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XXXIV.—An earthworm from Eduador (*Rhinodrillus ecuadoriensis*)

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Palpi picei, parte femorali sordide testacea. *Pedes* ad partem nigricantes vel subpicei, ad partem testacei: 1ⁱ paris picei sunt, femoribus fascia longitudinali subtestacea supra notatis, coxis, patellis et tibiis testaceis (saltem patellæ tamen linea picea longitudinali utrinque notatis); metatarsi hujus paris fuliginei sunt, fascia longitudinali testacea supra, tarsi nigricanti-testacei. In pedibus 2ⁱ paris coxæ et femora ad maximam partem picea sunt, sequentia internodia vero testacea, linea longitudinali picea utrinque, per patellam et tibiam usque in metatarsum ducta. *Pedes* posteriores picei, patellis basi oblique et metatarsi apice testaceis, tarsis testaceis totis, trochanteribus 4ⁱ paris testaceis quoque. *Abdomen* nigro-piceum, subter paullo pallidius, pilis appressis tenuibus albis sat dense vestitum. *Mamillæ* testaceo-piceæ.

♀ jun.—Lg. corp. $4\frac{1}{2}$; lg. cephaloth. pæne $2\frac{1}{2}$, lat. ej. 1: lg. abd. 2, lat. ej. pæne $1\frac{1}{2}$ millim. Ped. I. circa $5\frac{1}{4}$, II. circa $3\frac{1}{2}$, III. 4, IV. fere $6\frac{3}{4}$ millim. longi; pat. + tib. IV. pæne 2 millim.

One specimen only, a not fully developed female.

13. *Plexippus Paykullii* (Aud. in Sav.)

1827. *Attus Paykullii*, Aud. in Sav., Descr. de l'Égypte, 2^e éd. xx. p. 172, pl. vii. fig. 22.

A male and a female, both adult.

14. *Telamonía Peckhamii*, Thor.

1891. *Telamonía Peckhamii*, Thor., Spindl. fr. Nikobarerna &c., loc. cit. p. 125.

A single nearly adult female. This species had hitherto been met with only in the Nicobar Islands and in Sumatra.

XXXIV.—*An Earthworm from Ecuador* (*Rhinodrilus ecuadoriensis*). By W. BLAXLAND BENHAM, D.Sc. (London), Aldrichian Demonstrator in Comparative Anatomy in the University of Oxford.

[Plate X.]

ON November 23, 1889, I received, owing to the kind suggestion of my friend Prof. Jeffrey Bell, two small earthworms from Mr. Edward Whympster for the purpose of identification; and I wish to record my best thanks to that gentleman for allowing me not only to identify them but to retain them for purposes of further research.

The two worms, from their external characters, appeared
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to be one species at different ages, for in the smaller of the two the clitellum was undeveloped, whereas the larger—which is the subject of the present communication—was evidently mature. Being of this opinion, I cut the smaller worm into a series of sagittal sections and proceeded to dissect the larger; more recently, however, having had the leisure in which to examine these sections, I find that the former presents several important differences from the larger dissected one, and certain peculiar characters, which, at the moment, I have not time to discuss, so that I must leave the worm unidentified for the present.

Of the genus *Rhinodrilus*, Perrier, we at present know three species, all from the neotropical region, viz. *R. paradoxus*, Perrier *, from Caracas, in Venezuela, *R. Gulielmus*, Beddard †, from British Guiana, and *R. Tenkatei*, Horst ‡, from Surinam; the new species, which has affinities with both the latter, was collected at Cayambe, in Ecuador, at a height of 14,000 feet.

Rhinodrilus ecuadoriensis, sp. n. §,

is 3 inches (7.5 centim.) in length, and consists of some one hundred somites. It is thus smaller than any of the previous species, though *R. Tenkatei* approaches it most nearly, being 11.5 centim. in length.

The *colour* of the preserved specimen is perhaps worth recording, though no doubt very different in life; when stripped of its cuticle it was dirty olive-green, the clitellum buff, tending to orange laterally, the tubercula pubertatis being of a deeper brownish tint.

The *chaetæ*, as in the other species, are in four couples on each somite, the inner couples being very close to the middle (ventral) line; if this space be taken as the unit (*s*), the distance between the outer and inner couples is $1\frac{1}{2}$ *s*. In *R. Tenkatei* this lateral interspace is *less* than the ventral space, and in *R. Gulielmus* it is equal to *twice* the ventral space.

The *chaetæ* are absent from the second as well as from the

* "Rech. pour servir etc. Lombric. terrestres," Nouv. Arch. d. Mus. d'Hist. Nat. de Paris, viii. 1872, p. 65.

† "On the Structure of a new Genus of Lumbricidæ (*Thamnodrilus*)," Proc. Zool. Soc. 1887, p. 154. Mr. Beddard has recently recognized the characteristic features of *Rhinodrilus* in this worm, to which genus he now refers the species (Quart. Journ. Micr. Sci. xxxi. p. 159, footnote).

‡ "Descriptions of Earthworms," Notes from the Leyden Museum, ix. p. 101.

§ In a strictly etymological sense perhaps "*æquatorius*" would have been preferable.

first somite, so that the first chætigerous somite is the third. All the chætæ are ornamented in the manner characteristic for the genus, and somewhat similar chætæ are found in *Urochæta*, *Deodrilus**, and *Onychochæta (Diachæta) Windleyi* †, in *Anteus* ‡ and *Geoscolex* §, and in *Microchæta papillata* and *M. Belli* (Benham).

The ornamentation, which consists of a series of transversely-arranged crescentic ridges, is not so pronounced as would appear to be the case in other species; indeed, when the chætæ are mounted in glycerine, the markings might easily be overlooked with a low power, but in spirit and water they are distinctly visible. There are no specially modified "copulatory" chætæ, such as exist in the other species, where they are larger and straight, in *R. paradoxus* on somites xvi. to xix. and in *R. Gulielmus* on the clitellum, or larger and more distinctly marked in *R. Tenckatei*; nor do I find any fascicles of chætæ such as Horst described in his specimens on somites xvii., xviii., and xix.

The *prostomium* appeared from the exterior as a small rounded lobe, but on dissection was found to be retracted, as Beddard found to be the case in his species: it is some two or three times as long as the organ in the majority of earthworms.

The *clitellum* is very distinctly marked, partly from its colour, but chiefly from the thickness of the epidermis and the deep, conspicuous, intersegmental grooves; it is, as in the other species, "incomplete," and occupies somites xiv. to xxv., the last two somites, however, being less distinctly modified on the animal's left side. The latero-ventral boundary of the clitellum is nearer the middle line on somites xiv. to xix., and here involve the inner couple of chætæ; on the posterior somites xx. to xxv. the edge of the clitellum is bordered by a series of glands—the *tubercula pubertatis*—forming a semitranslucent band placed between two couples of chætæ, though nearer to the inner couple. A similar band exists in the other species, and in the case of Horst's and Perrier's species appears to be the only representative of the clitellum, the animals not being quite mature. In *R. Tenckatei* the seven pairs of tubercula traverse somites xx. to xxvi. ||,

* Beddard, Quart. Journ. Micr. Sci. xxxi. p. 467.

† Beddard, *ibid.* p. 159.

‡ Horst, 'Notes from the Leyden Museum,' vol. xiii.

§ Beddard, 'Annals,' Feb. 1892.

|| I may say that Horst appears in some doubt as to his numbers, as he places the tubercula on "20th (21st)–26th (27th)"; again, he mentions an "olive-green ring around the body from the 12th (11th)–15th (16th) segment."

in *R. paradoxus* they occur on somites xix., xx., and xxi. In *R. Gulielmus* the clitellum occupies almost the same somites as in the present species, viz. xv. to xxv., the tubercula have an identical position, and the same difference in regard to the ventral limit of the clitellum is noted and figured by Beddard for that species.

The *nephridiopores*, as in other species, are in line with the outer (lateral) couple of chætæ, the first pair being on somite iv.

The *male pores* were quite evident *between* the somites xix./xx., in a line with the second chætæ on each side. This is the position assigned to these pores by Perrier. Neither Horst nor Beddard succeeded in detecting them; but in a specimen of *R. Gulielmus* which I possess I find them to lie between somites xx./xxi. I could not detect any other genital pores on the surface.

There are no dorsal pores.

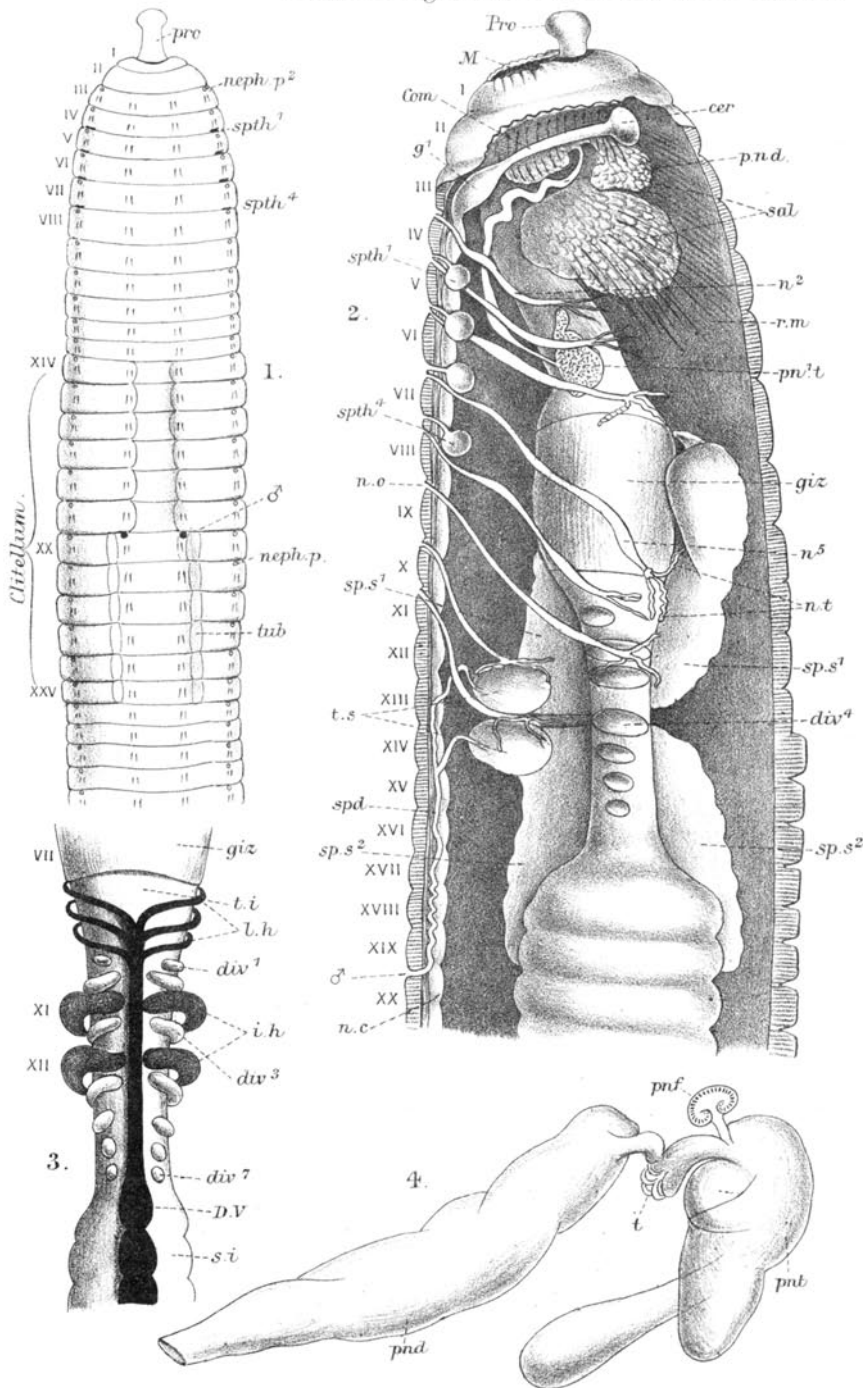
Internal Anatomy.

There is a great displacement of the internal organs, owing to the infundibulate nature of the septa, so that the organs appear to lie in somites considerably posterior to those to which they actually belong.

None of the septa are strong; in fact they are all particularly thin and transparent, and are therefore difficult to trace, for they overlap one another and allow the organs below them to be seen. But if the septa fail us in apportioning the organs to their true morphological position in the body, we have an excellent guide in the nephridia, which, as Horst noticed in his species, are very conspicuous; and by following them to their external pores I was able to determine the real somites to which the various other organs belong. These *nephridia*, as Beddard found in *R. Gulielmus* and is frequently the case in other genera*, differ in their size and shape &c. in different regions of the body.

The first pair, or "peptonephridia" as I have called them*, differs from the rest both in the greater length of the convoluted tube (Pl. X. fig. 4) and its more glandular appearance, and in the fact that the duct *communicates with the gut* and not with the exterior. The convoluted tube, forming a bilobed glandular-looking mass, lies about halfway along the œsophagus (fig. 2, *n't.*) at its side; from it the large muscular duct passes forwards and downwards, soon coming to lie

* Benham, "An Attempt to Classify Earthworms," Quart. Journ. Micr. Sci. xxxi. p. 212.



below the pharynx (as in *R. Gulielmus*) ; when it reaches the level of somite iii. it rises upwards along the sides of this portion of the gut, passes between the two lobes of the "salivary glands," and continuing (fig. 2, *p.n.d.*) forwards enters the muscular wall near the junction of the pharynx and buccal region; into the latter the nephridium probably opens.

In the previous species a similar "peptonephridium" is present; but it opens externally in the second (*R. Gulielmus*) or third somite (*R. Tenkateri*). I searched carefully for any pore on somites ii. and iii., but found none; and it is comparatively easy, despite the small size of the worm, to trace the duct along the course I have just indicated.

When removed from the body the peptonephridium is seen to be composed of a densely coiled tubule, the course of which would be very difficult to follow; it is provided with a funnel of rather larger size than the following ones. The surface of the peptonephridium is covered with a close network of blood-vessels.

I am not quite certain as to the segment to which the funnel belongs; but at any rate it will be seen that this nephridium, like the following, has a considerable length, passing from about the level of the second to that of the eighth somite, and recalls the enlarged thoracic nephridia of many of the tubicolous Polychæta.

The second nephridium (fig. 2, *n.*²) opens externally on somite iv.; the long duct passes backwards, alongside the pharynx, to reach the convoluted tube at the side of the anterior part of the œsophagus. The following nephridial apertures are regularly arranged, and the ducts of the nephridia extend backwards in a similar way; they are all quite easily followed from their pores to the coiled tubule, and it is the latter which it is important to note particularly.

The coil of the third nephridium is at the side of the œsophagus, behind the second nephridium, that of the fourth still further back, in front of the gizzard; the coil of the fifth nephridium (fig. 2, *n.*⁵) lies on the *upper surface of the gizzard* near its hinder end; and since this nephridium belongs to somite vii., the gizzard evidently belongs to the same somite, although thrust back into the following somites. The coils of the sixth and seventh nephridia are close together, immediately *behind the gizzard*, by the side of the "lateral hearts." The eighth nephridium belonging to somite x. has its coiled tubule immediately in front of, and very closely applied to, the sac which contains the first pair of ciliated rosettes, which thus belongs to somite xi. The ninth nephri-

dium is similarly situated with regard to the second ciliated rosettes.

I did not trace out the following nephridia, and am unable to say definitely how many there are in this series. Beddard found fourteen pairs in *R. Gulielmus* following the pepton-nephridium, differing from it and also from the following series, which, commencing in somite xvii., are smaller, have no long duct, and are less readily followed.

The *alimentary tract* (fig. 2) presents a gizzard in somite vii., as determined by tracing out the nephridia; it lies, however, at the level of somites viii., ix., x., appearing to occupy three somites, as Horst describes for *R. Tenkatei*; but the present species agrees with the other two in having the gizzard confined to *one* somite.

Immediately behind it there are the characteristic paired diverticula of the tubular intestine (figs. 2 and 3, *div.*); they contain crystalline particles which I took to be carbonate of lime; but I obtained no effervescence on treating the organ with weak and with strong acid. Nevertheless they have a structure closely similar to that of the œsophageal (calcareous) diverticula—"glandes de Morren"—in *Lumbricus*, as my predecessors have noted. In the present specimen there are *seven pairs* of these *diverticula*, all very close together, though probably occupying as many somites. The first gland is small and ventro-laterally placed, and might readily be overlooked in a strictly dorsal view; the next three are larger and kidney-shaped; the following three gradually diminish in size and are hemispherical. Both in *R. Tenkatei* and *R. Gulielmus* there are six pairs of these diverticula, agreeing in the main with those just described; and it is a most curious fact that in the "type" of the genus Perrier makes no mention of them. It is true they are hidden by the sperm-sacs and "hearts;" and as all these organs are closely packed together, it is reasonable to think that they were overlooked, though I believe, as I state below, that he *did* see these glands, but mistook them for "hearts."

It is not easy to fix the true position of these diverticula with regard to somites, and it can only be really decided by making longitudinal sections through a complete uninjured specimen. But by tracing other organs we can place them in somites viii. to xvi. or in ix. to xv., which agrees pretty well with Beddard's species, in which he found the six pairs to lie in somites ix. to xiv.

The sacculated region of the intestine begins shortly behind these glands and is provided with a *typhlosole*, fairly well developed, compressed so as to be a thin membrane, and

which presents this peculiarity, that its line of origin takes a *spiral course* round the wall of the gut; so that we have, in place of the straight valve commonly found in earthworms, a spiral valve.

The *vascular system* presents the characteristic "intestinal hearts" which Perrier was the first to describe, and which are now known in other genera than *Rhinodrilus*; there are two pairs only of these commissural vessels in the present species, greatly dilated and communicating not with the dorsal, but with the "supra-intestinal" vessel, as Mr. Beddard has figured for his species; they belong to somites xi. and xii., though they appear to lie in somites xiii. and xiv., the first passing between the second and third intestinal diverticula and the second heart between the third and fourth of these.

Immediately in front of these "intestinal hearts" (fig. 3, *i h.*) are three pairs of very much smaller "lateral hearts" (*l. h.*) arising from the dorsal vessel; these three lie close behind one another between the gizzard and the first diverticulum. It is a matter of some uncertainty whether these lie in somites viii., ix., x., or in vii., viii., ix. The dorsal vessel (*d. v.*) is ampullated in somite xv. and in each somite posteriorly, where it lies above the sacculated intestine; but anteriorly to this, in the region of the "intestinal hearts" and intestinal diverticula, it is practically cylindrical, though it gradually diminishes in size, and where the "lateral hearts" leave it it has become quite narrow. The dorsal vessel appears to *terminate behind the gizzard*, for I could see no median vessel beyond this point; Mr. Beddard states (*loc. cit.* p. 158) that anteriorly to the gizzard the "dorsal vessel runs some way above the surface of the cesophagus;" so that it is possible that I had removed it in this region, though it seemed to end quite definitely *behind* the gizzard.

In *R. Gulielmus* there are three pairs of "intestinal hearts" in somites x., xi., xii., the hindermost pair of which is smaller and not dilated; in front of these there are two pairs of narrow "lateral hearts."

In *R. Tenkatei* there are also two pairs of lateral hearts, which, according to Horst, lie in somites xii. and xiii., and behind these are two pairs of "intestinal hearts," passing between the first and second and between the second and third intestinal diverticula.

With regard to *R. paradoxus*, the "intestinal hearts" are stated to lie in somites xx., xxi., and xxii., though whether this apparent position is due to displacement or not can only be settled by a renewed examination of the species; it

is, at any rate, a very peculiar position for the "hearts" to occupy.

Perrier (*loc. cit.* p. 70) states that in the three somites immediately anterior to these intestinal hearts there exist as many pairs of "véritables cœurs." I believe that he is dealing really with *intestinal diverticula*, for he states that each of these organs is distinguishable into two very distinct parts:— (1) a superior, white, opaque, more voluminous region of ovoid form, and communicating at its narrow end with a vessel leading from the dorsal trunk; and (2) a more ventrally placed spherical region, with transparent walls, which is swollen with blood, and in relation to the ventral vessel. To quote his words:—"Sur chacun d'eux on distingue deux parties bien distinctes: l'une inférieure, à parois transparentes, gonflée par un sang bleuâtre coagulé, de forme sphérique: l'autre supérieure, blanche, opaque, plus volumineuse, de forme ovoïde, et s'abouchant par son petit bout avec le vaisseau qui conduit au tronc dorsal."

And he speaks of the inferior region as an "auricle" and the superior as "ventricle;" on the walls of the latter, he goes on to state, there can be seen some bluish veins starting from the apex, which soon disappear.

He was led to the above conclusion owing to his having observed, as he thought, a similar "heart" with ventricle and auricle in *Titanus* (i. e. *Geoscolex*, Leuckart).

Now I have examined a specimen of this worm, as I have previously mentioned*, and I find that the organ lying in somite xiii., whose relations were accurately described by Perrier, and which he mistook for a "ventricle," is in reality an intestinal diverticulum, having the same essential structure as the oesophageal glands of *Lumbricus* †.

I believe, then, that the three pairs of organs are the characteristic intestinal diverticula which occur in this region in the other three species of *Rhinodrilus*.

The *genital organs* (fig. 2).—There are two pairs of rather extensive sperm-sacs (*sp.s.*), which meet dorsally to a greater or less extent, and conceal the gizzard, the intestinal diverticula, and other organs in this region of the body. The anterior sac on each side appears to extend through somites viii. to xiii., and the posterior through somites xiv. to xvii.; but more careful observation shows the former to arise in somite xi. and pass forwards into somite vi., and the posterior to extend through somites xii. to xvii. There are two pairs

* "Studies on Earthworms, I." Quart. Journ. Micr. Sci. xxvi. p. 250.

† Mr. Beddard confirms my view of the matter in his paper in this Journal for February of the present year.

of testes and ciliated rosettes lying in somites xi. and xii., as determined by tracing out the nephridia and other organs; but they come to lie at the level of two somites further back. Each pair of testes and rosettes is contained in a common transversely-placed sac extending below the gut—the “testicular sac” (*t.s.*) as we may term it (the “Samenkapsel” of Bergh, the “median seminal vesicle” of some authors).

The anterior sperm-sacs arise from the sides of the anterior “testicular sac,” and the posterior sperm-sacs from the posterior testicular sac. Horst describes a similar arrangement, though, as in the case of the other organs of *R. Tenkatei*, he refers them to a more posterior position than in the present species. Beddard finds the same arrangement and position for these sacs in his species. Perrier found only *one pair* of sperm-sacs and ciliated rosettes, lying “immédiatement en arrière du gésier.” But in neither of these species is any mention made of the sperm-sacs extending beyond the segment in which they arise; they appear to be limited to one somite in each case; and the condition here described recalls that usual in the allied family Geoscolecidae, *mihi*, viz. in *Geoscolex*, *Urochaeta*, and *Diachata*, where each sperm-sac extends through at least four and usually more somites.

The sperm-ducts were easily traceable from the funnels to the body-wall, and, as I have stated above, open externally on each side between somites xix. and xx. I could find no ovaries, although I looked carefully for them; Beddard and Horst found them in the normal position, viz. somite xiii.

There are four pairs of spermathecae (*spth.*) concealed by the pharynx [?] perhaps that is the reason why Perrier found none; he would have expected them rather more laterally placed than is the case] and lying in somites v., vi., vii., and viii.; each is a nearly globular sac, with a narrow muscular duct, sharply separated from the sac, and passing to the external aperture on the anterior margin of the somite; these pores lie in the same line as the nephridiopores. On the left side of the specimen an additional very small spermatheca occurs in somite iv.

In *R. Tenkatei* there are three pairs of long pyriform spermathecae in somites vii., viii., and ix., whereas in *R. Gulielmus* there is only one pair of “spherical or pear-shaped pouches” in somite vii.

For the purpose of ready comparison with the other species I will summarize the characters of *R. ecuadoriensis*:—

1. Length 7·5 centim.
2. Clitellum on somites xiv. to xxv.; tubercula on somites xx. to xxv.

3. Male pores xix./xx.
4. The distance between the two couples of chætæ of one side is greater than that between the right and left ventral couples. There are no copulatory chætæ. The chætæ commence on somite iii.
5. The first nephridium opens into the buccal cavity.
6. The gizzard lies in somite vii.; there are seven pairs of intestinal diverticula.
7. There are three pairs of "lateral hearts" and two pairs of "intestinal hearts."
8. The two pairs of sperm-sacs are not confined to the somites in which the testes lie; there are four pairs of globular spermathecae in somites v., vi., vii., viii.

EXPLANATION OF PLATE X.

- Fig. 1.* Ventral surface of the anterior end of *Rhinodrilus ecuadoriensis*. *neph.p.*², pore of second nephridium; *Pro.*, prostomium represented in a protruded condition; *spth.*, spermathecal pores; *tub.*, tubercula pubertatis; ♂, male pore.
- Fig. 2.* Semi-diagrammatic view of a longitudinal section, derived from a study of a dissection. The left side of the animal and the left sperm-sacs are removed; the organs of the left side only are shown with the exception of the sperm-sacs, those of the right side being seen. The septa and blood-vessels are omitted for clearness' sake, and only the anterior nephridia are represented. ♂ indicates the pore of the left sperm-ducts; *cer.*, the cerebral ganglia; *com.*, the circumpharyngeal nerve-commissure; *div.*⁴, the fourth intestinal diverticulum; *g.*¹, the subpharyngeal ganglion; *giz.*, the gizzard; *m.*, mouth; *n.*², *n.*⁵, the second and fifth nephridia; *n.c.*, ventral nerve-cord; *n.o.*, nephridiopore; *n.t.*, convoluted tube of a nephridium; *n't.*, convoluted tube of the "peptonephridium;" *p.n.d.*, the duct of the peptonephridium, dissected out and entering the buccal cavity; *pro.*, prostomium, partially retracted; *r.m.*, radiating muscles of pharynx; *sal.*, "salivary glands" around the pharynx; *sp.d.*, sperm-duct; *sp.s.*¹, *sp.s.*², the anterior and posterior sperm-sacs of the right side; *spth.*¹⁻⁴, the four spermathecae; *t.s.*, "testicular sacs," enclosing testes and rosettes.
- Fig. 3.* Dorsal view of the tubular region of the intestine, with the seven pairs of "diverticula" (*div.*¹, *div.*³, *div.*⁷) and the vascular system of the region. *D.v.*, dorsal blood-vessel; *i.h.*, the two pairs of intestinal hearts (from the supra-intestinal vessel); *l.h.*, the three pairs of lateral hearts; *s.i.*, sacculated intestine; *t.i.*, tubular intestine.
- Fig. 4.* The peptonephridium removed entire from the body. *pn.d.*, the duct; *pn.f.*, the funnel; *pn.t.*, outline of the mass of convoluted tubules: the convolutions are very complicated, and the whole is covered by a dense network of blood-vessels, both of which are omitted, though a small portion of the tubule is shown at *t.*