. Apex from two penial setæ.
Fig. 178. Spermatheca showing the short and broad diverticle with pockets of spermatozoa.

Trigaster tolteca, sp. nov.

Fig. 179. Spermatheca. The small dots in the rounded chambers represent the nuclei of glandular cells.

Zapotecia ameca-mecæ, gen. et sp. nov.

Fig. 180. Spermatheca. The lower part which serves as diverticle contains many small pockets for spermatozoa.

Dichogaster Ribaucourti, sp. nov.

Fig. 181. Spermatheca. The dots in the round chambers represent the nuclei of the cells which compose the peculiar glandular structure of the inner lining of the organ.

Dichogaster Townsendi, sp. nov.

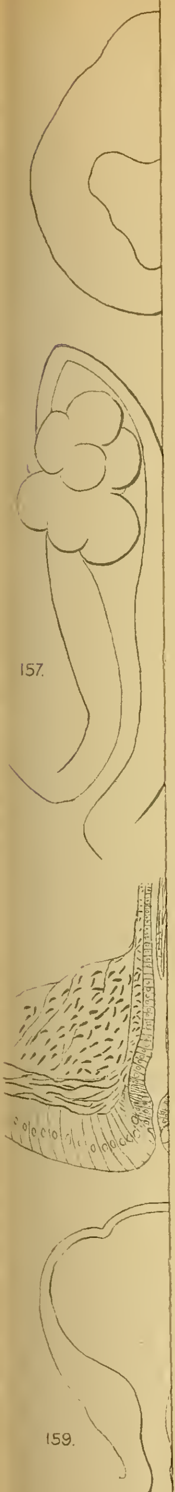
Fig. 182. Spermatheca. The sac is unusually thin-walled.

Microscolex parvus, sp. nov.

Fig. 183. Spermatheca, showing the two diverticles.
Fig. 184. Prostate with sperm-ducts.

Microscolex Horsti, sp. nov.

Fig. 185. Spermatheca.



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GUSTAV EISEN, DE

FIGS 155-156,

163-169, RE

[EISEN] PLATE XIV.

LITH. BRITTON & REY S.F.

... OCNERODRILUS TUBERCULATUS. FIGS. 157, 158, OCNERODRILUS TASTE. FIG. 159, OCNERODRILUS MEXICANUS. FIGS. 160-161, 162, ACANTHODRILUS CRISTALIFER. FIGS. 163-167, ACANTHODRILUS WHITMANI ... AFRICÆ. FIGS. 170, 171, BENHAMIA HAWAIIENSIS. FIGS. 172-174, BENHAMIA GUATEMALÆ. FIGS. 175-176, BENHAMIA VIRIDIS. FIGS. 177-178, DIPLOCARDIA KOEBELEI. FIG. 179, TRIGASTER ... FIG. 180, TRIGASTER ... AMERICA-MECÆ. FIG. 181, DICHOGASTER RIBAUCOURTI. FIG. 182, DICHOGASTER TOWNSENDI. FIGS. 183-184, MICROSCOLEX PARVUS. FIG. 185, MICROSCOLEX HORSTII.

PROCEEDINGS

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CALIFORNIA ACADEMY OF SCIENCES

THIRD SERIES

ZOOLOGY VOL. II, No. 3

California Water Birds

No. IV

Vicinity of Monterey in Autumn

BY

LEVERETT M. LOOMIS

Curator of the Department of Ornithology

WITH ONE PLATE

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CALIFORNIA WATER BIRDS.—No. IV.[1]

Vicinity of Monterey in Autumn.

BY LEVERETT M. LOOMIS,

Curator of the Department of Ornithology.

CONTENTS.

I. INTRODUCTION.

To bridge the gap between my summer and winter observations, I resumed the study of the water birds off the Monterey coast September 18, 1896, and for nearly two months, with but slight interruption, made week-day

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[1] 'No. I.—Monterey and Vicinity from the Middle of June to the End of August,' Proc. Calif. Acad. Sci., 2nd Ser., Vol. V, June 19, 1895, pp. 177–224, 1 map.

'No. II.—Vicinity of Monterey in Midwinter,' ibid., Vol. VI, Feb. 21, 1896, pp. 1–30, 1 map.

'No. III.—South Farallon Island in July,' ibid., Vol. VI, Aug. 29, 1896, pp. 353–366, 2 maps.

 February 8, 1900.

trips upon the ocean from the Hopkins Seaside Laboratory at Pacific Grove, the directors of the Laboratory again kindly allowing me the use of a building.

After the equinoctial, low fogs prevailed during several weeks. The last month the weather was stormy much of the time, the wind generally freshening sufficiently by noon to enforce return to the shelter of the land, for only an open sailboat, sixteen feet in length, was employed in the daily voyages. Nevertheless, there were but three days when the surf was too heavy for a surfman to launch a boat with safety, and on these occasions it moderated by afternoon, or at latest by the following morning.

With the exception of the omission of the vernacular and technical names of subspecies, the nomenclature in the following pages conforms to the second edition and eighth and ninth supplements of the A. O. U. 'Check-List.'

II. MIGRATION.

1. CALENDAR.

September 18. An afternoon upon the bay and ocean revealed that a lull existed in the migrations. Many small flocks of Northern Phalaropes occupied the kelp, apparently feeding and resting. Upon no occasion during the great August flights of 1892 and 1894 were so many found halting by the way. No Red Phalaropes were seen, save a single company tarrying upon the kelp. A stream of Dark-bodied and Black-vented Shearwaters, moving in the direction of Point Santa Cruz, passed near the buoy during the middle of the afternoon. Of three specimens taken of the former species, two had the organs of reproduction enlarged as in birds in the height of the breeding season—a circumstance not observed in May, June, July, and August. Accompanying the Shearwaters was a solitary Fulmar of the dark phase. Heermann's Gulls were not very numerous and Western Gulls, although abundant, were represented almost entirely by individuals having the mantle chiefly or wholly deep plumbeous. The only other birds noted were a Pomarine Jaeger, a few Royal Terns, several Short-tailed Albatrosses in dark plumage, many Brandt's Cormorants, some companies of California Brown Pelicans, and two Great Blue Herons.

September 19. Only one Shearwater (a Dark-bodied) was seen, although the day's cruise extended two miles below Point Pinos. Several flocks of Ducks and Geese passed south. Otherwise the situation was unchanged from the day before. The equinoctial storm began during the forenoon, a heavy gale springing up from the southwest.

September 21. But few Northern Phalaropes occurred on the kelp. A small number were migrating in companies. There was an extensive southward flight of Black-vented and Dark-bodied Shearwaters during a couple of hours of the forenoon I spent in the vicinity of the buoy. The two species appeared to be about equally abundant. With the exception of a group of the Black-vented resting upon the water, all flew speedily by, following the trend of the shore-line, the majority passing Point Pinos within half a mile of the land. A great column of Shearwaters, moving down the coast about a mile offshore, was seen from the Laboratory during the afternoon of the 20th (Sunday). To the transient birds of the 21st should be added a Pink-footed Shearwater, a Loon,[1] and several large flocks of Ducks.

September 22. Northern Phalaropes were not plentiful. An adult was secured as it dropped out of a band of passing migrants. A shot into a like company the previous day gave four young-of-the-year. Shearwaters failed to appear in numbers either on the bay or ocean. My range of observation on the latter extended about four miles west of the buoy. Except one individual, all observed were heading down the coast. The ovary of a Dark-bodied Shearwater was much enlarged. New birds were a pair of Elegant Terns, flying along the bay shore toward Point Pinos, and a solitary Murre, a straggler having marks of recent wounds.

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[1] In this section of the paper three species are included under the general name Loon; viz., *Gavia imber*, *G. pacifica*, *G. lumme*.

September 23. A trip during the forenoon, two miles northwest of the buoy, disclosed little movement beyond a scattering southward flight of Dark-bodied, Pink-footed, and Black-vented Shearwaters, the last predominating. About noon, however, a great army of Dark-bodied Shearwaters appeared from up the coast. The line of march, off the Seaside Laboratory, was not more than half a mile from the land, although no low fog prevailed. There were several divisions—each a solid phalanx about an eighth of a mile deep—following closely one upon the other. Between these, there were many individuals and companies. In all my previous experience I never encountered such a vast host, the most extensive summer movements amounting only to straggling columns. Not less than a quarter of a million passed in review during two hours and a half. They paid little heed to the boat. Occasionally one would give a passing salute, uttering its call-note. Much of the time we were within thirty yards of the flank nearest the shore—so close by, the movement of the myriads of wings was distinctly audible. The birds appeared to be under the direction of leaders, for every few seconds one, among those going by, would rise some twenty feet above its comrades, and then drop back into the ranks, apparently having reconnoitred the shore-line ahead. Surrounded by the Shearwaters, and keeping pace with them, were several squads of Forster's Terns, a white Fulmar, and a party of Shore Birds, apparently Black-bellied Plovers. Two companies of the Terns decoyed when dead birds were tossed into the air, but so bent were they upon the march, they halted only a moment. With the rear guard were a great many Black-vented Shearwaters. A few Pink-footed were seen, but they did not mingle with the others, although flying in the same direction. The generative organs of the Dark-bodied examined displayed great functional enlargement.

There was a notable increase over previous days in Pomarine Jaegers and Royal Terns—five of the former and above a score of the latter being observed. Northern Phalaropes exhibited a falling off in numbers. Some movement took place in 'fresh water ducks.' A female Shoveller was secured from a passing flock. The first Pigeon Guillemot of the season—a bird-of-the-year—was taken near the kelp during the morning.

September 24. A low fog hung over the bay and ocean early in the morning. After it lifted there was a haziness that obscured the coast-line. All the forenoon Dark-bodied and Black-vented Shearwaters were flying south in a continuous stream. Most of them doubled Point Pinos between the buoy and the land. During half an hour at eleven a rush occurred, the stream thickening into a solid column about a sixteenth of a mile in width, with an outlying flank of scattered birds extending slightly to the seaward of the buoy. Fully two-thirds belonged to the larger species. They showed little wariness, many going by within ten feet of the boat. Accompanying this throng was a band of Black-bellied Plovers—two of which were secured. Many Northern Phalaropes rested upon the kelp. Some, also, were winging their way down the coast, as were several small flocks of Heermann's Gulls, near the surface of the water, and a few Loons, high in air.

September 25. Dark-bodied Shearwaters went by on their way south in considerable numbers. About half past nine there was a lull for a while, and a few flew northward. Then another flight began, continuing, with slight cessations, as long as I remained upon the water, which was until midday. With the Shearwaters were two Pomarine Jaegers, each in a separate band. They flew at the same elevation as the Shearwaters, readily keeping abreast with them. A small number of the Black-vented were likewise journeying down the coast, and also a Pink-footed; the latter, although following the same path, kept aloof from the other species. Additional birds of special interest were several southbound Loons, an immature Murre on the water, and a small number of Northern Phalaropes loitering upon the kelp.

September 26. In the morning, shortly before seven, a dense fog settled down over the water. After one it lifted, leaving the sky overcast. As soon as the boat was fairly clear of the land, flocks of Shearwaters, hurrying down the coast, were dimly discernible through the fog. Before the buoy was reached it was manifest that there was an extensive movement in progress near the shore. At the outset Dark-bodied Shearwaters were well represented, but in a little while only the Black-vented appeared in force. After passing Point Pinos, instead of altering their course and heading south, all the Shearwaters proceeded directly out to sea. The fog was so thick that the outlying rocks at the Point could scarcely be perceived at the kelp. The coast-line to the southward was invisible, and the ocean seemingly boundless space, where the birds apparently lost their bearings and became bewildered, for a return movement set into the bay when the fog was densest. At the same time others continued to arrive from up the coast; the outward bound ones passing close to the Point and the inward bound in the vicinity of the buoy. After a while many flew about at random and a large flock congregated on the water. When the shore-line became visible the birds on the water resumed their journey southward. No rush took place after the fog raised, the flight having spent its strength. One small company of the Black-vented remained behind, joining a party of Western Gulls following a school of sardines. Twenty-five Pink-footed Shearwaters were counted in the neighborhood of the buoy during the forenoon. Two of them accompanied the foragers in pursuit of the sardines. The others were moving down the coast, straggling along singly, apparently unmindful of their congeners.

After the low fog several southbound bands of Heermann's Gulls were seen as they were pursuing their way along the shore, close to the surface of the water. Other birds whose presence had especial bearing upon migration were two Loons, a solitary Murre, a juvenile Short-tailed Albatross, about a dozen Pomarine Jaegers, and a few Northern Phalaropes.

September 28. There was further passage of Black-vented Shearwaters. They came from above in small companies, and proceeded directly down the coast. Of the

Dark-bodied, only a few stragglers appeared, and these in the track of the lesser species. No migration of Northern Phalaropes occurred, and only a few tenanted the kelp. A little squad of half a dozen Murres was found on the water. Previously, but three individuals had been seen. A specimen taken proved to be a bird-of-the-year. A White-winged Scoter, *in transitu*, was also observed.

September 29. This was also a day of considerable movement in Black-vented Shearwaters, but instead of going down the coast in bands, they were scattered over a highway, about a mile in width, which off Point Pinos touched the buoy. One bird in passing over a school of sardines made a sudden foray, plunging into the water. Upon emerging, it immediately resumed its course southward. A few others were attracted to the scene and tarried several minutes before continuing their journey. There were some Dark-bodied Shearwaters, but their numbers did not exceed a tenth of the other species. Only two Pink-footed Shearwaters were seen. During the forenoon five Pomarine Jaegers, southward bound, came sufficiently near the boat to be distinctly recognized. An Eared Grebe was captured—the first one of the season observed.

September 30. Migration in the Loons developed additional strength. Besides individuals and couples, several small companies passed by, flying southward high in air. As upon former occasions, none occurred on the water. Heermann's Gulls, previously rather scarce, showed a decided increase, an inroad having taken place. Shearwaters continued to go south, but the movement was feeble and intermittent. Several times a few Black-vented were noticed with Gulls hovering over fish. An Eared Grebe, two young Pigeon Guillemots (the second and third examples of the season), several Pomarine Jaegers, and three Night Herons (at dusk) completed the day's list of birds bearing particularly upon migration.

Just before sundown a low fog settled over the bay. Soon after dark, however, the stars were out.

October 1. The sun appeared above the horizon in a clear sky, and for the first time since my arrival the entire coast-line of the bay was visible. In spite of the fine weather migration appeared to be nearly at a standstill. But few birds were met with during a trip extending five miles northwest of Point Pinos. All the Shearwaters observed flew south, the bulk going by within a mile of the buoy. The Loons noted were likewise bound southward, and as usual kept close to the shore. A Fulmar was taken.

October 2. At seven in the morning flocks of Black-vented Shearwaters were passing near the Laboratory, almost at the surf—a thick fog hiding the land. They came from the east and disappeared in the west. Following in their wake, I soon discovered that close to the shore an avenue of flight was established, along which many flocks were pressing out to the ocean. They displayed an unusual timidity, sheering wildly from the boat as it loomed up before them out of the fog. The belt of kelp and the land seemed also to fill them with fear, those happening between the two being in especial straits, shunning first the one and then the other. By the time I reached the buoy orderly movement had nearly ceased, confusion reigning. The birds were flying about in all directions—those in extreme bewilderment in circles. Between half past nine and ten, the fog lightened and immediately order was restored, and progress southward resumed. A little later, when it became clear, quite a rush took place, flock after flock arriving in the vicinage of the buoy from up the coast, rounding the Point and heading south. About half past eleven the flight slackened. Neither the Pink-footed nor the Dark-bodied appeared in force, only five of the former and not more than a dozen of the latter coming under my observation. The following also deserve notice: Two Loons, flying south near the shore; a Rhinoceros Auklet (the first); two Pomarine Jaegers, on migration; a young Short-tailed Albatross, at the buoy during the fog; several Northern Phalaropes.

October 3. An influx of California Brown Pelicans evidently took place during the night or in the early morning hours, for more and larger companies flew in and out of the bay than upon previous occasions. Bands of Black-vented Shearwaters, varying from half a dozen to about fifty individuals, went down the coast at brief intervals during the entire time I was upon the water. Although it was clear, they doubled the Point near the buoy. Within the bay, off the Laboratory, few approached nearer the land than a mile. A Tufted Puffin and six Loons likewise appeared from above and passed on. A solitary Loon also came into the bay from the south, the first one to pause in its migration, so far as noticed. Not a single Dark-bodied Shearwater made its appearance.

October 5. At 5 A. M. there was a heavy fog which vanished when the sun rose. Quarter to nine the fog set in again, but lasted only about fifteen minutes in the vicinity of Point Pinos, a southwest breeze banking it up toward the Santa Cruz shore. During the clear interval many flocks of Black-vented Shearwaters were pushing down the coast. The flight stopped with the advent of the second fog. After it receded there was only a slight revival, perhaps because the opposite side of the bay was lost to view. The forenoon's cruise also disclosed a few Northern Phalaropes—a company migrating, and several loiterers flying about in various directions. During the middle of the afternoon a great congregation of Cormorants and Gulls (chiefly young Western), with a score or more of Pelicans, followed a school of sardines to the surf at the Laboratory. There were no Black-vented Shearwaters among them, the wave of the morning apparently having gone by without leaving any stragglers stranded to join the chase.

October 6. There was a low fog all the forenoon. Just after eight it increased in density, and soon Black-vented Shearwaters appeared near the surf at the Laboratory, flock after flock passing outward toward the ocean. They seemed to lose the way after venturing beyond Point Pinos, a general return into the bay taking place, followed by much wandering about. When the fog lifted sufficiently to unveil the landmarks, all hesitancy was at an end; regular movement southward resumed sway, continuing unabated at one o'clock—the time of my going ashore. When the fog was thickest, they gave our boat and the boats of the fishermen a wide berth. Their fear vanished, however, as soon as the way lightened. One large flock, midway between the Laboratory and buoy, on being fired into made an extended détour, but apparently so necessary was the land for its guidance that it returned to the line of flight near the kelp before resuming its course.

Southward movement was also witnessed in the following: In a few Loons, one Tufted Puffin, a Pomarine Jaeger, single Pink-footed and Dark-bodied Shearwaters, and a large flock of Surf Scoters, from which a specimen was secured. This was the first instance Surf Scoters were positively identified, although small southbound companies, supposed to be these Ducks, were seen at intervals during the previous weeks. No other individuals of any of the above birds were noted.

October 7. Again the shore-line was shrouded in mist all the forenoon. There was also a transit southward of Black-vented Shearwaters. When the land became visible, flock succeeded flock in frequent succession. As before, the fog rendered them shy. One band coming suddenly upon the boat hurriedly turned back upon its track. Migration in Loons was in the ascendency, more passing by than upon any other day. A Pomarine Jaeger and several Northern Phalaropes were likewise *en route* to the south. An immature Ring-billed Gull was the novelty of the day.

October 8. There appeared to be an eddy in the current of migration, although no diverting fog prevailed. The Loons observed—less than ten—all came into the bay near Point Pinos. During the forenoon, from nine to half past ten, a stream of Black-vented Shearwaters flowed northward outside of the heads. They were exceedingly tame, some passing within a few feet of the boat. An Eared

Grebe (the fourth—the third having been seen the day before), a Murre, and a Northern Phalarope were on the water. Three other Phalaropes flew southward.

October 9. A clear sunrise was followed at half past eight by a little fog at the buoy, lasting about a quarter of an hour. The rest of the day the sky was almost cloudless. Save three White-winged Scoters and a few Black-vented Shearwaters, no birds, so far as seen, went south. A still smaller number of the Shearwaters cruised about, apparently seeking food. Several hundred yards off the sandy beach north of Monterey, a decoy was tossed overboard and a passing Western Gull shot. This was the signal for a great concourse to collect overhead, for the beach was thronged with Gulls. Adult California Gulls were conspicuous in the gathering, forming a large and rather compact body among the more numerous Western Gulls. Before this only one California Gull had been recognized—an immature example, September 28. Further offshore a band of eight Elegant Terns decoyed in like manner, and in another place, one of seven. Previous to this occasion only half a dozen had been met with. A first occurrence was the Red-breasted Merganser—two females along the rocky shore of the inner bay. A couple of Northern Phalaropes floating on the surface, several Royal Terns, and a Pomarine Jaeger were the only other birds noticed except Pelicans, Brandt's Cormorants, and Pelagic Cormorants.

October 10. Migratory movement appeared to be confined to Loons, Surf Scoters, and Northern Phalaropes. About a score of the first and several companies of the second were observed. They passed rapidly southward, none lagging behind. The Phalaropes were limited to a party of three. Not a Shearwater of any species was detected. The preponderance of young over adult Western Gulls was marked, the ranks of the former having been reënforced since September.

October 12. An afternoon breeze on the 11th freshened into a gale. The wind died out during the night and on the morning of the 12th there was a clear sunrise. Notwithstanding the seemingly propitious state of the weather, the only transients noted were several Loons, one company of Surf Scoters, and three or four Northern Phalaropes. A few Black-vented Shearwaters, outside of the buoy, flew northward, and also a file of sixteen Tufted Puffins. Previously but two Puffins had been seen. A Gull being shot, several hundred Western, Heermann's, and California Gulls suddenly appeared upon the scene, apparently coming from the kelp half a mile away, near Point Pinos. The first two of these species were in the majority.

October 13. Clear until a little after twelve, when a low fog from the ocean encroached upon the outer part of the bay. For about thirty minutes during the last hour of the morning, Black-vented Shearwaters were passing down the coast in an uninterrupted stream. Off the Laboratory they were from half a mile to two miles from shore. In other species there was no obvious southward movement.

October 14. In the morning, from half past six until quarter to eight, there was a low fog. By eleven a brisk southerly breeze was blowing. Few migrants appeared aside from several large wedge-shaped flocks of Ducks, which came directly from the north without entering the bay. Loons were quite common on wing. At the close of the morning there was a small flight of Black-vented Shearwaters. They held a northerly course, which was also the case with a flock of Shore Birds, a number of Brandt's Cormorants, and all the Northern Phalaropes observed—a couple and two little companies. The following were met with also: A young Murre, two Tufted Puffins heading up the coast, three Eared Grebes on the water and one flying northward—a decided advance in numbers in this species. Single Grebes were seen on the 10th and 12th.

October 15. The sea was as smooth as glass during the morning, but the surf was heavier than on any of the days that had preceded. At half past ten the breeze came, increasing toward noon to a high southwest wind. Loons, awing, were so numerous that they gave almost a winter aspect to the bird life of the bay. A few Black-vented Shearwaters were skimming over the ocean, half a mile to three miles northwest of Point Pinos. They seemed to be looking for food, for individuals occasionally stopped for a moment, apparently securing some coveted morsel from the depths. A Red Phalarope suddenly appeared and decoyed when three Northern Phalaropes were cut down from a migrating company. No others, of either species, were observed. Three miles at sea a dark Short-tailed Albatross in coursing about came near the boat.

October 16. The wind was light and variable and the sky clear. The tide of movement, although slight, set southward in Black-vented Shearwaters. Three Rhinoceros Auklets and several Northern Phalaropes were found on the water, resting perhaps after the journey. A company of these Phalaropes, also, was speeding southward.

October 21. I was absent during the four days following the 16th. My boatman, however, was on the water on the 17th and reported southward movement in large flocks of Ducks, scattered Black-vented Shearwaters, and several Dark-bodied Shearwaters. The surf was so heavy on the morning of the 21st we failed in our attempt to get a boat off. By the latter part of the afternoon the sea had gone down considerably and two hours were spent on the bay near the Laboratory. Between two and three a school of sardines, driven by larger fish to the surf, attracted a great concourse of Gulls and a small number of Black-vented Shearwaters. At the same time an army of the Shearwaters was filing by about half a mile offshore. The sardines, in seeking safety, got in the track of the Shearwaters and a vast flock congregated. Soon some detached themselves and resumed their course, disappearing in the direction of the ocean, apparently having appeased their hunger. Others continued to arrive, and others still, further from land, passed by without joining the mêlée. When the sardines shifted again the Shearwaters did not pursue, but went their way down the coast. The line of passing birds was unbroken when I returned to shore, just before sundown. The persistency with which these skimmers of the sea fly near the surface of the water was well illustrated. To clear the higher waves they had to rise above them, but immediately descended to their former level when the obstacle was overcome. There was southward movement, also, in Surf Scoters and Loons. The companies of the latter were larger than upon previous occasions.

October 22. A little after seven in the morning Black-vented Shearwaters were passing out to sea along the shore of the bay within half a mile of the Laboratory. On going out to them it was found they crowded a highway about half a mile wide. With the sun behind us, they were transformed against the background of sky and water into white birds, the lining of the wings and the other under parts prevailing over the rest of the plumage. From the opposite point of view they were dark birds. All unhesitatingly changed their course southward at Point Pinos, many rounding the Point inside of the buoy. After half past ten the flight became feebler, and for a while they appeared in flocks, which finally increased into a stream, broken at intervals. By noon the line of movement within the bay had shifted nearer to the shore, and was not more than an eighth of a mile from the Laboratory. They were very unsuspicious and the boat could have been filled with specimens if they had been desired. There was a migration of Loons, in twos and threes and small companies. They pursued the same general path as the Shearwaters, but at a higher elevation. Most of the forenoon straggling parties of Heermann's and Western Gulls (the latter chiefly young birds) were moving down the coast. A decoy being thrown into the air, those passing at the moment decoyed, circling overhead. After a young Western and an old Heermann's had been shot the others proceeded on their way. A few solitary adult Western Gulls came into the bay from below. They seemed to pay no attention to the travellers going in the opposite direction. Five bands of Surf Scoters (the largest numbering over thirty), a squad of eight White-winged Scoters, and some undetermined Ducks passed south, following the coast-line closely. I did not observe any Ducks on the water or any flying up the coast.

October 23. A high fog occurred through the day. Migration was stronger in Loons than at any time since my arrival. There were a few loiterers—one upon the water, the first for the season. In other birds, except Ducks (mainly Surf Scoters), southward movement had nearly come to a halt. In the vicinity of the buoy scattered Black-vented Shearwaters were looking for food. Between one and two miles to the northwest, a flock with Gulls was preying upon sardines. Returning at midday to Point Pinos after a cruise five miles offshore, several hundred Black-vented Shearwaters were found congregated in the kelp, a school of sardines having sought refuge in its fastnesses. Associated with the Shearwaters were many Gulls, chiefly Heermann's, but also Western and California. The Shearwaters displayed extreme reluctance to take flight, some only rising to avoid being run down by the boat. Even the report of the gun did not cause them to retreat further than several hundred yards. Other noteworthy birds were: Four Rhinoceros Auklets, one Pigeon Guillemot, a Murre, two Royal Terns, and a Dark-bodied Shearwater.

October 24. Many Loons and Ducks were on migration. A slight retrograde movement occurred also in the former. One company of Loons numbered eleven and another seventeen. The Ducks seemed to be largely Surf Scoters. Of the White-winged, but a single band was identified with certainty. Black-vented Shearwaters were quite numerous, and flew about promiscuously, the majority below Point Pinos straggling up the coast. A Dark-bodied Shearwater (a 'pensioner') and several Northern Phalaropes were the only other birds of particular note.

October 26. It was slack water in the tide of southward movement. More Loons went up the coast than down. During the forenoon a goodly number of Black-vented Shearwaters were skimming over the surface of the ocean, which was as smooth as glass until ten o'clock. But a single Dark-bodied Shearwater was met with, and it was going south. In the afternoon a vast assemblage of Cormorants, Gulls, and Black-vented Shearwaters was fishing near the Laboratory. The Shearwaters did not fall short of a thousand. The following were resting upon the water: A company of three Tufted Puffins, a Rhinoceros Auklet, one Pigeon Guillemot, and eight Cassin's Auklets, including two groups of three and four, five miles at sea. It began to rain at noon, continuing into the night.

October 27. A southerly gale made it too stormy for the boat, and in the latter part of the afternoon I walked down to the shore opposite Seal Rocks. These islets were crowded with Brandt's Cormorants. As long as I was in the vicinity recruits were continually arriving from the direction of Monterey Bay. A few Pelicans and some Gulls found a roosting place among the Cormorants. The beaches in the neighborhood were cleared of Shore Birds, two Black-bellied Plovers being the only ones noticed.

October 28. The storm of the previous day was followed by a cloudless sunrise. The sea breeze came from the northward and gained in force as the forenoon wore on, finally becoming quite a strong wind. A flock of over fifty Red Phalaropes was discovered feeding in a 'current-rip' at the mouth of the bay. Sixteen were shot. Several of them appeared to be adults. Individuals and twos and threes were sparingly distributed on the bay nearly to Monterey. The few Loons seen came from the south, and the only Ducks were two White-winged Scoters heading down the coast. Pigeon Guillemots had advanced in the scale of abundance, the morning's cruise developing half a dozen adults. Black-vented Shearwaters were numerous over the bay, particularly out toward the ocean. They did not pursue any definite course—all seemingly on the lookout for fish.

October 29. The last vestige of the storm had disappeared. At noon the ocean was like a mill-pond. A little later a light westerly breeze sprang up and the sky became slightly overcast. No migratory movement appeared to be in progress. Loons were scarce. The few noted flew up the coast. Black-vented Shearwaters were generally dispersed, apparently bent on going a fishing. Between four and five miles northwest of the buoy, a flock of thirty Cassin's Auklets was found on the water. A couple and two trios were passed on the way out. All took wing readily, showing no signs of fatigue. A patch of drifting kelp in the vicinity of the flock of Auklets afforded a resting place to three Elegant Terns, an immature Mew or Short-billed Gull, and a company of Western and Heermann's Gulls. The Red Phalaropes had almost wholly departed. An Eared Grebe and three Rhinoceros Auklets were seen.

October 30. A clear sunrise and a land breeze ushered in the morning. After nine the wind veered round into the west, freshening into a stiff sea breeze that drove us from the ocean, two miles northwest of the buoy, to the shelter of Point Pinos, where some Pelicans and Gulls (principally Heermann's) and more than a thousand Black-vented Shearwaters were feasting upon sardines in the kelp. Straggling Shearwaters, coming from the interior of the bay, swelled the gathering.

Two Loons were on the water, and a few on wing, as many traveling up the coast as down. Red Phalaropes showed no advance in numbers, a group of four and several individuals being all that were met with. A new arrival was an adult Glaucous-winged Gull.

October 31. The only southbound travelers seen during the voyage of the forenoon were Loons and Black-vented Shearwaters. There were a great many of the latter, chiefly flocks following the shore near the kelp. A school of sardines crossed their path, but not a Shearwater stopped. After ten the flight weakened somewhat, and a gathering of several hundred was formed between the buoy and the land. These birds seemed to be tired, sitting motionless with heads drawn in close to the body or tucked under the wing. Stragglers, dropping out from the passing bands, added to their numbers. When pressed they took flight, a few starting at a time. All headed southward, some continuing this course until out of sight, but most reforming on the water after flying a short distance. As I returned to the Laboratory at midday individuals were found resting along the way near the shore. One of these loiterers joined some 'albacores'—in his eagerness accompanying the fish beneath the surface. The only water fowl observed were two Surf Scoters on the water. No distinctively northward movement occurred in any species. It was slightly foggy on the bay offshore in the morning.

November 2. Early in the day there was a slight movement southward in Black-vented Shearwaters, which gained impetus by noon, when small flocks appeared at brief intervals, rounding Point Pinos near the land. At the same time, a mile or two offshore, a few outlying stragglers were wandering about. At twenty minutes to four a continuous stream was moving down the coast a sixteenth of a mile off the Laboratory, breasting a strong southwest wind—the outgrowth of a sea breeze that began at ten o'clock. At five the flight had nearly subsided. Contemporaneous with the movement of Shearwaters was one of Western and Heermann's Gulls. Its height likewise occurred during the latter part of the afternoon, when numerous small bands wended their way along the shore out to the ocean—the Western Gulls crossing the Laboratory point and the Heermann's Gulls keeping just beyond the reach of the surf. So far as observed the Red Phalaropes were reduced to two—these on the water near the kelp.

November 3. The wind of the 2d bore fruit in a tremendous surf—the heaviest between the 17th of September and the 17th of November. A steamer that had gone on the rocks in a fog during the summer and had withstood previous storms was overwhelmed and went to pieces. The movement in Gulls of the day before seemed to be continued on a larger scale. At sunrise loose companies were passing outward by the Laboratory. At the wreck many were seen hovering over the breakers, perhaps feeding on the wheat that had formed a part of the unfortunate ship's cargo.

November 4. The day opened with a clear sky and an easterly breeze, a heavy surf being the only reminder of the storm. As the land warmed, the breeze became a northerly one. Before sunrise flocks of Heermann's Gulls (adults and juveniles) were passing down the coast near the Laboratory. Among them were a few immature Western Gulls. The flight continued through the forenoon, slackening at midday. There was no dallying, not even over sardines. A school coming in the way of a large flock, several hesitated, but only for a moment and then went on. All the forenoon, particularly during the morning, Surf Scoters were going south in bands varying in size from a dozen birds to upwards of a hundred. Like the Gulls they hugged the shore. Several individuals came into the bay from below. There was migration also in other Ducks. Five White-winged Scoters, however, were the only ones fully determined. Black-vented Shearwaters traveled southward in large numbers near shore. Companies and single birds frequently dropped out of line and circled about, forming a slight counter movement. It was an off day in Loons. A few Royal Terns and two Red Phalaropes were seen—all on wing heading down the coast.

November 5. A great migratory movement occurred in Heermann's Gulls and Surf Scoters. From half past six until half past ten there was an almost unbroken procession of companies and individuals of the former, chiefly older birds, moving down the coast close to land. Mingled with them were a few Western and California Gulls. In the latter part of the afternoon, when there was a northwesterly wind that made whitecaps plentiful, a second flight took place, rivalling the one of the forenoon. There were many Western Gulls, largely birds having white under parts. As on the day before slight disposition was manifested to linger over sardines. During the forenoon the movement in Surf

Scoters fell little short of that in the Gulls. The Scoters were mainly in large flocks and passed swiftly by near shore, heading south after doubling Point Pinos. Only one straggler was encountered, a bird upon the water. The following were also observed: One band of sixteen Loons and a half a dozen individuals (all on migration), a young Murre at the kelp, a Herring Gull or Vega Gull (first occurrence), a few Black-vented Shearwaters (mostly southbound), one Dark-bodied Shearwater going south, a party of twelve White-winged Scoters and another of forty—both migrating.

November 6. It was a bright day and the ocean was comparatively still. The wind not rising until after eleven, I remained out until noon collecting Pink-footed Shearwaters. The first one seen was about two miles from shore. The further the land was left behind the more plentiful they became. Upwards of forty were counted, single birds and couples hastening southward. The several dark Fulmars observed and the dozen Dark-bodied Shearwaters were likewise offshore birds; not so, however, the few Black-vented Shearwaters, which scarcely ventured 'outside' a mile. The event of the day was the capture, about six miles west of Point Pinos, of a Buller's Shearwater. There was less southward movement in Surf Scoters than on the previous day, but apparently no diminution in Heermann's Gulls. At sea, three miles out of the track of these migrants, a flock of the latter fished for sardines with Western Gulls. In their train was a little party of Bonaparte's Gulls, old and young, and a mile away a smaller party. This was the first appearance for the season, so far as noted. Near the same spot a flock of one to two hundred Red Phalaropes had collected in the kelp and other débris floated from the shore by the currents. A few individuals were scattered about elsewhere on the ocean. Loons were not numerous and their flight was not wholly southward. Rhinoceros and Cassin's Auklets did not abound. Of the former, five solitary birds, a couple, and a trio were seen.

November 7. We had a fair wind both ways, the land breeze carrying us out to sea in the morning and the sea breeze bringing us back to land early in the afternoon. A clear sky added to the pleasantness of the day. No less than two hundred Pink-footed Shearwaters were seen, most of them following sardines on the ocean about six miles west of Point Pinos. The generative organs of the specimens taken exhibited little if any functional enlargement. In the same vicinity a Slender-billed Shearwater was secured. There were several other small birds, but they were not distinguished with certainty, and may have been the Dark-bodied, of which there were at least a dozen. Black-vented Shearwaters were very scarce, especially in the neighborhood of the Pink-footed. When five miles from land we came upon two bands of Bonaparte's Gulls. The lesser numbered twenty-four and the greater over two hundred. Migration in Heermann's Gulls was on a smaller scale than on the 5th and 6th, and as usual was near the shore. A raft of drift-kelp six miles out gave a footing to a group of Western, California, and Heermann's Gulls. Red Phalaropes were quite generally distributed outside the buoy. A Western Grebe, on the water near the Laboratory, was the first example for the season. Other birds of particular interest were four Loons going south, a Tufted Puffin, also southbound, two Rhinoceros Auklets, several Glaucous-winged Gulls, and a Fulmar—all on the ocean between five and six miles from land.

November 10. Indoor work compelled me to forego a trip on the ocean on the 9th. However, it rained and was too windy for an extended voyage. The 10th was fair and a light land and sea breeze and smooth water invited an off-shore cruise. Nearly the whole day was spent on the ocean, much of the time fully eight miles northwest of Point Pinos. The fine weather found no response in migration. Loons were more abundant than of late, but quite as many went north as south. More Rhinoceros Auklets were seen than upon any former day. They were on the water however—chiefly in couples. Cassin's Auklets were very common, in small companies and twos and threes. They kept out of range, flying freely when pressed. Not many Heermann's Gulls were met with, and no southward movement witnessed. Pink-footed Shearwaters were reduced to about a dozen, but Black-vented Shearwaters showed a decided gain, and were generally dispersed. A flock gathered over sardines six miles offshore, and nearer land forty or fifty were taking a siesta on the water. A small number, in line, passed south near the buoy. Fewer Dark-bodied Shearwaters were seen than on the 7th. Only stragglers remained of the Red Phalaropes, and a single company, moving down the coast, were the only Surf Scoters.

November 11. At half past six the water was hidden from view, but the fog soon vanished. At noon the coast was sharply outlined to Point Ano Nuevo and buildings were visible in Santa Cruz over twenty miles away. With a fresh easterly breeze we sailed along the shore to Point Pinos and then on the ocean westward about ten miles. By ten o'clock the wind had worked round into the north, filling the sail for the homeward voyage. Between thirty and forty Pink-footed Shearwaters were seen. They flew swiftly southward, most of them passing within four or five miles of Point Pinos. Several, however, were fully ten miles at sea and one or two not more than a mile. On the way out many southbound Black-vented Shearwaters were observed in the vicinity of the buoy. Two miles from land we seemed to leave their path behind, few being met with further offshore. On the way in they began to increase within the two-mile limit, and near the buoy a steady stream was flowing in the direction of Point Cypress from the interior of the bay. It soon became evident that one of the largest movements of the season in Black-vented Shearwaters was under headway. Off the Laboratory they were at least two miles from land. There was a morning, midday, and afternoon flight of Gulls at the shore—mainly Heermann's and Western. The Western Gulls were white-breasted birds and young-of-the-year—the latter associated in flocks with the former or sufficiently near them to be within sight. Much migration occurred in Surf Scoters during the morning. Four were noticed on the water. Loons, too, went down the coast in some numbers. Two migrating companies were fully six miles from land. Besides Cormorants and Pelicans, the following were noted: A few Rhinoceros and Cassin's Auklets, two adult Murres, a Pomarine Jaeger, several adult Glaucous-winged Gulls and as many Herring or Vega Gulls (all going south), one Royal Tern, a dark Fulmar, two southward-bound Dark-bodied Shearwaters, a Great Blue Heron, a party of Red Phalaropes scattered over the water at the buoy, and groups of three and twelve Red-breasted Mergansers near the Laboratory. Individuals of the last species were seen during the past month whenever I ventured close to the surf along the south shore of the bay.

November 12. The morning was cold and clear with a fresh breeze from the east. There was scarcely any swell —hardly more than a summer ripple at the Laboratory beach. I did not go outside. Most of the forenoon was passed on the inner portion of the bay. Before half the distance to Monterey had been traversed more than two hundred Loons had gone by—individuals, and bands of eight, seventeen, fifty-two, eighty-six, thirty, and nine, flying high in air along the shore in the direction of the ocean. Surf Scoters were quite numerous. Like other inshore transients they avoided the Monterey harbor, shaping their course from the eastern shore toward a little promontory about half a mile east of the Laboratory, then westward close by the Laboratory point—the line of flight being from headland to headland along the south shore. With the flock of thirty Loons there were three White-winged Scoters. One or two independent companies also appeared. An extensive morning and afternoon flight occurred in Western and Heermann's Gulls—adults and birds-of-the-year. For the first time since my arrival the young of the latter were conspicuous on the rocks. Loitering juvenile Glaucous-winged Gulls were not uncommon over the water. A few California Gulls in light and dark plumage went down the coast, following the same path as the other species. A small stream of Black-vented Shearwaters set into the bay from the south, passing the Laboratory two miles offshore. Two Royal Terns and several Red Phalaropes were noted.

November 13, 14. The 13th was one of the calm days preceding a storm. At sunrise the atmosphere was perfectly clear. I had been waiting for such a day to make a trip to Point Carmel. A gentle breeze bore the boat from the buoy to Seal Rocks, where in landing I disturbed two flocks of Black Turnstones, all told perhaps a hundred. The wind dying out, the sea became like a mirror and the oars were relied upon the rest of the way. Any of the rocks at Point Cypress or Point Carmel could be landed upon, and the water was so clear in Carmel Bay the bottom was seen in many places. There was scarcely any southward movement that might be esteemed migration, a few companies of Loons and Surf Scoters being about the only birds which seemed to have other business than fishing. In the morning quite a stream of Heermann's Gulls came into the bay around Point Pinos. On the kelp near Seal Rocks there was a great gathering of these birds. Among them were many California Gulls. Scattered Black-vented Shearwaters, on wing, were plentiful as far as Seal Rocks. Most of them were heading up the coast. At the mouth of Carmel Bay two groups were taking their ease at midday upon the water. A school of 'albacores' appearing, some deserted, following in the wake of the fish. White-headed Western Gulls abounded at Carmel Bay. As there was no breeze to aid our return, the remainder of the afternoon was occupied in prospecting among the islets at Point Carmel for probable sites of next season's rookeries. Here the calls of the Black Turnstone were heard again. The closing of the day was like the opening. There were no vapors, the sun leaving the horizon all aglow as it sank into the ocean. The next morning broke fine, and with a brisk breeze from Carmel Valley the homeward voyage was begun. At the mouth of the bay we were becalmed. Rowing outside of Cypress Point, a strong head wind was encountered, forcing us to stand out to sea fully twelve miles. At half past ten the wind began to come in puffs and soon after hauled round into the northwest. By the time Point Pinos was doubled there was only a light breeze. The long tack developed no offshore migration. However, scattering Black-vented Shearwaters, going up the coast, were found as far out as we went. Near land a goodly number of Loons in bands passed down the coast. Otherwise there was no conspicuous southward movement. Two adult Murres are worthy of note.

Summary of Southward Movements.—With the daily fluctuations from the passage of migratory waves, some birds waned as the season wore on (the Northern Phalarope, Pomarine Jaeger, and Dark-bodied Shearwater for example), and others waxed in the scale of abundance, as the Loons, Surf Scoter, and Black-vented Shearwater. The Western Gull, while varying from day to day as the waves rolled southward (young or old predominating), maintained a comparatively even average through the season. In some species there was a marked hiatus intervening between the summer and winter occurrences, as observed in previous years; there apparently existing a first or late summer migration, and a second or late autumn migration bringing the winter visitants—examples, Western Grebe, Cassin's Auklet, Marbled Murrelet, Murre. Less pronounced periods of absence at the outset were noted in the California and Heermann's Gulls, and perhaps in the White-winged Scoter. A sort of aftermath of stragglers occurred in certain of the declining species, as in the Red Phalarope and Dark-bodied Shearwater.

The following examples illustrate the currents and counter-currents in the tide of southward movement:—

Date	Dark-bodied Shearwater			Black-vented Shearwater		
	Southward	Northward	Indefinite	Southward	Northward	Indefinite
Sept. 18		Many			Many	
19			One			
21	Great many			Great many		Group on water
22	Few			Few		
23	The vast host			Great many		
24	Great numbers			Great many		
25	Many	Few		Few		
26	Many			Great many		Company fishing
28	Few			Many		
29	Not many			Many		
30	Not many			Not many		Few fishing
Oct. 1	Few			Few		
2	About a dozen			Great many		
3				Large numbers		
5				Many		
6	One			Large numbers		
7				Many		
8					Many	
9				Few		Very few
10						
12					Few	
13				Many		
14					Not many	
15						Few
16				Not many		
21				Large numbers		Few fishing
22				Large numbers		
23			One			Not many, fishing
24			One			Quite numerous
26	One					Many, fishing, etc.
28						Numerous
29						Numerous
30						Many fishing
31				Great many		Large flock resting
Nov. 2				Large numbers		Few
4				Large numbers		Not many
5	One			Few		Very few
6			Dozen			Few
7			About a dozen			Few
10			Not a dozen	Few		More plentiful
11	Two			Large numbers		
12					Not very many	
13					Plentiful	Two groups on water
14					Plentiful	

As seen, high-water mark was reached in the Dark-bodied Shearwater on the 23rd and 24th of September, and was immediately followed by a rapid decline. The Black-vented Shearwater, on the other hand, advanced in numbers until its southward movements in October and November almost equalled the greater of the Dark-bodied in September.

No attempt has been made in the foregoing pages to chronicle the movements of the Geese and Shore Birds (except Phalaropes), for they flew at too great an elevation, or gave the boat too wide a berth, to be distinctly recognized in most instances. There were, nevertheless, movements of considerable extent, particularly in the Shore Birds in the early part of my stay.

2. CONCLUSIONS.

MIGRATION NORTHWARD AFTER BREEDING SEASON.

Migration from South Temperate Zone.—It has long been surmised that certain Petrels occurring in summer off the northern coasts of North America breed in winter or early spring on the oceanic islands of more southern seas. It has, also, been stoutly maintained that the breeding grounds of these birds would ultimately be discovered in the regions of their summer habitat. To Mr. William Brewster[1] and Capt. J. W. Collins[2] is due the credit of definitely determining by dissection that Wilson's Petrel and the Greater and Dark-bodied Shearwaters do not breed during their sojourn on the coast of New England and adjacent British possessions, although present in numbers after the winter season. This, coupled with the previous discovery by the Rev. A. E. Eaton[3] that Kerguelen Island is a breeding station of Wilson's Petrel, has given weight to the theory of migration from the South Temperate Zone. Corroborative, and seemingly conclusive, proof of such migration is afforded by the Dark-bodied Shearwater on the Pacific Ocean. The facts are as follows:—

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[1] Proc. Bost. Soc. Nat. Hist., Vol. XXII, p. 404.
[2] Rep. U. S. Fish Comm. for 1882, p. 314; 'Auk,' Vol. I, p. 237.
[3] Philos. Trans. Roy. Soc. London, Vol. 168, p. 133.

1. In May, 1897,[1] the Dark-bodied Shearwaters off Monterey were in worn and moulting plumage, as in birds just after the breeding season. The sexual organs of numerous specimens examined invariably displayed no functional development, which was also the case in the summer months of 1894.[2]

2. As shown in the preceding pages and in the first two papers[3] of this series, the migratory movements of these Shearwaters increased in extent, through the summer, nearly to the close of September, when there was an abrupt decline, only stragglers being seen thereafter.

3. Almost without exception, the September and October specimens secured were in fresh plumage *with sexual organs enlarged as in birds in the flush of the breeding season.*

4. During the period of absence from Monterey these Shearwaters occur in the South Temperate Zone,[4] breeding on oceanic islands from October to March.[5]

5. It is improbable that the Dark-bodied Shearwater should be found breeding in the remote antipodes and be overlooked in the Northern Hemisphere where rarer and less conspicuous Petrels (like Bulwer's, Ashy, and White-faced) are known to rear their young. In short, the evidence that the Dark-bodied Shearwaters of the California coast breed in the South Temperate Zone and not in the tropics or in boreal regions rests upon the same foundation as the evidence that the Bobolinks of Brazil breed in the North Temperate Zone and not in more southern latitudes.

The Slender-billed Shearwater, likewise, seems to be a migrant from the South Temperate Zone. It breeds in myriads in the vicinity of Tasmania and New Zealand[6] during the southern summer, but is apparently absent from

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[1] In the following pages occasional allusion is made to observations in May and early June, 1897. These observations are to appear in a subsequent paper, 'California Water Birds. No. V.'

[2] 'California Water Birds. No. I,' p. 181.

[3] Ibid., No. I, p. 181 et seq.; No. II, pp. 3, 5, 6.

[4] Off Corral, Chili (Lane, 'Ibis,' 7th Ser., Vol. III, p. 312).
Hobart, Tasmania (Buller, Trans. N. Z. Inst., Vol. XXVI, p. 199).

[5] Buller, Hist. Birds N. Z., 2nd Ed., Vol. II, pp. 232, 233.

[6] Ibid., pp. 230, 231.

the region between May and September.[1] It is not known to breed above the equator, although occurring as far north as the seas of Kamtschatka and Alaska.[2]

The Greater and Pink-footed Shearwaters may also be visitors from antipodal regions. So far as I am aware, their nesting habitat remains undiscovered, but both occur, during the warmer months, south of the Tropic of Capricorn.[3] As in the Greater Shearwaters on the North Atlantic (Collins, l. c.), the sexual organs of all the Pink-footed Shearwaters (twenty-two in number) obtained at Monterey in May and June, 1897, showed no seasonal enlargement, but the ovary of a female in high feather, taken November 10, 1896, was enlarged as in a bird of the nuptial period. As a rule, however, the autumn specimens did not exhibit any marked erotic development.

The following should, perhaps, be reckoned as migrants having fly-lines which ordinarily do not reach far north of the equator: Slender-billed Fulmar, Buller's Shearwater, Black-tailed Shearwater, Pintado Petrel.[4]

Migration from Subtropics and Tropics.—The southward movements of the Black-vented Shearwaters, referred to at length in the foregoing 'Calendar' and in the second paper of the series, are believed to be migratory movements to breeding grounds, and not mere local wanderings in search of food. This view of the matter appears to be sustained by the following facts:—

1. The flights of Black-vented Shearwaters were similar in character to those of the Dark-bodied. Also, the former species was observed traveling in company with the latter,

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[1] Montgomery, 'Ibis,' 7th Ser., Vol. IV, p. 210.

[2] Ridgway, Man. N. A. Birds, p. 62.

[3] Salvin, Cat. Birds Brit. Mus., Vol. XXV, pp. 374, 377.

Since the above was penned, I have learned from 'Fauna Chilensis' (p. 737) that *Puffinus creatopus* breeds on Mas-a-tierra (Juan Fernandez).

[4] There are other Tubinares occurring north as well as south of the line (as *Puffinus carneipes*) which also may be only visitors from austral zones, and not breeders in both hemispheres like *Pelagodroma marina*. (Cf. Cat. Birds Brit. Mus., Vol. XXV, p. 386; Hist. Birds N. Z., 2nd Ed., Vol. II, p. 234, ibid., p. 248; Ogilvie-Grant, 'Ibis,' 7th Ser., Vol. II, p. 51.) Even in this latter species there possibly may be interhemisphere migration, southern birds visiting the Northern Hemisphere while northern ones are breeding, and northern birds visiting the Southern Hemisphere while southern ones are breeding. See Calif. W. B. No. II, p. 11, foot-note.

as were Forster's Tern on the 23rd of September, the Black-bellied Plover on the 24th, and the Pomarine Jaeger on the 25th.

2. With the advance of the season the flights gained in strength, as in the Loons and Surf Scoters.

3. Sardines were passed over or slightly regarded on several occasions (particularly October 21, 31), seemingly manifesting that the Shearwaters were bent on a journey, and not merely seeking food, feeding, or resting, as on October 15, 23, 26, 28, 30, 31.

4. All the northward flights were insignificant compared with the southward ones, and were not more pronounced than the retrograde movements of the Dark-bodied Shearwater and the northern species during the temporary halts in migration.[1]

5. At the close of December, 1894, and in January, 1895, the sexual organs of specimens taken were much enlarged,[2] evincing that the breeding season was approaching. No such functional activity was detected in the autumn of 1896, although numerous individuals were dissected.

6. These Shearwaters were absent from the vicinity of Monterey through May and early June, 1897, and June, 1894[3]—for a longer time than the interval between the ending of the northward and the beginning of the southward migration in the Northern Phalarope.[4]

It seems highly probable therefore that the autumn and winter Black-vented Shearwaters off Monterey were migrating to breeding grounds lying to the southward, probably not above the subtropics, the northern boundary of the breeding range apparently corresponding in latitude to that

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[1] There are eddies in migration as in the Mississippi, where a current sets in the opposite direction from the main flow of the stream. This was especially exemplified in the closing of the northward migration in 1897, when counter-currents of Northern Phalaropes set strongly southward.

[2] Calif. W. B. No. II, pp. 3, 5.

[3] Ibid:, No. I, pp. 205, 216.

[4] Ibid., p. 187; forthcoming No. V.

of Audubon's Shearwater[1] of the Atlantic.[2] Whether any Black-vented Shearwaters cross the equator and enter the Southern Hemisphere is yet to be determined, the geographic distribution of the species being but imperfectly defined.

In brief, it is held that the hosts of Black-vented Shearwaters off Monterey are simply visitors on the high sea like the Dark-bodied Shearwaters, although having a fly-line that seemingly falls short of the Tropic of Capricorn.[3]

The Black-footed Albatross appears to be an additional example of northward migration from infratemperate regions after reproduction. It is reported as breeding on Gaspar Rico,[4] Laysan and adjacent islets,[5] and on the Volcano Islands,[6] and is common off middle California in summer,[7] but apparently does not occur there during the colder months of the year, for only Short-tailed Albatrosses were seen in midwinter in the vicinity of Monterey.[8] Further, specimens of both sexes from that locality in May and June, 1897, and August, 1894, uniformly had minute reproductive organs, witnessing that they were not breeding birds.

GUIDANCE BY PHYSICAL PHENOMENA.

The behavior of the Shearwaters and Northern Phalaropes during fogs in the summer of 1894,[9] and of the

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[1] Bahamas (H. Bryant, Proc. Bost. Soc. Nat. Hist., Vol. VII, p. 132).
Bermudas (Reid, Bull. U. S. Nat. Mus., No. 25, p. 274).

[2] For positive information concerning the breeding of the Black-vented Shearwater, we are indebted to Mr. A. W. Anthony ('Auk,' Vol. XIII, p. 225), whose excellent work on the water birds of the coast of Southern California and adjacent Mexico is well known.

Even if the breeding range of this Shearwater extended further north than the subtropics, the destination of the Monterey transients might nevertheless be far to the southward, for in every migratory species some individuals journey to nesting homes beyond those of others; e. g., the Yellow Warblers of the Arctic coast to homes further north than the Yellow Warblers of the sunny mountain valleys of the Carolinas.

[3] If it should prove that the Black-vented Shearwater breeds south as well as north of the equator, its presence on the North Pacific in higher latitudes than its breeding range may possibly be due in part to migration from the Southern Hemisphere, and not solely to retrograde movement from the subtropics or tropics.

[4] Dall, Proc. Calif. Acad. Sci., Vol. V, p. 277.

[5] Rothschild, 'Avifauna of Laysan,' p. 55.

[6] Seebohm, 'Ibis,' 6th Ser., Vol. III, p. 191.

[7] Calif. W. B. No. III, p. 353; etc.

[8] Ibid., No. II, p. 25.

[9] Ibid., No. I, pp. 191, 201, 202, 203.

Shearwaters in the autumn of 1896, particularly September 26 and October 2 and 6, apparently shows that they were guided in their course by the shore-line.

If birds are endowed with a superhuman faculty for determining direction, why were the Shearwaters bewildered when the land was hidden by fog? Why did they immediately resume their way when the fog was dispelled sufficiently to reveal the landmarks? If they had possessed any directing faculty other than the ordinary faculty of locating position by observing physical phenomena, it would not have failed them in these instances, whether they were migrating or not. The Cormorants had no difficulty in finding their way in the fog to their fishing grounds in the Bay and back to their rookery below Point Pinos,[1] nor did we experience any difficulty in finding our way without a compass through the fog back to the Laboratory. The Cormorants knew this bit of coast well, and so did we, and we kept our bearings in the fog; but not so the Shearwaters that pass hundreds or even thousands of miles of coast-line, and not so the unfortunate captain who headed his ship on a still foggy night the summer before directly into the land two miles south of Point Pinos, supposing that he was entering Monterey Bay.

The sudden coming of fog on the evening of September 30 may explain in part why the Shearwaters sometimes pass near the south shore of the Bay when it is clear. However, this short stretch of shore-line disappears with distance as well as with fog. Seen from Santa Cruz on a clear day, the background of mountains at Point Pinos, cut off by the Salinas Valley, appears like an island rising out of the sea.

It is significant that only species which migrate near the surface of the water were observed when the land was hidden from view. Perhaps those moving at considerable elevation are guided by the mountain tops, which rise above the low vapors, appearing from the overlooking heights as islands in a sea of fog.

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[1] The Murres at South Farallon, when fishing offshore, also seemed to know their bearings in foggy weather. See Calif. W. B. No. III, p. 354.

Because the Shearwaters and Phalaropes were dependent upon the land for guidance off Monterey, it does not necessarily follow that migrants over the sea are always guided by landmarks. Ofttimes currents and winds [1] may possibly be the directing phenomena.[2] The study of migration in the vicinity of isolated oceanic islands by a trained student of migration would probably throw much light upon this point.

To recapitulate: These investigations seem to prove, 1. That the Shearwaters off Monterey find their position and shape their course by the landmarks; 2. That birds do not possess a mysterious superhuman faculty for determining direction,[3] else the Shearwaters would not have been bewildered in the fog.

Guidance by Old Birds.

In the early southward movements, particularly along coast-lines, it often happens that birds-of-the-year are seen in advance of the adults. This simple fact has involved the migration of birds in obscurity, and given rise to much speculation concerning inherited experience, it even being affirmed that young birds but a few weeks from the nest, without the aid of their elders, unerringly perform the journey to the winter habitat, perhaps thousands of miles distant, meeting successfully all the vicissitudes of weather and other dangers by the way. No wonder the migration of birds has been styled the 'mystery of mysteries' if such exact knowledge of geography is stored in an egg-shell. Upon the surface, a more reasonable view would seem to be that the young are guided from the place of their birth to the winter abode through the experience of the older birds.

In the summers of 1892 and 1894 and in the autumn of 1896 it was discovered that the first migrants of a species were inclined to pass over Monterey Bay, stragglers only

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[1] See Calif. W. B. No. II, p. 13.

[2] Celestial phenomena, as well as terrestrial, may be a means of guidance, at least in locating the cardinal points.

[3] The supreme test in this matter is found in the highly pelagic species rather than in those dwelling upon the land.

halting upon the water, the Northern Phalarope[1] being an example in the early migrations and the Surf Scoter in the later. It was also found that the first representatives of a species in summer, *in transitu*, were either wholly old birds or old ones sparingly accompanied by birds-of-the-year, as in the Marbled Murrelet July 30, 31, 1894.[2] Under such circumstances it is not surprising that the young weak-winged travelers drop out from migrants passing by offshore and occur at the kelp and other places of refuge sooner than the adults, giving the appearance of migration of the young in advance of the old.[3] Not improbably the first adults are largely birds that have failed in reproduction,[4] as in the Murres at South Farallon.[5] Otherwise the young would be left behind, so far as their own kind is concerned, and compelled to seek their way alone, or depend upon such fortuitous guidance as might be afforded by belated old birds. It is true they might associate themselves with other species and be guided by them, provided there was no parting of ways.[6] Still the young of those last to go would be without direction if unaccompanied by their parents.

Older birds, however, occurred at Monterey in the closing as well as the opening movements of a species, for example in Western and Heermann's Gulls November 4, 5, 12. This seems to be the case also in the spring migrations, for birds in high plumage were well represented in May, 1897, the large flocks of Bonaparte's Gulls and Northern Phalaropes during the middle of the month having a liberal percentage.

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[1] 'Auk,' Vol. XI, pp. 27, 28; Calif. W. B. No. I, pp. 190, 195, 196, 201, 204, etc. See also 'Calendar,' Sept. 18.

[2] Calif. W. B. No. I, pp. 191, 192, also 194.

[3] The way is not open in early spring for an extensive passing over, obstructions of weather preventing it. Consequently the vanguard is more readily seen when territory is invaded by the advancing host of migrants. Later in the season the conditions are more favorable for protracted migration and the occurrence of loitering young birds.

[4] Possibly in some instances they are males or females that have left the young to the care of the opposite sex.

[5] Calif. W. B. No. III, pp. 357, 358.

[6] Manifestly such guides, even if part of a "straggling army, often hundreds of miles in length," must take the young directly to the winter habitat of the species, for fixity of destination in the young is as necessary as migration itself. Without it there could be no uniformity of dispersal, for the young become the old of following years. If there was any divergence of route, they would be thrown upon their own resources, old birds of the same species being wanting, and forced to decide which way to go. This being the case, the difficulty is merely shifted from the beginning to the latter part of the migration, the young still having to find their way to a *terra incognita*.

The association of old and young Broad-winged Hawks in the autumnal flights in Connecticut[1] tends to show that there is no lack of experienced leaders in the migration of land birds.

It should be borne in mind, if the migrants occurring in a locality are not seen *in transitu*, merely arrested migration is witnessed, only birds that have halted at the station being seen, extensive movements taking place unobserved. This was well illustrated in the Loons May 27, 1897. In the harbor at Monterey there were only a few individuals, and these upon the water, while on the ocean several miles off Point Pinos a migratory movement was under full headway, numerous bands of black-throated birds passing swiftly by on their way north. Hence the mere presence of young transients alone in a locality, early or late in the migration, does not prove they are migrating independently of the adults.[2] The true criterion is actual migration.

Where young-of-the-year have been seen moving by themselves near the land, as in the American Golden Plovers mentioned by Mr. Mackay,[3] I believe that there is migration of adults going on at the time offshore, as in the Loons just referred to, or else that the young have become separated from their seniors during the journey,[4] eventually to lose the way[5] if they do not fall in with some of their own kin or with other species having the same route. It may be the Black-bellied Plovers, September 24, sought the companionship of the Dark-bodied Shearwaters because they were lost. Not unlikely, young birds are sometimes misled, and taken out of range.[6] However, they are found

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[1] Trowbridge, 'Auk,' Vol. XII, p. 262.

[2] When the young of any land species greatly outnumber the adults on the breeding grounds, it may be questioned whether they are wholly natives, or largely stragglers that have fallen out of the ranks, a little later to resume the march with other comrades.

[3] 'Auk,' Vol. XIII, p. 91.

[4] The separation in the Golden Plovers may have happened after the halt "in the vicinity of Labrador" (l. c., p. 90).

[5] Such a mishap apparently befell a juvenile Bonaparte's Gull at the end of May, 1897. Left behind by all his kindred, but seemingly in good health, I found him in company with some superannuated 'Mud-hens' that had taken up their abode in a lagoon near the Monterey harbor.

[6] Old birds, perchance driven from their course by storms, seem to miss their way at times and wander to regions remote from the habitat of the species. A notable instance is Swinhoe's Wagtail in Lower California (Proc. U. S. Nat. Mus., Vol. IV, p. 414).

too abundantly with adults in winter for any very marked failure to occur in their migration.[1]

The presence of old birds with the young seems sufficient to establish as a fact that the young are not without their guidance. Ordinarily, perhaps, it may not extend beyond example, especially in straggling flights; still actual leadership sometimes, at least, appears to be exercised, as in the case of the adult California Brown Pelican that directed the movements of the little company of young-of-the-year,[2] and of the Dark-bodied Shearwater that apparently ordered a flank movement in a whole column of Shearwaters.[3]

To summarize: 1. Unless birds are actually *in transitu*, their occurrence, whether early or late in the migration, affords no real clue to the movements in progress—the mere fact of the presence of the young alone in a locality not proving that they are migrating independently of the adults.

2. As seen in the birds in passage upon the ocean off Monterey, adults inaugurate the southward migration and are also present with the young in their migratory movements.

3. It seems reasonable, therefore, to conclude that the young in the journey from their birthplace to the winter home of the species are dependent upon the guidance of the old birds who know the way because they have traveled it.

CAUSE OF MIGRATION.

- Cause
  - Physical or Outward . . . . Winter with Its Failure of Food
  - Psychological or Inward
    - Inheritance
      - Desire for Travel
      - Talent for Geography
    - Education
      - Guidance by Old Birds
      - Guidance by Physical Phenomena
    - Habit

[1] The wintering of old males in situations where females and young are wanting does not indicate that the latter have been killed off, for they appear later in the northward migration, the Towhee and Pine Warbler in upper South Carolina being examples.

[2] Calif. W. B. No. I, p. 188.

[3] Ibid., p. 198.

Winter with Its Failure of Food.—Because of winter with its failure of food all birds can not remain through the whole year at the place of their birth. The only escape from extensive extermination lies in depopulation, which is successfully accomplished by migration. This periodic movement, however, is not effected simply by the inhabitants of colder regions temporarily retreating to a warmer climate when they feel the pressure of winter, for there is migration in all latitudes where birds find a home, in all climates, and at all seasons of the year. Some birds breeding in the Arctic migrate to the North Temperate Zone, some to the tropics, or even to the South Temperate Zone. Similar diversity in migration exists in birds nesting in more temperate regions; for example, the Bobolink penetrates far into South America while the Ipswich Sparrow does not pass beyond the United States. In the opposite hemisphere, the Dark-bodied Shearwater and some other Petrels breed on the oceanic islands during our winter and afterward apparently change their abode to northern seas in the time of our summer. Other birds still of the Southern Hemisphere do not journey beyond the equator.[1] There is migratory movement confined to the tropics, contemporaneous with the wet and dry seasons,[2] and there appears to be migration northward from the subtropics and tropics after the breeding period to an area of greater food-supply, as in the Black-vented Shearwater and Black-footed Albatross. There is also much minor movement, like the migration of the Brown-headed Nuthatch on the approach of winter from the upper to the lower country in the Carolinas, and of the Mountain Partridge from the eastern slope of the Sierra Nevada across the summit to the warmer western slope. There is migration that is delayed until the ground is covered with snow, and migration that takes place before midsummer, for birds begin to migrate, after breeding, as soon in temperate as frigid climes, the Murres of the

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[1] As to migration in the Southern Hemisphere, consult Hudson, 'Argentine Ornithology;' Durnford, 'Ibis,' 4th Ser., Vol. I, p. 166; Aplin, ibid., 6th Ser., Vol. VI, p. 149; Seebohm, Geogr. Distr. Charadr., p. 37; Buller, Hist. Birds N. Z., 2nd Ed., Vol. I, p. xli.

[2] Gaumer, P. Z. S., 1883, p. 436.

California coast,[1] the Louisiana Water-Thrush of the South Carolina highlands,[2] and the Scarlet Tyrant of Argentina[3] moving toward the equator as early as birds on the shores of the polar sea.

In all this diversity there is unity—these varied movements and the return ones, as a whole, constituting the great movement that sways the bird population southward or northward as winter is dominant in either hemisphere. The complexity of this adjustment suggests that it has been evolved, as exigencies have arisen, through a long period of time. However, it is not evident that any movements survive that the immediate urgency does not demand.[4] So nice is the adjustment that the territory is occupied where winter and summer contend for the mastery, Horned Larks, Longspurs, Ducks, Geese, etc., retreating or advancing as the snow and ice advance or recede. Moreover, great destruction of bird life takes place when exceptional severity of season suddenly contracts the food areas to a degree unprovided for by the ordinary course of migration.[5] Also, the loitering of birds in mild autumns[6] apparently indicates that partial relief from winter would result in a decline in migration. In fine, it is maintained that winter, past and present, with its failure of food is the outward cause of all migratory movement.[7]

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[1] Calif. W. B. No. I, p. 180 et seq.

[2] 'Auk,' IX, p. 34.

[3] Cf. Hudson, 'Argentine Ornithology,' Vol. I, p. 154.

[4] The departure of birds early in summer, the replacing of breeding ones by individuals of the same species from higher life zones, the evacuation of winter quarters in tropical and warm temperate regions, are a necessity, it is contended, under existing conditions. Migration must be a gradual depopulation, and hence the movement begins when birds have finished the cares of reproduction. Independent of other considerations, pressure of population, because of winter, necessitates, it is held, the displacing of breeding birds by winter representatives of the species, and pressure of population, because of winter in the opposite hemisphere, necessitates the removal of winter sojourners in temperate and tropical regions to higher life zones; in the grand scheme of migration there being no room for birds without the bounds of their present habitats. Local variation is not lost sight of (cf. 'Auk,' Vol. XI, pp. 26-39). The fact of its being confined within narrow limits apparently evidences that it cannot be more extended without causing disaster.

[5] A recent instance is reported by Mr. Wayne from the Low Country in South Carolina, 'Auk,' Vol. XVI, p. 197.

[6] See 'Auk,' Vol. IX, p. 39; Cooke, Rep. Bird Migr. Miss. Vall., p. 26.

[7] This view is not intended to conflict with the theories of the origin of migration in a waning ice age and in secular refrigeration.

I have referred to physical cause in greater detail in 'The Auk,' Vol. XI, pp. 94-112.

Inheritance.[1]—Instinct and heredity have been convenient words on the pens of authors dealing with aspects of migration in which the facts were partially or wholly unknown. It is not unreasonable to suppose that there exist in migratory birds an inherent desire for travel and an "inherited talent for geography." The ease with which birds find their nests in the chaparral or in a sea of tules manifests that they possess memory of direction and locality in a remarkable degree. In migratory birds this faculty may attain higher development, becoming a talent for geography. The restlessness sometimes displayed in seasons of migration by wild birds reared in captivity is perhaps indicative of an inward incentive for travel. But here heredity seems to end and

Education to begin, for there appears to be guidance by old birds and guidance by physical phenomena. With education of the young into a knowledge of the way, the magic words instinct and heredity lose their potency. Intelligence and habit remain to account for the constancy of migratory birds to time and place. We cannot know whether a bird's

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[1] "Strong home affection," desire for procreation, physiological requirements as to temperature during reproduction, have been advanced by some writers as paramount causes in the return migration.

The short stay of some birds at their nesting homes in temperate climates (less than three months) and the variation in different years in the location of the home, as in the Dickcissel, discredit the theory of "strong home affection" as a factor in migration.

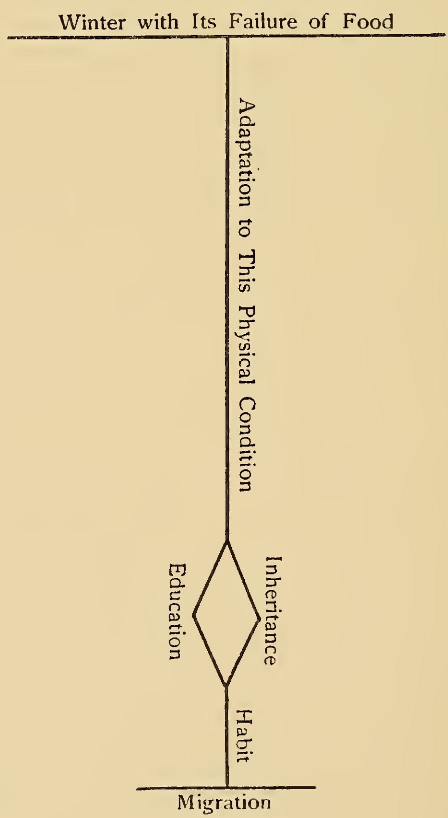
Desire for procreation, which exists in sedentary as well as migratory species, may be a prompting influence, as the waning of the breeding season appears to be in the opposite migration. However, the early summer movements toward the equator manifest that there are deeper incentives.

While the climatic conditions of the Cold Temperate Subregion may be more congenial than those of the Warm Temperate to such species as the Blackburnian Warbler, it remains to be fully established that these birds can not rear their young with equal success, so far as mere temperature is concerned, in any part of their habitat. Being migratory species of wide range, they are accustomed to great extremes in temperature, and it may be that their present distribution is simply an outgrowth of the adjustment of population to food areas—each species in process of time having found a place, which it holds independent of peculiar conditions of temperature. Thus is it explained why some Yellow Warblers breed in South Carolina and others on the Arctic coast; why some Robins winter in the valleys of the White Mountains and others in Florida; why the Parasitic Jaegers visiting the South Temperate Zone recross the equator; why the Orange-crowned Warblers wintering in the South Atlantic States return to the region to the westward of the Alleghanies instead of seeking a nesting home on the Atlantic Slope. Still it is not denied that physiological needs as to temperature during reproduction may be an additional incentive to migration; but above and behind this are fundamental causes, for migration exists without such stimulus, as is particularly evidenced by the early summer movements toward the equator in temperate regions.

education extends to a comprehension of the plan of migration. However, it seems plain, with the example and guidance of the old, migration could become in time a ruling

Habit in the life of a last summer's bird, holding it true to route and period of movement. In short, it is believed that the causes of migration are simple facts and not impenetrable mysteries lying beyond the domain of scientific enquiry.

Summary.—To sum up the whole matter in a single sentence: It is held that bird migration is a habit evolved by education and inheritance which owe their origin and perpetuation to winter with its failure of food.



III. LIST OF SPECIES.

Æchmophorus occidentalis. WESTERN GREBE.—Only one was observed during the two months.

Colymbus nigricollis. EARED GREBE.—Less than a dozen were seen, scattered along from Sept. 29.

Gavia imber. LOON.

Gavia pacifica. PACIFIC LOON.

Gavia lumme. RED-THROATED LOON.—Loons occurred from the outset, chiefly as passing migrants. They gradually increased in numbers until finally they became very common, particularly from the middle of October onward. Whether *pacifica* and *lumme* were present during the early part of my visit was not positively determined.

Lunda cirrhata. TUFTED PUFFIN.—Few were noted.

Cerorhinca monocerata. RHINOCEROS AUKLET.—None were seen in September and only a very few in October. In November they became more plentiful.

Ptychoramphus aleuticus. CASSIN'S AUKLET.—Occurring at irregular intervals after Oct. 25, they became decidedly common Nov. 10.

Cepphus columba. PIGEON GUILLEMOT.—Three young-of-the-year were observed in September and eight adults at the close of October. Two of the latter were taken, and were in pied plumage.

Uria troile. MURRE.—The following are all that were positively identified: Single birds on the 22nd, 25th, and 26th of September; six on the 28th; single birds on the 8th, 14th, and 23rd of October and 5th of November; two on the 11th and two on the 14th of November.

Stercorarius pomarinus. POMARINE JAEGER.—The migration of this species appeared to be nearly over on my arrival. After September only stragglers were noticed.

Larus glaucescens. Glaucous-winged Gull.—The first one came under observation Oct. 30. By Nov. 12 they were rather common.

Larus occidentalis. Western Gull.—They were very abundant. Through the passage of migratory waves, sometimes the old and sometimes the young predominated.

Larus argentatus. Herring Gull.

Larus vegæ. Vega Gull.—A large Gull with light mantle and black tips to primaries was seen Nov. 5. Six days later several other Gulls having the same style of coloration were also observed.

Larus californicus. California Gull.—But a single individual had been encountered up to Oct. 9, when a large flock was discovered among the Gulls thronging the beach. Afterwards the species was met with at intervals.

Larus delawarensis. Ring-billed Gull.—An immature example was taken Oct. 7.

Larus brachyrhynchus. Short-billed Gull.

Larus canus. Mew Gull.—A young bird belonging to one or the other of these species was captured Oct. 29.

Larus heermanni. Heermann's Gull.—Until the last day of September, Heermann's Gulls appeared to be rather scarce. In November their flights rivalled or exceeded those of the Western Gulls.

Larus philadelphia. Bonaparte's Gull.—On the 6th of November two small companies were met with, and on the following day another company and a flock of over two hundred.

Sterna maxima. Royal Tern.—This Tern occurred through my sojourn, but was not common after the middle of October.

Sterna elegans. ELEGANT TERN.—It was more sparingly represented than its congener *maxima*. No examples were noticed in November.

Sterna forsteri. Forster's Tern.—Several squads, accompanying an army of Shearwaters, were seen Sept. 23.

Diomedea albatrus. SHORT-TAILED ALBATROSS.—Several dark Albatrosses were observed Sept. 18 and several on the following day, when the equinoctial gale began. A specimen was secured on each occasion, and proved to be this species. After the equinoctial there was a hiatus, broken only by solitary birds on the 23rd, 26th, and 29th of September and on the 2nd and 15th of October. These individuals were in dark attire, with a single exception—a crippled adult, infested with mallophaga.

Fulmarus glacialis. FULMAR.—Fulmars were noted as follows: Two in September, one in October, several on the 6th of November and one on the 7th and one on the 11th.

Puffinus bulleri. BULLER'S SHEARWATER.—On the 6th of November, about six miles west of Point Pinos, two white-breasted Shearwaters dashed up to the boat—one a Pink-footed, the other a slender bird without conspicuous mottling on the sides of the head. The first glance revealed that the bird was a stranger. It was only a few yards away and I had to wait a moment for it to pass astern and get within proper range. A successful shot brought it down in perfect condition for a specimen. Dissection proved that it was a female, perhaps a young one, for the ova were indistinct as in a bird that had never bred.

Upon consulting the literature[1] it was found that the specimen agreed with the descriptions of Buller's Shearwater, and was the fourth one known to science. The bird had

[1] *Puffinus bulleri*, SALVIN, Ibis, 5th Ser., Vol. VI, 1888, p. 354; BULLER, Hist. Birds N. Z., 2nd Ed., Vol. II, 1888, p. 240, Pl. XLI, fig. 2; ibid., Trans. N. Z. Inst., Vol. XXIII, 1891, p. 42; ibid., Vol. XXVI, 1894, p. 198; SALVIN, Cat. Birds Brit. Mus., Vol. XXV, 1896, p. 371.
Puffinus zealandicus, SANDAGER, Trans. N. Z. Inst., Vol. XXII, 1890, p. 291.

been secured in a region far remote from the supposed habitat of the species, the types and third specimen having come from New Zealand seas. It may confidently be expected that persistent observation off Monterey will add to the list of pelagic wanderers from austral regions.

Puffinus creatopus. PINK-FOOTED SHEARWATER.—The following were seen: One, Sept. 21; a few, Sept. 23; one, Sept. 25; twenty-five, Sept. 26; two, Sept. 29; five, Oct. 2; one, Oct. 6; upwards of forty, Nov. 6; about two hundred, Nov. 7; a dozen, Nov. 10; thirty to forty, Nov. 11.

Puffinus opisthomelas. BLACK-VENTED SHEARWATER.—This species occurred as a transient, and was very abundant, particularly during October and November.

Puffinus griseus. DARK-BODIED SHEARWATER.—These Shearwaters, *in transitu*, were exceedingly abundant on the 23rd and 24th of September. Afterwards the species rapidly declined in the scale of abundance, in October and November only stragglers appearing.

Puffinus tenuirostris. SLENDER-BILLED SHEARWATER.—A female was secured Nov. 7. On the same day several other small dark Shearwaters were seen, which perhaps belonged to this species. It is probable the migration was just commencing, for Slender-billed Shearwaters were numerous off Monterey in December, 1895.[1]

Phalacrocorax penicillatus. BRANDT'S CORMORANT.—As at other seasons of the year, Brandt's Cormorants were abundant.

Phalacrocorax pelagicus. PELAGIC CORMORANT.—The small 'Shag' was quite common.

Pelecanus californicus. CALIFORNIA BROWN PELICAN.—Pelicans were conspicuous from the outset. On the 3rd of October it was evident that reënforcements had arrived. From that date they were very common.

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[1] Calif. W. B. No. II, p. 28.

Merganser serrator. RED-BREASTED MERGANSER.—Two females were seen on Oct. 9 near the town of Monterey. Subsequently the species was observed whenever we skirted the rocky shore of the south side of the Bay.

Oidemia deglandi. WHITE-WINGED SCOTER.—'White-winged Coots' occurred only as passing migrants. The first individual was seen Sept. 28. They did not become plentiful, although there was promise in November of the immediate coming of the winter bands.

Oidemia perspicillata. SURF SCOTER.—Toward the end of October they began to be common, and on the 4th, 5th, and 11th of November were abundant. With the exception of a few stragglers all hurried by Monterey Bay on their way down the coast. The first were positively determined Oct. 6. However, small companies, supposed to be these Scoters, were noted at intervals from the beginning.

Although there was considerable migration in Ducks and Geese during the two months, the Shoveller (Sept. 23) was the only species fully identified besides the Red-breasted Merganser and the two Scoters.

Ardea herodias. GREAT BLUE HERON.—Individuals were occasionally noted, chiefly at the kelp along the south shore of the Bay.

Nycticorax nycticorax. NIGHT HERON.—In the evenings, during the early part of my visit, the call-notes of these Herons, passing down the coast, were frequently heard at the Laboratory.

Fulica americana. AMERICAN COOT.—A large flock of 'Mud-hens' was found Nov. 3 on the lagoon at Monterey.

Crymophilus fulicarius. RED PHALAROPE.—They were met with as follows:—

September—18th, a small flock.

October—15th, one; 28th, a flock of over fifty and some scattered birds; 29th, several; 30th, a group of four and several solitary individuals.

November—2nd, two; 4th, two; 6th, a flock numbering between one and two hundred and a few scattered birds; 7th, individuals quite generally distributed beyond the buoy; 10th, a few; 11th, a little band; 12th, several.

Phalaropus lobatus. NORTHERN PHALAROPE.—Many were on the kelp Sept. 18 and again on the 24th. After this only stragglers occurred, loitering by the way or on migration. The last were seen Oct. 24.

The following were noted incidentally: Sanderling, Marbled Godwit, Black-bellied Plover (last date Oct. 27, two), Killdeer, Black Turnstone (appeared to be common to the end).

CALIFORNIA ACADEMY OF SCIENCES,
October 19, 1899.


California Coast
from
Piedras Blancas to Salt Point
Nautical Miles
From Chart of U.S. Coast and Geodetic Survey.

PROCEEDINGS

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Studies in Pacific Coast Entoprocta

BY

ALICE ROBERTSON

WITH ONE PLATE

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STUDIES IN PACIFIC COAST ENTOPROCTA.

BY ALICE ROBERTSON.

CONTENTS.

PLATE XVI.

I. Introduction.

The following studies were undertaken at the University of California under the direction of Professor W. E. Ritter, for whose cordial interest and unwearied kindness I wish to express my sincere gratitude.

The object of this paper is, first, to contribute to the knowledge of the Entoprocta by the description of two forms new to science, and secondly, to record the occurrence on the Pacific Coast of species already known. Of

 December 12, 1900.

the new forms, the one possesses features so markedly different from any known genus of the Pedicellinidæ as to warrant the formation of a new genus. The other is placed, at least provisionally, in the genus *Gonypodaria* Ehlers (1890).

Myosoma, gen. nov.

Diagnosis.—Zoarium with stolon composed partly of successive polypide-bearing segments and partly of alternate non-polypide-bearing segments; both stalk and calyx muscular, the muscle fibers continuous from one into the other; lophophore oblique.

Myosoma was obtained by Professor Ritter at Dillon's Beach near Tomales Bay, California. It has since been found at Fort Point and at San Pedro, California. As the name implies, its distinguishing generic characteristic is the possession of a muscular calyx, a feature not possessed by any other Entoproct known. Aside from the sphincter muscle, the Entoproct calyx is peculiarly destitute of muscular development. Ehlers (1890) describes certain muscle fibers in the calyx of *Ascopodaria macropus* which are connected with the nephridia, and others which he calls the lateral wall muscles. But in no case is there such a development as is found in this form.

Myosoma spinosa, sp. nov.

PLATE XVI, FIGS. 1-12.

Both stalk and calyx with surface differentiated into a spiny and a non-spiny region, the latter corresponding to the side of the polypide in which the musculature is more strongly developed.

A. Structure.

1. THE STOLON.—The colony of *Myosoma spinosa* forms a closely matted growth by the interweaving and fusion of its stolons. The stolon secretes a chitinous layer which is thicker on the under surface, and which serves both to attach itself to the substratum, and to unite adjacent stolons together laterally, thus forming a sort of band. From such a stolonic band, branches may extend laterally, both from

those stolons forming the outer border, and from the segments of any of the interior stolons. By this means a matted growth is produced which makes it impossible to tease out a colony without breaking it into small fragments. Figure 1 represents two stolons united for part of their length. It is not uncommon, however, to find four or more firmly united together. The stolon is segmented but not always to the extent that Ehlers considers characteristic of the Pedicellinidæ. Non-polypide-bearing segments (*non. pl. seg.*) occur, alternating with segments which bear polypides; but this is not the invariable rule. Polypides are frequently found upon successive segments, as is shown in the stolon extending to the right (fig. 1, *suc. seg.*). This drawing may seem to indicate that polypides are found upon successive segments only at the growing ends of stolons. This condition, however, is not confined to young stolons, but is found in older parts of the colony also. As an illustration of the variability of stolonic segmentation presented by the species, I would say, that in twenty cases in which this point could be determined with certainty, twelve showed an intercalated non-polypide-bearing segment, while in eight cases, the polypides grew upon successive segments.

2. THE POLYPIDE.—Each polypide consists of an unbranched holosarcine stalk, and a calyx. There is considerable difference in the height of the various individuals which form a colony. Of ten polypides, all of which are adult so far as the functioning of the digestive organs are concerned, the smallest measures 0.64 mm. in height, and the tallest, 3.60 mm. The average height of the ten is 1.90 mm. The extreme mobility of the calyx, the obliquity of the tentacular region, and the spininess of both stalk and calyx are very conspicuous features of a colony.

In the retracted position, the stalk is usually much curved, the calyx being then brought face downwards, and the convex surface of both bristles with a formidable array of spines (figs. 1 and 2). Although I have not had an opportunity to examine living specimens, I cannot but think that this peculiar curved position is one often assumed in life. On closer examination this conviction is strengthened, for the surface of both stalk and calyx is found to be differentiated into two regions, a spiny and a spineless one. The latter occupies a narrow strip extending from the base of the tentacles on the œsophageal side downward over the stalk to the stolon (figs. 1 and 2, *spl. reg.*). That this region possesses greater muscular power is apparent from a very casual examination of a glycerine mounted specimen. Figure 2 represents such a preparation. Here, in order to show the direction of the muscle fibers, the stalk is drawn in optical section. The spineless region (*spl. reg.*) and the longitudinal muscle fibers are seen to be on the same side.

Topographically, therefore, the surface of the polypide is divided into a ventral and a dorsal side. That part of stalk and calyx which possesses greater muscularity and which is free of spines is the ventral side; the spiny region is the dorsal. Throughout this description the terms ventral and dorsal, applied to both stem and calyx, will be used with this signification. Furthermore, although as we shall see, the connection between stalk and calyx is intimate, yet for purposes of description I will distinguish between them, and I will first describe the calyx.

(a). The Calyx.—The cuticle over the spiny region is thickened in places into ridges or ribs, upon which spines develop at regular intervals, although they are not lacking in other parts. One of these ridges is especially conspicuous, forming an almost circular rib at the base of the tentacles (fig. 1, *ten. r.*). It is thickened at the summit (fig. 1, *sum.*) of the tentacular disc and gradually grows more slender as it approaches the spineless region on the ventral side. Upon it six or eight spines are developed, forming a sort of coronet around the face, so to speak. From the summit of the calyx in the sagittal plane, a short, chitinous thickening of the cuticle extends forward upon the tentacular disc (fig. 1, *sag. r.*) This also bears one or more spines. Dorsally, in the sagittal plane, a double row of

spines extends to the base of the calyx, where another rib occurs which extends around it to the ventral side (fig. 1, *bas. r.*).

The Ventral Region.—Perhaps the most striking feature of the calyx is the extreme obliquity of the tentacular disc. This is so great that a point at the base of the tentacles on the dorsal side forms the summit of the calyx (figs. 1–2, *sum.*), and thus the whole tentacular region is on the ventral side. This, in the retracted condition, is a somewhat flattened oval disc which is bounded dorsally by the tentacular rib spoken of. In the center, an oval opening may be seen, around which the edge of the lophophore is gathered in strong folds by the sphincter muscle (figs. 1 and 2, *loph. f.*). Figure 3 is a para-sagittal section of the calyx and shows the sphincter muscle in cross-section (*sph. loph.*) and the fold of the lophophore projecting beyond it (*loph. f.*).

The cuticle on the ventral side is very thin, and is thrown into a number of transverse wrinkles or folds during contraction (fig. 3, *cu.*). Under the cuticle is a densely staining layer of ectodermal cells (fig. 3, *ec.*). Between the ectoderm and the œsophagus is found the somatic portion of the muscle which characterizes this form, and which, since it is to so large an extent continuous in both calyx and stalk, is designated as the *ventral muscle* (fig. 2, *v. mus.*).

The Musculature.—There are four systems of muscles in the calyx: viz., the somatic portion of the ventral muscle, the sphincter muscle, the tentacular muscles, and the muscles of the intestine.

The Ventral Muscle.—This muscle consists of a large number of bundles, each composed of a number of fibers. Scattered through it and at points of attachment are numerous large nuclei. Distally, it is attached to the body-wall of the calyx at the base of the tentacles. It extends in a longitudinal direction through calyx and stalk, and is attached proximally to the base of the stolon. The continuity of some of the fibers is broken by the septum which separates calyx and stalk, but a *large number* of them pass through the septum *without interruption.*

The somatic portion of the ventral muscle and its direct continuation into the stalk are shown in fig. 3. This represents a para-sagittal section near the median plane. The space between the ventral body-wall (*v. w.*) and the œsophagus (*œs.*) is seen to be completely filled with longitudinal muscle fibers. At the focus which is here represented, many of these fibers are seen to pass over the septum into the stalk. At a deeper focus, the septum comes into view, bounded on each side by the large nuclei (*nu.*) which mark the attachment of those muscle fibers which are not continuous. At the base of the sphincter muscle (*sph. loph.*) the fibers are seen to unite with the ectoderm. In cross-sections of the calyx in this region, the intermingling of the longitudinal muscle fibers with those of the sphincter may be clearly seen. There can not, however, be said to be any direct union between the muscles of these two systems, although their union of action seems probable. Figure 4 is a frontal section close to the ventral wall of the stomach. Here the direct passage of a number of the muscle fibers (*v. m. f.*) from stalk to calyx is clear and undoubted. At each side the septum (*sep.*) is clearly seen through the continuous fibers, while in the middle there is a region where at the focus represented no septum is present. This section shows another interesting fact about the ventral muscle. When the fibers enter the calyx, some of them are seen to diverge right and left. These diverging fibers form branches of the somatic ventral muscle (*br. s. v. mus.*) which pass on each side of the œsophagus. The empty space in the center represents the position of the stomach at the base of the œsophagus. In a series of sagittal sections the branching is very evident, and furthermore, it is clear that part, at least, of these diverging fibers attach themselves to the floor of the atrium. In cross-section this is perhaps more evident. Figure 5 represents a cross-section of the stomach and base of the œsophagus. The somatic muscle fibers (*so. v. m.*) which fill the space between the ventral wall (*v. w.*) and the œsophagus (*œs.*) are cut more or less obliquely. Close beside the œsophagus in the angle formed by its junction with the stomach (*st.*) are seen a few muscle fibers cut almost transversely. These are the branches of the somatic ventral muscle (*br. so. v. m.*). In sections above the plane represented by fig. 5, these transverse fibers become more distinctly grouped together and separated from the main body of the muscle (fig. 6, *br. so. v. m.*) They finally fuse with the floor of the atrium (fig. 7, *cls. at. fl.* and *br. so. v. m.*). In succeeding sections the atrial cavity appears and all signs of muscle bundles disappear. These branches may be called the atrial retractors, for by their contraction the floor of the atrium is drawn downward and the atrial cavity is enlarged.

All the muscle fibers which branch off from the ventral muscle do not, however, function as atrial retractors. Some of them seem to be in close connection with the genital duct, and perhaps with other organs. Figure 8 represents a section showing an apparent attachment of a muscle bundle (*m. g. d.*) on each side of the duct leading into the brood-sac. This section is just at the point where the duct (*cls. g. d.*) opens into the floor of the atrium (*at. fl.*) and taken in connection with indications found in other preparations, the inference seems to be a valid one that the ventral muscle is connected with the genital ducts in both males and females.

Sphincter Muscle.—When compared with other genera of Entoprocta, the lophophoral sphincter of *Myosoma* has an unusual development. According to Davenport (1893), the sphincter of *Urnatella* is composed of two or three fibers only. Ehlers gives seven or eight fibers for that of *Ascopodaria macropus.* An idea of the development which the sphincter attains in this form may be gained from fig. 3 (*sph. loph.*). Here the ends of the fibers appear, cut somewhat obliquely, in the deep fold of the lophophore (*loph. f.*). In frontal section, not represented in the drawings, this sphincter appears as a broad muscular band composed of twenty or thirty muscle fibers arranged in concentric circles.

Tentacular Muscles.—The number of tentacles varies between thirteen and fourteen. Each is provided with two muscles extending along the sides apparently to the tip. According to Davenport, tentacular muscles are unknown in any Entoproct except *Urnatella*. Comparing Davenport's drawing (Pl. IV, fig. 27) with fig. 9, it will be seen that *Urnatella* and *Myosoma* closely resemble each other in this respect. Figure 9 represents a cross-section near the base of three tentacles and the transverse ends of the tentacular muscle fibers are clearly shown (*tent. m.*). Figure 10 represents the same in longitudinal section, and the fibers (*tent. m.*) are seen extending through the length of the tentacles. The attachment of these fibers has not been definitely made out, but the indications are that they unite with the ectoderm at the base of the tentacular disc.

Intestinal Muscles.—In addition to the systems of muscles already described, there is an intestino-rectal sphincter. This consists of three or four well defined muscle bundles, showing in cross-section in the wall of the intestine. This is also reported for *Urnatella*. There is besides an anal sphincter, not differing apparently from that described for other Entoprocta.

The Organs.—The tentacles are ciliated on the inner surface. The atrial chamber is large and its floor is likewise ciliated. The alimentary tract does not differ materially from that described for other Entoprocts. It consists of œsophagus, stomach, intestine, and rectum, all heavily ciliated except the roof of the stomach, the region of the so-called "liver cells" (figs. 3 and 8, *cls. l.*). Figure 3 represents the alimentary tract, but the section is not in the median plane and consequently does not pass through the intestine and rectum.

No special study has been devoted to the nephridia, although the excretory ducts and pore have been observed. The nerve ganglion with its large nerve trunks is a conspicuous object, but no minute study of it has been made. Both males and females grow from the same stolon and are indifferently intermixed in the colony. The testes and the ovaries contained ripe products, and the brood-sacs were filled with embryos in every stage of development.

(b). The Stalk.—Externally, the stalk shows the two regions, dorsal and ventral, already described for the calyx. The dorsal side is characterized by the presence of spines which, however, have no regular arrangement. The ventral side occupies about one-fourth of the circumference (figs. 11, 12, *v. s.*). The cuticle of this portion is thin and is thrown into many transverse wrinkles by the contraction of the muscles beneath (fig. 1, *spl. reg.*).

The Musculature.—The stalk is of the type holosarcine. The muscle forms a cylindrical sheath just beneath the ectoderm. The sheath, as a whole, is much thicker than in other Pedicellines, and its thickness is considerably greater on the ventral side than on the dorsal (figs. 11, 12, *v. m. stk.*). In the ventral region the fibers are longitudinal (fig. 2, *v. m.*). From a line in the middle of the dorsal region the fibers take an oblique direction on both sides toward the ventral side (fig. 2, *o. m. f.*).

In the lower part of the stalk and in the stolon just below the stalk, large granular cells, with very large nuclei, attract the attention, even in an unstained specimen. Frequently there are several processes to each cell. They are often found part way up the stem united together by these processes, resembling a string of beads. These are probably the myoblasts, from which the muscle fibers originate. The muscle fibers which are not continuous with those of the calyx are attached at their distal end to the septum between calyx and stalk. Proximally, both longitudinal and oblique fibers pass into the stolon, spread out in radiating directions, and become attached to its base. Besides the myoblasts already mentioned, the interior of the stalk is filled with mesenchymatous tissue, resembling that filling the space between the body-wall and the alimentary canal of the calyx.

(c). The Neck.—The extensive development of the ventral muscles and the continuity of many of the muscle fibers from stalk to calyx have produced an appearance at the junction of head and stem very unlike that commonly seen

in the Entoprocts. Generally, the neck is small and the infolding of the cuticle to form the septum is alike on all sides. The plug of cells usually occupies a central position, and the regenerative cells are of equal size and are symmetrically arranged. A very different condition prevails in *Myosoma*. The neck is stout and broad. On the ventral side the stalk extends part way up the calyx, as shown in polypides three and four of fig. 1. The plug of cells is nearer the dorsal than the ventral side, and the regenerative zone is not symmetrically disposed. Figure 3 represents these conditions in part. This section does not show the calyx in its natural or usual position. It is thrown backward too much and makes the plane of the lophophore almost horizontal. The evidence that this is an unnatural position is found in the distortion of the cells (fig. 3, *cl. cls.*) which bridge over the opening in the center of the septum. In the normal condition these cells should be horizontal. This very distortion gives the best view of the ventral muscle and it was for this reason that the section was chosen. If proper allowance be made, the thickness of the neck, the proximity of the plug of cells to the dorsal side, and the asymmetry of the regenerative zone are plainly manifest in fig. 3. Figure 13 represents the usual appearance of the neck in the Pedicellines. Comparison of this with fig. 1 will perhaps make the difference more obvious, although allowance must be made for a difference in magnification.

B. Regeneration.

Corresponding to this thickness of the neck, there is a firmness of attachment between stalk and calyx very different from the fragile connection usually presented by this family. In *Myosoma* the calyces do not drop off easily, at least in preserved specimens. Experimentation seems to show that there is a greater tendency to break away from the stolon than for calyx and stem to separate, especially in the case of the younger polypides. In attempting to separate polypide and stolon by pulling them apart, the stem, in each case, stretched considerably before any break occurred. In older polypides, the separation took place just as often between stalk and stolon as between calyx and stalk. In younger individuals, out of fifteen experimented with, twelve broke either at the junction of stalk and stolon, or else part way up the stalk, and only three broke at the septum between stalk and calyx. Experimenting with other Pedicellines, the writer could in no case detect any stretching of the stalk. The calyx always separated at the septum and with the very slightest pressure. In the colonies of *Myosoma* which have been examined there is a remarkably small number of headless stems. It was only after a careful search among stems accidently broken from stolons while tearing them out that a few were obtained upon which calyces were forming in various stages of development; so that, although *Myosoma* does not lose its calyces as easily as most Entoprocta, yet, if the loss occurs, regeneration does take place.

C. *Discussion.*

Myosoma spinosa is an extremely interesting form, both as an example of correlated and adaptive variation, and as a form which while exhibiting a high degree of specialization, yet shows marked affinities with more primitive Entoprocts, especially with *Loxosoma*.

The stem of all Entoprocts is characteristically muscular. The calyx, except for delicate sphincter muscles, is just as characteristically devoid of muscles. Two observers, Allman (1856) for *Pedicellina echinata*, and Van Beneden (1845) for *Pedicellina belgica*, speak of finding retractor muscles in the calyx of these species. Their results on this point have not been confirmed by other observers, but, even if correct, the muscles to which they refer have an entirely different function from the somatic ventral muscle of *Myosoma*. The function of a retractor muscle in the sense spoken of by these observers is to draw the tentacles within the sheath. Indeed, Allman speaks of a structure which he calls a sheath in *P. echinata*, into which the tentacles are retracted. The ventral muscle of *Myosoma*, however, does not act as a retractor for the tentacles. It is closely connected with the longitudinal muscles of the stalk, both morphologically and functionally. The somatic portion together with the peduncular portion contracts the whole polypide upon the ventral side, forming the characteristic bow-shape so commonly assumed. The correlation of muscular development exhibited by *Myosoma* depends primarily upon the growth of the ventral muscle. Its action is antagonistic to that of the lophophoral sphincter; hence there follows the unusually strong development of the latter. In contraction, the ventral muscle draws the tentacular disc and the dorsal organs toward the ventral side. This would greatly diminish the space within the atrial cavity, which at certain seasons of the year, as when embryos are rapidly developing, would be a disadvantage. By the correlated growth of the atrial retractors the floor of the atrium is drawn downward and the space within is, in a measure, preserved.

Such muscles as are usually found in the calyx of the Pedicellinidæ, viz., the sphincter muscles, the tentacular muscles, and the body muscles mentioned by Ehlers for *Ascopodaria macropus*, are said to originate from the parenchymatous tissue of the calyx. It is difficult to conceive that such alone is the origin of the muscles of the calyx of *Myosoma*. In examining sections of the calyx, the assumption that the muscle fibers in the body arise in great part from those of the stalk, and that many of them have become secondarily divided, does not seem unreasonable. Such a hypothesis, however, can only be established by a study of the development of the polypide.

It is the open communication between the stalk and calyx of *Myosoma* which allies it so closely with *Loxosoma*. In the latter, the line of demarcation between body and stalk is not well defined. The muscle fibers of the stalk pass directly into the body, and, according to most observers, end somewhere in the lower part of the latter. In his account of *Loxosoma kefersteinii*, Nitsche (1869) says that the muscle fibers of the stalk are attached to the base of the stomach. Vogt (1876) in describing *L. phascolosomatum* says that the muscle fibers are distributed over the base of the body. Other observers who say nothing of the distal attachment of the muscle fibers represent them in their drawings as extending a short distance into the calyx or body, and as radiating around the base of the stomach. Through the courtesy of Dr. W. S. Nickerson of the University of Minnesota, I have had the privilege of examining some specimens of his new species, *Loxosoma davenporti*, a complete report of which has not yet been published. I have prepared a few individuals *in toto*, staining and clearing them in oil, and the muscle fibers of the stem come out distinctly. The indications are that part, at least, attach themselves either to the floor of the atrium or to the body-wall in the vicinity of the atrium. The opacity of the organs of the body, however, prevents a clear view of the distal attachment of the muscles of the stem, although there is no doubt that they extend far into the body on the ventral side.

Seeliger (1889) gives an interesting stage in the development of *P. echinata* from the larva, wherein the elements of the stalk are directly continuous with those of the calyx; and he says, "Auf diesem Stadium ähnelt die junge *Pedicellina* einer *Loxosoma*, bei der ebenfalls die Sonderung in Stiel und Köpfchen nur unvollkommen ausgeprägt ist."

Our species shows other *Loxosoma* affinities. In his very interesting study of *L. phascolosomatum*, Vogt (1876) contrasts *Loxosoma* and *Pedicellina* in the following words: "Ce qui distingue, ontre les points mentionnés par M. Nitsche, les Pédicellines et les Loxosomes en premier lieu, c'est la position de l'appareil tentaculaire et la conformation générale du corps. L'appareil tentaculaire est placé sur la face ventrale chez les Loxosomes, tandis qu'il se trouve au bout de l'axe de la tige et du corps chez les Pédicellines; le corps des Pédicellines est comprimé latéralement, celui des Loxosomes verticalement. * * * L'appareil tentaculaire est placé exactement au sommet chez les Pédicellines, sur le côté ventral un peu creusé chez les Loxosomes. Ce qui, chez les premières, se présente comme un sac à ouverture centrale, montre chez les derniers la forme d'un capuchon serré sous le menton et tiré sur la tête. Si cette différence est sensible, je dois dire cepéndant que la tendance vers une formation semblable se montre déjà chez les Pédicellines, dont les deux faces, ventrale et dorsale, sont loin d'être symétriques. Comme chez les Loxosomes, la paroi du corps, le long de laquelle remonte le rectum et que nous avons nommée la face postérieure, est plus bombée que celle à laquelle est adossé l'œsophage. Un plan vertical et longitudinal, placé par la tige et le corps d'une Pédicelline qui montre son corps de la manière ordinaire, en présentant l'œsophage d'un côté et le rectum de l'autre, coupe bien en deux moitiés symétriques la couronne tentaculaire, mais non le calice. La moitié contenant le rectum est plus volumineuse, plus bombée que celle contenant l'œsophage. Ces rapports se laissent déjà voir dans les bourgeons, quoique à un degré moindre, et ne peuvent donc pas dépendre uniquement du développement de la poche incubatrice, située dans le voisinage du rectum. La conformation asymétrique est bien déjà dans le plan primitif des Pédicellines; mais elle y est seulement indiquée, tandis qu'elle est poussée à l'excès chez les Loxosomes, où elle va jusqu'au déplacement de la couronne tentaculaire."

The above might almost as well answer for a comparison of *Myosoma* and *Pedicellina*, for the former corresponds closely to *Loxosoma* in the displacement of the tentacular crown, the consequent obliquity of the lophophore, and the lateral compression of the body. The resemblance between *Loxosoma* and *Myosoma* is still further emphasized by the continuity of the muscle fibers of stalk and calyx, extending, if my observations upon *L. davenporti* be correct, even to the union of some of the muscle fibers with the floor of the atrium.[1]

[1] Since writing the above, Dr. Nickerson has kindly furnished me with an outline of the musculature of *Loxosoma davenporti* previous to the publication of his paper on that animal. As far as can be learned from this, the arrangement of the muscles in *L. davenporti* and *M. spinosa* is strikingly similar. One especially interesting point is the existence of longitudinal muscle fibers which extend from the margin of the foot to the lophophore.

III. Gonypodaria ramosa, sp. nov.

PLATE XVI, FIGS. 13–16.

Diagnosis.—Zoarium composed of a chitinous branched segmented stolon, from each alternate segment of which stalks bearing polypides arise. Stalks merosarcine, furnished at their base and at intervals along their length with muscular dilatations from which branches proceed.

G. ramosa was first obtained at Pacific Grove by Professor H. P. Johnson of the University of California. It has since been found at Fort Point and Land's End, California, and on Channel Rocks, Puget Sound. A comparison of the colonies from these four localities leads one to suspect that there may be more than one species among them. They differ markedly in size and robustness of calyx and stalk, and especially in the number of branches. However, until more material can be obtained and further investigation made, they will all be placed under one species.

A colony of *Gonypodaria ramosa* presents an appearance very unlike the typical Entoproct. The stiff stems projecting to an unusual height and surmounted by their white calyces, the branching habit of growth and the stiff jerking movements, all contribute to make this Pedicelline an unique and interesting object of study. When examined closely the stalks are found to have the power of movement concentrated at definite points in barrel-shaped expansions, while the other portions are stiff and horny, and destitute of muscle fibers. Figure 13 represents part of a colony of *G. ramosa* and illustrates the characteristics mentioned above. The possession of several bulbous dilatations in the stalk places this form, at least provisionally, in the genus *Gonypodaria* Ehlers. The only other species of the genus known is *G. nodosa* Lomas (1886), described originally as *Pedicellina gracilis*, var. *nodosa*, and afterwards as *Ascopodaria nodosa*. These two species, *G. ramosa* and *G. nodosa*, differ in the number of muscular expansions on the stalk. The latter has not more than three, while *G. ramosa* has frequently four, five, or more. This in itself is not an important difference, since in a colony of *G. ramosa* individuals resembling *G. nodosa* may be found. But the branching is peculiar to this form and warrants the formation of a new species.

A. Structure.

1. THE STOLON.—This is stout and thicker than the ascending stalks. It has a yellow color in the younger parts of the colony but becomes brown with age. It is covered by a thin, transparent cuticle continuous over stalk and calyx. Beneath the cuticle is a thick chitinous layer to which the color and rigidity of the stolon are due. It is divided at intervals by perforated septa into segments of varying length. A segment which does not bear a polypide is intercalated between two which do. Sometimes the polypide-bearing segments are crowded together, in which case the intercalated segments are very short, and the septa at their extremities are placed almost close together. The stolon produces branches at right angles to it, or nearly so. These grow from below the basal dilatation of an ascending stalk, and may appear on one side only, or opposite, on both sides. In no case has a branch been observed to grow from a non-polypide-bearing segment of the stolon.

2. THE STALK.—The stalk begins as a muscular dilatation resting upon the stolon. Above this it grows slender, but stiff and rigid. The occurrence of several of these dilatations divides the stalk into definite sections to which, following Ehlers, the name phalanx will be applied—a phalanx being considered to consist of a dilatation and the rigid portion arising therefrom (fig. 13, *pha.*). The distal phalanx, then, may frequently consist of a dilatation and a calyx, depending upon the stage of growth to which the stalk has attained. Since the musculature of the stalk is confined to these bulbous dilatations at the base of each phalanx, the stalk is of the type merosarcine. The basal or proximal dilatation arises from the stolon with a rather broad base, widening out somewhat into a barrel-shaped structure. It is covered by a thin cuticle which is distinctly

annulated, the annulations consisting of wrinkles or folds in the cuticle alone. Above the annulations the rigid portion of the phalanx begins, wide at the base, and narrowing somewhat suddenly into the slender, rigid portion. Each dilatation, then, is capped by a truncated chitinous cone. Beneath the thin cuticle of the dilatations the longitudinal muscle fibers are seen, forming an inner sheath or mantle. These are attached proximally to the stolon, and distally to the base of the cone which covers the top of the dilatation (fig. 13, *m. dil.*).

The rigid portion of each phalanx is covered externally by a thin cuticle continuous over stolon and basal expansion. Beneath is a thick chitinous layer, yellow or brown in color, resembling that of the stolon. In it, numerous pores occur irregularly disposed over the surface (fig. 13, *p.*). In longitudinal section these appear as deep, wide notches which are covered externally by the thin cuticle (fig. 16, *p.*). Similar pores occur in the stalk of *Ascopodaria macropus*, and Ehlers suggests that an opening to the outside may be found in them. There is no evidence for this in *G. ramosa.* The interior of the phalanx is filled with a mesenchymatous tissue continuous with that of the interior of the muscular dilatation. Near the base of the rigid portion of each phalanx a septum occurs. This is perforated and allows a free passage from one part of the stalk to another. The maximum number of phalanges in a stalk is six so far as the writer has observed. Four or five is a common number in the older parts of the colony. The description of the first phalanx, however, answers in the main, for all the others. As a stalk grows, the first calyx is differentiated before the rigid portion of the first phalanx has attained its full length. Before this time also, the first annulations of a second expansion appear below the calyx, so that by the time the calyx performs the function of nutrition it may have been carried into or above the second phalanx. Whether in this way the original calyx is carried to the summit of a stalk containing the maximum number of phalanges, or whether regeneration may occur before the maximum height is reached, is perhaps doubtful.

Branching.—From the distal portion of any phalanx branches may arise. Generally two opposite branches are produced, but frequently three may occur around the base of the same bulb. A branch is always separated from the parent stem by a double perforated septum (fig. 13, *dou. sep.*), so that, however twisted the growth may become, the branches may always be distinguished from the parent stalk. It is probable that branches begin to form at an early stage in the growth of the polypide. They are often found below the second dilatation, and frequently no difference can be discerned between the first phalanx of the branch and the second of the parent stalk except one of length. A branch may itself be composed of several phalanges similar in all respects to those of the parent, and the distal end of each of its phalanges may in turn give rise to secondary branches.

The complexity of growth is further increased in certain cases by the production of what may be called a stolonic process in the place of a branch (fig. 16, *sto. pro.*). Such a process, like a branch, is separated from the parent stalk by a double perforated septum, and like a stolon, it forms alternate polypide-bearing and non-polypide-bearing segments (fig. 16, *non. pl. seg.*). Sometimes the segments are short, when dense masses of stems are formed about a single bulb as a center of growth (fig. 15). Sometimes a single long stolon is produced with segments of average length, thus forming a basis for a new growth of polypides. Transitions are often found between what has been called a simple branch and a stolonic process. Thus, fig. 15 represents part of a parent stalk (*pa. stk.*) whose first lateral bud has produced a simple branch (*br. 1*). At the base of the latter another bud has produced a second branch (*br. 2*). A continuation of this process would produce a growth very closely resembling a stolonic process, especially if that portion of the stem which is intercalated between the two septa (*in. seg.*) at the base of the two branches (*br. 1*, *br. 2*) should be somewhat prolonged. Such a case is represented by fig. 16. Here another stalk (*pa. stk.*) has produced a branch (*br.*) and a stolonic process (*sto. pro.*). This latter structure differs in no way from the true stolon attached to the substratum, except that it arises part way up the stem. It is composed of alternate polypide-bearing and non-polypide-bearing segments, and these vary in length just as they do in the original stolon. No hard and fast line, then, can be drawn between a polypide-producing branch and a stolonic process; and that portion of the stem which is intercalated between the two septa at the base of an ordinary branch (fig. 15, *in. seg.*) may perhaps be homologous with the non-polypide-bearing segment of the stolon (fig. 13, *non. pl. seg.*) or of a stolonic process (fig. 16, *non. pl. seg.*).

In the jointed character of the stalk and in the branching, *G. ramosa* bears considerable resemblance to *Arthropodaria benedeni* Foettinger (1887). In the latter, however, the differentiation of the muscular expansion has not been carried to the extent that appears in *Gonypodaria*. In the drawing given by Foettinger, the muscle fibers are represented to extend through the length of each segment or phalanx and the budding region appears to be about the middle of the expanded portion of the stem. In the character of their stems these two forms seem to be nearly allied to *Urnatella*. Davenport (1893) has discussed very fully the relationship between the segmentation of the stalk and the ability to produce buds. His remark upon the "suggestive parallelism" which exists "between the formation of segments and the production of buds" finds further confirmation in *G. ramosa*, where segmentation is complete and regular and is accompanied by the regular and constant formation of buds.

3. THE CALYX.—This differs in no essential respect from that described for the Pedicellinidæ in general. As a rule it is situated just above a muscular expansion. Its lophophore is at right angles to the axis of the stem. Externally it is covered by a continuation of the delicate cuticle of the stalk. The number of the tentacles varies from sixteen to nineteen. The various systems of organs, digestive, nervous, genital and excretory, correspond closely to those so fully described by Ehlers for *Ascopodaria macropus*.

B. Regeneration.

The union between stalk and calyx is extremely fragile, and as a consequence the calyces are frequently lost. A zone of regenerative cells occurs immediately below the calyx, as in other Pedicellines, and from this it is renewed. It is no uncommon thing to find a colony which has lost half of its calyces, while at the same time many regenerating ones occur. This species may be said to possess a second regenerative zone—that from which the branches arise. This region of branch formation is always in close relation with the bulbous dilatations. It lies just beneath them, and it is probable that it retains its power of external budding for only a short time—only until the thick layer of the cuticle becomes chitinized; but it seems to retain the power of regeneration from the inner layer of cells for a much longer time. An illustration of this is afforded by the condition represented in fig. 14. Here an old stalk (*o. stk.*) had lost calyx and upper phalanx, so that the distal end of the lower portion was left entirely exposed at a point just below where a muscular dilatation had occurred. At this part of the stem no septum is found. Yet from the inner layer of cells a young shoot has arisen with well differentiated calyx, basal dilatation, and rigid portion. In the discussion previously mentioned, Dr. Davenport maintains the importance of septa in enabling a regenerative zone to bud. On page 20, he says, "If we seek an explanation of the dissepiments, I think it is to be found in the protection of the stock against the influx of water and destroying organisms at the time of the loss of calyx or lateral branches which would make regeneration impossible." At the same time this writer holds (p. 21) that "segmentation has succeeded, rather than preceded, the condition of bud formation from the stalk, it being desirable owing to the greater danger from mutilation to which the stalk is exposed." From this point of view, *G. ramosa* retains a primitive capacity in a high degree in its ability to regenerate from a point where no septum has developed.

C. Movement.

A living colony of *Gonypodaria* presents a scene of considerable activity. Movement is greatest in the upper dilatations of the stalk, especially in the one at the base of distal rigid portion. Two movements can be detected, one from side to side, which is stiff and jerky, the other, a circular movement. In the first, the phalanx bends almost at right angles to one side, then to the other, and in the return to its original upright position it executes a partially circular movement. It is not possible to say whether or not the polypides respond to stimulus. Upon touching one with the dissecting needle there seemed sometimes to be response, but one could not be sure but that the movement might have taken place without such stimulus. There was no united, wave-like movement throughout the colony, such as Ehlers describes for *A. macropus*. What the stimulus is, it is difficult to say, especially when, as Ehlers also found in *A. macropus*, one sees stems which have lost their calyces execute the same movements as those which possess them.

IV. SUMMARY.

1. The new genus *Myosoma* is distinguished by the possession of a somatic ventral muscle which is continuous with that of the stalk and forms the great ventral muscle.

2. The somatic portion of the ventral muscle sends branches to each side of the œsophagus. These form the atrial retractors. It is probable that part of these branching fibers are connected with the genital ducts.

3. The musculature of the stalk consists of the longitudinal muscle fibers of the ventral muscle, and also of oblique fibers which proceed from the dorsal to the ventral side.

4. The tentacles contain each a pair of muscles, and the sphincter of the lophophore attains an unusual development.

5. Owing to the continuity of the ventral muscle, the neck of *Myosoma* is unusually broad and holds the calyx more securely upon the stalk than is the case in other Pedicellinidæ.

6. This communication between stalk and calyx, and the continuity of muscle fibers from one part of the polypide to the other, together with the oblique setting of the lophophore, allies *Myosoma* rather closely with *Loxosoma*.

7. The new species, *Gonypodaria ramosa*, is distinguished by the possession of a branching stalk. The branches arise from any bulbous dilatation, and are of two kinds, simple and stolonic.

8. It is difficult to draw a real distinction between these two kinds of branches. Transitions between them can often be found.

9. A septum is found below the calyx and above each muscular dilatation of the stalk. A double septum is produced at the origin of a branch.

10. That part of the branch which is enclosed by the double septum may perhaps be homologous with a non-polypide-bearing segment of the stolon.

11. Regeneration of a stalk from the inner layer of cells at the base of a muscular dilatation may take place, even though the whole upper portion of the stem with the muscular dilatation be broken away.

V. IDENTIFICATION OF KNOWN SPECIES.

The following is a list of the species of Entoprocta found on the Pacific Coast, which have been previously described. The classification given by Ehlers has been followed.

Pedicellina *Sars.*

Pedicellina echinata *Sars.*

Pedicellina echinata SARS, Beskrivelser og Jagttagelser, 1835.
Pedicellina cernua (PALLAS) HINCKS, Brit. Mar. Polyzoa, Vol. I, p. 565.

Habitat.—Lime Point, California. Found growing on old hydroid stems together with *Eucratea chelata*.

Ascopodaria *Busk.*

Ascopodaria gracilis *Sars.*

Pedicellina gracilis SARS, Beskrivelser og Jagttagelser, 1855, p. 6.
Pedicellina gracilis HINCKS, Brit. Mar. Polyzoa, Vol. I, p. 570.

Habitat.—Lime Point and San Pedro, California.

Ascopodaria macropus *Ehlers.*

Habitat.—San Pedro, California. Small quantities of this species have been obtained at various times from San Pedro, where it seems to be fairly abundant.

UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA,
January 2, 1900.

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ABBREVIATIONS USED IN THE FIGURES.

ap. sep.—aperture of septum.
at. re.—atrial retractor.
at. fl.—atrial floor.
atr.—atrium.
bas. r.—basal rib.
br.—branch.
br. so. v. m.—branch of somatic ventral muscle.
cls. l.—" liver cells."
cl. cls.—closing cells of septum.
cls. at. fl.—cells of atrial floor.
cls. g. d.—cells of genital duct.
cu.—cuticle.
chi. l.—chitinous layer.
dor. s.—dorsal side.
dor. m.—dorsal muscle.
dor. sep.—dorsal septum.
dor. w.—dorsal body-wall.
ec. stk.—ectoderm of stalk.
ec. ca.—ectoderm of calyx.
ec.—ectoderm.
gn.—ganglion.
int.—intestine.
in. seg.—intercalated segment.
loph. f.—lophophoral fold.
m. dil.—muscular dilatation.
m. g. d.—muscles of genital duct.
m. stk.—muscle of stalk.
non. pl. seg.—non-polypide-bearing segment.
nu.—nuclei.
œs.—œsophagus.
o. m. f.—oblique muscle fibers.
o. stk.—old stalk.
pa. stk.—parent stalk.
p.—pore.
pha.—phalanx.
re. cls.—regenerating cells.
rec.—rectum.
sag. r.—sagittal rib.
spl. reg.—spineless region.
sto.—stolon.
so. v. m.—somatic ventral muscle.
sep.—septum.
sph. loph.—sphincter of lophophore.
st.—stomach.
stk.—stalk.
sto. pro.—stolonic process.
suc. pl. seg.—successive polypide bearing segments.
sum.—summit of calyx.
tent. m.—tentacular muscles.
ten. r.—tentacular rib.
v. s.—ventral side.
v. m.—ventral muscle.
v. m. stk.—ventral muscle of stalk.
v. w.—ventral body wall.

EXPLANATION OF PLATE XVI.

All drawings made with the aid of a camera lucida, except figs. 1 and 13.

Fig. 1. Part of a colony of *Myosoma spinosa*, gen. nov. The two stolons which are represented were not actually growing side by side, but were chosen to show the variability in segmentation. They are, however, typical. The arrangement of the younger polypides is somewhat diagrammatic, but each individual is as faithful a copy as could be made. × 25.

Fig. 2. A single polypide of *Myosoma spinosa*, showing a characteristic position, and the arrangement of the muscle fibers in the stalk. × 75.

Fig. 3. Para-sagittal section of the same through calyx and part of stalk, to show the somatic ventral muscle and its continuity into the stalk. × 300.

Fig. 4. Frontal section of the same, close to ventral wall of stomach. It shows the continuity of the muscle fibers from stalk to calyx, and also a few fibers of the branches of the ventral muscle. × 300.

Fig. 5. Cross-section of the calyx showing the branches of the somatic ventral muscle which form the atrial retractors. Section near the base of the œsophagus. × 130.

Fig. 6. Same as above (fig. 5), but three sections higher. × 130.

Fig. 7. Same as the two preceding figures, the section passing through the point where the atrial floor (*cls. at. fl.*) begins to appear. × 130.

Fig. 8. Sagittal section of calyx of *M. spinosa*, showing the connection of muscle fibers with the genital duct. × 650.

Fig. 9. Cross-section near the base of three tentacles of the same, to show the tentacular muscles. × 300.

Fig. 10. Longitudinal section of the same. × 300.

Fig. 11. Cross-section of the stalk of *M. spinosa* a few sections below the calyx, showing greater thickness of the muscle sheath on the ventral side. × 130.

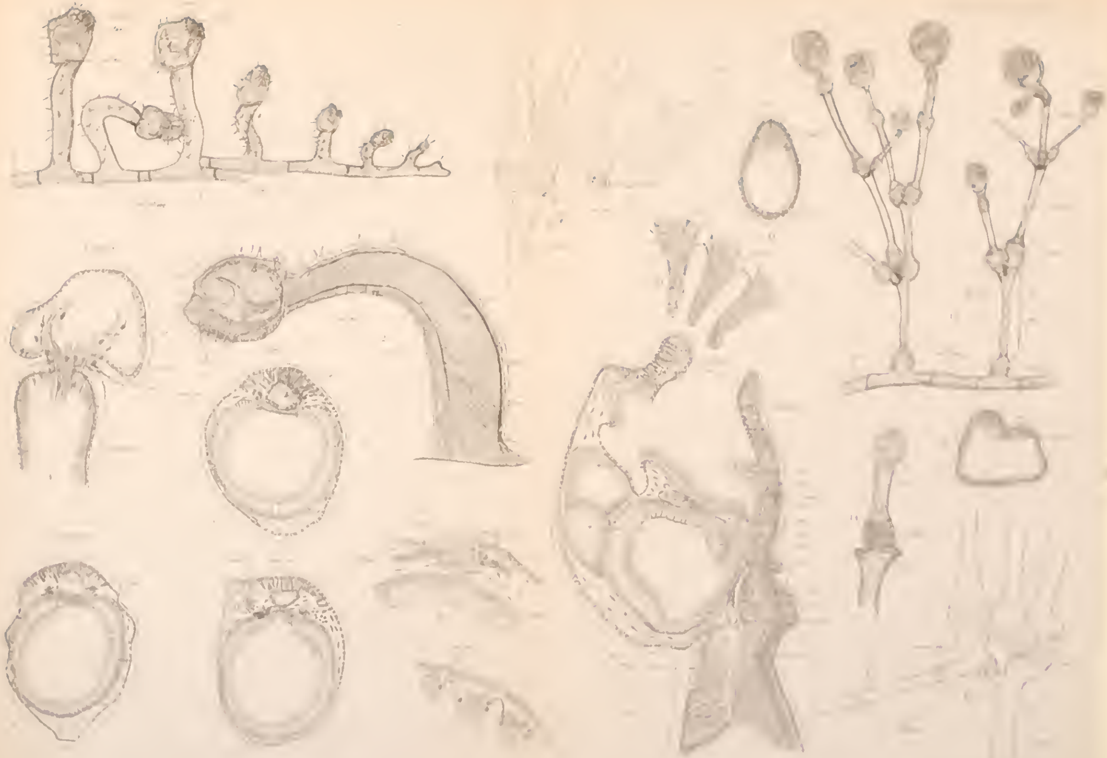
Fig. 12. Same as the preceding, except that the section passes through the lower part of the stalk. × 130.

Fig. 13. Part of a colony of *Gonypodaria ramosa*, sp. nov. × 15.

Fig. 14. Part of an old stalk of *G. ramosa*, the distal end of which shows a regenerating polypide. × 100.

Fig. 15. A cluster of branches formed at the base of a muscular dilatation of the parent stalk. A transition from simple branching such as is shown in fig. 13, and stolonic branching is indicated by the growth of a second branch (*br.* 2) from the basal dilatation of the first (*br.* 1). × 100.

Fig. 16. Represents a simple branch and a stolonic process growing from the base of a muscular dilatation of the parent stalk. × 100.



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California Water Birds

No. V

Vicinity of Monterey in May and Early June

BY

LEVERETT M. LOOMIS

Curator of the Department of Ornithology

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CONTENTS.

The results of a study of the water birds off Monterey from May 1 to June 12, 1897, are presented in this paper, together with some reflections upon the cause of return migration and some observations upon specimens. That the birds of the harbor might be observed more fully than on previous occasions, the town of Monterey was selected as a base of operations, and from this vantage-point week-day excursions were made upon the bay and ocean, the voyages extending several miles beyond Point Pinos when the weather permitted. May proved to be a windy month and at times there were rather heavy seas. However, only on six days did wind or waves prevent the boat from reaching the ocean. With the advent of June low fogs began to prevail.

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[1] 'No. I.—Monterey and Vicinity from the Middle of June to the End of August,' Proc. Calif. Acad. Sci., 2nd Ser., Vol. V, June 19, 1895, pp. 177–224, 1 map.

'No. II.—Vicinity of Monterey in Midwinter,' ibid., Vol. VI, Feb. 21, 1896, pp. 1–30, 1 map.

'No. III.—South Farallon Island in July,' ibid., Vol. VI, Aug. 29, 1896, pp. 353–366, 2 maps.

'No. IV.—Vicinity of Monterey in Autumn,' ibid., 3rd Ser., Zool., Vol. II, No. 3, Feb. 12, 1900, pp. 277–322, 1 map.

December 24, 1900.

I. Migration.

Summary of Movements.

Bird Waves.—While there were fluctuations seemingly due to migration in most of the species observed, extensive movements to breeding grounds occurred only in the Loons, Bonaparte's Gull, Forster's Tern, and Northern Phalarope.

LOONS. At the time of my arrival a bird wave was apparently receding. It appeared to be composed chiefly of the three species of Loons. For several days they were numerous on the water and on May 3 there was an extensive northward flight, which expended its strength on the following day. By the 5th few were to be found anywhere.

May 12 there was a great passage of Loons in companies upon the ocean—the Pacific Loon apparently predominating. It was foreshadowed by a considerable movement on the 11th and was followed by a period of little activity from the 14th to the 19th. On the 19th and 20th many solitary ones passed north. Then for nearly a week little movement took place and stragglers increased on the water.

May 27 there was a large flight of black-throated Loons, mainly *G. pacifica*. As on the 12th, they flew in bands and passed Point Pinos without entering Monterey Bay. By the 29th this flight had subsided. Afterwards no extensive migratory movement was witnessed, although stragglers were observed to the end of my stay.

BONAPARTE'S GULL. On May 10 a migratory movement began in Bonaparte's Gulls which reached its height on the 14th and 17th, when they were abundant. After the 18th only stragglers were encountered.

FORSTER'S TERN. These Terns were plentiful from May 11 to May 14; afterwards none were seen.

NORTHERN PHALAROPE. From the 11th to the 14th of May there was a great inroad of Northern Phalaropes. They departed suddenly, from the 15th onward a few laggards only being met with—the last, June 5.

Pauses in Migration.—Northbound migrants lingered by the way to feed, Bonaparte's Gulls, Forster's Terns, Northern Phalaropes, congregating where food was plentiful. Besides halting upon the water, migrants made counter-movements. For example, May 12, when Northern Phalaropes were numerous on wing, more flocks in the vicinity of Point Pinos flew southward than northward. Again, on June 1, when Loons awing were quite common, as many went down the coast as up the coast. These instances emphasize that daily observations, recorded in detail, alone reveal the real character of the movements of the birds of a locality, this being particularly true in the summer migrations from breeding grounds in temperate regions.

During the great flight of Loons on the 12th of May, there were a few loiterers on the water in the Monterey harbor. If observation had not been extended to the ocean, these stragglers would have been all that were observed, evidencing how false an impression of migratory movements may be gained if only arrested migration is studied.

Retrograde Migration.—It was noticed that many of the Bonaparte's Gulls *in transitu* over Monterey Bay apparently came down the east shore to the harbor and then turned westward, following the south shore to Point Pinos where they headed northward, seemingly making this retrograde movement in order to sight the coast-line above Santa Cruz. It is not improbable that they came from the interior, for an extensive migration down the Pajaro Valley was observed by Mr. J. R. Chalker in May, 1889.[1]

Overflow from Southern Breeding Grounds. — Dark-bodied Shearwaters were abundant from the outset. Before my departure, it seemed that the return movement southward was beginning. Pink-footed Shearwaters were scarce until the end of May. In June they became quite abundant. Black-vented Shearwaters were absent during the

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[1] 'Zoe,' Vol. IV, p. 225.

entire time of my visit, while Black-footed Albatrosses were rather common. Heermann's Gulls were rare in May, but in June they appeared in force, becoming decidedly common. Specimens examined in June seemed to have recently bred. These circumstances considered in connection with the autumnal movements [1] of this Gull and its occurrence in April on Isla Raza, Gulf of California,[2] apparently indicate that it moves northward after the breeding season, as is believed to be the case in the Black-vented Shearwater and Black-footed Albatross.[3] Not improbably the movement extends to other water birds breeding in the subtropics and tropics,[4] there being an extensive overflow to northern latitudes and great food-store after the tie to the nesting rocks is loosed.

Cause of Return Migration.[5]

"The day is passing when scientists seek to employ striking or extraordinary phenomena in the solutions of their problems; rather are they looking to that which appears insignificant and commonplace."

The summer movements from breeding grounds in temperate regions appear to be the key to the fundamental causes of migration, for these movements occur without procreative stimulus or direct pressure from winter,[6] the incentives to migration being therefore limited to narrow bounds. In the previous paper [7] facts have been presented showing that the young are guided by the old, and that the latter are directed by physical phenomena which repeated

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[1] Calif. W. B. No. IV, pp. 294-299.

[2] Streets, Bull. U. S. Nat. Mus. No. 7, p. 26. (See also Nelson, N. A. Fauna No. 14, p. 23.)

[3] Calif. W. B. No. IV, pp. 305-307.

[4] There seems to be no reason for rejecting the old record of *Creagrus furcatus* off Monterey merely because of the remoteness of the nesting habitat. (Cf. A. O. U. 'Check-List,' 2nd Ed., p. 326; Rothschild and Hartert, 'Novitates Zoologicae,' Vol. VI, p. 190; Salvin, Trans. Zool. Soc. Lond., Vol. IX, p. 506.)

[5] The term return migration is employed because the first migration in each bird is from the place of its birth, the movement back to the breeding habitat being therefore a return migration.

[6] Early departure after nesting, in temperate climes, is by no means a recent discovery; it was known to Gilbert White more than a century and a quarter ago. (See letter to Daines Barrington on the Swift.)

[7] Calif. W. B. No. IV, pp. 307-312.

journeys have apparently rendered familiar. With the young educated into a knowledge of the way, heredity, as a factor in migration, is stripped of its potency—at most there remaining only an innate desire for travel and an "inherited talent for geography."[1] Under the guise of science the word heredity may harbor as great superstition as the word hibernation in an earlier period in the study of migration. Outward necessity exists for the early movements—coming winter with its failure of food. Whether old birds comprehend that they must depart early in order that the exodus migration may be a gradual depopulation is hidden from us. Supplementary migration, owing to sudden contraction in the food area, seems to indicate an intelligent appreciation of the necessity of migration. Whatever be the case, young birds might readily acquire the habit of migration by following the example of old travelers, who in youth had acquired the habit in like manner from their elders. "In its early days the developing animal is reading the paragraph of life. Every sentence mastered is built into the tissue of experience, and leaves its impress on the plastic, yet retentive brain. By dint of repetition, the results of acquisition become more and more firmly ingrained. Habits are generated; and habit becomes second nature. The organism which to begin with was a creature of congenital impulse and reaction becomes more and more a creature of acquired habits. It is a new being, but one with needs not less imperious than those with which it was congenitally endowed."[2]

In short, it is held that birds-of-the-year, inheriting probably a desire for travel and a talent for geography, learn early exodus migration from the old birds, and that habit (possibly also foresight) holds the old birds to route and period of movement, thus maintaining the adjustment to winter with its failure of food.

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[1] Cf. Calif. W. B. No. IV, p. 315.

[2] C. Lloyd Morgan on 'Instinct and Intelligence in Animals,' 'Nature,' Vol. LVII, 1898, p. 329.

Winter renders return migration as imperative as exodus migration.[1] Habit in the old birds loses none of its force through erotic promptings to return to the nesting abode. Young birds who have successfully met the difficulties of one journey are not less fitted to follow the old in the return movement. Hence, it is maintained that heredity (implying at most an innate desire for travel and a talent for geography), education of the young into a knowledge of the way, and habit in the old birds (possibly also foresight), holding them true to time and place, are the paramount inward causes[2] of the return as well as of the exodus—the two movements constituting the adaptation of the bird population to winter, northern and southern, with its failure of food.[3]

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[1] For example, the return movements in the Northern Hemisphere are necessitated, it is held, because they are integral parts of the vast movement which sways the bird population northward, relieving the pressure arising from winter in the Southern Hemisphere. The complicated system of movements composing this grand movement is believed to be the outgrowth of time. So close is the adjustment of population to the existing food-supply that stability in the established order is essential to the success of migration. (Cf. Calif. W. B. No. IV, p. 314.)

Some writers, dwelling upon the perils of the journey, envelop migration in a cloud of mystery, losing sight of the fact that it is safer for the birds to go than to stay. There are numerous ordinary undertakings in human life that are not less free from danger than avian migration. Some one has aptly remarked that it is dangerous to live.

[2] As stated in 'No. IV,' p. 315, desire for procreation may be a prompting influence in the return migration. That it is not a paramount cause is further indicated by the existence of sedentary species.

It was also affirmed in the same paper that there may be, in some species, special physiological demands as to temperature during reproduction. If it requires such nice climatic adjustment to bring the young into the world, it is remarkable that in the space of a few weeks they should be fitted for the changes of climate incident to migration. It may be, however, that a species repairs to a higher life zone not because of the peculiar food or temperature of the region, but because in the struggle room has been found nowhere else. Perhaps the solution of this whole question is to be obtained from migration to oceanic islands, such as the Long-tailed and Shining Cuckoos to New Zealand and the Turnstone and Smaller Golden Plover to Hawaii. Applying the interpretation set forth in the preceding pages, it is held that the Cuckoos in the unfolding of migration gained New Zealand as a breeding place, and the two Shore Birds gained Hawaii as a winter resort; that the young, inheriting probably a desire for travel and a talent for geography, learn the way to these habitats from the old; that habit (possibly also foresight) holds the old ones true to the way that has been learned, thus perpetuating the intricate movements forming the adjustment to winter, northern and southern, with its failure of food.

[3] While it is contended that the present conditions enforce present migration, it is not denied that the evolution of the seasons was the cause of the evolution of migration.

II. General Observations.[1]

Æchmophorus occidentalis. Western Grebe.—A few individuals were all that were noted.

Colymbus nigricollis. Eared Grebe.—Only one small Grebe was seen, and it appeared to be this species.

Gavia imber. Loon.
Gavia pacifica. Pacific Loon.
Gavia lumme. Red-throated Loon.—On my arrival these three Loons were numerous upon the water. As they had not been molested, they had become tame at the Monterey wharf, paying little attention to the loungers or to the fishermen going and coming in their boats. By May 5 all the Loons had disappeared from the vicinity of Monterey except stragglers, a northward movement having taken place. Afterwards there were inroads of *Gavia imber* and *Gavia pacifica*, but neither became as abundant on the water as at the outset. Loiterers remained to the day of my departure. Offshore there were migratory movements —see preceding 'Bird Waves.' The last extensive one occurred May 27, when numerous bands of black-throated birds (chiefly *Gavia pacifica*) appeared from the south and passed swiftly by, heading in a northwesterly direction; off Point Pinos the line of flight of the majority was several miles at sea. *Gavia lumme* disappeared early, an adult May 8, being the last positively identified.

All the black-throated specimens secured of *Gavia pacifica* exhibited traces of the winter garb on the fore-neck. *Gavia imber* was taken in similar transitional stage and in full nuptial plumage. There were some individuals of both species in worn winter plumage. They were found chiefly on the water in the harbor, and were probably sickly birds. *Gavia lumme* was also obtained in breeding attire. At Tomales Bay a number of black-headed *Gavia imber* and

[1] Subspecific names are omitted; otherwise the nomenclature conforms to the A. O. U. 'Check-List,' second edition and eighth and ninth supplements.

chestnut-throated *Gavia lumme* were seen March 17, 1899. A female of the latter species, shot at Drake's Bay, March 16, 1898, is in high nuptial feather.

Lunda cirrhata. Tufted Puffin.—May 4 several companies were seen, and afterwards individuals, at times, to the end of my stay.

White prevails so largely on the breast and abdomen of a male taken Oct. 26, 1896, that it bears a striking resemblance to a Rhinoceros Auklet.

Cerorhinca monocerata. Rhinoceros Auklet.—Several were met with during the middle of May.

Ptychoramphus aleuticus. Cassin's Auklet.—They were observed as follows: May 27, three on the water, about three miles west of the buoy; June 5, several bands, all told about sixty individuals, resting upon the ocean three or four miles offshore; June 7, two small parties flying northward.

Cepphus columba. Pigeon Guillemot.—These Auks were abundant on the water on the 3rd and 4th of May. By the 6th most had disappeared. Afterwards there were reënforcements, but they were transient, the species declining with the ebbing of the migration. Early in June all had forsaken the bay and ocean in the vicinity of Point Pinos.

An adult female from Monterey, May 27, has some white feathers on the breast and abdomen, which is likewise the case, in a lesser degree, in a female from Kadiak, Alaska, June 28.

Uria troile. Murre.—Very few were seen at the outset, but at the end of May and in June visitors were common on some days. They were probably birds on fishing excursions from the rookeries above Santa Cruz, and not early southbound migrants.

In a male, June 4, the throat is almost wholly white, and in another specimen, May 27, it is chiefly white, both examples therein having the plumage of a winter bird-of-the-year.[1] Several young autumn and early December birds from the vicinity of San Francisco, having the bill partially developed, resemble *Uria lomvia*. One of these is somewhat melanistic, its upper parts being brownish black. It is much darker than any other specimen in the Academy's series of forty-three old and young birds taken at various seasons. I have examined the specimen upon which Dr. Cooper based his California record of *Uria lomvia*[2] and find that it is an immature *Uria troile*. The specimen was captured and mounted by Mr. W. G. Blunt, and by him donated to the Academy. Several years ago, at my request, Mr. Blunt examined the specimen, confirming that it was the one identified by Dr. Cooper as *Uria lomvia*.

Stercorarius parasiticus. PARASITIC JAEGER.—A Jaeger, having the central rectrices acuminate, was seen May 11. It is probable that it was this species rather than *S. longicaudus*.

Larus glaucus. GLAUCOUS GULL.—An immature specimen in worn plumage is referred to *L. glaucus* instead of *L. barrovianus*, for the depth of the bill through the angle is less than the depth through the base. The specimen was secured May 4, and was with a flock of Western Gulls on the beach near the Monterey wharf.

Larus occidentalis. WESTERN GULL.—Western Gulls were abundant during the early part of my sojourn. Later, however, they were not numerous, there being no nesting colony in the vicinity.

White-headed birds are frequently seen late in fall and in winter. Generally such specimens have faint traces of markings on the head or neck.

Larus californicus. CALIFORNIA GULL.—Some half a dozen, heading northward, were seen on the ocean near the buoy May 19.

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[1] Cf. Calif. W. B. No. II, p. 21.
[2] Proc. Calif. Acad. Sci., Vol. V, p. 414; 'Auk,' Vol. III, p. 126.

Larus heermanni. HEERMANN'S GULL.—In May Heermann's Gulls were rare. In June they increased in numbers, becoming decidedly common by the second week. White-headed birds predominated.

An autumn specimen has several primary coverts on both wings abnormally white.

Larus philadelphia. BONAPARTE'S GULL.—During a gale May 1 several bands of these Gulls on migration passed the Monterey harbor. Then there was a hiatus, broken only by a few loiterers, until the 10th, when began an influx which lasted for more than a week. On the 14th and 17th it was at its height. On the former day numerous flocks occurred on the water and on the latter day an extensive flight took place, which was continued on a smaller scale on the 18th. This movement closed the northward migration of the species in the vicinity, for only stragglers were met with afterwards, a young bird, June 2, being the last one. This bird, forsaken by his fellows, had sought the companionship of the Loons in the Monterey harbor. Two days before, apparently the same bird was seen in company with some sickly American Coots that had found an asylum on a lagoon near the harbor.

White-throated birds with the tail band were in the majority, and pied-headed ones were plentiful. Nevertheless, in every flock there was a fair proportion of adults in full nuptial plumage, proving that the young are not without experienced leaders in the closing of the return migration.

Xema sabinii. SABINE'S GULL.—A fine adult male in high breeding plumage was shot May 12. These Gulls probably pass Monterey Bay in considerable numbers, for they have been found in abundance as far south as Callao Bay, Peru.[1] However, those visiting Peru may pursue the same route as the Franklin's Gulls.

Since the above was written, the Academy has come into possession of two additional specimens from Monterey Bay,

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[1] MacFarlane, 'Ibis,' 5th Ser., Vol. V, p. 207.

an adult male and a young female taken Oct. 5, 1899, by Mr. Alvin Seale. Much of the nuptial hood and collar is still retained in the male.

Sterna maxima. ROYAL TERN.

Sterna elegans. ELEGANT TERN.—Six Terns of the larger kind were observed May 8 as they passed northward near the buoy. They probably belonged to one or the other of these species.

Sterna forsteri. FORSTER'S TERN.—They were plentiful during the four days following May 10. None were noted before or after this interval.

An April male from the vicinity of San Francisco has the jugulum, breast, and sides of abdomen very pale gray, in this respect resembling lighter examples of *Sterna paradisæa.* Several other April specimens are tinged with gray on these parts.

Diomedea nigripes. BLACK-FOOTED ALBATROSS.—Between May 3 and June 9 seventeen were met with. Four of these occurred May 11 and three May 28. On both occasions, mistaking us for fishermen, they came to the boat, expecting to share in the catch. One of them fearlessly alighted on the water within twenty-five feet of us. Although I shouted and threw an empty cartridge and a Murre at him, he did not take wing. In one instance, when there was a heavy sea, an individual came to the inner part of the bay near the harbor. Usually, however, they kept to the ocean, those of the 11th and 28th being fully five miles to the westward of Point Pinos. My trips did not extend sufficiently offshore to develop 'Gonies' in abundance.

Puffinus creatopus. PINK-FOOTED SHEARWATER.—Previous to May 27 comparatively few Pink-footed Shearwaters were observed. In June they became quite abundant. Males greatly outnumbered the females, which was also the case in the autumn of 1896. Individuals frequently came close to the boat, seemingly prompted by curiosity.

Several specimens (apparently adult) have the white of the under parts immaculate anterior to the lower abdomen.

Others (apparently immature) have the white more or less variegated with gray, the chin and throat being densely mottled, sparsely mottled, or faintly streaked, and the breast and abdomen, in extreme examples, transversely marked. The majority of forty-seven specimens have whitish mixed with the dark color of the lower tail-coverts.

In certain Black-vented Shearwaters (apparently immature birds) the white of the lower parts is also invaded by gray, the jugulum and throat being mottled, and in some cases the chin and fore-breast. An extreme specimen is sparsely spotted on the abdomen and posterior portion of the breast. Some specimens display considerable white on the lower tail-coverts. The chord of the longest wing, in a series of eighty-seven specimens, measures 9.6 inches.

Puffinus griseus. Dark-bodied Shearwater.—From the outset, these Shearwaters were abundant. On several occasions large numbers were congregated on the water feeding. During a dense fog on the morning of June 2, and again on the morning of the 3rd, many in going down the coast passed within a few hundred yards of the Monterey wharf, illustrating the deflecting influence of low fogs upon movements.

In a series of eighty-three specimens, several have the chin and anterior portion of the throat white, more or less obscured by gray. The breast in some specimens presents a decidedly mottled appearance, the feathers being extensively white or whitish. Two specimens are albinistic; one of them has much of a greater covert white, and the other has the throat largely white. A bird having white on the scapular region was seen, but not captured.

Oceanodroma homochroa. Ashy Petrel.—A few small Petrels, seemingly this species, were seen June 5 as they winged their way northward over the ocean.

Phalacrocorax dilophus. Double-crested Cormorant.—Only on one occasion, May 4, was this species satisfactorily identified.

In a female, Feb. 22, the jugulum and breast are white, relieved by a few brown feathers, some of them very dark; the abdomen is variegated with light and dark brown and whitish. Another female, March 14, has the fore-breast brownish white in sharp contrast with the dark color of the posterior lower parts.

Phalacrocorax penicillatus. BRANDT'S CORMORANT.—Visiting Seal Rocks May 14, I found that the nesting was just commencing. A few nests had nearly reached completion, and several of these contained incomplete sets of eggs. In most cases, however, construction had advanced no further than starting the foundation. The rookery appeared to be larger than in 1894, having encroached upon the portion of the islet exposed to view from the land. About the bay, Shags were abundant.

The nuptial filaments are about half-grown in an adult female of Feb. 28. Six July birds (three of each sex) have the lower parts largely greenish brown, somewhat mottled in appearance. The upper parts in five of them are greenish brown, tending toward bottle-green. With one exception, all these brown birds possess at least traces of nuptial filaments.

Phalacrocorax pelagicus. PELAGIC CORMORANT.—At first they were very common on the bay, but as the breeding season drew near all disappeared save a few stragglers.

Besides the adults in fine feather, there were a few in worn brown dress, apparently diseased birds. An individual of this kind, taken May 7, has traces of the mature plumage. Its generative organs showed no functional enlargement. A female, Dec. 28, has indications of the white flank-patches and filamentous feathers of the neck.

Pelecanus californicus. CALIFORNIA BROWN PELICAN.—They were not common until June. Both white- and dark-breasted birds were present.

A male, Feb. 4, from Mazatlan, Mexico, has the entire feathered portion of the head straw yellow.

Merganser serrator. RED-BREASTED MERGANSER.—Four individuals were met with—the last one May 25.

In a female, April 3, the white of the chin and throat is mottled with brownish black, the black prevailing over the white on the lower throat. A brownish black patch surrounds each eye.

Histrionicus histrionicus. HARLEQUIN DUCK.—A female, with bleached wing and tail feathers, was shot May 25.

Oidemia deglandi. WHITE-WINGED SCOTER.—Four were seen on the 5th of May and six on the 10th. All were flying up the coast.

Oidemia perspicillata. SURF SCOTER.—At intervals, up to the 24th of May, loiterers were quite common off the sandy beach above the Monterey wharf. One was seen as late as June 12.

Ardea herodias. GREAT BLUE HERON.—May 31 being too windy for a trip upon the bay, I visited the Monterey lagoon, finding, besides a few other water birds, a Great Blue Heron.

Nycticorax nycticorax. NIGHT HERON.—On the day of my visit to the lagoon, a little company of these Herons occupied the live-oaks overhanging the water.

Fulica americana. AMERICAN COOT.—About a dozen Mud-hens were also at the lagoon on May 31. A male and three females were taken, and were in worn and faded plumage. They appeared to be sickly birds.

Phalaropus lobatus. NORTHERN PHALAROPE. — Not many were noticed during the first ten days of my stay, but on May 11 there was an influx, and for four days they were abundant. During the forenoon of the 14th, several great flocks were assembled with Bonaparte's Gulls on the ocean near Point Pinos. They were apparently feeding on tunicates, which abounded in an 'oil-slick.' There were adults as well as immature birds in these gatherings, evidencing that the young do not lack the guidance of the old in the closing movements of the return migration. After May 14 only a few stragglers were encountered. Two on June 5 were the last. One of these was shot, and had the testes of a breeding bird. In 1894, southbound Northern Phalaropes arrived July 11 (Calif. W. B. No. I, pp. 187, 223), the interval between the two migrations at Monterey being therefore but little over a month.

Except in the case of lost or diseased birds, the presence of boreal species in the summer months in the region below the breeding habitat is seemingly explained by late return and early exodus migration.

The shore was not patrolled, so little was learned of the waders frequenting the beaches and surf-beaten rocks. The following were met with: Sanderling (a large flock May 19), Wandering Tatler (call-notes heard May 8), Black Turnstone (common May 8), Black Oyster-catcher.

California Academy of Sciences,
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On the Inhibition by Artificial Section of the Normal Fission Plane in Stenostoma

BY

WILLIAM E. RITTER AND MISS EDNA M. CONGDON

WITH ONE PLATE

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ON THE INHIBITION BY ARTIFICIAL SECTION OF THE NORMAL FISSION PLANE IN STENOSTOMA.

BY WILLIAM E. RITTER AND MISS EDNA M. CONGDON.

PLATE XVII.

1. THE PROBLEM SUGGESTED.

THE question presented itself to one of us (Ritter) a number of years ago while studying monogenesis in compound ascidians: What would be the result of artificial section between two just-beginning normal fission planes in the budding young of an *Amaroucium* or a *Pyrosoma*?[1]

2. SELECTION OF ANIMALS FOR EXPERIMENTATION.

The difficulties in the way of carrying out the experiment on these animals having proved to be great, efforts were directed to the finding of some other creature that would furnish essentially the same conditions and at the same time would present fewer manipulative obstacles.

Several species of naidiform worms of the genera *Nais*, *Chætogaster* and *Pristina* were subjected to experimentation at first, but from these only negative results were obtained; i. e., in spite of artificial division the normal fission proceeded as though no cut had been interposed, and small pieces between the cut and the normal fission plane were separated from the parent worm. It should be said, however, that our experiments with these worms have been

[1] It will be recalled that in these, as well as in various other tunicates that reproduce asexually, the method, in essentials, is that the posterior portion of the young animal developed from the egg divides up into pieces by transverse fission, each piece giving origin to an ascidiozooid, which may, or may not, become entirely severed from the parent zooid. See, for example, figures in most text-books taken from Kowalevsky, Salensky, Brooks, etc.

December 26, 1900.

far less extensive than with *Stenostoma*, and we do not regard our negative results here as conclusive.

We next selected for trial a species of *Stenostoma*, probably *S. leucops* O. Schm., which occurs in abundance at some seasons of the year in Lake Merced and the Marine Hospital Lake, San Francisco. This has proved favorable for our purpose. After having found through a large number—more than 150—of preliminary experiments, the most favorable conditions of temperature, food, etc., and the best methods of keeping the animals that have been operated on, we are now able to get positive results in nearly every instance in which the proper conditions are fully met.

The experiment in this case is very simple. The animal, placed on a glass slide in a drop of water, is cut across with a small scalpel, the operation being performed under a dissecting microscope. The slide with the drop of water containing the animal is then kept in a moist chamber and examined at short intervals as development proceeds.

For some reason wholly unknown to us, the animals disappear almost entirely during several months of the year, i. e., from about July to January. Owing to this fact, we have not yet been able to get a sufficient number of observations to clear up several subordinate but interesting points that have arisen in course of the work. However, the question which gave rise to the investigation having been answered, we have felt that since it may be a considerable time yet before we shall be in position to publish our full results, a brief presentation of the main point is desirable at the present time.

3. General Statement of Result.

Stated in a word, the answer to the initial question is this: Under certain conditions *artificial section of a dividing worm, in another plane than that of normal fission, inhibits the normal fission plane and transfers to the artificial plane the production of those structures of the derivative worm that would otherwise have been produced adjacent to the normal fission plane.*

4. Nomenclature Employed.

To facilitate reference to the various elements involved, we use the following abbreviations:

F. P.—normal fission plane.
A. Y.—anterior young worm.
P. Y.—posterior young worm.
a. c.—anterior cut.
p. c.—posterior cut.
a. f. p.—anterior fission piece.
p. f. p.—posterior fission piece.
a. p.—anterior piece.
p. p.—posterior piece.

All normal elements, it will be noted, are indicated by capital letters and all artificial ones by small letters (Fig. 1).

5. Specific Statement of Results and Description of Experiment.

(a) Result Specifically Stated.—The general result stated in specific terms is this: Under certain conditions when *a. c.* is the artificial division plane, *F. P.* is inhibited and entirely disappears, and *a. f. p.*, which in the normal course of things would have become the tail of *A. Y.*, under the experiment becomes added to *P. Y.*, to make its head; i. e., the derivative worms become *A. Y.* — *a. f. p.*, and *P. Y.* + *a. f. p.*

This result follows whatever be the distance of *a. c.* from *F. P.*

The time at which *a. c.* is made relative to the state of advancement of *F. P.* is a matter of much greater importance than is its position. As would naturally be expected, the less advanced *F. P.* is, the greater the likelihood that it will be inhibited; and after it has reached a certain stage of advancement its inhibition is impossible. The latest stage of *F. P.* that has been inhibited is that marked by the beginning of the "ciliated pits," but in only a few cases advanced to this extent has success been achieved. Operated on at this stage, the normal fission usually proceeds to completion.

(*b*) *Outline of Process of Normal Fission.*—To gain some notion of what this stage is, a brief statement follows of the order of events in normal fission, as seen by examination of the living worm under moderate magnification.

The first indication of division is an enlargement of a few cells on each side of the body about two-thirds the length of the animal back from its anterior end. These cells soon come to form a mass of considerable size (figures, *c. m.*, Pl. XVII), and occupy the space between the ectoderm and the wall of the gut. These are, according to Ott (1892), and our observations are to the same effect, the beginnings of the cerebral ganglia, and are due to growths on the lateral nerves of the body. Next follows a clearing up and slight constriction of the gut at this point. About simultaneous with the earliest changes in the gut a constriction in the ectoderm takes place; and slightly later the beginnings of the ciliated pits make their appearance.

All these changes soon become pronounced, and a little time after the appearance of the ciliated pits the pharynx begins to form. The mouth breaks through before the complete separation of the two worms, and even before the severance of the gut; it does not appear, however, that food is actually taken in through the mouth until the two worms are fully severed.

From this account it is seen that inhibition of *F. P.* is possible after it has reached a rather advanced stage; i. e., after changes have begun in all the tissues involved in the division, and the foundations of at least two sets of organs of the head, viz., the cerebral ganglia and the ciliated pits, have been laid.

(*c*) *Development when F. P. is Inhibited.*—After being cut, both pieces remain for a time considerably contracted. They soon, however, assume their normal size and shape, and *a. p.* almost invariably swims about in a violent way for a time, while *p. p.* generally remains quiet.

No visible change of any kind, either in *F. P.* or any other part of the piece, takes place for about twenty-four hours.

Soon after this, careful examination, particularly by comparing measurements made now with those made at the time of the operation, discovers that the cell masses *(c. m.)* have changed position somewhat; and from this on it becomes obvious that they are slowly moving toward the anterior end of the piece. This migration continues until they have reached a position which, relative to the whole of *p. p.*, would correspond with that of the brain in a normal worm, and here they become fixed and form the brain of the new worm, *P. Y.* + *a. f. p.* A curious fact about this migration is that the left cell-mass appears to always advance more rapidly than the right, (see figures, Pl. XVII).

We have no evidence that the ciliated pits migrate forward, as do the ganglionic cell-masses, when they are present in *P. Y.* at the time of section. On the contrary, without having reached positiveness on this point, it appears that the original foundations disappear, and that new ones form in *a. f. p.*, the head of the new worm. The incipient changes that had set in in ectoderm and gut-wall likewise gradually disappear.

By the time the cerebral ganglia reach their destination, the anterior end of the worm has become filled, within the ectoderm, by a loosely arranged, confused mass of cells within which the brain becomes more or less hidden. From this incoherent mass the pharynx seems to take its origin; but precisely what happens here is impossible to determine on the living animal. That, however, the new mouth at least is formed by breaking through the ectoderm of the piece *(a. f. p.)* there can be no doubt.

(*d*) *Behavior when the Artificial Section is p. c.*—This case has never resulted in the inhibition of *F. P.*, though it must be said that fewer experiments have been performed here than in the other case, i. e., with *a. c.* as the division. This operation has, however, a marked and interesting influence on the further course of events. While *a. c.* frequently has the effect, when it does not inhibit *F. P.*, of hastening it perceptibly, *p. c.* on the contrary appears always to exercise a retarding influence on

F. P. The rule seems to be that *F. P.* is *wholly arrested until the part cut away*, i. e., *p. p., is entirely restored by regeneration.* This regeneration having been accomplished, *F. P.* then proceeds to completion. This we say seems to be the rule. We have not yet sufficient data on the point to put the conclusion wholly beyond question; there is little doubt, however, that further observations will do so.

6. A Few Theoretical Considerations.

(a) Comparison of the Diversion of a. f. p. from Its Original Destination, with the Diversion of Blastomeres in the Embryo.—The "regulation" here accomplished may be compared with that wherein some of the blastomeres of the segmenting egg, as in the familiar experiments of Driesch, Wilson, and others, are diverted artificially from their natural course and induced to take some other part in the formation of the adult animal than that for which they were originally destined. Various obvious and important differences between the two are, however, to be observed: The diversion is much wider in the case of *Stenostoma;* i. e., while the blastomeres of the embryo are made to produce some part of the animal other than that which they would have produced in normal development, in *Stenostoma* the piece *(a. f. p.)* which would be compared with the diverted blastomere or group of blastomeres is not only diverted to the production of a part of the organism other than that for which it was originally destined, but is diverted *from one individual animal to another;* i. e., *what would have become the tail end of one animal is induced to become the head of another.* Nor can the transfer of this piece from one individual to another be compared strictly with grafting, for, in the first place, the really successful graft is both physiologically and morphologically similar to, if not actually homologous with, the part which it replaces; and in the second place the scion ordinarily retains its original characters. We do not forget, in connection with the first

point, such cases as the grafting the cock's spur upon the ox's ear, mentioned by Darwin, nor the union of the posterior parts of two earth-worms to produce an animal with a tail at each end recently accomplished by Joest (1897) and by Morgan (1897). It should be borne in mind, however, that these can hardly be regarded as truly successful grafts; i. e., they do not really get into the life cycle, reproduction included, of the organism. In the case of the earth-worm, for example, the success of the graft is local, so to speak; i. e., it is successful, in all probability, only in respect to the tissues that actually unite with one another, and can hardly have much significance for the total life of an individual earth-worm.[1] With regard to the second point it is only necessary to recall the fact that the question was long in debate, if indeed it is fully settled yet, as to whether the graft can exert any reciprocal influence at all upon the stock.

Another obvious difference between the "regulation" in *Stenostoma* and that in the embryos referred to is in the fact that in the first case the regulation begins with an adult, and hence already differentiated, part, whereas in the second it begins with wholly undifferentiated parts. Accepting the idea of the equivalency of the blastomeres, the regulative changes in *Stenostoma* would seem to lie nearer the roots of the morphogenic process here than in the embryos. They are more comparable to the class of regulations of which the production of new tentacles from the cœnosarc in the hydroides, as first observed by Miss Bickford (1894) is a type.

Still another difference is seen in the larger part which external factors play in the embryonic than in the *Stenostoma* regulation. The blastomeres are actually held to their new position by external pressure, while there is no such

[1] From Joest's results it seems that at best the union of two posterior ends lengthens the life of both pieces somewhat. The oldest worm of this kind reported by him was eleven months and two days. Morgan found that the posterior, unregenerable ends would heal the wound and live for four months at least. It would be interesting to know whether united pieces of this kind would live longer under precisely the same external conditions than ununited pieces of the same number of somites.

influence exerted upon the diverted piece in *Stenostoma.* In both cases there is a remarkable display of the inherent formative power of the organism, but with *Stenostoma* this comes more prominently to view in that what is accomplished here is done by this power acting more independently, with less external aid than it has in the embryos. There is no reason assignable to external influences why the normal fission should not continue after the operation and separate off wholly the piece *a. f. p.* In fact, this generally does happen, and when it does the derived worm *(P. Y.)* is as complete in every respect as when it retains *a. f. p.*, and is never of reduced size as appears to be always the case when a larva is produced from an embryo from which one or more of the blastomeres have been removed.

(b) As to the Causes of the Migration of the Ganglionic Cell-Mass.—If the facts here presented are questioned relative to the nature of the formative forces of organisms, which we want so much to get hold of, the reply that comes, while of course in no sense final, does, it seems to us, strongly confirm the conception that, whatever their ultimate nature, they must be regarded in their relation to *the organism as a whole.*

Sachs' conception of "specific formative substance" and his generalization that all differences in the form of organs are correlated with differences in their chemical constitution, and that the principles of science require us to suppose the form-differences to be derived from the chemical differences,[1] probably represents the best that biological science can do at present in this direction toward the solution of the problem of development. But this conception is wholly incapable of yielding much light on the problem in detail, unless the reciprocal action of form and form-changes upon chemical constitution receives adequate recognition.

For example, we may appeal to some tropism, probably cytotropism, with much confidence, in view of recent studies on this subject, particularly by Herbst (1894) and Roux (1894)

[1] Quoted by Loeb, 1893, p. 55.

to explain the migration of the ganglionic cell-masses to their new position in the worms made up of *P. Y.* + *a. f. p.* This tropism would have to be supposed to rest ultimately on some physico-chemical peculiarity of the cell-masses. What is this peculiarity and how does it come about? It may be conjectured that the cut, not very far in front of the masses, in some way, possibly by putting the tissues of the cut surface into more intimate contact with the water and its contained oxygen, may have produced changes of this nature requisite to bring about the migration; but this explanation would appear to be negatived by the fact that it is usually not until after about twenty-four hours, i. e., after the cut has had time to heal up and so exclude the water and give the tissues more nearly their original character, that the migration begins. Were this explanation the right one it would seem that the migration should take place soon after the wound is made, while the conditions supposed to cause it would be most fully present. Nor can we appeal to a specific physico-chemical change set up through hereditary causes; for never before in all the phylogenetic history of *Stenostoma* has its brain migrated. The journey, and it will be noted that it may be a rather long one, the length depending on how far forward *a. c.* is placed, is made now for the first time. It looks as though the *primum movens* in the operation, even though we assume some tropism to be the *immediate* cause, is the *specific form of the animal.*

We may conceive all the tissues of the individual animal to be in a state, not of *equi*-librium but of *Stenostoma*-librium; and that when this is disturbed in any way the whole system *together* tends to re-establish it; and this may be done *through* physico-chemical means. Loeb's conclusion (1899) that the number of embryos produced from a single ovum is dependent upon the geometrical form of the egg substance, would seem to be well taken, not only for the particular phenomena to which it relates, but so far as concerns the potency of form, as touching a general principle that is very wide reaching.

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EXPLANATION OF PLATE XVII.

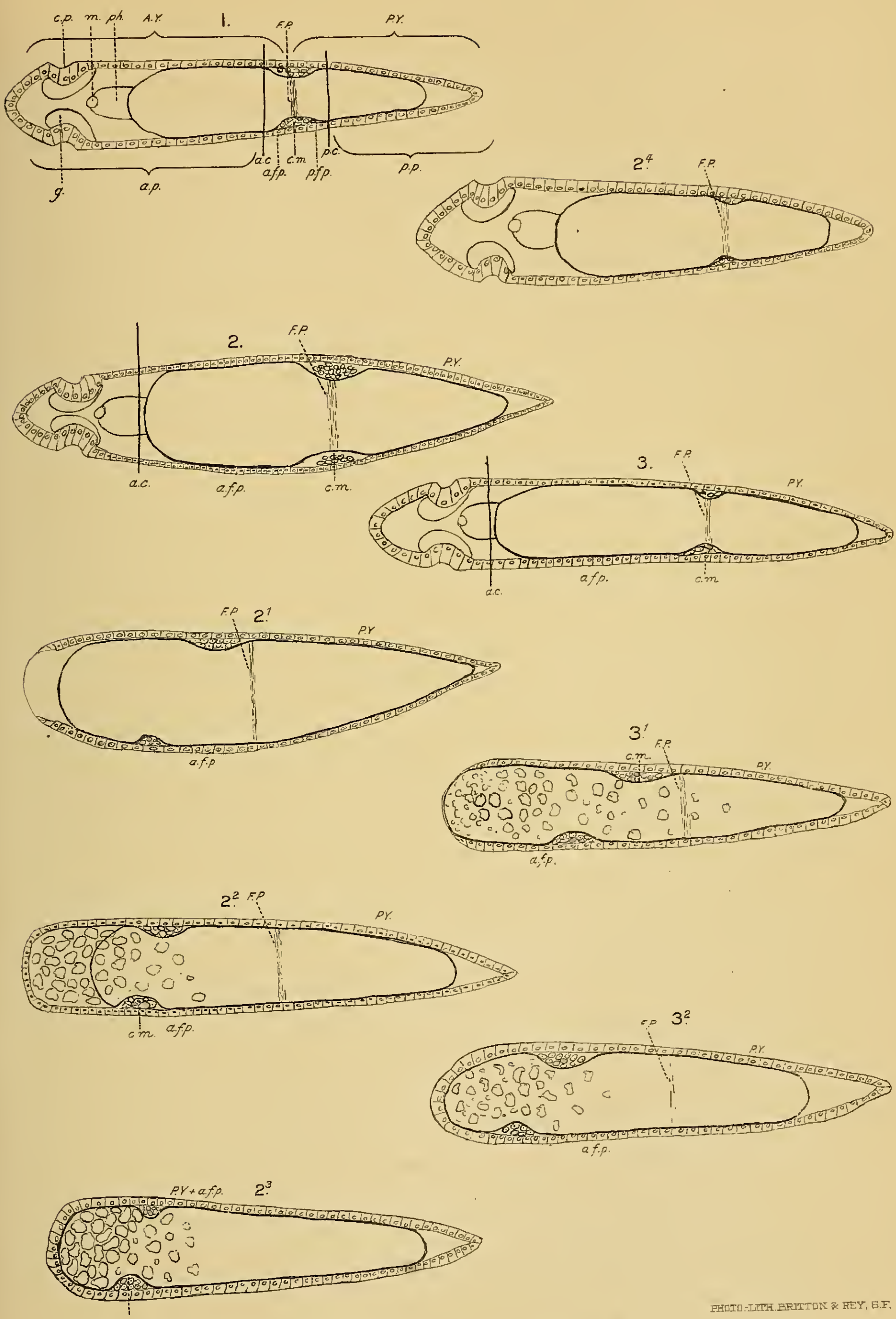
Fig. 1. Scheme of *Stenostoma* undergoing normal fission in the plane *F. P.* The several elements entering into the experimental treatment of the animal are here shown. For the abbreviations pertaining to these see page 367.

Figs. 2 to 2^4. A parent worm (2) and its derivative at various stages in its development, produced by the cut *a. c.* with the consequent inhibition of *F. P.* 2^4 is the fully formed young made up of *P. Y.* + *a. f. p.* and is beginning to develop *F. P.* for the second generation.

Figs. 3 to 3^2. Another series similar to 2, though not going through to the adult young. This series was selected as being a case in which the migration of the ganglionic cell-masses *(c. m.)* was particularly well shown.

The following abbreviations in addition to those given in the text are used:

c. m.., ganglionic cell-mass.
c. p., ciliated pits.
g., cerebral ganglia.
m., mouth.
ph., pharynx.



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STENOSTOMA FISSION

PROCEEDINGS

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THIRD SERIES

ZOOLOGY VOL. II, NO. 7

Description of Two New Genera of Fishes (Ereunias and Draciscus) from Japan

BY

DAVID STARR JORDAN AND JOHN OTTERBEIN SNYDER

WITH TWO PLATES

Issued April 24, 1901

SAN FRANCISCO
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1901

DESCRIPTION OF TWO NEW GENERA OF FISHES (EREUNIAS AND DRACISCUS) FROM JAPAN.

BY DAVID STARR JORDAN AND JOHN OTTERBEIN SNYDER.

PLATES XVIII AND XIX.

Ereunias (COTTIDÆ), gen. nov.

Body moderately elongate, tapering into a long and slender tail, the nuchal region elevated. Head large, not compressed or depressed. Eye very large. Preorbital broad. Mouth horizontal, lower jaw included, maxillary extending a little beyond anterior margin of pupil. Teeth in villiform bands on jaws, vomer, and palatines. Gill-openings wide, the gill-membranes broadly united, free from the isthmus. Gill-rakers short, club-shaped; a small oval slit behind last gill-arch. Suborbital stay distinct, covered by the rough skin. Nasal spines present; a stout spine before eye; a much larger one on upper rim of orbit; a divided spine at nape; two small ones on lower margin of preorbital; a large hooked spine at angle of preopercle; two smaller, sharp spines below the latter; a blunt spine on upper edge of opercle. Skin close set with velvety prickles. Lateral line distinct, armed with spines which are strong and curved anteriorly. Sides with two series of stout, curved spines, besides three series of smaller ones. Dorsal fins separate, of moderate height, with ten slender spines; rays, I, 12. Anal low, of twelve rays, opposite soft dorsal. Caudal small, truncate. Pectoral short, of eleven united rays, below which are four simple, free ones, similar to those of *Prionotus* and *Trigla*. Ventrals entirely wanting.

The relations of the genus are at once with Cottidæ and Triglidæ. We place it provisionally as a subfamily, Ereuniinæ, near *Triglops* in the Cottidæ. It is not unlikely that the absence of ventrals, and the singular form of the pectoral will demand for it a distinct family.

One species known (*Ereunias grallator*), from the shores of Japan.

 April 22, 1901.

Ereunias grallator, sp. nov.

PLATE XVIII.

Head, measured to end of opercular flap, $2\frac{2}{3}$ in length; depth $4\frac{3}{4}$; eye $3\frac{1}{3}$ in head; maxillary $2\frac{1}{2}$; D. X—I, 12; A. 12; P. 11+4; lateral line 42. Length of type 305 millimeters.

Body moderately elongate, tapering into a long, slender, quadrate, caudal peduncle, the length of which is contained $1\frac{1}{2}$ times in the head; its depth 6 in its length. Vent slightly in front of middle of body. Eye very large, placed high, its upper margin projecting above outline of head, its diameter about equal to length of snout, its upper part covered with rough skin. Mouth horizontal, the lower jaw included, the maxillary reaching slightly beyond line of front of pupil. Teeth villiform, on jaws, vomer, and palatines; those on palatines in a long narrow band. Gill-openings broadly united over the isthmus; a small oval slit behind last arch. Gill-rakers short, club-shaped, about 3+11 on first arch. Pseudobranchiæ large, of long filaments. Branchiostegals 6. Suborbital stay short, triangular.

Head and body covered with a velvety shagreen. Nasal spines short and sharp; upper rim of orbit with spines, the posterior of which is large and strong, its length contained about $4\frac{1}{2}$ times in eye; side of nape with a large double spine; some small spines on temporal region; opercular spine obscure; preopercle above with a curved spine, the length of which is contained about 6 times in eye; two sharp spines below the latter, the upper of which is the longer; two small spines on lower edge of preörbital. Maxillary rugose, without barbels. Sides of body with rows of slender hooked spines; the uppermost row extending from nape to tail; the second row, of smaller spines, along lateral line; the third, below the curved part of lateral line, coalescent with it on the straight part; the fourth row, of strong spines, beginning above vent and extending to base of caudal; a few spines below this, constituting a fifth row along base of anal. Lower edge of caudal peduncle with a long groove.

First dorsal low, of slender spines, the longest about 3 times in head. Dorsals separate, but close together, the longest soft ray $1\frac{3}{5}$ in head. Anal similar, its longest ray $3\frac{3}{5}$ in head. Caudal fin short, truncate, $2\frac{1}{2}$ in head. Pectoral fin of two parts: the upper of 11 rays, mostly branched, the longest ray $1\frac{3}{4}$ in head; lower part of fin of 4 separate, simple rays similar to the free appendages in Triglidæ; the uppermost longest, $1\frac{1}{3}$ in head; the lowermost shorter, $2\frac{1}{6}$ in head.

Color blackish, lining membranes of body dusky. Dorsals black, with a broad, whitish, median band which disappears posteriorly on the spinous dorsal and anteriorly on the soft dorsal; membrane posterior to last dorsal spine white. Anal black, with a broad, white, longitudinal band near its base. Caudal dusky at base, broadly suffused with blackish posteriorly, middle part whitish. Pectoral dusky, the upper, anterior part whitish, blotched with black; free rays black.

Of this very remarkable fish two specimens are known; they were taken in the Kuro Shiwo, or Black Current, at a depth of 290 fathoms off the coast of Misaki, Sagami

Province, Japan, by Professor Kakichi Mitsukuri. One of these specimens is in the Imperial University of Tokyo, the other was presented by Professor Mitsukuri to Stanford University, where it is registered as Type, No. 6432.

The specimen in the Imperial Museum has, according to our notes, a conspicuous barbel at the tip of the maxillary. No trace of such a barbel is to be found on the type.

Draciscus (AGONIDÆ), gen. nov.

Closely allied to *Podothecus*, from which it differs in the extraordinary size of its soft dorsal and anal fins. Type *Draciscus sachi* from northern Japan.

Draciscus sachi, sp. nov.

PLATE XIX.

Head $3\frac{1}{2}$ in length; depth $7\frac{1}{3}$; snout 2 in head; eye $4\frac{2}{3}$; D. VIII—14; A. 16; P. 15; spines in lateral line 44.

Body formed about as is usual in *Podothecus;* caudal peduncle long and slender, contained about 4 times in the length. Snout long and pointed; two spines on tip of snout above; two small, closely apposed spines behind middle of snout, at the end of its second third; ridge of mouth with a small double spine at its extremity; a stout spine above eye. Bones of sides of head with granular, radiating ridges. Tip of upper jaw and angles of mouth with clusters of barbels; their length equal to more than one-half the diameter of eye. Sides of body with 4 longitudinal rows of spinous plates, the spines stout, hooked; the upper row begins at nape and extends to base of second dorsal; the other 3 rows run from head to base of caudal. Plates on breast without spines.

First dorsal rather high; its first spine highest, contained about $2\frac{2}{5}$ times in head. Soft dorsal inordinately high; its middle rays longest, $2\frac{2}{3}$ in length. Anal still larger, a little higher and beginning farther forward, the highest rays behind the middle; its height about $2\frac{2}{3}$ in length; pectorals rather long, $4\frac{4}{5}$ in body; some of the lower rays produced and with free tips. Ventrals short, $3\frac{2}{5}$ in head.

Color brownish, with some dark blotches on back. Vertical fins dusky, becoming black on distal portion, each fin with irregular rows of round, white spots in the dark marginal areas. Pectorals pale, with a dusky blotch at base. Ventrals pale.

Type, a single dried specimen 240 millimeters long, presented to the Museum of Stanford University by Mr. Sotaro Saito, Director of the Museum of Aomori, Japan. It is

Type, No. 6431 on the Stanford Museum register. It was taken in the Bay of Aomori, where the species is locally known as Sachi.[1]

No specimens were taken by us in Japan, but other dried specimens were seen, the expanded fins rendering it one of the local curiosities. One of these, 385 millimeters long, in the Imperial Museum of Japan, numbered 817, from Hokkaido, agrees closely with the type specimen. (D. VIII–13; A. 15; P. 16; scales 40.) Another from Hokkaido differs slightly in markings of the fins. In the museum of Hakodate is a specimen from Kayabe, called by the local name of "Tokuhira," meaning, perhaps, "melting flake." There is also another specimen in the Museum of Aomori from Aomori Bay.

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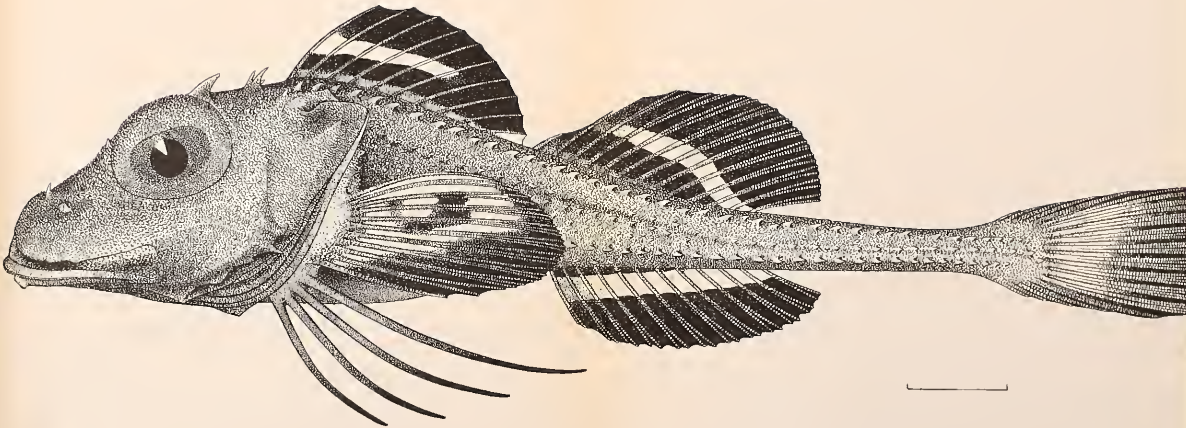
[1] *Blepsias cirrhosus* is called Sachiko, that is child of the Sachi. Sachi in Japanese means good fortune.



…S. STARKS DEL.

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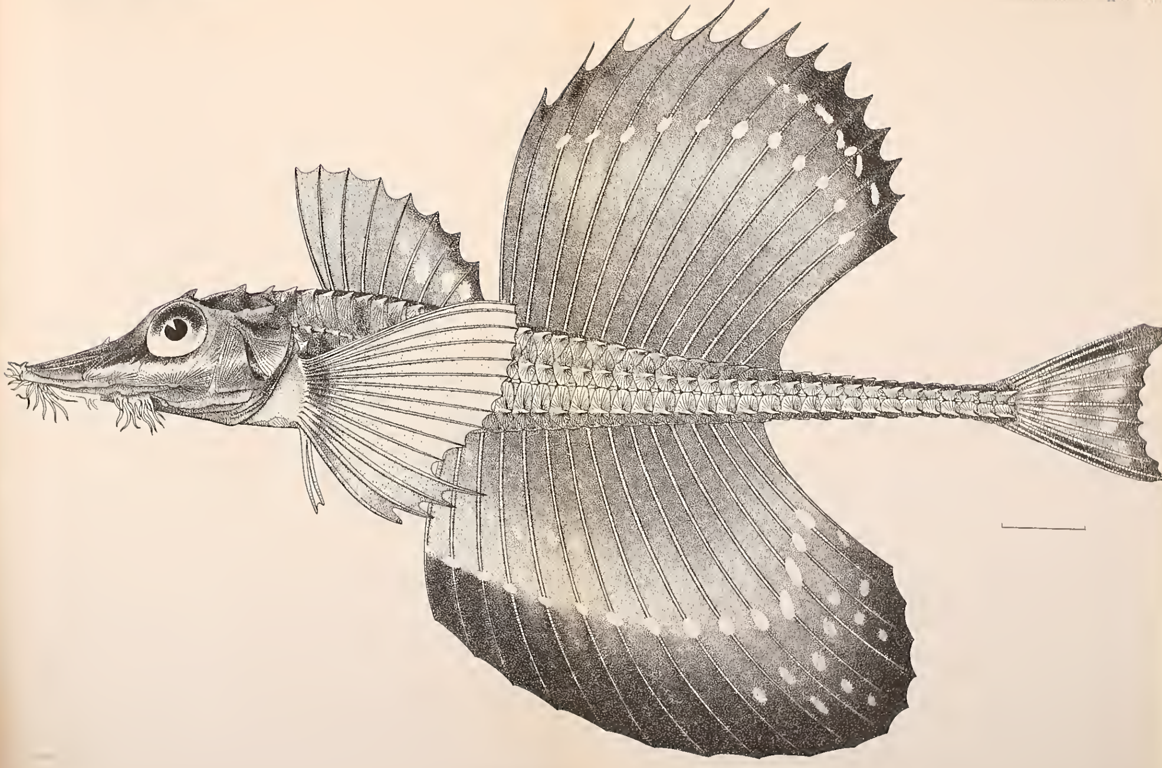

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Description of Three New Species of Fishes from Japan

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DESCRIPTION OF THREE NEW SPECIES OF FISHES FROM JAPAN.

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PLATES XX AND XXI.

Snyderina (SCORPÆNIDÆ), gen. nov.

Body robust, compressed, sparsely covered with non-imbricate, thickened or granular scales. Head naked, ridged, without cranial spines. Profile angulated in front of eye; preorbital with a long sharp spine. Preopercle with a long sharp spine above and four smaller ones. Teeth villiform, in bands on jaws and vomer; palatines toothless. Gill-membranes narrowly united and narrowly connected with the isthmus. No slit behind fourth gill. Branchiostegals seven. Lateral line present. Dorsal continuous, with about thirteen spines and ten rays. Anal with three spines. First dorsal spine short, inserted above middle of eye; last dorsal ray adnate to caudal peduncle. Ventral rays I, 5. Pectoral without free ray. Caudal rounded. Fins all scaleless.

This genus is named for Mr. John Otterbein Snyder, in recognition of his studies of Japanese fishes. It is allied to *Cocotropus* Kaup.

The single known species is *Snyderina yamanokami*.

Snyderina yamanokami, sp. nov.

PLATE XX.

Head 2.6 in body; depth 2.7; eye 4 in head; maxillary 2.5. Dorsal XIII, 10; anal III, 5. Pores of lateral line 21.

Body compressed, the back elevated anteriorly, deepest over posterior part of head, tapering to a rather small caudal peduncle.

Head with many spines and ridges, the ridges smooth and covered with thin skin. Profile very steep from first dorsal spine to snout, which latter projects at a sharp angle and is less nearly vertical. Mouth very oblique, the lower jaw slightly projecting. Maxillary broad at the posterior end, transversely concave. Teeth finely villiform, in bands on jaws and vomer; palatines toothless. Width of interorbital space about two-thirds diameter of eye. Two nearly parallel high sharp ridges run from first dorsal spine to

 April 22, 1901.

snout. A ridge around anterior margin of eye runs backwards to beneath base of third dorsal spine; it has a depression above middle of eye and another above posterior part of eye. Superior margin of eye with a ridge which is scarcely continuous with that of anterior margin. From behind eye, about on a level with superior margin of pupil, a broken horizontal ridge extends backwards above gill-opening nearly to tip of opercular flap. Suborbital stay with a sharp, smooth ridge extending back and joining at right angles a ridge that follows around margin of preopercle. From the latter and below its junction with suborbital ridge the preopercle sends a ridge backwards which ends in a sharp spine. Preorbital with a short spine anteriorly projecting transversely to maxillary; a long sharp spine follows upper contour of maxillary and is as long as half the diameter of eye. Gill-rakers short, blunt, uneven; about 4+8 in number.

Entire head, a space on back below dorsal, breast, and a space behind base of pectoral, naked. Sides of body covered with small granulations which are somewhat thickened towards their posterior margins but are not spiniferous.

Dorsal without a notch between the spinous and rayed portions. The first spine not longer than eye (its tip broken), its base above middle of eye. The second spine over twice as long as the first; the fifth equal to distance from eye to tip of opercular flap. The middle rays of soft dorsal longest; their length equal to the distance from tip of snout to preopercular ridge; the posterior margin of the fin straight, forming an angle slightly less than a right angle with the superior margin. The last ray is adnate to the caudal peduncle for its whole length, the membrane not quite reaching to base of caudal.

The anal spines are graduated; the first scarcely as long as diameter of eye, the third twice the length of the first. When the fin is depressed the tips of the middle rays reach the base of the caudal. The last ray is adnate to the caudal peduncle for about half its length. When ventral fins are depressed the longest ray reaches to the base of the first anal spine, while the tip of the ventral spine falls short of it a distance equal to the diameter of the eye. Pectoral angulated, the sixth and seventh rays longest, reaching to above the first anal ray. Caudal fin narrow and elongate, with the posterior margin rounded; its length 1¼ in head.

Color (from a specimen long in spirits) slaty white with brownish markings. Membrane of spinous dorsal clouded with brownish; some of the spines with a small, dark spot in front of them. All of the other fins with vermiculated markings transversely across the rays. A large dark brown spot behind upper part of gill-opening and a smaller one on lateral line below base of last dorsal spines. Eye with traces of lines radiating from the center.

The type is a single specimen (No. 6433 on the Stanford Museum Register) in good condition, 217 mm. long, presented to Stanford University by Professor Mitsukuri of the Imperial University of Tokyo. It is said to be from Kagoshima in Kiusiu, and to bear the local name of Yama-no-kami, or Mountain Goddess, in local mythology a woman with wings, capable of starting a storm.

Dimensions.

	mm.	Hundredths of length without caudal.
Entire length	217	
Length without caudal	163	
Head		.40
Depth		.37
Eye		.10
Maxillary		.16
Snout		.10
Depth of caudal peduncle		.08
Length of pectoral		.37
Length of fifth dorsal spine		.20
Length of longest dorsal rays		.22
Length of longest anal rays		.24
Length of ventrals		.27
Distance from base of last anal ray to base of caudal		.20

Pomacentrus cœlestis, sp. nov.

PLATE XXI.

Head 3.5 in body; depth 2.8; eye 3.1 in head; maxillary 3.2; interorbital 4, equal to snout. Dorsal XIII, 14; anal II, 14; scales 2½—25—9.

Body regularly ovate-oblong, the anterior dorsal profile more convex than ventral. Interorbital space convex. Tip of snout on a level with lower margin of eye. Mouth small, slightly oblique, the jaws about equal; maxillary reaching to below anterior edge of pupil; teeth in a single row in jaws, conical, rather blunt. Preorbital entire. Preopercle sharply denticulated.

Dorsal without a notch between the spinous and rayed portions. The rays and spines are evenly graduated from the first spine to the eighth or ninth soft ray. The last spine is about twice the length of the first, while the ninth ray is about three times. The rays thence rapidly shorten, leaving the longest rays projecting beyond the tip of the last ray a distance nearly equal to the latter's length, and reaching past base of caudal rays. Anal similar to dorsal and about of the same height; its base and tips of longest rays ending slightly anterior to those of dorsal. Pectoral shorter than head by about half the eye's diameter; its tip reaching to within a scale and a half above origin of anal. The first ray of ventral filamentous; its tip just reaching to anal. Lobes of caudal pointed, the upper lobe the longer.

Snout, lower jaw, interorbital ring, and edge of preopercle naked. Cheeks with two rows of scales. Scales on top of head extending forward to above anterior edge of pupil. A row of scales between each ray and spine of anal, dorsal, and caudal. Lateral line on sixteen scales, stopping under base of last dorsal spine.

Color in alcohol: back above lower edge of pectoral cobalt blue with a vertical dark line at the base of each scale, which extending under the transparent edge of each preceding scale shows through it, the color below fading into a purplish brown with a faint blue spot on each scale; dorsal and anal blackish, darker anteriorly; ventrals light, the outer edges dusky; pectorals and caudal yellowish, a black band across base of pectoral rays; edges of caudal and tips of rays dusky.

Dimensions.

Length without caudal in millimeters	58
Head in hundredths of length	27
Depth	35
Eye	9
Distance from snout to dorsal	34
Depth of caudal peduncle	13
Length of pectoral	26
Length of ventral	25
Length of caudal	33
Greatest height of dorsal	21
Greatest height of anal	21
Number of dorsal rays	XIII, 14
Number of anal rays	II, 14
Scales	2½—25—9

This strongly marked species is described from a single specimen collected by Jordan and Snyder at Wakanoura, in Kii, Japan. It is numbered 6434 in the collection of Stanford University. It differs from almost all other species of *Pomacentrus* in the elongation of the body.

Heptranchias deani, sp. nov.

The shark occasionally taken on the coast of Japan, and hitherto recorded as *Notidanus indicus*, or better *Heptranchias indicus*, is distinct from the latter species which belongs to the East Indies and is not known either from Japan or from California.

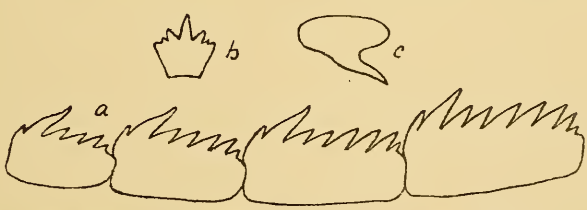
Head narrow, as broad as deep; snout rather short, sharply pointed in profile, narrowly rounded when viewed from above, its length from mouth contained once and a half in cleft of mouth. Nostrils a little nearer mouth than tip of snout. Mouth rather pointed or very narrowly rounded in front, the width across lower jaw at base of cleft of mouth slightly less than length of cleft of mouth. Upper teeth without lateral cusps, sharp and slender, and hooked backwards at an angle from their base. Four teeth on each side of lower jaw and a single tooth at tip of jaw, the cusps of each tooth on a level forming a serrated cutting edge; the median tooth with a median enlarged cusp and two or three small cusps on each side of it; the lateral teeth with the first and last cusps very small, the second large and the succeeding ones except the last subequal and half the size of the second. The following is the formula of cusps, the addition marks separating sizes: 1+1+3+1; 1+1+4+1; 1+1+5+1; 1+1+6+1. Eye very large, the width across iris nearly half the length of snout.

Dorsal with the anterior oblique edge a little longer than its base—the fin inserted before anal a distance equal to the anterior margin of the anal. Height of anal scarcely more than half that of dorsal; its base equal to base of dorsal. Ventrals long and low, but a little higher than anal, their anterior oblique edges contained twice and a fourth in their base. The anterior edge of pectoral is contained about once and a half in head. Lower lobe of caudal is contained four and one-fourth times in upper lobe.

The color in life is plain brown, paler below. In a photograph in the Imperial University a few whitish spots are shown.

Comparing an adult female specimen of *Heptranchias deani* from Misaki with the excellent figure of *Heptranchias indicus* given by Macdonald and Barron of a specimen from Bass Straits, the following differences are apparent.

The snout in the Japanese species is longer and more pointed. The gill-openings rise much higher, their upper edge on the level of the spiracle. The more marked difference lies in the teeth. As figured by Macdonald and Barron, the teeth are different in the two sexes, the central tooth above only being alike in the two. In the male of *Heptranchias indicus* the denticles diverge from an axial line, or principal fang, in each lower tooth, the upper teeth having two denticles at base of the central point. In the female the principal fang and all the denticles in the lower teeth diverge from the central line of the whole jaw.



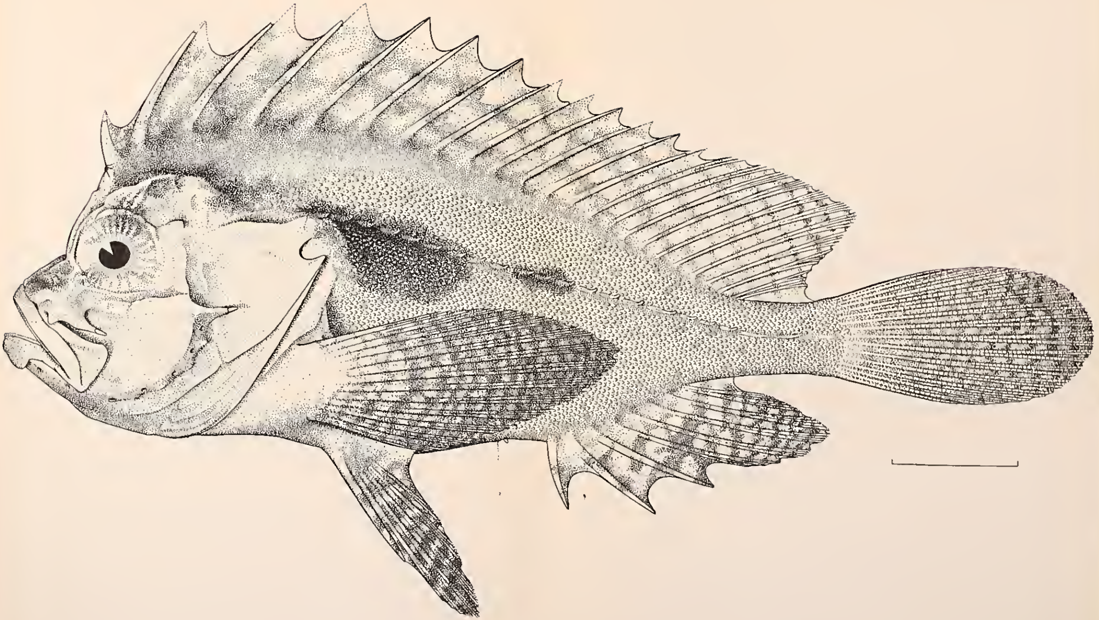
Heptranchias deani, sp. nov.—*a*, lower teeth; *b*, lower median tooth; *c*, upper tooth.

In the upper teeth there is but one denticle, at the base of the larger one; these teeth are nearly erect. In other words, the upper teeth in the male have the denticles arranged above, 1+1+1, the median largest; the lower, 3+6, the third and fourth largest. In the female, the upper teeth are 1+1, the second denticle largest, the lower, about six, all turned the same way, the second rather largest, the others on a slanting base and progressively decreasing.

In *Heptranchias deani*, the lower teeth in the female have the cusps placed nearly on a level, subequal in size, except the second, which is much higher than any of the others. The upper teeth are much more oblique than in *Heptranchias indicus*.

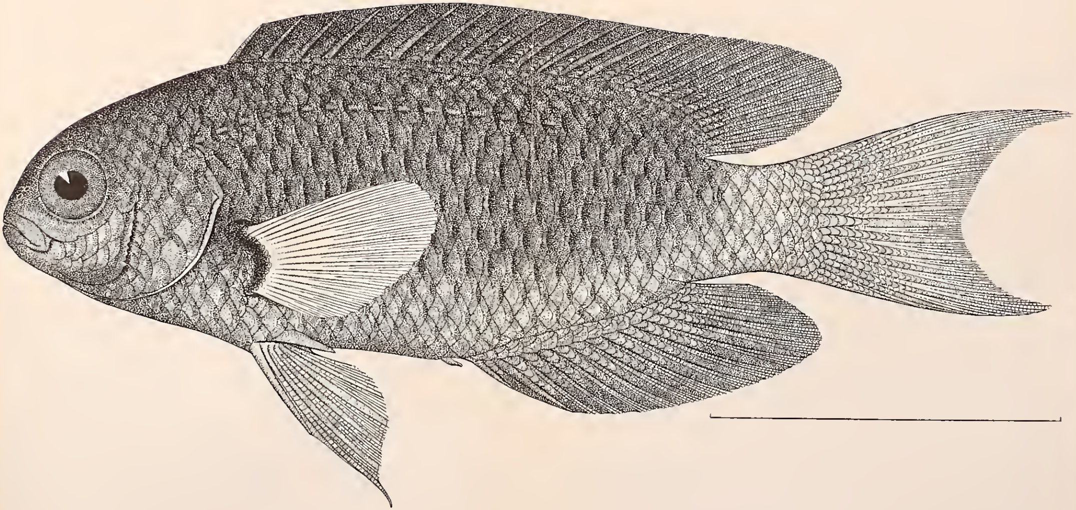
This species is known to us from an adult female (No. 12620, Stanford University Museum) taken at Misaki by Kumakichi Aoki with hook and line in deep water. It was studied at the time by Dr. Bashford Dean and the senior writer. We take great pleasure in naming the species for that accomplished student of Selachology.

STANFORD UNIVERSITY,
March 10, 1901.



SNYDERINA YAMANOKAMI, GEN. ET SP. NOV.

PHOTO LITH BRITTON & REY, S.F.



C. L. STARKS

POMACENTRUS CŒLESTIS, SP. NOV.

PHOTO-LITH BRITTON & REY, S.F.

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

THIRD SERIES

ZOOLOGY VOL. II, No. 9

Notes on Cerococcus

BY

ROSE W. PATTERSON

WITH THREE PLATES

Issued May 24, 1901

SAN FRANCISCO
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1901

NOTES ON CEROCOCCUS.

BY ROSE W. PATTERSON.

Plates XXII–XXIV.

Among the most injurious insects found upon the oaks west of the Rocky Mountains are those scale insects belonging to the genus *Cerococcus*. But three species of this genus have thus far been observed and described: viz., *Cerococcus quercus* Comst.[1], *C. ehrhorni* Ckll.[2], and *C. corticis* Town.[3]

The published accounts of these interesting coccids are limited to brief descriptions of the adult females. In each species the female lives within a case formed of waxy secretion. She is apodous, has single-jointed antennæ bearing stiff spines, and the terminal segment of her abdomen is prolonged into two lobes. Spinnerets of two kinds, single and double, occur. The mentum is two-segmented. Practically nothing descriptive of the immature stages or of the general biology of the insects has been published. As two of the species are common on the oaks of California, I have had opportunity to observe something of the life-history of these two forms, and the following notes include the results of this study. This paper was prepared in the Entomological Laboratory of Stanford University, under the direction of Professor V. L. Kellogg.

Cerococcus ehrhorni *Ckll.*

Plate XXII, Figs. 1–9; Plate XXIV, *A*.

This species was first found on the live-oaks in the vicinity of Mountain View, California by Mr. E. M. Ehrhorn, and was described by Professor T. D. A. Cockerell in

[1] U. S. Agric. Report 1881–1882, pp. 213, 214.
[2] "Psyche," Vol. VII, 1895, p. 255.
[3] Journal N. Y. Entom. Soc., Vol. VI, 1898, p. 170.

May 4, 1901.

"Psyche".[1] It probably occurs in all the comparatively moist regions of California west of the inner Coast Range; but the limits of its distribution have not been ascertained. In the Santa Clara Valley, it is found in abundance on *Quercus agrifolia*, the live-oak, and has been observed on a few scattered white-oaks, also. The insects seem to prefer the more sheltered parts of the tree and are most plentiful on the under sides of the branches, although they are also found hidden in the cracks of the rough bark on the trunk. Those on the branches are usually covered with a white fungus[2], while on the trunk they are free from it. The scale secretes a thin pellicle of white waxy material, ellipsoidal in form. The insects themselves are bright crimson and may be seen through their semitransparent coverings, often lying in close proximity to each other.

First Stage (fig. 1).—The insects are viviparous and the young begin to appear about the last of January or the first of February. In the first stage, they are about .21 mm. long, elliptical in outline, and distinctly segmented. The tip of the abdomen bears two lobes, each terminating in a long filament and bearing a pair of spiny hairs on its inner margin. The anal opening is between these lobes and is surrounded by four spines. Legs are present, and the tarsi are each furnished with four knobbed digitules (fig. 2). In these respects, the insect resembles *Dactylopius*. The antennæ (fig. 3) are composed of five segments including the basal joint, the first four being about equal in length, and the last twice as long as one of the others. There are two longitudinal rows of double pits on the dorsal surface of the abdomen, a pair in each segment about as far apart as they are distant from the lateral margins of the body. The insect is very active during this stage.

Second Stage (fig. 4).—With the first moult, important changes take place in the insect. Its legs disappear, and it begins to form its waxy case. Its many-jointed antennæ

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[1] June, 1895.

[2] This white fungus completely covers and protects the enclosed scales, and undoubtedly lives in a sort of symbiotic relation with the insect. The fungus derives food (honey dew) from the scale, while the scale gains an effective protective covering.

are replaced by minute non-segmented ones scarcely longer than wide and truncate at the tip; spines take the place of the long caudal filaments. Spiracles also appear; and the double pits are increased in number and scattered irregularly over the surface of the body. The insect has increased in length from .21 mm. to .354 mm., and the segments of its body are less distinct than in the first stage.

Adult Female. — Although there may be changes in structure between the second and the last stages, they have not been observed. The adult female (fig. 5) is from .75 to 1. mm. in length, regular in outline, and balloon-shaped. The terminal segment of the body is the only one that is plainly distinguished from the others. It is strongly chitinized and ends in two prominent points or lobes. Each lobe has a stout spine near its tip and bears several short ones on its inner margin. Both dorsal and ventral surfaces of the insect are covered with irregularly arranged pits, single and double. The latter, which have hairs growing from them, are not so numerous as the former. The antennæ (fig. 6) are small, unsegmented, and truncate at the tip. I have found only four comparatively long bristles and several short ones, although it has been stated by one author in a previous account that there are five. On the ventral side of the insect are two pairs of large spiracles (fig. 7), near each of which is a group of spinnerets, varying in number from two or three in the second stage to from eight to twelve in the adult.

Cerococcus quercus *Comst.*

PLATE XXII, FIGS. 10–15; PLATE XXIII, FIGS. 16–22; PLATE XXIV, *B.*

Cerococcus quercus is a large Coccid abundant on the oaks of Arizona and southern California. According to Professor Comstock, it is found on *Quercus oblongifolia*, *Q. undulata*, var. *wrightii*, and probably on *Q. agrifolia*.[1] The insects secrete thick coverings of bright yellow wax

[1] U. S. Agric. Report 1881–1882, p. 213.

and are thus very noticeable on the tree, especially when they are massed together, as is usually the case. Dr. Howard, who became interested in the wax produced by this insect, had it analyzed and expressed the opinion, as Professor Comstock had done before, that the product might be of practical value, the supply being very great.[1]

First Stage.—In the laboratory, the young insects (fig. 10) began to hatch in February and continued to do so until the middle of May, emerging through the opening in the posterior end of the waxen case of the mother. As food was not at hand, they ran about in a lively way; but when placed upon the tree, selected a suitable spot and inserted the beak. From this time on they appeared to be inactive, and it was found that they had begun to secrete their coverings. The wax seemed to come from the double pits and stood out from the body of the insect in transparent rods, giving it a spiny appearance. In the first stage, the insect is about .5 mm. long, elliptical in outline, and distinctly segmented. The caudal segment (fig. 11) terminates in two prominent lobes with long filaments, as in *C. ehrhorni*, and bears at least four pairs of comparatively short spines. Eight spines surround the anal opening. The legs of this species (fig. 12) are long compared with those of *C. ehrhorni*, and the tarsi each bear four knobbed digitules. The antennæ (fig. 13) are six-jointed, counting the basal segment, the third being about as long as the first and second combined, the rest approximately equal in length. The dorsal surface of the body has large double pits arranged in six longitudinal rows about equidistant from each other; no single pits occur.

Intermediate Stage.—As the second stage of the insect is not to be found in the material at hand, it is necessary to pass to a later stage. Here the insect (fig. 14) is subovate, about 1.4 mm. long, and the abdomen is distinctly segmented. The long filaments at the end of the body have disappeared and short spines take their place. In the

[1] U. S. Dept. Agric., Div. Ent., Bull. 9, New Series, p. 39.

original description, it was incorrectly stated that the insect has no antennæ. These organs (fig. 16) are minute and unsegmented, irregularly cone-shaped and truncate at the tip, bearing several long stiff bristles and a number of short ones. In this stage the insect has remarkably large tracheal tubes which may be seen plainly when the specimen has been boiled in K O H. The spiracles, also, are easily seen. Double pits connected with large glands are scattered irregularly over the dorsal surface of the body, and single pits are very numerous in certain regions. Large groups of the latter extend from the margin of the body to each of the spiracles, and in each of the five segments next to the last a distinct band of single pits extends across the body. The last segment has a small group near the base of each terminal lobe.

The sac of the insect (fig. 17) at this stage is not so convex as that of the adult and is somewhat like an air-cushion in form. The larval skin, which is orange-colored, is imbedded in the wax at the center of the dorsal surface; and the secretion forms two rings about it. Slightly dorsad of the posterior end of the case is a tubercle in which is an opening.

Adult Female.—The adult female is elliptical in outline and more or less distinctly segmented. The terminal segment is not strongly chitinized, and the caudal lobes, which are not so prominent as those of *C. ehrhorni*, each bear a long bristle and several short ones. Double pits in large numbers are scattered over the surface of the body, but single pits do not appear to be numerous as in the intermediate stage just described. The antennæ are similar to those of the preceding stage (fig. 16). The sac of the fully developed female (fig. 18) is about 6 mm. long and 5 mm. wide. It is irregularly elliptical in outline, very convex above, and somewhat flattened below. The larval skin is slightly cephalad of the center of the dorsal surface, and along the lateral margins are a number of little projections, probably corresponding to the segments of the body. The wax forms a smooth sheet, as if the filaments which compose it had melted and run together. When the eggs are laid, the body of the female shrinks away and is pushed to one side, the space within the waxen case being closely packed with eggs.

Male.—One specimen, only, of the male (fig. 19) was obtained. It was found within its cocoon (fig. 20) in some material that had been killed with cyanide and was imperfect. From the cephalic to the caudal extremity, the insect measures about 1.3 mm. The head, thorax and abdomen, though closely connected, are easily distinguished. The head, which appears to be nearly globular in form, is pointed in front. One pair of large eyes was observed on the dorsal side in close proximity to the bases of the antennæ. Though others may occur, they were not distinguished. The antennæ are ten-jointed and are attached to the dorsal surface of the head very near its cephalic extremity. The first joint is short and about as wide as it is long, the second is large and club-shaped, the third is the longest, and the remaining joints are about equal in length, each being about two-thirds the length of the third joint. The antennæ are covered rather densely with hairs, and the last joint bears two pair of knobbed digitules attached near its tip.

The thorax is large, subquadrate in form, with rounded angles, and nearly as wide as it is long. The wings, which are attached to the lateral margins of the thorax, are thin and delicate and more or less evenly covered with short hairs. Balancers were not observed. The legs (fig. 21) are more slender than those of the female and covered, not very densely, with hairs. They resemble each other in form, and the tarsi each bear four knobbed digitules.

The abdomen is slightly wider than the thorax and about twice the length of the latter. It is composed of nine segments, the first of which is wider than the others. Those from the second to the eighth inclusive are similar in form, but increase in size to the fourth, then decrease. The ninth (fig. 22) is modified in form, and from it projects the penis.

Cerococcus corticis *Town.*

PLATE XXIII, FIGS. 23–28.

Cerococcus corticis was discovered by Mr. Koebele, in 1897, on *Quercus engelmanni*, in Nogales, Sonora. It is between the two species described above in size and shape, but resembles the former in being bright crimson and in having conspicuous spiracles. A black fungus follows this scale, rendering it less noticeable than it would otherwise be. The covering of the insect is of white wax and is not smooth on the surface, but is covered with fine filaments which give it a cottony appearance. But two stages in the development of this species were observed—the first stage and the adult female.

First Stage.—Like *C. ehrhorni*, these insects are viviparous. The young (fig. 23) are similar to those of the two species described above, being elliptical in outline, distinctly segmented, and having two caudal lobes. The latter, however, bear stiff hairs (fig. 24) instead of long filaments. As with *C. quercus*, the legs (fig. 25) are long, and each is furnished with four knobbed digitules. The antennæ (fig. 26) are six-jointed like those of the last named species, but are different from them in form. The first, second, fourth, and fifth joints are nearly equal in length, the third is slightly longer than the first, and the last about twice as long as the first.

Adult Female.—The adult female (fig. 27) is similar in outline to the intermediate stage of *C. quercus*. The terminal segment of the body, though strongly chitinized, is not so prominent as that of *C. ehrhorni*. The antennæ (fig. 28) are very small, unsegmented, about as broad as long, and truncate at the tip, with eight bristles.

EXPLANATION OF PLATE XXII.

Cerococcus ehrhorni Ckll.

Fig. 1. First larval stage of female; *a*, double pits.
Fig. 2. Leg of first larval stage of female.
Fig. 3. Antenna of first larval stage of female.
Fig. 4. Second stage of female; *a*, antenna; *b*, spiracle.
Fig. 5. Adult female; *a*, antenna; *b*, spiracle; *c*, mouth-parts; *d*, fungus filaments.
Fig. 6. Antenna of adult female.
Fig. 7. Spiracle of adult female.
Fig. 8. Fungus filaments.
Fig. 9. Mouth-parts of adult female.

Cerococcus quercus Comst.

Fig. 10. First larval stage of female.
Fig. 11. Caudal segment of first larval stage of female; *a*, double pits.
Fig. 12. Leg of first larval stage of female.
Fig. 13. Antenna of first larval stage of female.
Fig. 14. Intermediate stage of female; *a*, antenna; *b*, mouth-parts; *c*, spiracle; *d*, tracheal tube.
Fig. 15. Mouth-parts of intermediate stage of female.

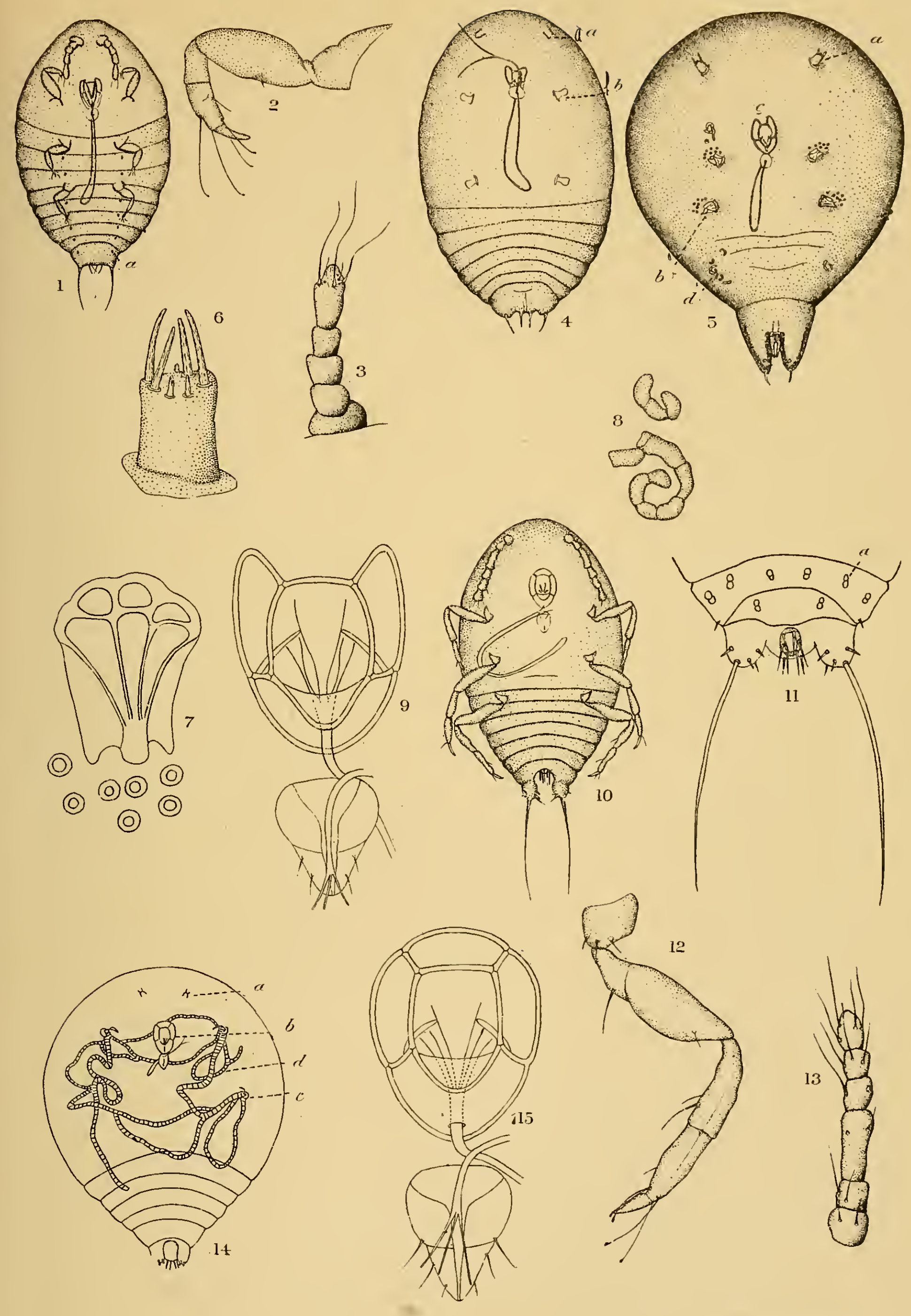

PHOTO-LITH BRITTON & REY, S.F.

FIG'S. 1-9. CEROCOCCUS EHRHORNI *CKLL.*
FIG'S. 10-15. CEROCOCCUS QUERCUS *COMST.*

EXPLANATION OF PLATE XXIII.

Cerococcus quercus COMST.

Fig. 16. Antenna of intermediate stage of female.
Fig. 17. Sac of intermediate stage of female; *a*, larval skin; *b*, opening in tubercle.
Fig. 18. Sac of adult female; *a*, larval skin; *b*, opening in tubercle.
Fig. 19. Adult male.
Fig. 20. Cocoon of male.
Fig. 21. Leg of adult male.
Fig. 22. Last abdominal segment of adult male.

Cerococcus corticis TOWN.

Fig. 23. First larval stage of female.
Fig. 24. Tip of abdomen of first larval stage of female.
Fig. 25. Leg of first larval stage of female.
Fig. 26. Antenna of first larval stage of female.
Fig. 27. Adult female; *a*, antenna.
Fig. 28. Antenna of adult female.

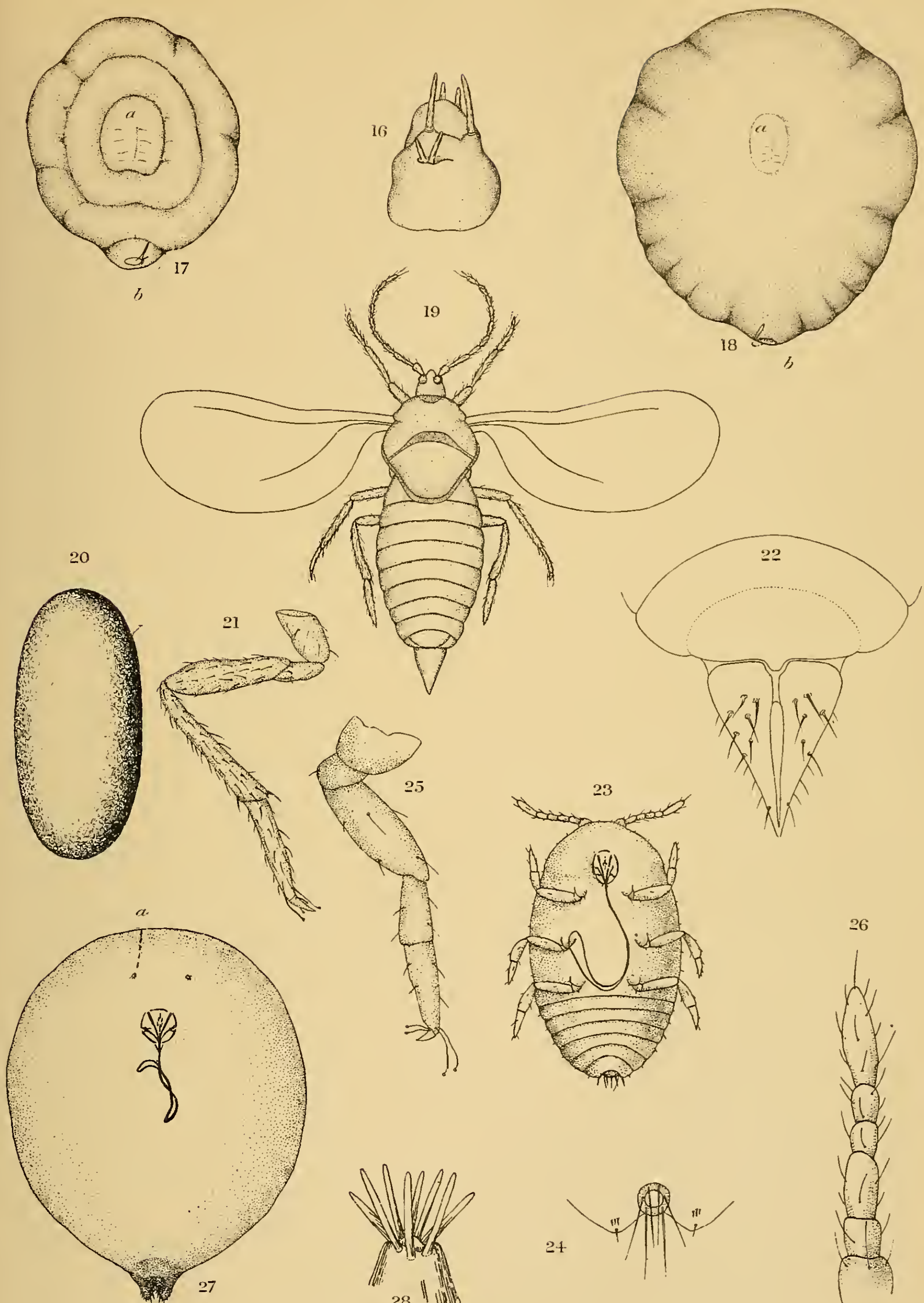

PHOTO-LITH. BRITTON & REY, S.F.

FIG'S. 16-22. CEROCOCCUS QUERCUS *COMST.*
FIG'S. 23-28. CEROCOCCUS CORTICIS *TOWN.*

EXPLANATION OF PLATE XXIV.

A. *Cerococcus ehrhorni* Ckll., from photograph.
B. *Cerococcus quercus* Comst., from photograph.

A. Cerococcus ehrhorni *Ckll.*

B. Cerococcus quercus *Comst.*

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

THIRD SERIES

ZOOLOGY VOL. II, No. 10

Notes On New and Little Known Californian Coccidæ

BY

S. I. KUWANA

WITH TWO PLATES

Issued May 28, 1901

SAN FRANCISCO
PUBLISHED BY THE ACADEMY
1901

NOTES ON NEW AND LITTLE KNOWN CALIFORNIAN COCCIDÆ.

BY S. I. KUWANA.

PLATES XXV AND XXVI.

INTRODUCTION.

THE present paper is made up of descriptions of three new species of Coccidæ, or scale insects, from California, with some notes on a little known form. The writer's thanks are due Professor T. D. A. Cockerell, for his courtesy in examining specimens, and for his assistance in their determination.

This paper was prepared in the Entomological Laboratory of Stanford University, under the direction of Professor V. L. Kellogg.

DESCRIPTION OF NEW SPECIES.

Eriococcus artemisiæ, sp. nov.

PLATE XXV, FIGS. 1–10.

Adult Female.—Enclosed in a broad oval sac about 3 to 5 mm. long and 2 to 3 mm. broad; snow-white, more or less woolly, and uniform in texture. (The sacs vary more or less in shape and size; some are somewhat pointed at one end, while others are perfectly round, etc.)

Body oval in form, very plump, 4 mm. long, 2.5 mm. wide; color black, legs and antennæ pale brown. Antennæ seven-segmented, each segment with a few spiny hairs; seventh segment longest, other segments variable. I have observed the following variations in lengths of segments:

$$\left.\begin{array}{r} 7\ (6,\ 2,\ 3,\ 1)\ 4,\ 5 \\ 7,\ 3\ (2,\ 6)\ 4,\ 5,\ 1 \end{array}\right\}\ \text{one specimen.}$$

$$\left.\begin{array}{r} 7\ (2,\ 4)\ 1,\ 6\ (5,\ 3) \\ 7\ (6,\ 4,\ 2)\ (1,\ 3,\ 5) \end{array}\right\}\ \text{one specimen.}$$

$$\left.\begin{array}{l} (6,\ 3)\ 1,\ 2,\ 5,\ 4 \\ 7\ (1,\ 3)\ 6,\ 2\ (4,\ 5) \end{array}\right\}\ \text{one specimen.}$$

May 20, 1901.

Legs, comparatively small; coxa very stout, very much wider than long; trochanter of the usual triangular shape; femur very much narrower than the coxa and longer than tarsus; tibia about two-thirds as long as the tarsus; claw stout and curved; both tarsus and claw with long filiform digitules. Dorsal surface with prominent capitate spines; ventral, with spiny hairs. Anal ring large, with six long hairs; posterior extremity with a single long bristle on each side of the anal ring.

Adult Male.—Wing expanse about 2 mm.; length of body 1.2 mm.; color reddish purple; antennæ and legs yellowish brown, eyes dark purple, wings slightly dusky. Body long and slender. Head rather small, wider than long. Three pairs of eyes, one pair on each dorsal and ventral surface, the third pair, which are small and transparent, on the side. Antennæ nine-segmented, each segment with many spiny hairs; first and second segments stoutest, third longest, the rest subequal, ninth segment with six long knobbed hairs. Prothorax very small, mesothorax largest, metathorax as wide as mesothorax but very much shorter. Legs slender and more or less hairy; only two tarsal digitules are to be seen. (If there are any on the claw they could not be found.) On each side of eighth abdominal segment are three long hairs supporting a long white waxy filament.

Larva.—A full grown male larva taken out from the cocoon is elliptical in form, and slightly reddish black in color; antennæ and legs, yellowish brown, about 2 mm. long and 1 mm. wide. Antennæ six-segmented, stout, each segment with a few spiny hairs; sixth segment longest, third next to the longest,—formula 6, 3, 2, 1 (4, 5). Legs stout; tarsus and tibia almost equal in length. No capitate hairs on dorsal aspect.

Egg.—Broadly elliptical, .38 mm. long, .3 mm. wide, purple in color, and smooth.

Habitat.—Found on sage-brush (*Artemisia* sp.), in the foot-hills of the Sierra Morena, Stanford University. Collected by the author March 24, 1900.

Cocoons of male and female sacs are found at the base on the trunks of the shrubs, where they are covered by decaying leaves or sheltered by other substances. The specimens first collected were all males, but several weeks later the female sacs were also found. The adult males came out about the middle of April, in the laboratory; they were badly infested by the larvæ of a species of ladybird. While trying to rear adult males and eggs from male cocoons and egg-sacs, my specimens were all devoured by these coccinellid larvæ.

Ripersia festucæ, sp. nov.

Plate XXV, Figs. 11–16.

Adult Female.—Elongate-elliptical in form, covered with white powder; sac suboval or round, about 2 mm. long, loosely woven, composed of long white wool.

Body about 3 mm. long and one-third as wide as long, with short spiny hairs on dorsal surface. (After being boiled in hot water in order to take the waxy substance off, the color was darkish purple; legs and antennæ pale brown.) Antennæ seven-segmented,[1] each segment with a few spiny scattered hairs; seventh segment usually longest, second next in length, fourth, fifth, and sixth usually subequal. There is quite a variation in the segments even in the same insects, as shown in the following formulæ:—

$$\left.\begin{array}{r} 7,\ 2,\ 1,\ 4\ (5,\ 6)\ 3 \\ 7,\ 2,\ 1,\ 6\ (3,\ 4)\ 5 \end{array}\right\}\ \text{one specimen.}$$

$$\left.\begin{array}{r} 7,\ 2,\ 1,\ 3\ (4,\ 5,\ 6) \\ 7\ (1,\ 2,\ 3)\ 6\ (4,\ 5) \end{array}\right\}\ \text{one specimen.}$$

$$\left.\begin{array}{r} 7,\ 2\ (1,\ 4)\ (3,\ 6)\ 5 \\ 7,\ (1,\ 2,\ 4)\ (3,\ 5,\ 6) \end{array}\right\}\ \text{one specimen.}$$

Legs large and well developed; coxa stout, almost as wide as long; trochanter triangular in form; femur very long, .16 mm. long, .05 mm. wide; tibia smaller than femur, about .18 mm. long; tarsus about .06 mm. long; claw about .02 mm. long, and rather stout; digitules of tarsus knobbed, long, and moderately stout; those on claw short and extending slightly beyond the claw. Anal ring with six hairs.

Egg.—The egg is smooth, elliptical in form, .33 mm. long, .21 mm. wide; color purple.

The Newly Hatched Larva.—Body subelliptical, very pale brown, .85 mm. long, .46 mm. wide, anterior end subparabolic. Antennæ very large, six-segmented, with a few scattered hairs; sixth segment longest, third next in length, first, second, and fifth subequal, fourth shortest,—formula 6, 3, 5, 2, 1, 4. Eyes inconspicuous. Mouth-parts well developed. Legs stout, well developed; coxa very stout, wider than long, with a few spiny hairs; trochanter triangular, with single short spiny hairs; femur the longest segment of the leg, but slightly narrower than the coxa; tibia shorter than femur and very much smaller, with a few short spiny hairs; tarsus shorter than tibia, tapering toward extremity, finished with a few spiny hairs, and four knobbed hairs, of which the lower pair are shorter, and with a short rather stout claw. Abdomen consists of nine segments, posterior end deeply emarginated, a long hair and a few spines on each projecting part. Anal ring with six long hairs.

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[1] One specimen examined had one antenna seven segmented, the other, only six-segmented,—formula $\left\{\begin{array}{l} 6,\ 3\ (1,\ 2)\ 5,\ 4 \\ 7,\ 2\ (1,\ 3)\ 6\ (4,\ 5) \end{array}\right.$

Habitat.—Found on grass *(Festuca scabrella)* on Black Mountain, Santa Clara County, California. The specimens were collected by the writer March 24, 1900,—eggs and newly hatched larva at the same time.

Lecanium adenostomæ, sp. nov.

Plate XXVI, Figs. 17–26.

Adult Female.—Shape subhemispherical, with the edges not flattened. Average length, 4 mm., width 3 mm., height, 2 mm. The shape and proportions vary somewhat according to the place upon which the scale formed. Color varies from light brown to dark brown, dorsal surface smooth. When removed from the twig there remains a little white cottony substance.

Antennæ rather small, seven-segmented, about .26 mm. long,—formula 3, 7, 4, 2 (5, 6) 1 (sometimes fourth segment longer than the seventh), third segment about .05 mm. in length, seventh with many rather long hairs, the others with but few. Legs small; coxa very stout, with a few long hairs; tibia about .09 mm. long; tarsus (without claw) about .045 mm. long, a few knobbed hairs on the extremity; claw stout and curved. Anal ring with eight long hairs.

Egg.—Elliptical in form, .3 mm. long and about one-third as wide; color, light reddish brown, with a peculiar curled marking.

The Newly Hatched Larva.—Body broadly elliptical, .38 mm. long, about .21 mm. wide, rounded in front and narrow behind; color, pale reddish brown, with legs and antennæ pale brown. Antennæ six-segmented, third segment longest, sixth next to the longest; sixth segment with several long hairs, the others with but few,—formula 3, 6, 2 (1, 4, 5). Eyes prominent, with red pigment. Mouth-parts and legs well developed. The three pairs of legs similar in form; coxa quite long, about one-half as thick as long, with one or two longish hairs; trochanter small and triangular in shape, with a single hair; the femur the longest joint of the leg, and almost equal to the coxa in diameter, with several long hairs; tibia a little shorter than femur, with a few long hairs; tarsus a little shorter than tibia, slightly tapering toward the extremity, which is furnished with a few spiny hairs and four knobbed hairs, or digitules, of which the lower pair are shortest, with a single rather long claw at the end.

Habitat and Life-History.—Found on *Adenostoma fasciculatum*, in the foot-hills of the Sierra Morena, Stanford University, and on Black Mountain, Santa Clara County, California. Taken by the writer March 24, 1900.

The female became mature about the latter part of March or the first of April. The eggs were laid irregularly beneath the body. The larvæ hatched from eggs, in the laboratory, for the first time, about May 1; they are very active. The male of this species is unknown.

Pseudolecanium tokionis *Ckll.*

PLATE XXVI, FIGS. 27-46.

Adult Female.—Length about 7 mm., width about 1.5 mm., very pale pinkish yellow (dried specimens dark brown), caudal end dark brown. Margin with capitate spines. Mouth-parts very small, but well chitinized. Antennæ very small, consisting of a single segment with a number of spines; two hairs on each side of dorsal aspect near caudal end; caudal end deeply cleft, with a number of long hairs on each side. Anal ring with twelve prominent hairs. The scale produces a white cottony secretion.

The Newly Hatched Larva.—Length .8 mm., breadth .29 mm. Color pale brown (the larvæ being dead when found, the fresh color is not known, but after boiling in K O H it is pale brown.); segments distinct; sides nearly straight, with capitated spines. Front margin of head round, with several capitated spines; mouth-parts large, well developed; eyes prominent, red. Antennæ .11 mm. in length, six-segmented, the segments very distinct, with strong constrictions between them, and each with a few prominent hairs; first segment stout, second smaller and shortest, about one-half the length of first, third a little longer than first, fourth shorter than third but longer than second, fifth slightly shorter than third, sixth as long as third,—formula usually 3, 6, 5, 1, 4, 2. Legs long and stout; coxa short and stout. Four capitate spines on dorsal aspect near caudal end, the extremity with a deep cleft, a small hair on each side, and two long caudal bristles; a row of short but stout spines along each side; anal ring without hair.

Second Larval Stage.—Length 1.16 mm., breadth .45 mm; color pale yellow, caudal end yellowish brown; margins with capitate hairs; legs wanting; antennæ consisting of a single segment as in the full grown female; segments distinct.

Cocoon of Male.—Length 1.50 mm., breadth .65 mm.; color white, subtransparent.

Male Pupa.—Length 1.04 mm., breadth .36 mm.; color pink, legs and antennæ pale brown; antennæ long and rather stout, reaching to base of second legs, nine-segmented, tapering toward extremity; wing-case narrow and long, reaching to the base of last leg; the coxa large, the tarsus slender, tapering, and without claw.

Adult Male.—Length about 1.4 mm., breadth .4 mm.; general color pink, with two basal segments of antennæ pink, while the other segments of antennæ and legs are pale brown. Head nearly round, pointed at front. Antennæ nine-segmented, reaching to the anterior part of the abdomen; first segment very stout, and shortest, second a little longer and more slender than first, third longest, and stoutest at apex, fourth, fifth and sixth nearly equal, and

slightly shorter than third, seventh and eighth shorter than sixth, ninth shorter than eighth,—all are provided with short hairs. Eyes, three pairs, large and conspicuous, one pair on dorsal and one pair on ventral aspect pinkish, the pair on the side smaller and transparent. Prothorax narrow and short, mesothorax largest and well developed, metathorax shorter than mesothorax. Legs long and comparatively stout, with many hairs, the three pairs of legs similar, except that the front ones are directed forward, and the tarsi are the longest; the four posterior legs directed backward; coxa all stout and short; trochanter short and somewhat triangular in shape, closely united with femur; femur nearly three times as long as trochanter and stouter; tibia longer than femur and trochanter combined, more slender, with several spines along the inside and one long spine at the posterior end; tarsus less than one-half the length of tibia, except in the first pair, tapering toward tip, where it is terminated by a short movable claw with an enlarged base, and by four knobbed hairs. Wing, length .45 mm., width .10 mm., rather thick, transparent, narrow, and reaching to second or third abdominal segment, covered with many minute hairs, margins nearly straight. Balancers were not observed. Abdomen oval in shape and almost as wide as thorax, tapering toward extremity.
From the ninth segment is formed the penis, and its enlarged base is kept slightly within the eighth segment. The penis is in the form of a long, slender, tapering style, which enlarges a little at the tip.

Habitat.—Lives under sheathing bases of leaves of bamboo. The female always found with the head down.

This interesting insect was first discovered on bamboo, in Tokyo, Japan, by Mr. Takahashi, and was described in 1896 by Professor Cockerell,[1] of New Mexico, from dried specimens of full grown females with newly hatched larvæ. It was first found in this country by the writer, on the campus of Stanford University, February 19, 1899, this being the first time the male had been seen.

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[1] U. S. Dept. Agri., Divi. Ent., Technical, Ser. No. 4, 1896, p. 49.

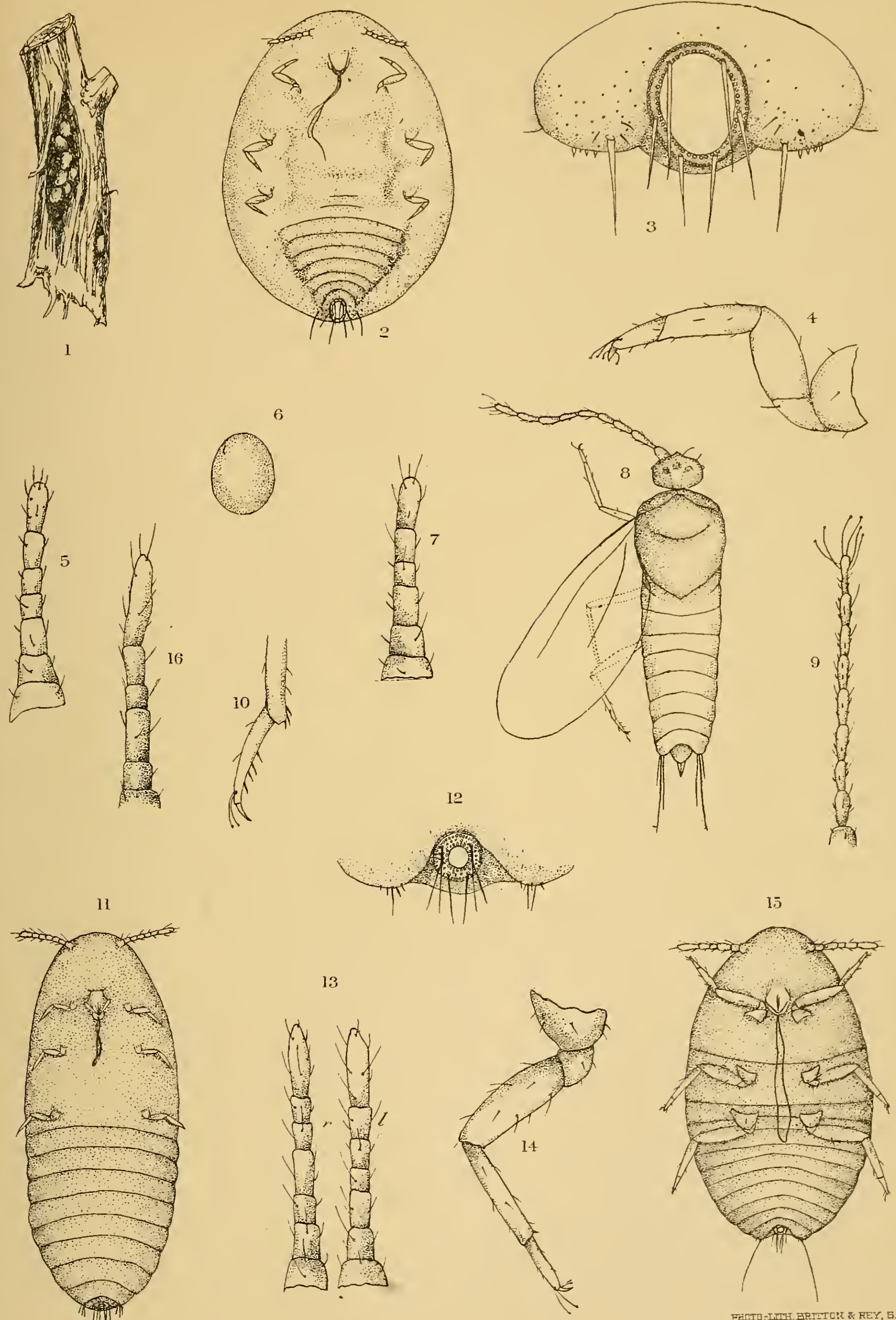
EXPLANATION OF PLATE XXV.

Eriococcus artemisiæ, sp. nov.

Fig. 1. A twig with female sacs.
Fig. 2. Adult female.
Fig. 3. Last abdominal segment of female.
Fig. 4. Leg of female.
Fig. 5. Antenna of female.
Fig. 6. Egg.
Fig. 7. Antenna of male larva.
Fig. 8. Adult male.
Fig. 9. Antenna of male.
Fig. 10. Tarsus of male.

Ripersia festucæ, sp. nov.

Fig. 11. Adult female.
Fig. 12. Last abdominal segment of female.
Fig. 13. Antennæ of female: *r*, right; *l*, left.
Fig. 14. Leg of female.
Fig. 15. First larval stage.
Fig. 16. Antenna of first larval stage.



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FIG'S. 1-10. ERIOCOCCUS ARTEMISIÆ, SP. NOV.
FIG'S. 11-16. RIPERSIA FESTUCÆ, SP. NOV.

EXPLANATION OF PLATE XXVI.

Lecanium adenostomæ, sp. nov.

Fig. 17. Female, ventral aspect.
Fig. 18. Last abdominal segment of female.
Fig. 19. Antenna of female.
Fig. 20. Leg of female.
Fig. 21. A group of spines of female.
Fig. 22. Marking on the dorsal aspect of female.
Fig. 23. Egg.
Fig. 24. First larval stage.
Fig. 25. Antenna of first larval stage.
Fig. 26. Tarsus of first larval stage.

Pseudolecanium tokionis CKLL.

Fig. 27. Females on bamboo.
Fig. 28. Specimen separated from host.
Fig. 29. Female.
Fig. 30. Dorsal aspect of last abdominal segment of female.
Fig. 31. Ventral aspect of last abdominal segment of female; all hairs but two removed from the anal ring.
Fig. 32. Antenna of female.
Fig. 33. Spines of female.
Fig. 34. First larval stage.
Fig. 35. Dorsal aspect of last abdominal segment of first larval stage.
Fig. 36. Leg of first larval stage.
Fig. 37. Antenna of first larval stage.
Fig. 38. Dorsal aspect of second larval stage.
Fig. 39. Dorsal aspect of last abdominal segment of second larval stage.
Fig. 40. Ventral aspect of last abdominal segment of second larval stage.
Fig. 41. Dorsal aspect of male pupa.
Fig. 42. Adult male.
Fig. 43. Dorsal aspect of head.
Fig. 44. Ventral aspect of head.
Fig. 45. Leg of male.
Fig. 46. Antenna of male.

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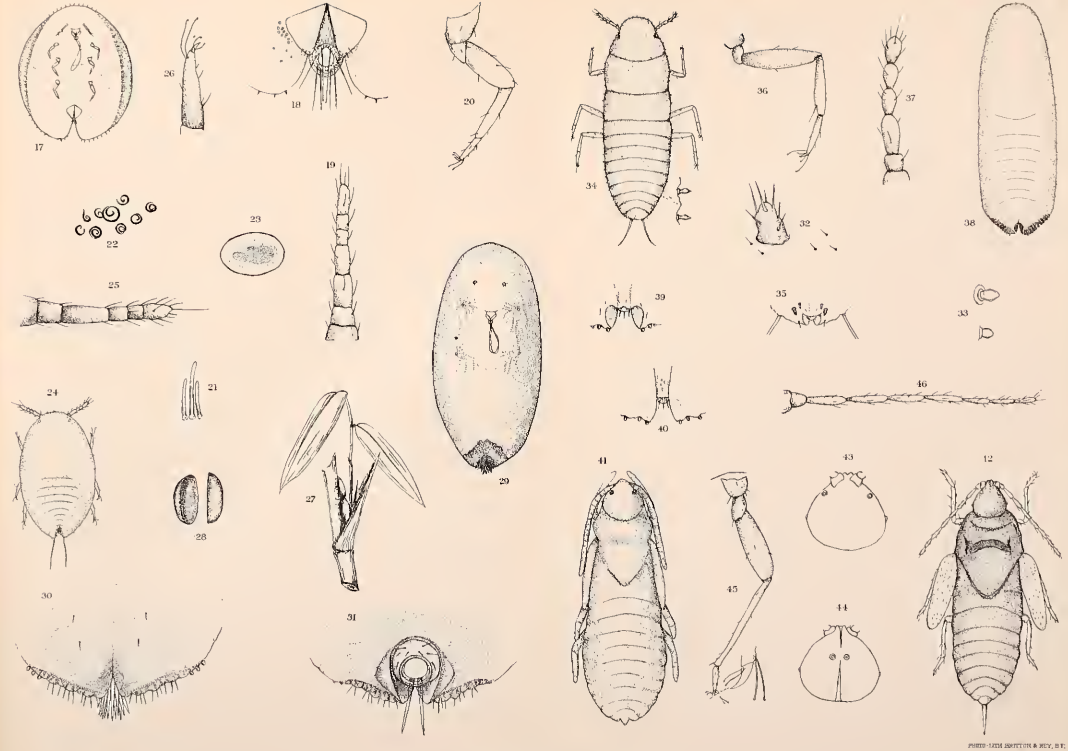

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Fig's. 17-26 Lecanium adenostomæ, sp. nov.
Fig's. 27-46. Pseudolecanium tokionis *Ckll.*

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

THIRD SERIES

ZOOLOGY VOL. II, NO. 11

The Redwood Mealy Bug

(Dactylopius sequoiæ, sp. nov.)

BY

GEORGE A. COLEMAN

WITH ONE PLATE

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THE REDWOOD MEALY BUG (DACTYLOPIUS SEQUOIÆ, SP. NOV.)

BY GEORGE A. COLEMAN.

CONTENTS.

PLATE XXVII.

PREFATORY NOTE.

THE author's attention was first called to the Coccid described in this paper, in December, 1899, while searching for scales on a small isolated redwood tree *(Sequoia sempervirens)* on the grounds of Cedro Cottage Place, about one mile west of Stanford University. Early in January, 1900, the young were found making their appearance on the lower branches of redwoods, where the tree was thick and the insects well protected.

From this time on, the insects were under daily observation, both on their native trees and on potted branches in the laboratory, until the male and female were fully developed, the female had deposited her eggs, and the young

May 6, 1901.

were hatched and had passed into winter quarters. The descriptions of the various stages in the development of the male and female, and notes on the habits of this species, will occupy the major part of this paper.

I have to acknowledge my indebtedness to Mr. T. H. Pergande of the Division of Entomology, U. S. Department of Agriculture, who, after an examination of my specimens determines the scale to be new (with *D. citri* and *D. poæ* showing most resemblance to it).

This paper was prepared in the Entomological Laboratory of Stanford University, under the direction of Professor V. L. Kellogg.

I. Description of the Species.

Dactylopius sequoiæ, sp. nov.

Plate XXVII.

1. The Egg.—The egg is ovate in form, averaging about .37 mm. in length, and .2 mm. in breadth at the widest part. In newly laid specimens the color is a transparent, light lemon yellow, but after a few days it gradually changes to a darker yellow, probably on account of the developing embryo showing through the transparent shell. The average number of eggs laid by each female is about seventy-five.

2. The Larva. (*First Stage*, fig. 1).—On emerging from the egg the young are very small, averaging about .4 mm. in length, and .2 mm. in breadth. The general shape of the body is elongate oval, widest at the middle, beginning to taper rather abruptly at a point about 5 μ distant from the middle on either side. The extremities of the body are slightly truncate. The color is at first a rather dark yellow, but soon changes to the characteristic grayish color. The integument of the young larva is quite transparent, revealing such of the internal organs as are not of themselves transparent.

The segments composing the body are not easily made out but seem to be at least thirteen, viz.: one to the head, three in the thorax, and nine abdominal, although the ninth is so closely associated with the eighth that it cannot be clearly distinguished. In specimens which subsequently develop into males, the lateral margins of each segment are furnished with a few slender spines, visible only under the high power of the microscope. These spines are not present in the female at any stage. There are about six short hairs, or spines, between the eyes, three on either side of the middle point. From either margin of the eighth abdominal segment there arises a conical protuberance, bearing a single long hair and two short ones about one-third the length of the long one. The caudo-ventral margin of the ninth segment bears the anal ring, a narrow, flattened, circular ring-plate, bearing the six slender, equidistant hairs, which are about .06 mm. in length. Protruding from this ring may be noticed a conical organ supposed to be the anus. The outer lobes of the ninth segment bend around until they are nearly on a level with the end of this organ.

The two eyes are situated on the cephalo-lateral angles of the head, and rather below the lateral line. They are not very prominent and show no dark pigment as in some other species. The mouth-parts are similar to those of the adult female, except that the buccal setæ are quite long, so that when doubled up in the body they reach to the last abdominal segment. The labium, or beak, is also large in proportion to the other parts.

The antennæ arise from the cephalo-lateral angles of the head, just in front of the eyes. They are about .15 mm. in length, of quite regular outline, and six-jointed. The formula is 6, 2, (3, 4, 5) 1; i. e., the sixth segment longest, the second next in length, segments three, four, and five about the same, and segment one the shortest. The antennæ are well supplied with hairs, the figure (fig. 1) showing their distribution.

The legs are nearly equal in size and shape, so that a description of one will answer practically for all. The coxa is quite large, rather broad at the base. The trochanter is also large, its angle being somewhat more than a right angle. The femur is longer and broader than any other segment.

The tibia is short and much wider at the lower end than at the upper. The tarsus is slightly longer than the tibia and terminates in a single, rather heavy claw. The coxa has no hairs. The trochanter bears one long hair on the outer side near its articulation with the femur. The femur has several short hairs. The tibia bears several hairs at each end. The tarsus also bears several hairs, and on the upper side a long hair ending in a knob. On the ventral side of the claw near its base are two digitules reaching somewhat beyond the claw and knobbed at their tips.

Second Stage.—The young grow very rapidly, the most marked change occurring about February 1, in the antennæ, which become seven-jointed by an elongation and division of the third segment. The formula now is 7, 3, 6, (1, 2, 4, 5). There is no change in the body or legs except the increase in size. The marginal spines of male specimens show distinctly.

3. DEVELOPMENT OF THE MALE (figs. 2, 3, 4).—Those individuals destined to become male flies continue to grow rapidly until about March 1, when they are considerably larger than the adult female. The segments of the body are now well developed and distinctly marked.

The marginal groups of five or six hairs each are now plainly visible on each abdominal segment. On each lateral margin of the eighth segment there is a group of about ten spines, and the marginal tubercle bears one long hair and three shorter ones. On each margin of the thoracic segment are three groups of from six to eight spines each. On the head there is a small group just above each eye, a large group near the base of each antennæ, and between the antennæ are four smaller groups.

The antennæ are now seven-jointed, formula 3, 7, (1, 2, 4, 5,) 6. They are also well supplied with hairs (fig. 2).

The legs are well developed; coxæ, trochanter, and femur being very stout, tibia and tarsus long and rather slender, the tarsus about two-thirds the length of the tibia. The claw is rather longer and more slender than that of the female, and it bears a short conical tooth on the ventral side near the distal end. The claw bears two knobbed digitules at its base which extend slightly beyond the end of the claw. All the segments of the legs are more or less covered with hairs which are arranged in rather definite rows.

The mouth-parts are not as large in proportion to the size of the body as in the female of about the same age, and markedly less so than in the adult female. The buccal setæ are especially short.

4. FORMATION OF THE PUPAL CASE (fig. 3).—About February 20, the male larvæ begin to secrete the waxy fibers for the cocoon. With this secretion there is a slight change in the form of the body. The ridge on the back is now quite pronounced, and there is a folding in of the integument near the dorso-lateral margin of each segment, so as to form a second ridge (fig. 3). The secreted fibers first appear at the lateral margins, and there form white plates extending out from the body at right angles. Gradually the whole body becomes enveloped in a white waxy cocoon of semicylindrical shape, slightly conical at the lower end, and bearing two projecting tubes, in which the long waxy caudal filaments are formed. There are also two projections at the cephalic end enclosing the antennæ.

5. THE PUPA (fig. 4).—On examining a somewhat advanced pupa, we notice, first, a general change in form. The head has become much reduced in size and contracted in form, being now very distinctly separated from the prothorax, which is also smaller, and quite distinctly marked off from the mesothorax. The wing-pads are well developed. The lateral margins of the fifth, sixth, and seventh abdominal segments are marked by large tubercles, each bearing a single stout spine. The anal projection of the ninth segment is prominent, and the penis and other reproductive organs have begun to develop. The anal ring and hairs have disappeared, as have also the mouth-parts. The ocelli are not yet visible, although there are indications of them.

The antennæ are noticeably longer and although still enclosed in their pupal sheath show plainly the ten joints and the numerous hairs which are still compressed in the enveloping sheath. The legs are longer and more slender than in the larval stage.

The pupa at this stage is of a grayish purple color, and the body is covered with short fine hairs.

6. THE ADULT MALE (fig. 5).—The following description was drawn from living specimens:—

Measurements:—Body, from tip of head to tip of abdomen, 3 mm.; caudal lobe, .5 mm.; from tip of head to end of folded wing, along dorso-median line, 5 mm.; antennæ, 3.48 mm.; wings, length, 3.4 mm., width 1.4 mm.; front legs, femur, .6 mm, tibia .9 mm.; tarsus .3 mm., claw .07 mm.; hind legs, femur .8 mm., tibia .1 mm., tarsus .33 mm., claw .08 mm.

Color:—Head, dark olivaceous; eyes, blackish; thorax olivaceous; abdomen, light olivaceous with yellowish tinge; caudal filaments white; legs, olivaceous; wings, semitransparent, smoky, with iridescent rose tint in strong light.

Balancers stout, with three long hooked claws fitting into socket in wing (fig. 5, *a*).

The head is very much reduced, in fact, it seems to serve simply as the seat for the eyes and the antennæ. It is longitudinally bisected by a distinct groove, ending posteriorly on the ventral side in a triangular depression occupying the position of the obsolete mouth-parts. On each lateral half of the head there are seven ocelli arranged in a transverse line just back of the antennæ. Posterior to the middle one of these ocelli there is, on either side, a single large ocellus. The antennæ are ten-jointed, formula, 4, (3, 5, 6,) 7, 8, 9, 10, 2, 1. All segments have numerous hairs.

The legs are very slender, covered with rather long slender hairs for their entire length. The tarsi are armed on either side with a ventro-lateral row of short stiff spines. The tibia have also a few short spines on the ventro-lateral margins of the distal half. The claws are rather slender, with a slight tooth on the ventral side near the tip. The two digitules are present at the base, though not perceptibly knobbed.

7. THE ADULT FEMALE (fig. 6).— The adult female just before impregnation is rather long and slender as compared with the male propupa stage. The length is then about 1.8 mm., width about 1 mm. After impregnation there is a considerable shortening of the body and a consequent broadening as the eggs develop. The shape of the unimpregnated female is almost a perfect oval as to dorsal and lateral outlines, the ventral a nearly flat surface.

In the live insect the color is a characteristic gray. The abdominal segments are distinctly marked dorsally, although the lateral margins show almost no indentation.

The antennæ are rather slender, about .65 mm. in length, and eight-jointed,—formula, 8, (2, 3,) 7, (4, 5, 6,) 1. The number of hairs and their arrangement on the segments are about as described for the first larval stage. The eyes are prominent though not very large. The legs have not developed in proportion to the size of the body. The shape and relative lengths of the different segments are about as in the first larval stage, except that the tibiæ are now longer than the tarsi. The claws terminate in distinct hooks and have the two knobbed hairs, or digitules, at the base on the ventral side. There is a single long hair at the distal end of the tarsus, on the dorsal side (fig. 6, *a*).

The anal ring bears six long hairs as in the young, and the marginal lobes of the eighth segment each bear a single long hair, with two shorter ones at the base.

The head, thorax, and abdomen are covered with short hairs, and on the caudal margin of each abdominal segment is a row of longer hairs. A few scattering long hairs are visible on the thorax and head.

II. LIFE-HISTORY AND HABITS.

1. THE YOUNG LARVA.—The young larvæ within the egg-sac were quite active soon after hatching, crawling about over the unhatched eggs. In a few days they left the egg-sac and ran about over the leaves and twigs. In a week or ten days after the first young appeared all were hatched and had entirely deserted the egg-sac. Those hatching on

potted branches in the laboratory all left the branches and disappeared in a few days.

June 1, 1900, I marked several females on a redwood tree at Cedro Cottage Place, which were just beginning to secrete ovisac. I watched them until the young had disappeared from the egg-sac, and although I searched very carefully for these young on leaves and branches none was found.

In January, 1901, I found the young insects abundant on this same tree and of exactly the same form as the just hatched larva, the antennæ still being six-jointed and of the same formula, legs the same shape. The only change that had taken place was that they had grown to nearly twice the size of the very young stage. They must, therefore, conceal themselves on the branches or in the bracts at the base of the leaves on the lower branches, where they are thick and protected. There they lead a semiquiescent life for a period of about six months. In the first days of January they began to crawl about and were easily found, always, however, partially concealed at the base of the needles.

2. Second Larval Stage.—These larvæ grew quite rapidly, and about February 1 the antennæ became seven-jointed. There was, however, no perceptible change in form at this time. Possibly a third change may be noticed in the male just before pupation, but it is very slight. In the course of these three stages I have not actually observed any moulting.

3. The Male Pupa.—The male begins to secrete the wax for its cocoon about February 20, and I have found the completed cocoons by March 1. Now begins the radical transformation of the male larva, a complete metamorphosis being undergone before the fly issues. The whole process occupies a period of about twenty days.

The process of emerging from the pupal case and skin is very interesting. On March 21, at nine a. m., I found the young male in the cocoon which was completed March 1 to be in the act of emerging. The pupal skin first split along the dorso-median line of the head. The head suddenly burst through, next the wings, then the legs. In the process, the skin became exactly reversed, leaving the abdomen attached until the very last thing. The male had entirely freed himself from the skin by twelve o'clock, and soon began to move the legs and antennæ, at first very feebly, gradually increasing the movements as he gained strength.

The process of the unfolding of the wings is also very interesting. In a few minutes after the male emerged, the wing-pads began to swell up at the base, and proceeded to expand in much the same way that a balloon does in being inflated with gas. The swelling passed rapidly from base to apex of wing, the wing expanding at the same time. This process occupied about fifteen minutes, although the full expansion of the wing was not complete until the following morning.

The long waxy caudal filaments were at first folded up and it took some time for them to straighten out.

Soon after emergence the male began to move about quite actively, walking with wings extended at an angle of about forty-five degrees above a horizontal plane. The long white filaments were also extended at an angle of about thirty degrees and directed slightly upward, giving him a very graceful appearance.

When approaching a female, the antennæ were used to discover her definite location, and there was a rapid vibration of the wings when he first found her. I reared a number of males in glass breeding jars, and in no case did I observe even a short flight, or attempt to fly, although I shook the jar and even touched the insects with a needle.

From my observations, I should say that the males live on an average for three days after maturity; the longest record I have is four days, and the shortest, two days.

4. THE FEMALE AND OVISAC (fig. 7). — The females began to secrete ovisac about April 1. The first appearance of it was a little white fringe of waxy filaments protruding from the ventral margins of the three caudal segments of the abdomen. As the process of secretion continued and the ovisac grew in length and thickness, the abdomen of the female was gradually raised up so that it finally stood nearly at right angles to the natural position. In about two days

the proximal third of the ovisac was completed, and the egg-laying process began. No eggs, however, were deposited in the proximal third, the eggs being deposited in the remainder of the sac as it was completed. The whole process occupied about five or six days.

The first young appeared in about twenty days and in two or three days more all had hatched. The mother insect usually lives for several days after the young are hatched. In one case she survived for ten days after all young were hatched. The larger number of females come to maturity in April and the first part of May; but there are stragglers until late in June and even a few in July. However, the great bulk of the young appear about the middle of May.

5. Distribution.—I found the first specimens of this species in December, 1899, on a small, isolated, cultivated redwood tree *(Sequoia sempervirens)* on the grounds at Cedro Cottage Place, one mile west of Stanford University. Later, I found them on a well protected redwood tree in the Stanford Arboretum. A few scattering specimens were found on other redwood trees in the arboretum, but they were most abundant on the single tree mentioned.

March 1, 1900, I found the young quite abundant on a clump of young redwoods at Woodside, about six miles west of the University, near the foot-hills. A curious fact with reference to these last mentioned individuals is that they nearly all developed into males, the proportion being about ten males to one female. On the tree in the arboretum exactly the reverse of this is true.

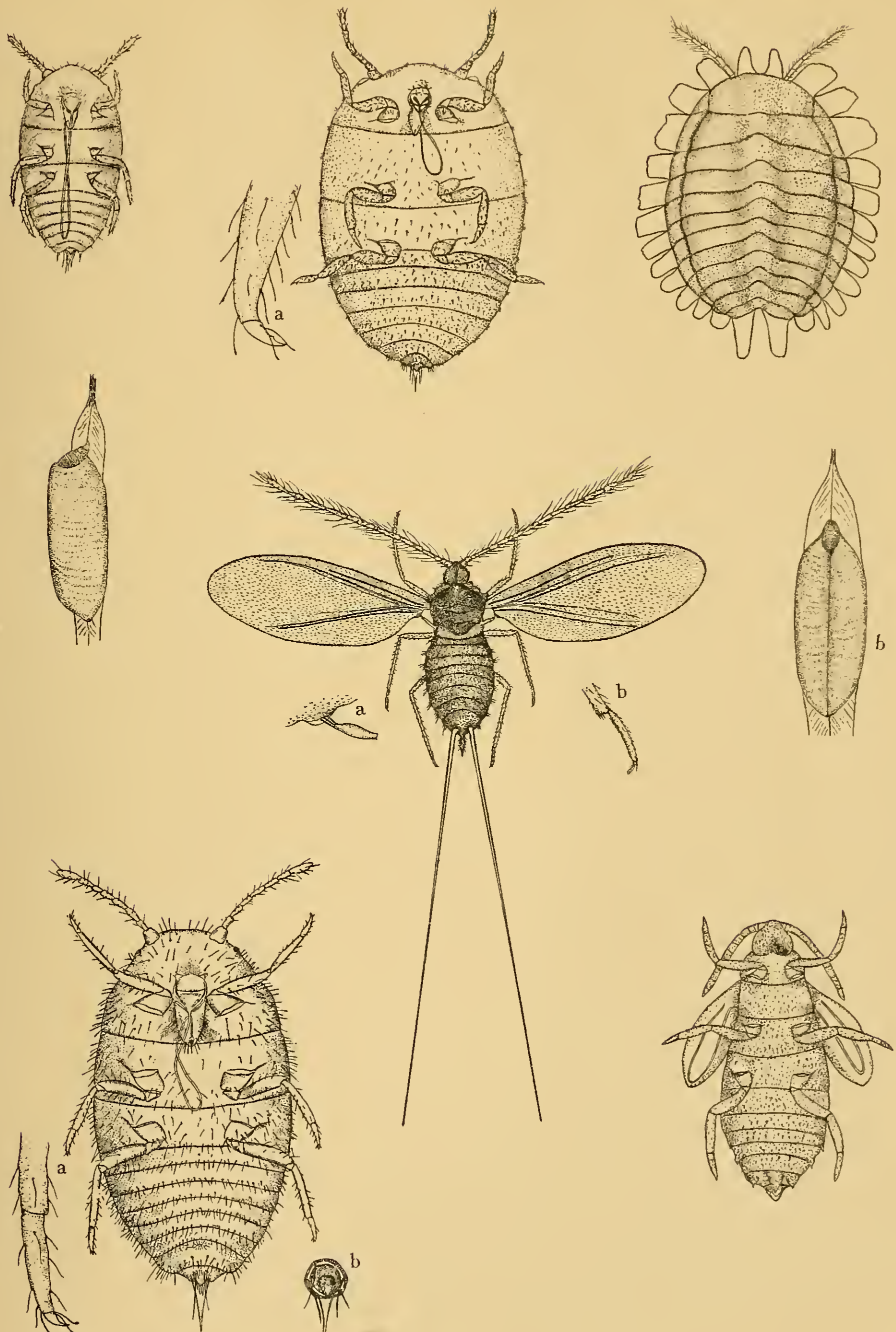
I have since found this scale all through the Sierra Morena Mountains, extending to the coast, and for a distance of from ten to sixty miles from Stanford University, wherever there are redwood trees. They do not seem to be abundant in any locality.

6. Parasites.—I have found the larva of a ladybird, species as yet undetermined, eating the young and using the waxy filaments of the egg-sac for its own cocoon. I have also bred from the body of the female scale a Chalcid fly, of which the species has not yet been determined.

EXPLANATION OF PLATE XXVII.

Dactylopius sequoiæ, sp. nov.

Fig. 1. Larva, first stage.
Fig. 2. Male larva, propupa stage: *a*, enlarged tarsus and claw.
Fig. 3. Male larva beginning to secrete wax for cocoon.
Fig. 4. Male pupa, advanced stage.
Fig. 5. Adult male: *a*, balancer and pocket; *b*, enlarged tarsus and claw.
Fig. 6. Adult female: *a*, enlarged tarsus and claw; *b*, anal ring and hairs.
Fig. 7. Adult female and ovisac: *a*, lateral view; *b*, dorsal view.



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DACTYLOPIUS SEQUOIÆ. SP. NOV.

Index to Volume II.

New names in **heavy-faced type.**

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