

anterior abdominal vein loses its direct connection with the sinus venosus, and acquires a secondary one with the hepatic portal system."

In the European frog *Bombinator*, which is closely allied to the New Zealand frog *Liopelma*, Goette* had already described a similar course of events, while Hochstetter† found in the larva of the salamander that the two abdominal veins are at first separate for the greater part of their length, but unite near the liver to form a median vein which enters the left precaval vein; but with the absorption of the yolk this communication is lost and a new one established with the hepatic portal system.

The occasional persistence in *Rana* of either a right or a left connection with the sinus venosus by way of a precaval has already been emphasized by Woodland and O'Donoghue.

That the present instance is not an exact recapitulation of the larval condition is seen by the fact that the anterior end of the lateral vein on each side is not connected with the sinus venosus but with the precaval, which is apparently an earlier condition, as seen in the Elasmobranchs.

ART. IV.—*Some Earthworms from Stephen Island and D'Urville Island.*

By PROFESSOR W. B. BENHAM, D.Sc., F.R.S., Hutton Memorial Medallist.

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DURING the present year Dr. J. Allan Thomson visited these islands in Cook Strait, and amongst the animals collected by him were a few earthworms, which he was good enough to send to me for identification.

No earthworms have hitherto been recorded from D'Urville Island, though we are already acquainted with three species from Stephen Island. Some were collected by Schaunsland during his visit in 1896-97, and others by Thilenius; and they have been described by Michaelsen (1) and by Ude (2) respectively.

These three worms are *Octochaetus thomasi* Beddard, *Maoridrilus tetragonurus* Michaelsen, and *Dinodrilus gracilis* Ude. The first of these species is a well-known and widely distributed South Island form, which was one of the earliest of the New Zealand worms to be accurately described (3); the other two species are so far confined to Stephen Island, though they belong to genera which are known in the South Island and the North Island.

The present collection contains two out of these three species, and in addition two new species of *Maoridrilus*, one from each of the islands, together with a new species of *Perieodrilus*, a genus hitherto known only from the mountains of the west coast of the South Island. So, as one would expect, the Oligochaeta fauna of the two islands is mainly derived from the South.

* A. GOETTE, *Entwickel der Unke*, 1875.

† F. HOCHSTETTER, *Morphol. Jahrbuch*, vol. 21, p. 19, 1894.

Octochaetus thomasi Beddard.

Three individuals of this common South Island species were included in the collection from Stephen Island.

Maoridrilus tetragonurus Michaelsen.

This handsome species is evidently tolerably common on Stephen Island, as Michaelsen obtained four specimens. Ude speaks of several, and Dr. Thomson sent me seven individuals collected during his brief visit.

The largest specimen in this last gathering measures 210 mm. in length, which is not so long as those described by Ude, which attained as much as 280 mm.

I have nothing to add to the two accounts given by these two zoologists.

M. megacystis n. sp.

A single specimen of a small worm measures 90 mm. in length, with a diameter of 5 mm.; but it is poorly preserved, so that its dimensions are not accurately indicated by these figures.

Its colour is greyish-purple when preserved, and the clitellum has a redder tone.

The clitellum is fairly well marked over segments 14–22: that is to say, the segments themselves are glandular, but the intersegmental furrows still remain distinct.

The chaetae have the arrangement usual in the genus: the spaces *aa*, *bc*, and *dd* are practically equal, though *aa* is rather less than *dd* or *bc*—at any rate, behind the clitellum. Owing to the softness of the worm, it does not show the squareness of the tail which is so common in the genus.

Porophores are but feebly developed, and the ventral region of the segments 17 and 19 between the porophores is depressed so that in the 18th segment a slight transverse pad is left on the ventral surface. The spermathecal grooves are convex mesially, and lie mediad of the ventral chaetae, which are quite distinct here, and are not thrust out of line of those in the neighbouring segments (as are those in the next species).

Internal Structure.—The septa separating the segments 8–14 are more or less thickened.

The dorsal vessel is single throughout the worm; the last heart is in the 13th segment.

The gizzard lies in the 6th. This is its true or "morphological" position, but, as is usually the case, it gets pushed backwards owing to the fact that the preceding region, like the gizzard itself, is longer than the segments to which it belongs.

There are large oesophageal glands in the 15th and 16th segments, and a smaller pair in the 14th. They are subspherical dilatations of the tube on each side, and the anterior two pairs meet their fellows above the gut.

The reproductive organs lie in the usual segments and in their normal positions.

Each spermatheca (fig. 1) has a relatively enormous diverticulum, which is as large as the ampulla—so large, indeed, that at first one thinks there are four spermathecae. The diverticulum, further, is not racemose, as usual, but has a smooth wall and a nearly globular form. When mounted, however, and viewed under the microscope one can see the outlines of the characteristic chamberlets into which its cavity is divided; but these walls do not affect the surface.

Another peculiar feature is that the duct of each of the two sacs opens into a large muscular "atrium," which in its turn opens to the exterior.

The penial sacs are large, and the penial chaetae long. These are bluntly pointed, and the edges are curved upwards so as to form a short shallow furrow extending a short distance from the apex (fig. 2). These edges are ornamented with a few short bluntly pointed processes, but the rest of the chaeta is smooth. I examined not only a fully developed chaeta, but also one of the reserves, which exhibit precisely the same features, so that the processes are not produced by wear of the edges.

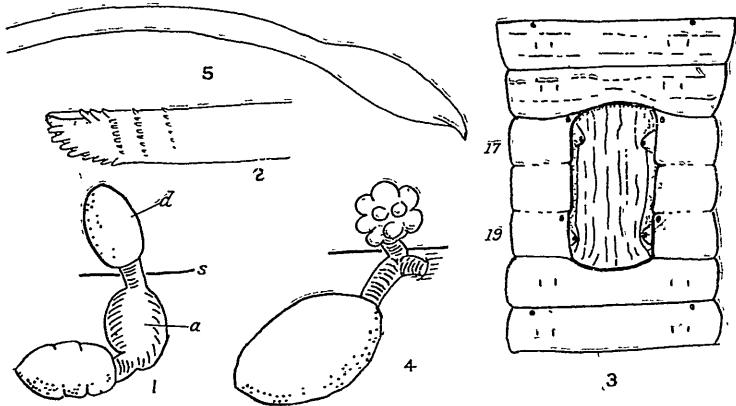


FIG. 1.—*Maoridrilus megacystis*. Spermatheca. *a*, muscular "atrium" common to the ducts of the ampulla and the diverticulum (*d*); *s*, septum.

FIG. 2.—*M. megacystis*. Tip of a penial chaeta, under a high power.

FIG. 3.—*Maoridrilus thomsoni*. View of the ventral surface of segments 15-21 ($\times 4\frac{1}{2}$), showing the characteristic "trough" and the position of the ventral nephridiopores.

FIG. 4.—*M. thomsoni*. Spermatheca.

FIG. 5.—*M. thomsoni*. Penial chaeta.

Locality.—Stephen Island.

Remarks.—The only species at present known in which the dorsal vessel is single throughout the body is *M. michaelsoni* Ude (2), which was collected at Westport; but in that species the diverticulum of the spermatheca is quite small, its duct is narrow, and there is no "atrium"; further, the penial chaetae are quite different. The size of the diverticulum suggests the specific name.

M. thomsoni n. sp.

Of this species also there is but a single individual, which seems to be of about the same size as the previous species, but is in even a worse state of preservation than it. It is damaged just behind the clitellum, and is very soft. Its posterior end is missing, and there is as yet no sign of tapering. We do not know, therefore, what is its length. The fragment contains 198 segments and measures 65 mm. in length. The first 24 segments contribute 10 mm. to this.* Its diameter behind the clitellum is

* In the previous species this anterior region accounts for 25 mm., but I did not make corresponding measurements of the other features, for I had opened it before studying the present worm.

5 mm., but, as usual, is somewhat less at about the 7th segment, which is but 4 mm. across, and less again at the genital region, which is only 3 mm. It is evident that these measurements do not give a true idea of the dimensions.

The chaetae are equally spaced, so far as one can see on the animal.

The clitellum, though not yet thickened, seems to cover segments 16–20, for the intersegmental furrows are evanescent. Probably when the worm is mature the clitellum extends farther forward than this.

The spermathecal pores are conspicuous owing to their tumid lips.

There is one external feature in which this worm seems to show a marked peculiarity. On the ventral surface of the segments 17–19 there is a rather deep rectangular trough, with well-defined lateral and terminal boundaries, while the non-glandular floor is marked by longitudinal foldings. The appearance is that this ventral region is withdrawn by internal muscles (fig. 3).

The longitudinal margins correspond to the level of the ventral couples of chaetae, but on these segments, owing no doubt to the retraction of the ventral region, which results in the formation of the trough, the ventral chaetae and the nephridiopores are carried mediad of the line formed by these structures in the neighbouring segments. Under a dissecting-lens the chaetae themselves are not visible on these three segments, but the ventral nephridiopores of segments 17 and 19 are quite conspicuous and are out of the line.

The porophores lie within this lateral margin, and are not prominent. They project rather into the trough from the sides than from its floor, so that the pores face inwards towards the middle line.

The spermatic groove is very evident: its outer lip is formed on each side by the edge of the lateral wall of the trough; the inner lip is seen lower down this wall.

Internal Structure.—I did not note any specially thickened septa, as everything is so soft.

The dorsal vessel is single throughout the worm; the last heart is in the 13th segment.

The gizzard belongs morphologically to the 6th, for the septum 5/6 is inserted at its hinder end; but its "apparent" position is in the 8th and 9th segments—that is, a transverse line across the body as dissected, passing over its anterior end, cuts through the intersegmental furrow 7/8, and its posterior end lies at the transverse line through 9/10.

Oesophageal glands are large and spherical, and meet above the tubes in 14th and 15th, while in the 16th is a smaller gland; the intestine commences in segment 20.

The spermatheca has a large ampulla (larger actually than that of the previous species) with a narrow duct, which carries a small racemose diverticulum of the form usual in the genus (fig. 4).

The penial sac, and consequently the copulatory chaetae, are not nearly so long as usual. This, I think, is to be accounted for by the external trough, which probably aids in the process of copulation in this species, as it appears to do in certain other families of worms. But I can detect no "arcuate" muscles in these segments. The penial sac is not only relatively, but absolutely, smaller than in the previous species. Here it is scarcely longer than the length of the segment, whereas in *M. megacystis* it extends across the body-wall half-way towards the dorsal mid-line.

The penial chaeta (fig. 5) is slender, curved, and slightly swollen just below the apex, whose sharp point is slightly bent up to form a hook; it has no perceptible furrow. The sides are not ornamented by rows of minute teeth as in *M. michaelsoni*, but in certain lights some five or six faint transverse lines can be made out just below the swollen region.

Locality.—D'Urville Island.

Remarks.—This species certainly has some resemblances to *M. michaelsoni*, especially in the possession of a depression on the segments 17–19. But from it the present species differs in one or two features that seem to be specific. The gizzard, which in that species is said to occupy the two segments 6 and 7, here lies only in the 6th. I was careful to trace out the septa as above described.

The oesophageal glands, four in number, are said by Ude to be "small." The penial chaetae are described as "long," "spoon-shaped," and ornamented with very fine teeth in transverse rows; and, though the tip is curved, its curvature is in the other direction, and there is no swelling below the apex. Thinking that perhaps this last feature was due to pinching with the forceps, I examined a "reserve," or undeveloped, chaeta, which I find exhibits the same subterminal enlargement.

Ude also speaks of the penial sac as being "absent." I have noted its very small size, and it may be that in a well-hardened specimen it would not project within the body-wall.

Had it not been, however, for the distinctness between the form of the penial chaetae in the two forms, I should have regarded this as merely a variety of Ude's species.

Perieodrilus durvilleanus n. sp.

A single individual was received, which unfortunately is immature.

A brick-red worm, with its mid-dorsal line of much deeper tone than elsewhere; each segment is marked by a number of white spots, in each of which is a chaeta.

Length, 108 mm.; diameter, 6 mm.; with 117 segments. The body is cylindrical, with scarcely any tapering at the hinder end.

The prostomium is tanylobic.

There are some 20–24 chaetae on each side of each segment. They are not in definite couples, but are more or less equidistant, though here and there a chaeta is absent.

The dorsal "gap" is about one-third the width of the ventral gap.

Dorsal pores are present, but I failed to note at what segment they commence. No nephridiopores are visible under the dissecting-lens, owing, I believe, to the softness of the wall.

There is no sign of a clitellum. On the 17th and 19th segments, outside the ventralmost chaeta on each side, is a faintly expressed papilla, recognizable in its immature condition by its pink colour in contrast with the nearly white colour of the surrounding skin. No spermathecal groove is as yet present.

Internal Structure.—The septa behind the segments 9 to 13 or 14 are thicker than the rest.

The dorsal vessel is double throughout the worm; enlarged hearts in 10th to 13th segments.

The gizzard is long, lying apparently in the 7th and 8th, but in reality it belongs to the 6th and possibly partly to the 7th.

The oesophageal pouches or glands are four pairs, in segments 10, 11, 12, and 13: each is a subglobular outgrowth marked by a series of vertical lines which indicate the attachment of internal folds or lamellae. They are quite lateral in position and do not overlap the gut.

The intestine commences in the 18th segment.

The gonads occupy the usual position on the hinder face of the septa of their respective segments, inserted close to the attachment of the septa to the body-wall. The prostates are as yet very small but quite distinct under a lens, and are of the usual form; the muscular ducts are recurved. There are no penial sacs, and at present no transverse muscles in these segments such as are present in the mature stage of the other species.

The spermathecae occupy the usual position: each consists of a pointed ovate sac, or "ampulla," with a short stout duct, into the anterior face of which opens a bifid diverticulum, the free ends of which lie at the right

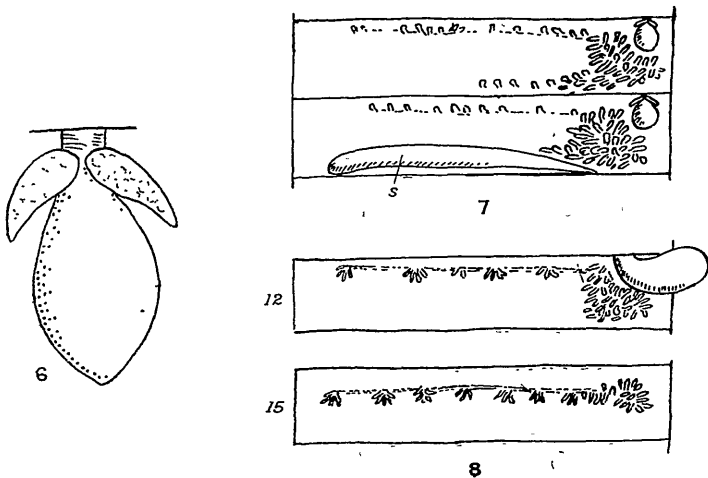


FIG. 6.—*Perieodrilus durvilleanus*. Spermatheca. The dotted circles on the diverticula indicate the chamberlets, which are visible only when the organ is cleared.

FIG. 7.—*P. durvilleanus*. The left side of segments 8 and 9, showing the spermathecae, nephridial tuft and its lateral extension, and in the latter segment the sperm-sac (s). The median line is towards the right side.

FIG. 8.—*P. durvilleanus*. The left half of segments 12 and 15, showing the gradual dissolution of the nephridial tuft and its extension dorsalwards.

and left sides of the ampulla (fig. 6). Externally they appear simple, but when mounted and viewed as transparent objects the internal chamberlets are visible. In this condition the diverticulum appears as a semicircular collar round the duct, much as I have figured it for *P. ricardi* (5); but seen in the animal the distinctness of the two long processes of the diverticulum is very evident.

There are four pairs of sperm-sacs, in segments 9, 10, 11, 12. The two anterior sacs have at present the form of long white slender cylindrical tubes resting against the hinder septa of the segments (fig. 7); each terminates upwards in a rounded end, and is attached ventrally to the septum close to the body-wall and nerve-cord. The two posterior sacs are shorter, wider, and lie along the anterior wall of their segments (fig. 8): in short, they have the usual position, but are at present only commencing to form.

The Nephridia.—From the 2nd to the 14th segments, inclusive, the nephridium is represented by a conspicuous tuft of minute looping tubules arranged in such a way as to form a sort of "rosette" close to the nerve-cord and occupying nearly the whole length of its segment. It is thus a more or less rounded or quadrate mass of tubules. These tufts are much larger in the more anterior segments, and in the 2nd, 3rd, and 4th seem to represent the entire organ, but farther back one sees that the tubules are not confined to these tufts but extend outwards along the body-wall for a short distance as a linear series of isolated loops near the septa (fig. 7). In about the 7th–11th I believed that under a high-power dissecting-lens I could detect a duct or tube passing outwards, and ending apparently on the body-wall about half-way up the side of the body. I therefore cut out, stained, and mounted a portion of the side of the body, including the segments 7–11, in the hope of being able to satisfy myself as to the locality of the pore; but I was unsuccessful. The body-wall is too soft to allow such a small aperture to be recognized.

I then mounted the cuticle of these segments, but was no more successful, for, though the large spermathecal pores and the linings of the chaetiferous follicles are perfectly evident, there is no pore that I could interpret as being the nephridiopore.

Sections were equally useless, owing, as I believe, to the soft condition of the specimen.

To continue the internal appearance: The dissolution of the tuft of the tubules, which commences about the 7th segment, continues till at the 15th almost all the loops are arranged in the linear series (fig. 8), and by the 17th I fail to see any tuft or rosette. At the 20th I am unable to detect any loops under a lens, but by picking up at random the tissue that lies between the septa I find under the microscope that it consists of minute nephridial tubules with accompanying blood-vessels.

I was unable to detect any funnel, but the poor state of the tissue has rendered it difficult to make as thorough an investigation on this important point as is necessary.

However, it is clearly, I think, a "meganephric" worm such as I have previously described.

Locality.—D'Urville Island.

Remarks.—The genus *Perieodrilus* (which Michaelsen has separated from my *Plagiochaeta*) (4) is so far confined to the mountains of the West Coast: it is therefore not surprising that a representative occurs in this island.

It is evident that the present species is nearly related to *P. montanus* and to *P. ricardi* (5), but from each it differs in one or more features. Externally its coloration recalls that of the former, as also in the concentration of the nephridial loops near the ventral region of the body (6); but in *P. montanus* the gonads are situated on the posterior wall of their segments, in *P. ricardi* they are on the ventral wall midway between the septa. Only in *P. lateralis* are they in their normal anterior position as in the present species, but in that worm there are no oesophageal glands and only two pairs of sperm-sacs. In the two other species, while there are four pairs of sperm-sacs, there is only one pair of oesophageal glands. The form of the spermathecal diverticulum likewise differs from that in the known species.

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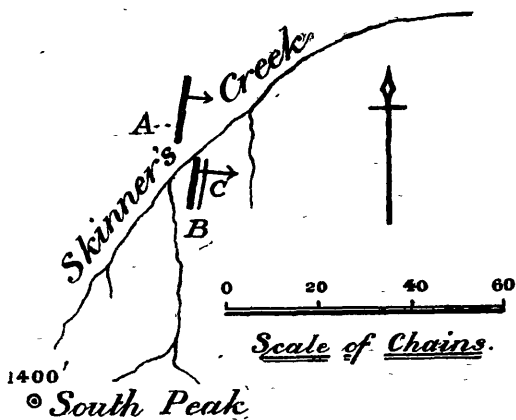
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ART. V.—*On the Occurrence of Three Bands of Marble at South Peak, near Hampden, Otago.*

By Professor JAMES PARK, F.G.S.

[Read before the Otago Institute, 10th December, 1918; received by Editor, 27th December, 1918; issued separately, 14th May, 1919.]

IN the early part of last November, while investigating the extension of the Shag Point beds to the landward side of Hampden, I was informed by Mr. A. Craig, of that place, that an attempt had been made some twenty years ago to burn limestone in a kiln somewhere near the upper end of Baghdad Road. As the result of two days' search, with the assistance of Mr. Craig, I found a small outcrop of a grey crystalline limestone on the north side of Skinner's Creek, at an altitude of 450 ft. above the sea, at a point about 300 yards from Baghdad Road. The outcrop had been opened out by blasting, and I concluded that this was the place from which the material for the experimental burning had been excavated. I continued the search towards South Peak, and succeeded in discovering three well-defined bands of limestone, two on the south side of Skinner's Creek and one on the north.



A, B, and C, lenses of limestone.

These bands are interbedded in the altered argillite that forms the core of the coastal range lying behind Hampden. They strike almost north and south (true), and dip east at angles that vary from 50° to 65° .

Band A is about 5 ft. thick; band B, 12 ft.; and band C about 2 ft. Bands B and C are separated from one another by 32 ft. of argillite. Band A, geologically the lowest, is perhaps 200 ft. below band B.