and legs dark brown externally, grizzled whitish internally; upper surface of hands naked, flesh-coloured, of feet pale brown, lightening terminally to whitish; soles quite naked, finely granulated. Tail long, finely haired, yellow for its terminal two inches and along its under surface; the remainder dark brown.

Skull and teeth agreeing word for word with the description of those of *P. longicauda* given in the 'Catalogue of Marsupials.'

Dimensions of the type, measured in skin:—

Head and body 300 mm.; tail 177; hind foot (s. u.) 59; ear (wet) 28.

Skull—basal length 57·2 mm.; greatest breadth 23·3; nasals 27 × 5·2; interorbital breadth 12·8; palate, length 37; combined length of three anterior molariform teeth 10.

Hab. Avera, Aroa River, British New Guinea.

Type. Adult male. B.M. No. 3.12.1.23. Collected by A. S. Meek. One specimen.

In the conspicuous striping of its dorsal surface this handsome species differed from all known Bandicoots, though it was possible that when dried skins of *P. longicauda* were examined, some indication of a similar pattern of coloration would be found to exist in that animal.

EXPLANATION OF PLATE XXIII.

Fig. 1 *a*. *Anisomys imitator* (p. 200). Lower view of skull, natural size.
1 *b*. ,, ,, ,, Left upper molar series, $\frac{4}{1}$.
1 *c*. ,, ,, ,, Upper view of skull.
1 *d*. ,, ,, ,, Front view of incisors.
1 *e*. ,, ,, ,, Right lower molar series, $\frac{4}{1}$.
2 *a* & 2 *b*. *Hyomys meeki* (p. 198). Lower and upper views of skull, natural size.
2 *c*. *Hyomys meeki* (p. 198). Right lower molar series, $\frac{2}{1}$.

The following papers were read:—

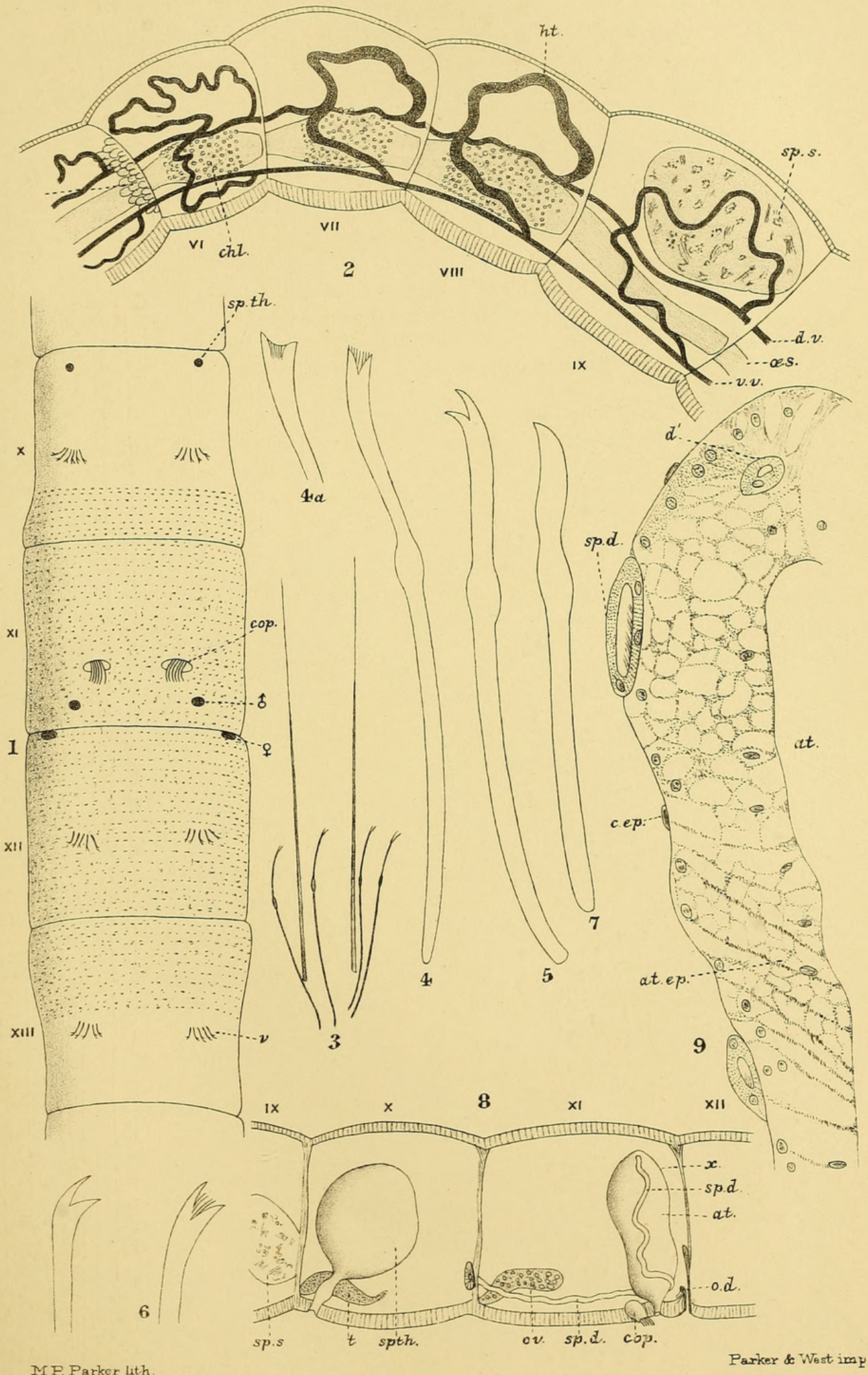
1. On some new Species of Aquatic Oligochæta from New Zealand. By W. B. Benham, D.Sc., M.A., F.Z.S., Hon. M.R.S. Tasm.; Professor of Biology in the University of Otago.

[Received July 24, 1903.]

(Plates XXIV.–XXVI.* and Text-figure 23.)

In the course of a biological survey of the New-Zealand lakes undertaken, during the year 1902, by Messrs. K. Lucas and Hodgson, of Cambridge, a considerable number of specimens of Oligochæta were obtained which were placed in my hands for identification. My best thanks are due to Mr. Lucas for his

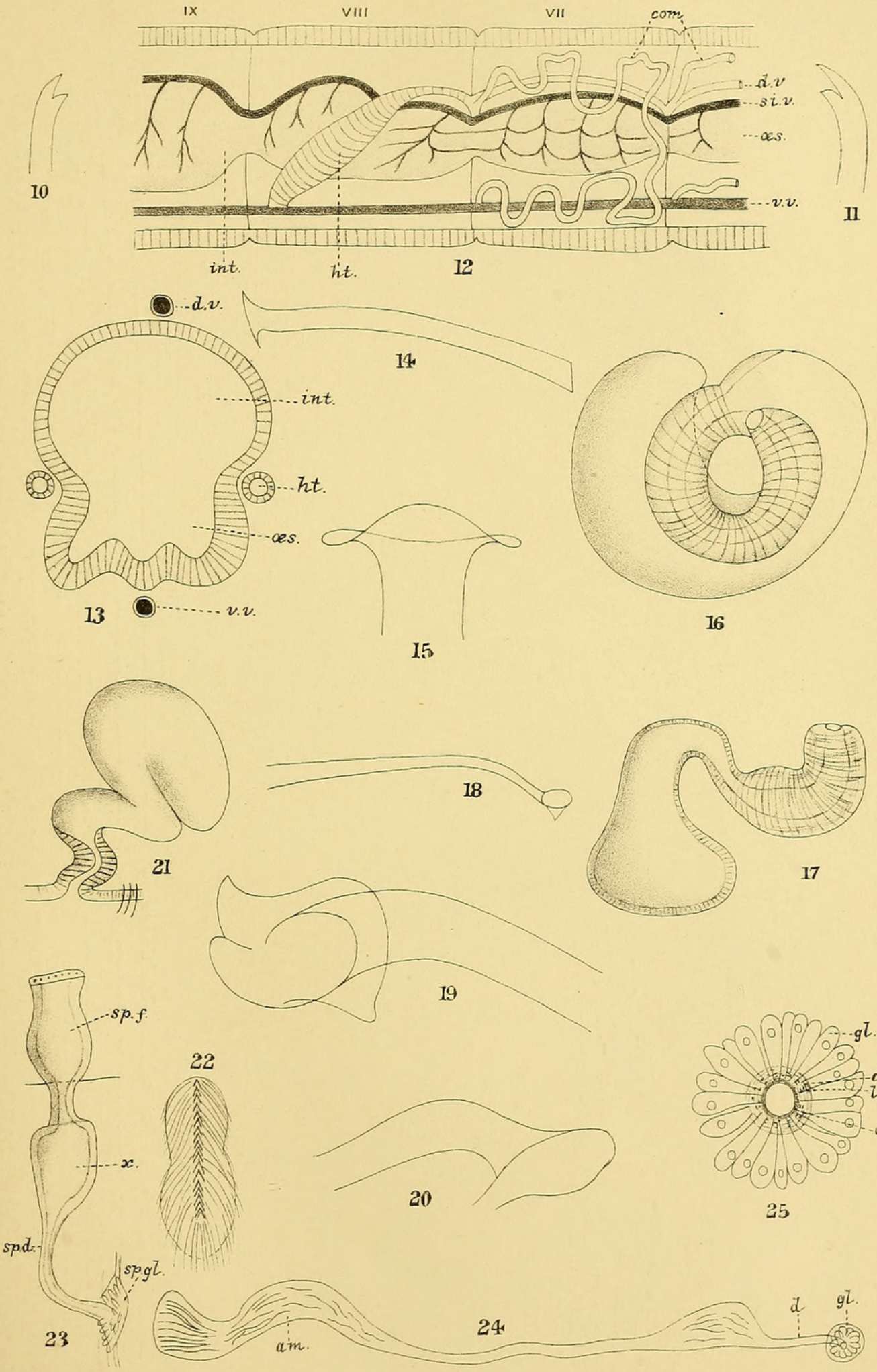
* For explanation of the Plates, see pp. 231, 232.



M. P. Parker lith.

Parker & West imp.

AQUATIC OLIGOCHÆTES FROM NEW ZEALAND



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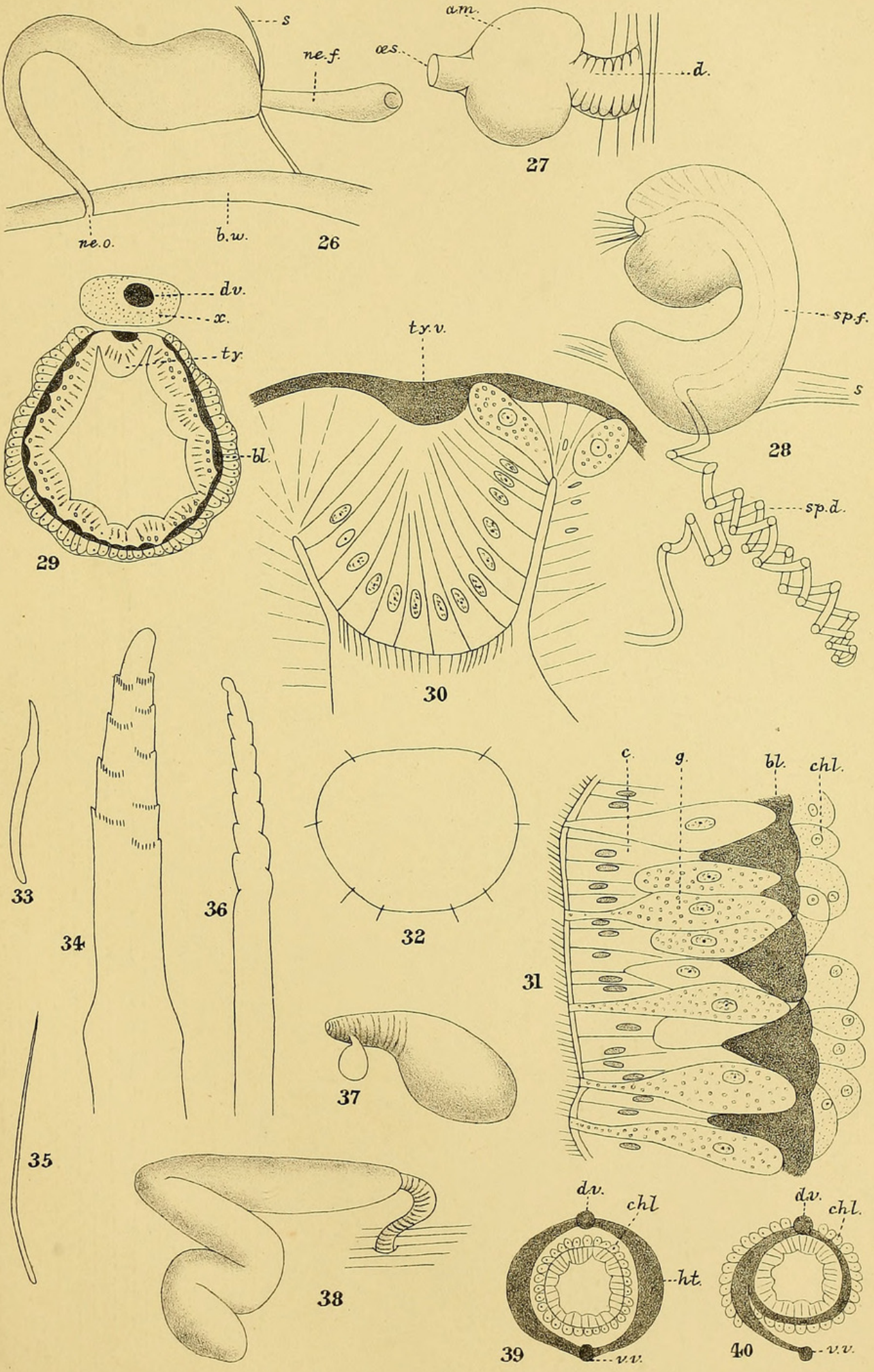
AQUATIC OLIGOCHÆTES FROM NEW ZEALAND.



M. P. Parker lith.

Parker & West imp.

AQUATIC OLIGOCHÆTES FROM NEW ZEALAND.

generosity in thus affording me an opportunity, for many years to come likely to remain unique, of examining the deep-water Oligochæta of our lakes.

In view of the extremely interesting character of the terrestrial Oligochætes of New Zealand, both from a morphological and a zoo-geographical aspect, it seemed probable that our deep lakes of the South Island would contain equally interesting species; but the result of my investigation, though not wholly without interest, is rather disappointing. For, whereas our terrestrial fauna includes several endemic genera, like *Maoridrilus*, *Plagiochæta*, *Neodrilus*, *Deinodrilus*, and *Octochætus*, our lacustrine genera are, with one exception, of an exotic character; and even the single new genus that I have ventured to create, viz. *Taupodrilus*, is very near akin to a European worm, *Branchiura coccinea* of Vejdovsky.

But amongst the new species that are here enumerated, some are of considerable interest. Of the genus *Phreodrilus* Beddard, originally founded for a New-Zealand worm, but now extended to include certain South-American aquatic species previously placed by Beddard in the genus *Hesperodrilus*, I find two new representatives: one of which is "Hesperodrilid" in the nature of the male efferent apparatus, and therein agreeing with the Kerguelen-Island form and South-American species, rather than with the original representative from New Zealand. This genus thus has a distribution similar to that of our earthworms belonging to the genus *Notiodrilus*.

Two other species deserve mention here: *Diporochæta aquatica*, sp. n., and *Plutellus lacustris*, sp. n., for both of these genera are characteristically Australian.

The genus *Diporochæta* was founded originally by Beddard for *D. intermedia* from Lake Brunner in this colony; but it has now been extended so as to include a number of Australian species, and hitherto Beddard's species has been the only representative on this island. It is worth noting that both our species occur in water, whereas the majority of the species are terrestrial.

As to *Plutellus lacustris*, it differs from the rest of the species in certain characters, viz., the loss of gizzard, and the absence of nephridia in the pregenital segments; and at first I was inclined to form a new genus for it, but these features, in which it approaches *Pontodrilus* (an inhabitant of the sea-shore in various parts of the world), appear correlated with an aquatic habit.

These two genera, *Diporochæta* and *Plutellus*, belong to the subfamily Megascolecinæ, and they are the only representatives of this subfamily in New Zealand. It is true that Schmarda attributed *Notoscolex* (*Hypogæon*) *orthostichon* to New Zealand, but this appears to have been due to an error—to a *lapsus calami*. He gives as the locality "Mt. Wellington": now, there is no such mountain in the district visited by Schmarda in New Zealand, but he did visit Mt. Wellington at Hobart, Tasmania; and there is no doubt in my mind that he obtained "*H. orthostichon*" in

Tasmania, and not in New Zealand, for the genus *Notoscolex* is common in the former locality, and has never been recognised amongst the numerous collections of New-Zealand worms examined by Beddard or by myself.

Again, Baird described "*Megascolex antarcticus*" from New Zealand—this in all probability should be placed in my genus *Plagiochæta*. With these two doubtful exceptions, then, the only representatives in the New-Zealand area of the extensive subfamily Megascolecinæ are:—

Diporochæta intermedia Beddard,
D. chathamensis Benham,
D. aquatica, sp. n.,
and *Plutellus lacustris*, sp. n.;

and the occurrence of these four species is rather difficult of explanation, for the subfamily is characteristic of Australia, and, if we except the Malayan *Pheretima*, is almost confined to Australia and Ceylon.

The remaining species belong to common and probably widespread aquatic genera, viz., *Limnodrilus*, *Tubifex*, *Enchytræus*, *Achæta*, and *Haplotaxis*.

Of the first two genera, representatives have already been referred to by Beddard as occurring in this colony, but no description of the species has been published. Of the Enchytræidæ Beddard * has recorded *Henlea ventriculosa* and *Fridericia galba* (=*F. antarctica* Bedd.), both of which are terrestrial species living in swampy places; while of *Haplotaxis* we already know *H. smithi* Beddard from this country.

A special interest appears to be connected with some of the new species described in this paper, in that they were obtained from very considerable depths; at any rate the soundings given by Mr. Lucas for the hauls enumerated below imply that the worms were obtained from the bottom, and, moreover, the intestine is loaded with mud- and diatom-valves; although I do not know what means, if any, were employed to prevent the entrance of organisms as the dredge was pulled up through the water. The absence from this collection of the families Naididæ, Æolosomatidæ, and Lumbriculidæ seems to indicate that some such means were employed, as these families occur in shallower waters amongst water-weeds; and representatives of Naids and Lumbriculids do occur in New Zealand, as I have collected them in the neighbourhood of Dunedin, but I have not yet worked them out.

List of Worms obtained by Mr. K. Lucas, and described in the present paper.

Fam. Phreodrilidæ.

1. *Phreodrilus lacustris*, sp. n.
2. *P. mauianus*, sp. n.

* Beddard, Proc. R. Phys. Soc. Edinb. xii. p. 41.

Fam. TUBIFICIDÆ.

3. *Taupodrilus simplex*, gen. et sp. n.
4. *Limnodrilus vejdovskyanus*, sp. n.
5. *L. lucasi*, sp. n.
6. *L.* sp. inc.*
7. *Tubifex* sp. inc.*

Fam. ENCHYTRÆIDÆ.

8. *Enchytræus simulans*, sp. n.
9. *Achæta maorica*, sp. n.

Fam. HAPLOTAXIDÆ.

10. *Haplotaxis heterogyne*, sp. n.

Fam. MEGASCOLECIDÆ.

Subfam. MEGASCOLECINÆ.

11. *Diporochæta aquatica*, sp. n.
12. *Plutellus lacustris*, sp. n.

The total number of individuals examined is about 150, and these were obtained at 27 stations in six lakes; of which two are in the South Island, and four in the North Island.

The following table shows the distribution of the above species in these lakes, the depth at which they were obtained, and the number of stations at which each species occurred.

Table showing Distribution of the Worms.

Name.	*No. of Specimens.*	*No. of Stations.*	*Lake.*	*Depth in feet.*
Phreodrilus lacustris	16	4 1	Wakatipu. Manapouri.	300–1000 150–500
„ *mauianus*	1	1	Taupo.	150–500
Limnodrilus vejdovskyanus	30†	1	Waikare.	9
„ *lucasi*	many	1 1	Taupo. Rotoiti.	300–450 100–228
„ sp. inc. (A)	1	1	Wakatipu.	1000
„ „ (B)	1	1	Manapouri.	150–500
„ „ (C)	1	1	Waikaremoana.	200–750
Tubifex sp. inc.	1	1	Taupo.	150–500
„ „	2	1	Rotoiti.	100–228
„ „	1	1	Waikaremoana.	200–750
Taupodrilus simplex	6	2	Manapouri.	10–1000
„ „	11	2	Taupo.	150–500
„ „	1	1	Waikare.	9
Enchytræus simulans	7	1	Taupo.	?
Achæta maorica	1	1	Manapouri.	350
Haplotaxis heterogyne	2	1	Wakatipu.	550
Diporochæta aquatica	2	2	Manapouri.	350–550
Plutellus lacustris	17‡	7	Wakatipu.	300–1200

* The specimens being immature are not named.

† Together with six immature specimens probably of this species from Waikaremoana, 800–840 ft.

‡ Also some cocoons, which appear to belong to this worm.

Analysis of the Oligochæte Fauna of each of the Lakes.

Lake Wakatipu, South Island.
Greatest depth, 1242 feet.
Number of stations at which worms were obtained, 10.
Total number of specimens, 37.

The commonest worm appears to be *Plutellus lacustris*, which was obtained from 7 stations at different parts of the lake, so that it is evidently widespread throughout; but it appears to be limited to this lake, as none were obtained elsewhere.

Phreodrilus lacustris also occurred at three stations, and appears to be somewhat less widely distributed, though living at the same depth. *Haplotaxis heterogyne* was obtained only at one station, and a single undetermined immature specimen of *Limnodrilus*.

Lake Manapouri, South Island.
Greatest depth, 1458 feet.
Number of stations, 6.
Number of specimens, 16.

This, the deepest lake, so far as this survey is concerned, contained a greater variety of Oligochætes than any of the other lakes, for it yielded 6 genera.

Phreodrilus lacustris and *Taupodrilus simplex* account for twelve out of the sixteen specimens; the former was obtained once only, the latter at two stations. At two other stations *Diporochæta aquatica* and at another *Achæta maorica* were captured, while an immature *Limnodrilus* completed the list.

Lake Taupo, North Island.
Greatest depth, 534 feet.
Number of stations, 4.
Total number of specimens, 32.

Taupodrilus simplex and *Limnodrilus lucasi* account for more than two-thirds of the total, the former occurring in two hauls, the latter in one only. With the former, *Phreodrilus mauianus* was obtained, while at another spot *Enchytræus simulans* occurred, and an undetermined species of *Tubifex* completes the list.

Lake Rotoiti, North Island.
Greatest depth, 228 feet.
Number of stations, 2.
Number of specimens, many.

This lake is characterised by *Limnodrilus lucasi*, of which 3 or 4 dozen were obtained at one spot; while at the other station immature specimens of *Tubifex* occurred.

Lake Waikaremoana, North Island.
Greatest depth, 846 feet.
Number of stations, 3.
Number of specimens, 16.

Unfortunately these were very poorly preserved, much broken

and immature specimens of *Tubifex* sp. and of *Limnodrilus*, amongst which some appear to be *L. vejdovskyanus*.

Lake Waikare, North Island.

Greatest depth 9 feet. Only one haul was taken, which yielded numerous specimens of *Limnodrilus vejdovskyanus* and one individual of *Taupodrilus simplex*.

It will thus be seen that the lakes in the North and South Island respectively differ considerably in their Oligochætes, so far as research has yet gone.

The two species of *Phreodrilus* are very distinct, one confined to the north, and the other evidently common in the southern lakes.

Of *Taupodrilus*, the northern and southern representatives may be distinct, though I have included them in the same species, as the southern material was not in sufficiently good condition to permit me fully to investigate the details of the reproductive organ.

Unfortunately the southern representatives of *Limnodrilus* are immature, but they appear to differ in the form of their chætæ from each of the northern species, *L. vejdovskyanus* from Waikare and *L. lucasi* from Taupo.

PHREODRILUS LACUSTRIS, sp. n.*

A very narrow worm in which the ventral *chætæ* are in couples of two kinds: each couple consists of (*a*) a simple hook-like bristle and (*b*) a hook with a very minute tooth in the back. These chætæ measure 0·06 mm. in length.

The ventral chætæ are absent on segments xii., xiii., though on the latter segment they are replaced by special copulatory chætæ.

Dorsal chætæ solitary, capilliform, beginning on segment iii.

The *clitellum* covers the hinder part of segment xii. and the whole of xiii.

The *male pores* are in line with the ventral chætæ at the hinder margin of segment xii.

The oviducal pores are in the same line, at the boundary of segments xii./xiii.

The *spermathecal pores* are in line with the ventral chætæ at the anterior margin of segment xiii.

Copulatory chætæ, a pair of couples; each pair in a special ovoid glandular follicle just behind the spermathecal pore.

The preclitellar nephridium appears to extend through segments vii. to x.

No sperm-sacs; but loose developing spermatozoa in segments viii. to xii.

Spermiducal gland of large size, filling segment xii., slightly convoluted, receiving the sperm-duct at its short, narrow neck, where it enters a large protrusible penis, enclosed in a muscular

* A detailed account of this species has been sent to the Editor of the Quart. Journ. Micros. Sci.

penial sac. There is no atrial sac, and the atrium itself is not longer than the penis. In its general arrangement it resembles the apparatus in *Hesperodrilus albus* of Beddard.

The *spermathecæ* (one pair) extend through segments xiii. to xv.; the pore leads into a very slightly dilated muscular duct which soon becomes narrow and is much arched dorsally; on passing through the septum xiii./xiv. the duct, still narrow, becomes glandular, and then opens into the ampulla, which occupies the hinder part of segment xiv. and the whole of segment xv.

Dimensions. 20 mm. × $\frac{1}{4}$ mm. 75 segments.

Localities. Lakes Manapouri and Wakatipu, South Island of New Zealand.

Remarks.—This worm agrees closely with those South-American worms for which the genus *Hesperodrilus* was founded by Mr. Beddard*; but Dr. Michaelsen† has shown good reason for merging this genus with *Phreodrilus* owing to the discovery, in Kerguelen, of a worm which in certain respects presents the characters of both the genera.

The discovery in New Zealand of two new species, this and the following, belonging to the section of the genus hitherto found in the Falkland Islands, South America, and Kerguelen, is a most interesting additional fact in our knowledge of the geographical distribution of the Southern Oligochæta.

PHREODRILUS MAUIANUS‡, sp. n.

This new species is founded on a single immature individual, which, however, differs from any hitherto described.

The ventral chætæ are, as usual, of two kinds, one of each in each bundle, viz.—(*a*) a simple hook-shaped, single-pointed bristle, and (*b*) a similar bristle with a very distinct tooth on its upper, convex, surface. These chætæ measure 0·15 mm., and are thus much longer than those of the species just described.

The dorsal chætæ are capilliform, solitary, and commence in segment iii.

The œsophagus is narrow up to segment vi., where it dilates, and is then constricted by the following septa. In the middle of segment ix. the gut presents a slight constriction, and the epithelium suddenly changes in its character—the œsophagus passing suddenly into the intestine. The dorsal vessel lies free of the gut in segment x. and forwards; a supra-intestinal vessel is recognisable in segments vii. to xv. An enlarged commissural vessel exists in segment x., and a contorted, swollen, heart-like organ in the following segment (xi.), which appears to be connected

* Beddard, Ann. Mag. Nat. Hist. (ser. 6) xiii. p. 206; & Ergeb. Hamb. Magalhaen. Sammelreise, 1896—"Naid. Tubificid. u. Terricolen," p. 9.

† Michaelsen, Oligoch. d. deutsch. Tiefsee Exped. 1902.

‡ The specific name "*mauianus*," in which the syllable *au* has the sound of *ow* in *cow*, refers to the mythical Hercules of the Pacific, known to the Maoris as Maui. The North Island of New Zealand owes its origin to Maui, who, while fishing from a boat at sea, hauled up the land at the end of his fishing-line. Hence the original Maori name for this island was "Te ika a Maui"—the fish of Maui.

with the supra-intestinal vessel. As I have studied the specimen only as an entire object, I cannot say anything as to the structure of this organ, but it seems to resemble in its external features the "blood-gland" which Beddard describes as occurring in segments xii., xiii. in *P. subterraneus*.

Dimensions. 15 mm. × $\frac{3}{4}$ mm. It is much stouter than *P. lacustris*, and consists of 70 segments.

Locality. Lake Taupo, North Island, New Zealand.

Taupodrilus, gen. nov.

Taupodrilus simplex, sp. n. (Plate XXIV. figs. 1–9.)

Of this worm I found about a dozen individuals, most of which are only the anterior ends, and a few are entire. They are all much coiled, rendering it a matter of some difficulty to make sagittal sections.

The following account is based on the study of three individuals, more or less sexually mature, stained and mounted in Canada balsam, and a series of longitudinal sections through the anterior segments, and transverse sections of the middle region, in addition, of course, to the usual glycerine and potash preparations.

The *prostomium* is conical and relatively long.

Chætæ.—The dorsal bundles consist of capilliform (at any rate in the anterior segments), accompanied by bifurcate chætæ (Pl. XXIV. fig. 3), with a few delicate intermediate teeth. Such chætæ may be termed "multidentate" or "ctenate," and occur also in *Tubifex rivulorum*.

The ventral bundle consists almost wholly of crochet-shaped chætæ, with intermediate teeth. In the dorsal bundle there are one or two capilliform and usually three or four ctenate chætæ (in one individual the former were only present on segments v., vi., vii.; in another they did not begin till the fourth segment, and in one specimen I was unable to detect them), and typically they occur only on the first 12 to 15 chætigerous segments.

In the "ctenate" set the chief teeth or prongs are scarcely curved (Pl. XXIV. figs. 4, 4 *a*), and the number of intermediate teeth varies from two or three to several; usually they all separate, but in a few instances a delicate striated membrane unites the chief teeth as in "*Psammoryctes*." The dorsal chætæ of segment ii. are smaller than the rest.

In the ventral bundle there are from 4 to 6 chætæ in the anterior segments, diminishing to 3 or 4 in the mid-body. The chief teeth are curved as in normal forked bristles or crochets; the upper tooth is less stout than the lower, and over the greater part of the body the two teeth are of the same length, but in the anterior segments the upper tooth is slightly the longer (Pl. XXIV. figs. 5, 6). Generally, all the crochets in a bundle have intermediate teeth, which lie in a different plane from the main teeth; but in the anterior segments a minority in each bundle are normal crochets.

The *clitellum* envelops the body, and extends over three segments, from the middle of x. to the middle of xiii. (Pl. XXIV. fig. 1).

The *male pores* are near the posterior margin of segment xi. and lie outside the line of ventral chætæ, which in this segment are modified to form a bundle of copulatory bristles.

The *oviducal pore* is at the anterior margin of segment xii., practically intersegmental, and further laterad than the male pores.

The *spermathecal pores* are close to the anterior boundary of segment x.

Internal Anatomy.

The pharynx, in segment iii., is provided with the usual dorsal, ciliated pouch, whence radiating muscles pass to the body-wall. The œsophagus is quite narrow; the chloragogen cells begin in segment vi.; the gut suddenly enlarges in the tenth segment, and food occurs there consisting, amongst other things, of diatom-valves; this intestinal region is thereafter wide, but septally constricted.

The *Vascular System.*—The dorsal vessel is distinct throughout the body; it is connected with the ventral vessel by undulating commissurals in each of the segments ii. to x., while the dorsal vessel bifurcates in the first segment, and each branch passes forwards into the prostomium, bends downwards and backwards to unite to form the ventral vessel in segment ii.

Of the commissural vessels, those in segments vii. and viii. are slightly larger and less extended than the rest; they, however, are not dilated to form "hearts" such as occur in *Limnodrilus* and other Tubificids (Pl. XXIV. fig. 2). A pair of vessels passes backwards on the sperm-sacs to segment xvii., but as to the exact origin of them, or whether there is a second pair supplying the ovisacs (as in *Branchiura coccinea*), I am unable to ascertain. Nor can I state whether any of the commissurals connect with the supra-intestinal vessel which is present in at least part of this region. I have not been able to detect any integumental vessels, either in sections, or in the glycerine and potash preparations. I do not think they exist.

The *Reproductive System* (Pl. XXIV. fig. 8).—The testes, ovary, and oviducts are in the positions usual in this family.

There are two pairs of sperm-sacs, one in segment ix., the other extending through segments xi. to xvii. and constricted by each septum through which it passes, while segment x. is filled with loose masses of developing spermatozoa, not enclosed in a special sac. Large ova, contained in an ovisac, occupy segments xvi., xvii., xviii., in one specimen; but in another, in which the sperm-sacs are not so extended, the ovisac is not so far back.

The condition of the male efferent apparatus is the most interesting feature of this new genus.

The sperm-funnel, on the hinder wall of segment xi., is flat and

moderately extensive. The sperm-duct is comparatively thick; it passes below the ovary nearly directly backwards to the hinder septum of the twelfth segment; there it makes a single loop round the neck of the atrium, and then runs up it to enter its distal extremity.

This atrium (or spermiducal gland—for it is both) is a large pyriform or sausage-shaped sac, with a capacious cavity; its broader end is directed upwards, its narrower end is suddenly constricted to form an extremely short and narrow duct, just long enough to pass through the body-wall. In its microscopic structure the atrium presents what is probably to be regarded as an archaic character; at any rate, it is simpler than that of any Tubificid hitherto described. The epithelium consists of a single layer of tall, glandular, and much vacuolated cells, outside which is a thin peritoneal membrane with flat nuclei (Pl. XXIV. fig. 9). There is apparently no muscular coat, except for a few circular fibres near its lower end where it is about to penetrate the body-wall.

In the figure (fig. 9, which is drawn under a camera, and represents as accurately as may be the arrangement of the nuclei and vacuolation of the cytoplasm) two kinds of nuclei are to be seen in the epithelium: most of them are circular and situated towards the outer surface of this epithelium; others, however, are oval, elongated in a direction vertical to the surface, these lie nearer the inner ends of the cells. These latter suggest a columnar epithelium distinct from the gland-cells; but I have been unable to detect any cell boundaries corresponding to these oval nuclei, which, moreover, are not arranged in close array to suggest an epithelium. It may very well be, however, that some of the epithelial cells are short and have not become glandular.

The sperm-duct opens into this atrium at its apex, *i. e.* at the point furthest from the external opening. In this feature it bears a nearer resemblance to *Branchiura coccinea* than to *B. sowerbyi*; but even in the former species the duct enters the side, rather than the apex, of the nearly spherical atrium.

The *copulatory chætæ* form a bundle (varying from only 3 to as many as 7 or 8) of simple bristles, lying in a pit or depression near the male pore. Viewed from the side in a mounted specimen, the two organs appear coincident; but sections show the true relation. Each of these chætæ, one of which is figured (Pl. XXIV. fig. 7), is a nearly straight rod, thicker than the other chætæ, terminating in a point, which is not terminal, but directed to one side.

The *spermatheca* is globular, with a well-marked duct about half as long as the diameter of the ampulla. The neck of the latter is provided with a ring of elongated glandular cells, forming a prominent, valve-like structure (in longitudinal section). The duct is lined by cubical gland-cells, and is provided with a muscular coat. There are no spermatophores.

Dimensions. Length of an entire individual 15 mm.; diameter $\frac{1}{2}$ mm. Number of segments 70.

Locality. Lake Taupo, North Island, New Zealand. Also one individual from Lake Waikare, and some immature and imperfect individuals from Lake Manapouri, in the South Island, belong to this genus, but I am unable to say whether they are identical with the above.

Remarks.—This new genus appears to be most nearly allied to the genus *Branchiura* Bedd.*, as extended by Michaelsen to include "*Ilyodrilus coccineus*" Vejdovsky. But it will not fit into this genus, chiefly on account of the structure of the atrium.

In *B. coccinea* the spherical atrium is lined by a layer of ciliated cells, outside which is a layer of vesicular cells, corresponding to the compact "prostate" (Cement-drüse) of *Tubifex*, &c. Apart from this fact, the general arrangement of the male efferent apparatus is like that of the new genus: the thick sperm-duct, and the short atrial-duct, with muscles at its base, forming a slightly protuberant papilla.

With this species, too, *B. coccinea* agrees in the presence of copulatory chætæ on segment xi., but in the form of these there is considerable difference: for in *B. coccinea*, according to fig. 13 d_1 d_2 on pl. iv. of Štolc's memoir †, they are of two kinds, both sigmoid and crochets; while in the new species they are of neither of these two forms, but simple pointed, straight rods, with a nodal swelling. There are other points of difference, as in the undulating, instead of simple, form of the commissural vessels, in the position of the spermathecal pore, and the presence, in *Taupodrilus*, of a distinct muscular duct.

From *B. sowerbyi* there are more numerous differences, apart from the presence in this species of the gills.

So far as the atrium is concerned, the new genus exhibits points of resemblance to *Clitellio arenarius* ‡, in which a thick and relatively short sperm-duct enters the apex of an elongated, dilated, glandular "atrium," which appears rather as a swelling in the course of the duct. Of its minute structure we have no account; but in the total absence of a "prostate" there is a close similarity to the new genus. But in all other points there seems to be no close affinity between the two, for there are no capilliform bristles in the dorsal bundles; the chætæ being "only forked"—both Beddard and Michaelsen give this as a generic character. Further, two pairs of dilated hearts exist in segments viii., ix.

It is difficult to separate generic from specific characters, but probably we may regard as in the former category:

(*a*) the presence of fan-shaped chætæ dorsally;
(*b*) presence of copulatory chætæ on segment xi.;
(*c*) character of the atrium.

The structure of the atrium of *B. coccinea* has hitherto been regarded as the simplest amongst the Tubificidæ (Beddard, Monog.

* Beddard, Quart. Journ. Micr. Sci. 1892, xxxiii. p. 325.
† Štolc, Abhandl. Böhm. Ges. 1888.
‡ *Cf.* Beddard, P. Z. S. 1888, p. 491.

p. 233), and indeed agrees with that of certain of the Naididæ, such as *Stylaria lacustris* *, though I should place *Clitellio* at a lower grade even than *B. coccinea*, for in it apparently, and at any rate in the new genus, the atrium is still simpler, and approaches that found in *Nais elinguis*, or in *Dero*, or in *Chætogaster*. In the first named, Štolc † shows the atrium as a dilatation of the sperm-duct, from which it is not distinctly marked off; its lining appears to consist of low, cubical cells (? glandular), outside which is a layer of flat, peritoneal cells.

In the atrium of *Chætogaster*, as described and figured by Vejdovsky ‡, the glandular lining and flat epithelial cells are distinctly shown; while Beddard § thus describes the organ in *Dero*:—"The atria are lined by a columnar epithelium, but I could observe no layer of cells covering this organ externally and forming the structure which has sometimes been termed prostate."

In these forms, and in *Taupodrilus*, the atrium, indeed, is in its most simple form, as a distinct and definite organ—definitely marked off from the sperm-duct, but still, evidently, a dilatation of its distal extremity.

LIMNODRILUS VEJDOVSKYANUS, sp. n. (Plate XXV. figs. 10–17.)

From Lake Waikare I received about two dozen stout, greyish worms, in which the cuticle is much wrinkled, the body-wall thick, and the segments distinctly bi- and tri-annulate.

The *prostomium* is conical, with a rather acute point; it is relatively long, and exceeds the length of the first segment.

The *chætæ* are in the usual four bundles: 4 and 5 per bundle; even 6 in the bundles of segments ii. to vi.; but throughout the greater part of the body there are 4 ventrally and 3 dorsally.

The dorsal chætæ are slightly smaller in all dimensions than the ventral, but in form they are similar (Pl. XXV. figs. 10, 11). The upper tooth is very distinctly longer and less robust, and has a sharper point than the lower tooth.

The ventral chætæ are absent on segment xi.

The *clitellum* covers segments xi. and xii., and does not encroach at all on segment x. The genital pores have the usual position.

Internal Anatomy.

This was studied both in entire specimens—stained in alum-cochineal, and mounted in Canada balsam—and in serial transverse and longitudinal sections.

The *alimentary canal* is without a distinct muscular pharnyx; the buccal region passes through segment i. into the commencement of segment ii.; its wall is here folded and provided with a few retractor muscles. Following this is the beginning of the

* Vejdovsky, Syst. u. Morph. d. Oligoch. 1884, pl. iv. fig. 10.
† Štolc, SB. Böhm. Ges. 1887, p. 228, fig. 7.
‡ Vejdovsky, Syst. u. Morph. d. Oligoch. 1884, pl. v. fig. 7.
§ Beddard, P. Z. S. 1889, p. 444.

œsophagus, in the hinder part of segment ii.; it thickens out considerably, right and left, in segment iii., forming a somewhat quadrangular organ, looking—in an entire specimen—like a pharynx. The walls of this organ are comparatively thin, somewhat folded laterally, and lined by tall, columnar, ciliated epithelium*, which is surrounded by a very feebly developed muscular layer; the floor is raised into a ridge in the median line. The structure recalls that described by Nasse for *Tubifex*†. In segment iv. the œsophagus, retaining the same structure, diminishes in size vertically, but is still rather wide laterally.

The chloragogen cells—which are quite pale—begin in segment vi.

In the eighth segment (Pl. XXV. fig. 12) the œsophagus passes into the intestine. The former region reaches into the first half of the segment, then suddenly, at about the middle of the segment, dilates to about three times its former size. The epithelium, anteriorly high, is there quite low, and the cells contain blackish granules. The chloragogen granules have been dissolved out in the sections, but these dark intestinal granules remain.

The intestine is greatly dilated in each segment, and constricted by the successive septa.

The *Vascular System.*—In the œsophageal region the dorsal vessel is free from the wall of the gut, as is the case in Oligochæta generally. In the eighth segment it presents an arrangement which appears to be, in its details, unique (Pl. XXV. fig. 12). In the anterior (œsophageal) moiety of segment viii. the vessel becomes very muscular, and at the junction of œsophagus with intestine the dorsal vessel bifurcates; each branch, one on either side, passes downwards and *backwards*, along the line of union of œsophagus with intestine, to join the ventral vessel. This connecting vessel adheres closely to the wall of the gut, lying in a furrow therein, and has a very thick muscular wall (Pl. XXV. fig. 13); it is, however, not specially dilated in the way that the "lateral heart" of *Tubifex* is, and, further, it is connected with the dorsal vessel, and not with the supra-intestinal as is the case in other Tubificids [*vide* Štolc; Beddard, Monog. p. 240].

Behind the eighth segment, the dorsal vessel comes to lie below the peritoneal cells, above the gut-wall, in the usual way. Anteriorly to the eighth segment there is a "supra-intestinal" vessel adhering to the œsophageal roof; it passes forwards through several segments, but I did not ascertain how far it reaches.

In the intestinal region the vascular network on the gut-wall is connected with the dorsal vessel; while in the œsophageal region it is, as usual, connected with the supra-intestinal vessel.

Commissural vessels, undulating along the inner surface of the body-wall for the whole length of the segment, occur in segments

* This arrangement reminds one of the condition found in *Æolosoma*, and described in detail by Vejdovsky in his 'Syst. u. Morph. d. Oligoch.' p. 101, but in that low form there is no preceding buccal region.

† Nasse, 'Beit. z. Anat. d. Tubificiden,' 1882.

ii. to vii. They are all narrow, of about the same diameter, and put the dorsal and ventral vessels into communication at the hinder part of each of these segments. It appears to me that in this region the dorsal and supra-intestinal vessels are connected at the septum, and that it is at this point of fusion that the commissural vessels start. This union does not occur in *Lophochæta* or *Bothrioneuron*, in which the vascular system has been so well figured by Štolc.

I cannot detect any integumental network in spite of repeated examination of various individuals, in different media.

The *nephridia* are not enclosed in vesicular cells.

The *brain* is very slightly notched posteriorly.

The *Reproductive System.*—The spermiducal funnel is large and flat, and has the usual position on the hinder wall of segment x. The sperm-duct takes a much undulated course, pushing the septum xi./xii. backwards. The duct gradually widens in this region to form the atrium, which receives a quite small lobulated "spermiducal gland" (prostate, Cement-drüse); it then passes forwards to become the penis.

The muscles of the penis are spirally disposed, as in some other species.

The chitinous penial tube is of considerable length, about 10 times as long as the basal diameter, and when the worm is compressed it extends through segments xi. and xii., reaching nearly to the posterior end of the latter. The free extremity is suddenly expanded to form what appears in side view to be a thin flat plate, the margin of which may be even slightly reflexed (Pl. XXV. figs. 14, 15).

The *penis* is almost straight, its slight curvature being possibly due to compression, as it is not constantly identical in amount; but there is no sudden bend as in the species next to be described. I could detect no "valvular apparatus" at the aperture of the penis.

The *spermatheca* appears to be variable in form; in one entire individual it was spirally coiled, so that the ampulla—an elongated ovoid—formed the larger coil, and the narrower duct an inner, smaller coil; while in another case the ampulla was more globular (Pl. XXV. figs. 16, 17). The duct is about half the length of the ampulla.

I observed no spermatophores.

Dimensions. Length 20–25 mm.; diameter $\frac{3}{4}$ to 1 mm. The number of segments in one specimen was 66 + a regenerated tail of 33 very short ones; and in another 75 + 40 very small segments.

Localities. Lakes Waikare and Waikaremoana, North Island, New Zealand.

Remarks.—This species, so far at least as the general form of the penial tube is concerned, is most nearly allied to *L. claparedianus* Ratzel; but the latter species is of much greater size, viz., from 50–80 mm., and its chætæ are from 5 to 10 per bundle;

but how far the number is liable to variation is a subject that has received but little attention. In my specimens they are pretty constantly 4 ventrally and 3 dorsally, except the very anterior ones. At any rate, Vejdovsky's figure (pl. viii. fig. 22) gives a form very different from that of the new species; for the upper tooth is not pointed, but blunt, and much larger than the lower tooth, the proportions being very different from those in my species.

The presence of a single pair of hearts in this and the following species, which, at any rate in *L. vejdovskyanus*, have a peculiar form and arrangement, would appear to demand the creation of a new genus for this worm; for Michaelsen, in 'Das Tierreich,' gives two pairs of hearts in segments viii. and ix. as a character of the genus *Limnodrilus*. But in the character of the chætæ, and still more in the chitinous penial tube, this species agrees so precisely with *Limnodrilus*, that I deem this procedure unnecessary.

LIMNODRILUS LUCASI, sp. n. (Plate XXV. figs. 18–22.)

A slender worm with thick body-wall; the segments are not annulated.

The *prostomium* is short and rounded; the peristomium is as long as segment ii.

The *chætæ* are 5 in each bundle in the most anterior segments (ii., iii., iv., v.), then diminish to 4; and later (in segment x. and posteriorly) to 3 in each bundle.

The dorsal and ventral chætæ on segment ii. are rather shorter than on the other segments. All the chætæ are alike; the prongs or teeth are nearly equal in length, but the lower or proximal tooth is slightly the stouter, and in the posterior segments it is a trifle longer than the lower prong. But even in one and the same bundle the relative length of the two prongs exhibits various proportions.

Ventral chætæ are present on segment xi. even in the adult.

The *clitellum* occupies two segments, extending from $\frac{1}{2}$ x. to $\frac{1}{2}$ xii.

Internal Anatomy.

The pharynx extends through segments ii. and iii.; the chloragogen granules are dark brown and commence in segment v.

A large heart exists in segment viii., but I have not been able to make out, in the entire individuals, the exact relations of this organ. The blood has accumulated in the vessels at the posterior end of the body, and the vessels are empty anteriorly. I did not investigate this species by means of sections. The usual undulating commissural vessels are present in the anterior segments, but I find no integumental vessels.

The dorsal blood-vessel shifts from its proper position in the intestinal region, and takes up a lateral position as in *Branchiura sowerbyi* (which, according to Beddard, is the only instance amongst the Turbificidæ of this arrangement).

Sperm-sacs occupy segments xii., xiii., and eggs lie free in segments xiv., xv.

The chitinous *penis* is about ten times as long as the breadth of its base (Pl. XXV. fig. 18); it is distinctly bent at a point just below its outer end, and terminates in an asymmetrical, somewhat trumpet-mouthed expansion, which is apparently imperfect on one side, as the chitin here becomes very thin (Pl. XXV. figs. 19, 20); there appears to be a "valve-like" arrangement, somewhat like that figured by Vejdovsky for *L. claparedianus* (pl. xi. figs. 7, 8). The muscles surrounding the penis are spirally wound.

The *spermatheca* (Pl. XXV. fig. 21) has an irregularly pyriform ampulla, connected to the pore by a narrow neck passing into a short muscular duct, which is rather wider in the middle of its course than at either end. The duct is much shorter than in the previous species. The spermatophores (Pl. XXV. fig. 22), which I observed in one instance, are dumbbell-shaped—*i. e.*, an oval constriction round its shorter diameter.

Dimensions. Length 15–35 mm.; diameter $\frac{1}{4}$ mm. or $\frac{1}{2}$ mm. With 60 to 80 segments.

Localities. Lakes Rotoiti and Taupo, North Island, New Zealand. Obtained in considerable numbers at both places.

Remarks.—This worm is much more slender than *L. vejdovskyanus*, and, like it, differs from the majority of species of *Limnodrilus* in possessing no integumental vessels, so far as can be made out in preserved specimens. As the blood was distinct enough in the intestinal network, it seems unlikely that I overlooked the vessels on the body-wall, or going thereto. It appears to approach *L. dugesi* Rybka*, from Mexico, from the diagnosis given by Michaelsen; but I have not access to the original paper in which it is described.

LIMNODRILUS sp. inc.

From Lakes Wakatipa, Manapouri, and Waikaremoana some immature specimens were obtained to which I will not give a specific name, but which differ from either of the preceding species.

The chætæ are in bundles of 4 or 5 anteriorly, but soon decrease to a couple: or in some instances (the single individual from the southern lake) the maximum, anteriorly, is two per bundle, and posteriorly, both dorsally and ventrally, a single cheta. But in both cases the form of the crochet is the same; the upper prong is much larger than the lower, indeed as much as twice the length, and is much more slender and more elegantly curved, as it seems, than in the preceding species; the lower tooth is slightly stouter than the upper.

A more important difference from the preceding species is the possession of two pairs of swollen hearts in segments viii. and ix.

In one case, although only the rudiments of the generative organs are present, the epidermis is slightly, but definitely, thickened on segments $\frac{1}{2}$ x., xi., $\frac{1}{2}$ xii.

* Rybka, Mém. Soc. Zool. France, xi. p. 380.

Remarks.—In 1889 (P. Z. S.) Mr. Beddard recorded the occurrence in New Zealand of "*Limnodrilus* sp. inc.," but gave no details as to its anatomy; but in 1892 (P. Z. S. p. 354) he states that the New-Zealand *Limnodrilus* possesses two pairs of greatly dilated hearts in segments viii., ix. In his Monograph, p. 247, he repeats this; and both on this page and p. 230 he refers to this worm as "*L. novæzelandiæ.*" Possibly this is a MS. name and crept into the Monograph unintentionally; but it is regrettable that no further details have hitherto been published, and as his specimens are stated to be immature, it is probable that we shall never know what "*L. novæzelandiæ*" is: it is a name that has to disappear. It is quite likely, of course, that the present "species" is identical with Beddard's, and I hope to obtain more material before giving it any name.

In view of the general distinctness between the lacustrine worms of the Northern and Southern lakes, it is possible that two species are included here; but in the immature condition I detect no peculiarity sufficient to differentiate them.

In looking up the literature dealing with the genus *Limnodrilus* and other Tubificids, I have been struck with the paucity of information, on many anatomical points, about the common European species. It seems to me desirable to have some information as to the amount and degree of variation that may occur in the form of the chætæ of *Limnodrilus*, so as to be able to ascertain how far the relative size of the two prongs is a reliable specific character.

Another point that requires attention is the extent of the clitellum in different species of Tubificids, for in Michaelsen's and in Beddard's Monographs little attention is paid to this point; and since in the Earthworms it is of value in identification, it seems likely that here, too, it would have a certain, but perhaps more limited, value.

It is only in the case of those species that have been examined in recent years that this point has been determined. In neither monograph do I find a statement as to its extent, for instance, in the common European species of *Limnodrilus*, and, indeed, in very few members of the family. Beddard (p. 85) in a tabular statement showing the position of the genital organ in the various families of the Oligochæta, writes under the heading "clitellum":—

"Tubificidæ..... 10, 11."

But in the discussion on the characters of this family, further on in the volume, it is not stated, either explicitly or implicitly, whether the comma between the two numerals stands for the word "and" or "or"; and no details as to the point in question are to be found in the account of the genera or species of the family. But from the few records that we have, it is evident that in the family Tubificidæ the clitellum is not limited to one or even to both of these segments, and it is more extensive and variable in

its extent than would be supposed from the above scant statement. For instance, I have picked out from Michaelsen's systematic summary of the family, in 'Das Tierreich,' the following definite statements, and these are the only ones that I can find:—

Branchiura sowerbyi	x. to xii.	Beddard *.
Tubifex (Heterochæta) costatus	$\frac{1}{n}$ x. to $\frac{1}{n}$ xiii.	Benham †.
T. (Psammoryctes) velutinus	$\frac{1}{2}$ x. to xii.	Randolph ‡.
T. (P.) plicatus		
T. (Spirosperma) ferox	$\frac{1}{n}$ x. to $\frac{1}{n}$ xii.	
Tubifex blanchardi	(ix.) x. and xi.	
Rhizodrilus (Vermiculus) pilosus	x. to $\frac{1}{2}$ xiv.	Goodrich §.
R. lacteus	$\frac{1}{2}$ x. to $\frac{1}{n}$ xiii.	F. Smith ‖.
Bothrioneuron americanum	xi., xii.	Beddard ¶.
Clitellio arenarius	x. to xii.	
Limnodrilus gotoi	$\frac{1}{2}$ x. to $\frac{1}{2}$ xii.	Hatai **.

I have not at my command the earlier literature on the subject; but it is a curious fact that in neither of these monographs is there a record as to the position of the clitellum in such common European species as *Tubifex rivulorum*, *Limnodrilus claparedianus*, &c.

TUBIFEX sp. inc.

From Lakes Taupo and Rotoiti some immature worms were obtained which appear to belong to this genus.

The dorsal bundle contains 2 to 4 long capilliform chætæ together with 2 to 4 "ctenates"; the ventral bundle 4 crochets anteriorly, dwindling to 2 posteriorly; the two prongs of about equal length, but the lower is rather stouter than the upper. In one instance the capilliforms occur only in the first few segments, in other cases (from Rotoiti) they are present throughout the body. Only one chæta exists in the ventral bundles of segment x., and none at all in segment xi. Commissural blood-vessels are present in segments ii. to xi., those of the last two segments being very long; while in segment viii. is a large, much dilated "heart."

Though these characters are insufficient to permit me to give a name to the species, it appears to be different from *T. rivulorum*, which species has been recorded by Beddard (1889) from New Zealand.

ENCHYTRÆUS SIMULANS, sp. n. (Plate XXV. fig. 25 & XXVI. figs. 26–28.)

Seven short and relatively stout worms were amongst those

* Beddard, Quart. Journ. Micr. Sci. xxxiii. p. 325.
† Benham, Quart. Journ. Micr. Sci. xxxiii. p. 188.
‡ Randolph, Jen. Zeit. xxvii.
§ Goodrich, Quart. Journ. Micr. Sci. xxxvii. p. 253.
‖ Smith, Bull. Illinois Lab. v. p. 244.
¶ Beddard, Ergeb. Hamb. Magalhaen. Sammelreise, p. 7.
** Hatai, Annot. Zool. Jap. iii. p. 5.

collected in Lake Taupo, and clearly belong to the genus *Enchytræus*.

The *prostomium* is short, rounded, and somewhat conical; the anterior segments are well marked, though the body-wall is thin and transparent.

The *chætæ* are in four bundles, of (usually) three in each bundle; they are straight rods with blunt ends; all are alike in form and size. The three chætæ in each bundle are arranged fanwise, *i. e.*, the middle one upright, and the other two making equal angles with it on either side. Occasionally, in the anterior ventral bundles, a fourth chæta was noted.

The *clitellum* covers segments xii., xiii., and part of xiv.

The *male pores*, on segment xii., are in depressions on either side and in line with the ventral series of chætæ, which, however, are absent in this segment.

Internal Anatomy.

The brain is convex posteriorly. Peptonephridia are absent from the back of the pharynx.

The ordinary *nephridium* has a relatively long and narrow preseptal region (Pl. XXVI. fig. 26); the postseptal region is about twice the length of this, and is distinctly marked off from it. It consists of an irregularly pear-shaped "body," which tapers off posteriorly to form a long narrow duct, set nearly at right angles to the "body," but slightly inclined forwards.

The *spermiducal funnel* is particularly large (Pl. XXVI. fig. 28), about four times as long as its breadth; it is thick, and bent in more than a U-shaped curve (perhaps due to changes during preservation), for it appears S-shaped in longitudinal section. The entrance is narrow, but there are no columnar cells at its margin, which is not reflexed. The wall of the whole funnel consists of long glandular cells, which in their distal moities are filled with granules.

The sperm-duct is short, confined to its segment, and coiled in a close and regular zigzag; it opens in a depression which results from the contraction of several radiating muscles in this region, near a group of gland-cells which open through the epidermis on the outer side of the male pore.

The *spermatheca* (Pl. XXVI. fig. 27), which communicates with the œsophagus, lies in the usual segment. The ampulla is nearly spherical; the duct is distinctly marked off from it, is about half the length of the ampulla and much narrower than it.

Gland-cells are present around the duct throughout its length; that is, the epithelium consists of tall cells with clear contents; the greater part of each cell projects beyond the muscular wall of the duct, and these portions form a continuous extra-muscular layer (Pl. XXVI. fig. 28). The actual lining of the duct appears to be formed by a protoplasmic sheet, in which I detect neither cell-boundaries nor nuclei; and this sheet appears to result from the fusion of the internal ends of these "glandular" cells. The

condition, indeed, is similar to that figured by Michaelsen for "*E. möbii*" (= *E. albidus*).

Dimensions. Length 15 mm.; diameter $\frac{3}{4}$ mm. Segments about 58.

Locality. Lake Taupo, North Island, New Zealand.

Remarks.—It seemed likely, from a preliminary examination, that this species might be *E. albidus* Henle, which has a very wide distribution; but in the details of the more important organs there appear to be sufficient differences to permit the bestowal of a new name.

The figures of the male apparatus given by Eisen* and by Michaelsen† show a distinct everted lip to the spermiducal funnel; the sperm-duct is not so compactly coiled in a zigzag, while it may reach as far back as the eighteenth segment.

The nephridia of *E. albidus* also appear to differ from these organs in our species‡; while the absence of a peptonephridium in our New-Zealand worm appears to mark it off from *E. albidus*.

In possessing only 3 chætæ per bundle, it resembles *E. hyalinus* Eisen, and *E. adriaticus* Vejd. From the latter it is distinguished by the form and proportions of the three regions of the nephridium. With the former, however, it agrees very closely in the structure of the male efferent apparatus §, but the spermatheca in that species has an "atrium-like dilatation" on its duct, which is absent from the new species. The form of the nephridium is also a point of agreement. But the fact that *E. hyalinus* occurs in Novaya Zemlya seems to exclude the possibility of its introduction into Lake Taupo.

ACHÆTA MAORICA, sp. n. (Plate XXV. figs. 23, 24.)

A single, but fortunately a mature specimen of this small worm was obtained at Station 18 in Lake Manapouri.

It was stained in alum-cochineal and mounted entire, and its anatomy studied as far as possible. It was then unmounted, and the anterior half was cut into a series of longitudinal sections, and the rest of the body into transverse sections. Owing to the flattening to which it had previously been subjected, the former series was not very satisfactory, especially as the sections were a good deal torn by the diatom-valves and dirt in the intestine. Nevertheless the anatomy was sufficiently studied for systematic purposes.

The *prostomium* is short, rounded, and provided with the usual terminal pore.

There are no chætigerous sacs, nor could I detect any "chlorophyll-glands."

The *clitellum* appears to include only segment xii., encroaching but slightly into the hinder region of segment xi.

* Eisen, Svenska Ak. Handl. (n. ser.) xv. p. 25, pl. ix. fig. 18, pl. x. fig. 20.
† Michaelsen, Untersuch. u. *E. möbii*, 1886, p. 1, pl. iii. fig. 9.
‡ Goodrich, Quart. Journ. Micr. Sci. xxxix. p. 51, pl. v. fig. 2 (nephridium).
§ Eisen, *loc. cit.* pl. x. fig. 20.

I could not detect any "great cells," such as occur in the clitellum of some species of this genus.

The *male pores* are paired and situated at about the middle of segment xii.

The *spermathecal pores*, paired, lateral, lie at the anterior boundary of segment v.

Internal Anatomy.

There are septal glands on the hinder septa of segments iv., v., vi., and these septa are rather stouter than the rest.

Segments vii., viii. (as indicated by their ganglia, for the external boundaries are difficult to detect in the transparent worm) are much shorter than their neighbours; the tenth and following are almost twice the length of either of these two.

The *dorsal vessel* arises in segment x.; but I fail to discover any swellings on its course.

The *sperm-funnel* occupies about half of segment xi.; it is urn-shaped, without an everted margin (Pl. XXV. fig. 23), and its length is about equal to twice its breadth. The sperm-duct, less than twice the length of funnel, takes a nearly straight course backwards to about the middle of segment xii., when it bends downwards almost at right angles; it is dilated after passing through the septum xi./xii., but it soon narrows again, and the external opening is surrounded by a small lens-shaped mass of glandular cells (spermiducal gland), which it perforates at about the centre.

Loose masses of developing spermatozoa occur in the body-cavity of segments ix. and x., and a few even in segment viii.

The *spermatheca* is much elongated (Pl. XXV. fig. 24); its aperture (surrounded by a group of gland-cells) leads by a short canal into an ovoid dilated sac lying in segment v., thence a narrow canal passing through segments vi., vii. begins to enlarge after passing through the septum vii./viii. to form a large "ampulla" lying in segments ix. and x., which is constricted at about its middle. The ampulla contains bunches of ripe spermatozoa.

The *ovary* and *duct* have the usual positions, and the body-cavity of segment xii. is fully occupied by a couple (or more) of large eggs, which distend the body.

Dimensions. Length 4 mm.; breadth very small. Number of segments 22, with an anal segment.

Locality. Lake Manapouri, South Island, New Zealand.

Remarks.—This species agrees with *A.* (*Anachæta*) *cameranoi* Cognetti* in its smaller size and in the total absence of chætigerous follicles, but in nothing else; for its spermatheca somewhat resembles that figured by Vejdovsky (Syst. u. Morph. pl. vii. fig. 22) and labelled *A. eisenii*, but which Beddard † suggests really belongs to *A. bohemica*. But in the point of origin of the dorsal vessel it differs from each of these species.

Having only a single preserved specimen, I am unable to give

* Cognetti, Boll. Mus. Zool. Anat. Comp. Torino, xiv. 1899, no. 354.

† Beddard, 'Monograph,' p. 356.

any details as to lymph-corpuscles, nephridia, and certain other anatomical features.

HAPLOTAXIS HETEROGYNE, sp. n.*

The *prostomium* is long, but not annulated.

The *chætæ* are four per segment, isolated, one dorsal and one ventral on each side; the form agrees with that found in *H. gordioides*. The ventral chæta is from two to three times the length of the dorsal, but less difference exists in the anterior segments. The dorsal chætæ occur throughout the body.

The *clitellum* surrounds segments xi. to ½ xiv.; it is complete and thickest laterally.

The *genital pores* were not detected externally; but the ducts, traced in sections, meet the body-wall at points indicated below. There are two pairs of male ducts which reach the epidermis in segments xi., xii. anteriorly to the ventral chætæ. There is a single pair of oviducal pores on segment xiii. laterad of the line of ventral chætæ, but rather nearer the anterior margin of the segment than these; but they are much further back in their segment than the male pores are.

Two pairs of spermathecal pores lie at the anterior margins of segments viii., ix.

The *alimentary canal* is remarkable for possessing a strongly muscular *gizzard* in segment iv.; it is quite different from a pharynx, which is here absent. A similar, but more extensive, gizzard has been recorded by Michaelsen † for *H. gordioides*.

The first pair of *nephridia* lie in segment x.; they are rather smaller than the postovarian nephridia. These organs are absent in segments xi., xii., xiii., but reappear in segment xiv. *et seqq.*

The nephridial canal perforates a string of large cells having distinct boundaries and highly vacuolated cytoplasm. Each nephridium reaches the epidermis close to the ventral chæta, through a short "duct" formed of a highly granular syncytium.

As in the case of the sperm-ducts, I was unable to detect an actual perforation or opening through the epidermis.

Reproductive System (text-fig. 23, p. 224).—Two pairs of testes and sperm-funnels occur in the usual positions in segments x., xi. The sperm-duct leaves the large, thick, flattened sperm-funnel at its ventral edge, as Beddard ‡ found was the case in *H. smithi*. But the sperm-duct in that species has the usual structure, *i. e.* is surrounded by a definite epithelium.

In the present species the sperm-duct perforates a series of cells the boundaries of which are not distinguishable, and has an undulating course in this syncytium, which extends up to the level of the lateral line. The duct passes upwards to this level, then bends upon itself, still within the syncytium, and reaches the body-wall in front

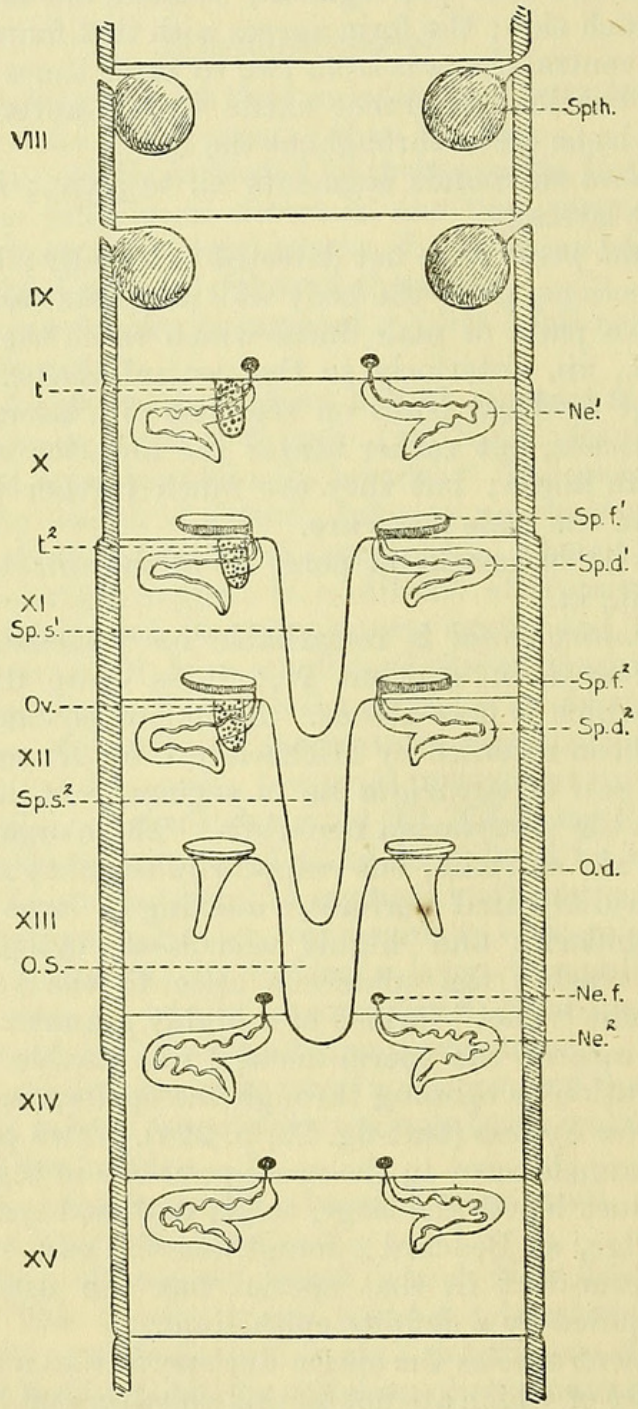
* A detailed and illustrated account of this worm has been sent to the Editor of the Quart. Journ. Micr. Sci.

† Michaelsen, Zool. Jahrb. (System.) xii. p. 105.

‡ Beddard, Ann. & Mag. Nat. Hist. ser. 6, i. p. 389 (1888).

of the ventral chæta. A transverse section through the sperm-duct has all the appearance of a section across a nephridium: we see, not an epithelium surrounding the lumen, but a perforated cell, with rarely more than one nucleus in the plane of the section,

Text-fig. 23.



Plan of genital organs in *Haplotaxis heterogyne*, composed from study of entire worm and sections. The gonads are omitted on the right side in order to show the full course of the sperm-ducts, each of which leaves its funnel at its ventral edge; it has a course similar to that of a nephridium, and, like the latter, traverses a cord of cells.

Ne.[1], the first nephridium; *Ne.*[2], the second; *Ne.f.*, nephridial funnel; *O.d.*, oviduct; *O.s.*, ovisac; *Ov.*, ovary; *Sp.d.*, sperm-duct; *Sp.f.*, sperm-funnel; *Sp.s.*, sperm-sac; *Spth.*, spermatheca; *t.*, testis.

sometimes none. The general disposition of the perforated syncytium is very similar to a nephridium, and the canal takes a course similar to the latter tube, but is not quite so undulating. The canal bears cilia throughout its whole extent.

So similar is this sperm-duct to a nephridium in this worm, that the differences are only perceptible when the organs are examined under a very high magnification (such as $\frac{1}{12}$ homogeneous immersion). But that this nephridium-like tube does actually serve as a sperm-duct, is demonstrated by the presence of sperms within the canal, and the fact that in the case of one funnel I noted spermatozoa entering the mouth of the canal. Though I traced the ducts to the body-wall, I was quite unable to detect the pore in either sperm-duct; nor was Michaelsen successful in finding the actual aperture in *H. gordioides*. Of the two individuals obtained by me one was fully mature; the segments x., xi. were filled with ripe and developing sperms; and the spermathecæ were also filled with them; hence copulation had recently occurred. The other individual was quite immature, although the three pairs of gonads and the ducts were present; in this individual, likewise, there are no nephridia (unless the sperm-ducts are nephridia) in segments xi., xii., xiii.

It appears to me that in this worm *the nephridia do act as sperm-ducts*, as was suggested by the earlier students of *Haplotaxis*. There are two median sperm-sacs, in the form of simple pouches, formed by the septa x./xi., xi./xii., which are pushed backwards above the gut so as to reach into segments xii., xiii. respectively. Each of the sperm-sacs is filled with developing and ripe spermatozoa.

There is but a single pair of ovaries and oviducts: the former in segment xii.; the latter opens in about the middle of segment xiii. The oviduct is a wide tube surrounded by a ciliated epithelium, and opens by a wide funnel into segment xii. This duct is present in the immature specimen, and can be seen traversing the anterior half of segment xiii.

The presence of a single pair of female organs marks off this species from the two other known representatives of the genus; and in this respect our species resembles *Pelodrilus*, an allied genus, originally founded by Beddard * for a New-Zealand worm, *P. violaceus*; but the discovery by Michaelsen † of *P. ignatovi* from Central Asia, in which the two pairs of sperm-ducts open on independent segments, forms a passage to *Haplotaxis*. But in all other characters this new species agrees with the diagnosis of *Haplotaxis* and differs from that of *Pelodrilus*.

A single median ovisac, filled with eggs, passes backwards through segment xiii.

In segments xi., xii., xiii. are paired copulatory glands, similar to those present in some Enchytræids; those of segment xii. open laterally, near the ventral chætæ; the other two pairs open below

* Beddard, Trans. R. S. Edinb. xxxvi. p. 292.
† Michaelsen, Verh. naturw. Ver. Hamburg, 1903.

Benham, W. B. 1903. "On some new species of aquatic Oligochaeta from New Zealand." *Proceedings of the Zoological Society of London* 2, 202–232.

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