

On some new Japanese Land Leeches.

(*Orobdella* nov. gen.)

By

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With Plates XXVIII-XXX.

Whilst examining a small collection of Japanese leeches in the Museum of the Zoological Institute of this University, my attention was attracted by some specimens of land leeches, totally different from *Haemadipsa japonica* Whitman, and since all that was known of this interesting group of animals, as it occurs in this country, was confined to the single species just mentioned, I set to work to investigate these new forms thoroughly.

The collection contained only 17 specimens, but to these I was able to add others from various localities, from time to time, so that now I have in all 31 specimens kept in alcohol, and have, besides, cut 10 others into sections in order to examine their internal structure. An account of their external characters, and a general outline of their internal organisation are presented in this paper.

They are so much alike in external features, that at first I took them all to belong to one species, and ascribed the slight but apparent differences between some of them to a difference of age. A minute study of them, however, convinced me that I had three distinct species before me, and that these were

members of a genus separated, more or less widely, from all the genera of land leeches that had been then defined.

They decidedly form deviations from the generally accepted rule, that in *Gnathobdellidae*, each unabbreviated somite consists of five rings. We know, indeed, at present, thanks to the untiring researches of Dr. R. Blanchard of France, one genus of *Gnathobdellidae* which has only three rings in a complete somite, and two others from the Family, *Herpobdellidae* (Syn. *Nephelidae*), which have respectively six and eight rings in a somite. Moreover, some specimens of *Trocheta* from the Crimea were found to have as many as eleven rings in each complete somite. Such being the case, the leeches I am going to describe are not the only instances, in which a somite consists of a number of rings other than five. What is striking in them, however, is that the number of rings in a complete somite is not even constant within the limit of the genus, though constant in each species. Besides, these new land leeches exhibit many other peculiarities, so that an account of them should certainly not be without interest both to systematists and to those investigators who are occupied with the external morphology of the order *Hirudinea*.

I take the opportunity here of expressing my heartiest thanks to Prof. Mitsukuri for affording me various conveniences for investigation and to Prof. Ijima for kindly placing at my disposal a specimen out of his own collection. For a number of specimens I am indebted to Prof. Nakagawa of Kumamoto, who collected them for me during his stay among the Nikko mountains.

So far as I am aware, there are only five well established genera of the Order *Hirudinea*, whose members are exclusively terrestrial, viz.: *Hæmadipsa*, *Xerobdella*, *Mesobdella*, *Cylicobdella* and *Lumbricobdella*.

Hæmadipsa Tennent (1861), which is found in Ceylon, India, Burma (1894), and Japan (1886), may be regarded as a terrestrial representative of the medicinal leech, being so nearly allied to the latter that both were long known under the common generic appellation of *Hirudo*. In fact, *Hæmadipsa* differs from *Hirudo* only in those points, that are most likely to be influenced by change of habit. They agree in having three toothed jaws and five pairs of eyes, and differ only in the number of suppressed rings at both extremities of the body. The second genus, *Xerobdella* von Frauenfeld (1868), is closely allied to the preceding one. It has three toothed jaws, like *Hirudo* and *Hæmadipsa*, but differs from them both in having four pairs of eyes instead of five. This genus is characterised, further, by the presence of a pair of tentacle-like appendages at the anterior extremity of the body. The only species, by which this genus is represented, *Xerobdella Lecomtei* von Frauenfeld (1868), has hitherto been found only in the mountainous parts of Europe. The third genus, *Mesobdella* R. Blanchard (1893), is certainly the most remarkable of all the land leeches. It occupies a place in between the two natural divisions of *Hirudinea*. While it agrees with the Gnathobdellids in possessing ten eyes and three denticulated jaws, each of its somites consists of three rings and its intestine is provided with a number of large lateral blind sacs, as is the case in the Rhynchobdellids. This genus is represented, like the preceding one, by only one species, which is a native of Chili. The two remaining genera *Cylicobdella* Grube (1871) and *Lumbricobdella* Kennel (1886), both of which are confined to South America and the West Indies, form a group to themselves, in contrast with the remaining land leeches. They are found in the same localities and closely resemble each other externally. They have both no eyes and no jaws. One of them, *Lumbricobdella*, has no acetabulum. Their internal organisation shows that they are to be placed in the Family

Herpobdellidæ. It is very interesting to notice that *Lumbricobdella Schæfferi* Kennel has 262 rings counted on the ventral side, a number which clearly shows, that we have in this animal another example of a leech with more than five rings in each somite. How many external rings come to one somite in this case was, however, not ascertained by Kennel.

A form of land leech from Australia is mentioned by Whitman (1886) under the name of *Geobdella* (nec *Geobdella* de Blainville, 1828). This genus is very nearly allied to *Hæmadipsa*, but differs from it in having only two jaws, and also in the fact that the genital openings are separated by seven and a half rings instead of five. So far as I know, this leech was only briefly referred to by the same author in speaking about the Japanese land leech, and we do not even know what specific name he gave to the Australian animal.

The existence of still another land leech is recorded by Forbes (1890) from North America. It is a species of the genus *Semiscolex* Kinberg, whose members are generally aquatic. According to the description given by Forbes, this genus seems to be very nearly related to, if not identical with, the well-known genus *Hæmopsis* Savigny (1820) (Syn. *Aulastoma* Moquin-Tandon, 1826).

The new genus of Japanese land leeches, for which I propose the name of *Orobdella*,¹ may be characterised as follows :

Orobdella nov. gen.

Body, almost cylindrical, more or less flattened toward the hind extremity ; the lateral margins of the body nearly parallel for the greater part of the length; slightly tapering toward both ends.

Rings, differing in number according to the species, but constant

1 'Ορος mountain, βδέλλα leech ; leech inhabiting mountains.

for each ; the surface of the rings quite smooth, destitute of any protuberances ; the furrows between the rings distinct but not deep.

Somites. Number of the rings in an unabbreviated somite variable, but constant for each species (4, 6, or 8).

Mouth-opening occupying, on the ventral side, a space corresponding to 4-6 rings, at the anterior extremity of the body ; the two following rings forming, on the ventral side, the posterior lip of the mouth.

Eyes. Only one pair externally visible, situated always at the anterior margin of the second ring, wide apart from each other. A few minute black dots sometimes visible on the 4th or 5th ring.

Maxillæ. Entirely wanting.

Genital Orifices. The male orifice is placed about the middle point between the 5th and the 6th ganglia (not counting the œsophageal ganglionic mass). The female orifice is situated just in front of the 7th ganglion. The number of rings which intervene between these two orifices variable, but constant in each species.

Clitellum occupying a space of three somites' length, *i. e.*, the two somites bearing the genital orifices, a greater portion of the somite preceding them, and a few rings of the somite following them.

Nephridial pores opening on the ventral surface of the last ring of the somites.

Acetabulum rather small, ovate, the diameter being less than half the breadth of the animal.

As I have only alcoholic specimens, now, I am unable to give an exact description of the colour of all these leeches in the living state, but judging from a water-colour drawing made from the fresh object and also from specimens that had been kept only for a short time in alcohol, the following may be said of all three species. The dorsal surface is always darker than the ventral. The median line of the dorsal

surface is the darkest. The dorsal surface is divided indistinctly into three longitudinal areas, one broad median and two narrow lateral. The lateral areas, as well as the whole ventral surface, are of a pale orange colour. The median area of the dorsal surface is of different colours according to the species, and also even to the individual (olive green, grayish, bluish red).

The land-leeches of the genus *Orobdella* are found in various mountainous parts of Japan. The localities, where the specimens in my collection come from, are Kioto, Gifu, Hakone, Nikko, and Kibōzan near Kumamoto. They are found crawling under moss and fallen leaves or in moist earth, in the same manner as earthworms, which constitute the chief source of their nourishment. Being possessed of no jaws these leeches have no power of biting and consequently of sucking blood. They go about in pursuit of earthworms and swallow them entire, as I have repeatedly found by dissection. My sections of these leeches show sometimes the peculiarity of presenting the structure of two worms at once, that of the leech and that of the earthworm swallowed. With regard to habits, therefore, *Orobdella* has almost nothing in common with *Hamadipsa*, but rather resembles *Cylicobdella* and *Lumbricobdella*.

The *Orobdellæ* are pretty large leeches, most of the specimens that were found mature being more than 10 cm in length. Among the collection there is an extraordinary large one preserved in alcohol that measures more than 27 cm.

Before proceeding to the description of the individual species, I may here say something about the methods followed by different authors in counting the rings and determining the boundary of the somites. According to the method proposed by Whitman (1884), the rings are counted on the dorsal surface, beginning with the first ocular ring. This is certainly very simple, and has hitherto been

followed by Blanchard (1892, etc.) but we have then to disregard wholly that portion of the body lying in front of the first pair of eyes. Kennel (1886), in describing the land-leeches of South America, counts the rings on the ventral side, beginning with the first complete ring behind the posterior margin of the mouth, but this method is still less satisfactory than the first one, especially when we want to mark precisely the position of the eyes or some other organs in the head region. Lastly, Apathy (1888) counts every ring in the body, whether in front of the first pair of eyes, or behind it. As this method seems to be the least artificial, I have followed it in the present paper, as well as in my former articles on leeches. It need not be added, that in so doing I do not necessarily attribute to each apparent ring at the anterior extremity of the body, the value of one morphological ring.

In studying the external morphology of ten-eyed leeches, Whitman (1885) points out the occurrence of certain segmental sense-organs on the first ring of every somite. If this were the case throughout the whole Order, the determination of the boundary of somites would not have been a very difficult task. But, there are a great many genera and species, in which, as in *Orobdella*, all the rings constituting a somite look exactly alike, so that the method proposed and carried out by Whitman can not always be applied with success. In such forms, Blanchard (1892 &c.) used the nephridial pores alone as the starting point for the determination of the somites. In the following diagnoses, I fixed the number of rings in a complete somite in each species, by means of the position of the nephridial pores and the nervous ganglia, and for the determination of the numerical order of the somites I counted them forward and backward from the genital openings, whose position had been previously ascertained by dissection.

*Orobdella Whitmani** (Ijima MS) nov. sp.

Diagnostic Characters.

Body nearly cylindrical, somewhat flattened toward the hind end, tapering slightly toward the head.

Rings 88, distinctly marked. Behind the last complete ring, there is still one more which is distinctly visible only on the dorsal side.

Somite, when complete, consisting of 4 rings.

Mouth occupying a space corresponding to the 4 foremost rings; 5th and 6th rings forming on the ventral side the posterior lip of the mouth.

Eyes, in one pair, at the anterior margin of the 2nd ring; on the 4th ring a pair of small pigment dots, representing rudimentary eyes.

Genital orifices. The male orifice is situated on the ventral surface of the 27th ring, the female orifice on the 32nd; 4 rings between the rings bearing them.

Clitellum, embraces 12 rings, beginning with the 22nd and ending with the 33rd.

Acetabulum, ovate, small, the diameter measuring nearly half the breadth of the animal.

Anus, on the dorsal surface of the acetabulum, about one ring's breadth behind the posterior margin of the last ring.

Nephridial pores hardly visible externally, opening in the median portion of the body on every fourth ring, on the ventral surface more or less distant from the lateral margins.

* This, as well as the following specific names, is constructed in strict accordance with the 'Règles de la Nomenclature des êtres organisées' published lately by the Société Zoologique de France.

There are in my collection 18 specimens of this leech, of which 14 are adults. The dimensions of the three largest specimens are as follows :

Length,	107 mm.	103 mm.	80 mm.
Width,	11 mm.	10 mm.	7.5 mm.
Depth,	6.5 mm.	6.5 mm.	6.5 mm.

In smaller specimens, the difference between the two last dimensions is less obvious, so that their body has exactly the same form as the earthworm.

Of the external rings, the 3rd and the last rings present peculiarities, in so far as the former is divided on the dorsal surface by a furrow into two unequal parts, and the latter is distinct only on the dorsal side. On passing over to the ventral surface, the last ring enters into the formation of the acetabulum, so that, if counted on the ventral side, the latter organ comes next to the penultimate ring.

As concerns the colour, this species exhibits great variability. While the larger specimens obtained from Kiōto are decidedly greenish on the dorsal side, as shown in the Fig. 1 (Pl. XXVIII), all the smaller ones from various other localities are of a bluish-red colour. There are still others, whose dorsal surface is brownish or greyish.

There being no segmental papillæ, which distinguish some of the rings from the rest and are of great use in determining the boundary of the somites, we have no other method of counting the somites than by examining the internal organs. As already noticed, I began by ascertaining the topographical relation of the external rings to the nervous ganglia, which exhibit the metameric arrangement more regularly than any other organ. There are in this species, as in all other known *Hirudinea*, twenty one ventral ganglia, not counting the oesophageal and the acetabular ganglionic masses. A median longitudinal section of the whole animal hardened in alcohol shows most clearly, that, of

these twenty-one ganglia, fifteen at least are situated at an interval of four rings from each other. This regular arrangement of the ganglia, taken together with the fact that the nephridial pores open on every fourth ring, admits of no doubt that in this species an unabbreviated somite consists of four rings, although this number has never been recorded for any leech, whether a Rhynchobdellid or a Gnathobdellid. The sections show also that the ring, on which the nephridial pores open, immediately precedes the one containing the ganglion. This leads us to the conclusion that, in this leech also, the ganglion lies in the first ring, and the nephridial pores open on the last of each somite, as is actually the case in every other Gnathobdellid.

The specimens of this species were collected at Kinkwazan near Gifu (Nawa), at Chi-on-in in Kiōto (M. Kikuchi) and at Kibōzan near Kumamoto (Nakagawa).

Orobdella Ijimai nov. sp.

Diagnostic characters.

Body subcylindrical, slightly tapering toward both ends.

Rings 129; a few of the last rings again divided by furrows.

Somite, when unabbreviated, consisting of 6 rings.

Mouth, occupying a space corresponding to the 5 foremost rings; 6th and 7th rings forming on the ventral side the posterior lip of the mouth.

Eyes, in one pair, at the anterior margin of the second ring.

Genital orifices. The male orifice is situated on the 39th ring, the female orifice on the 47th; 7 rings between those bearing the genital pores.

Clitellum embracing 19 rings, beginning with the 31st and ending with the 49th.

Acetabulum, small, ovate, the diameter measuring about one-half the width of the animal.

Anus, on the dorsal surface of the acetabulum, about one ring's breadth behind the posterior margin of the last ring.

Of this leech there are 10 specimens in my collection. Only 4 of them are mature. The dimensions are as follows :

Length,	78 mm.	77 mm.	72 mm.	68 mm.
Width,	6 mm.	5.5 mm.	5 mm.	6 mm.
Depth,	4.5 mm.	4.5 mm.	4.5 mm.	4 mm.

By comparing the rings of this species with those of *Orobdella Whitmani*, the specimens being of equal length, the respective breadths of the rings are found to be in the proportion of 2 to 3. In the head region, this difference is not so obvious.

In determining the number of rings in a complete somite, I followed exactly the same method as in the last species. After opening the animal from the dorsal surface the position of the ganglia was carefully marked out by means of pins in order to ascertain which rings contained them. It became very evident that one ganglion was allotted to every 6 rings. The nephridial pores open on every sixth ring too.

In colour, this leech reminds us immediately of the earthworm. The dorsal surface is of a reddish grey colour, sometimes varying to a pale blue. Near the lateral margins of the body, the colour becomes lighter by degrees and goes over to the pale whitish colour of the ventral surface. There are also specimens in which the lightening of the colour is less gradual, so that the dorsal surface looks to be of the same dark colour all over except at the margins where it is whitish.

All the specimens we have of this leech were collected at Nikkō (Ijima, Nakagawa). They are found generally in localities where earthworms abound, and on account of similarity in colour, are very liable to be mistaken for the latter.

Orobdella octonaria nov. sp.*Diagnostic Characters.*

Body, subcylindrical, more or less flattened toward the hind end ; lateral margins parallel except near the extremities.

Rings, 171.

Somite, when unabbreviated, consisting of 8 rings.

Mouth, occupying a space corresponding to the 6 foremost rings ; 7th and 8th rings forming, on the ventral side, the posterior lip of the mouth.

Eyes, in one pair, situated at the anterior margin of the second ring, near the lateral borders of the anterior lip of the mouth.

Genital orifices. The male orifice is on the 51st ring, the female orifice on the 62nd ; 10 rings are between the rings bearing them.

Clitellum embraces 24 rings, beginning with the 41st and ending with the 64th.

Acetabulum, small, the diameter less than one-third the width of the animal, in large specimens hardly of any suction function.

Anus, on the dorsal surface of the acetabulum, about a ring's breadth behind the posterior margin of the last ring.

This species is represented in my collection by three specimens only, whose dimensions are as follows :

Length,	270 mm.	130 mm.	80 mm.
Width,	14 mm.	9 mm.	12 mm.
Depth,	10 mm.	6 mm.	5 mm.

In this species the rings show sometimes a tendency to be divided into secondary rings by means of shallow grooves. Toward both extremities, especially at the head end, we find also many rings that are double on the dorsal surface but single on the ventral. In the above diagnosis, such rings are counted as separate. The breadth of a

ring in the middle portion of the body is only one-half that of a corresponding ring of *Orobdella Whitmani*, and, in consequence, the animal appears very finely annulated.

That in this species each complete somite consists of eight rings was very easily shown by the method I had used for the other two. For this purpose, the two larger specimens were cut open from the dorsal surface, and the position of the nervous ganglia was carefully examined. In both of them, I could demonstrate most clearly that, in the median portion of the body, every eighth ring lodged a ganglion. The nephridial pores could not be recognised externally in the two smaller specimens, but they were visible in the largest one. They open, in the middle part of the body, on every eighth ring too, and each of these rings immediately precedes one containing a ganglion. Thus, and by comparing this with other leeches, it becomes clear that the groove between the ring that bears the nephridial pores and that lodging the ganglion, is the boundary between two somites. Toward both extremities of the body, where abbreviation of the rings takes place, this regularity comes naturally to an end.

This species is certainly one of the largest leeches that are known. A specimen preserved in alcohol, and in a state of contraction at two places, measures a little more than 270 mm. It therefore far surpasses in length the largest leech hitherto described, *Hæmenteria Ghiliani* de Filippi (1849), concerning which de Filippi made the following remark: "Cette espèce doit figurer au nombre des plus grandes sangsues; en effet l'exemplaire dans l'alcool mesure 0 m.135 en longueur, et 0.05 en largeur; et lorsqu'il était vivant, inasi que Mr. Ghiliani m'a dit, il s'allongait jusqu'à un pied de Paris." A specimen of *Orobdella octonaria*, which measures nearly as much in a somewhat contracted state, must have surely been longer at least by half that dimension when fully stretched.

The specimens of this leech were collected at Kinkwazan near

Gifu (Nawa) and in the Hakone mountains. The specimen from Gifu shows the tendency toward a farther division of the rings much more distinctly than the other two which were brought from Hakone.

External Morphology.

It is very interesting to notice that the three species described above bear a striking resemblance to each other in external features, in spite of the great difference in the number of the rings. The position of the eyes and the genital orifices is coincident in all the species. The number of rings that intervene between those bearing the genital orifices is different according to the species, but if we disregard the external rings and take only the somites into consideration, these openings are found to be situated in the corresponding portion of the corresponding somites. In the Figs. A, B, & C (Pl. XXIX.) I have tried to show the relation of the rings to the somites, in the different species, which might be summed up in tabular form as follows :

I-VI	somites	<i>Or. Whitmani</i> 12 rings	<i>Or. Ijimai</i> 17 rings	<i>Or. octonaria</i> 22 rings
VII-XXIII	„ 17 × 4 = 68	„ 17 × 6 = 102	„ 17 × 8 = 136	„
XXIV-XXVI	„ 8	„ 10	„ 13	„
Total number		88	129	171

Although the body of *Orobdella* appears to have a uniform structure throughout its whole length, except at the acetabulum, we can still recognise in it, by careful examination, a certain number of regions. These are not, in fact, so apparent in our leeches as in some other forms, such as *Branchellion* and *Ozobranchus*, in which some of the regions are easily distinguishable externally, but as they present differences not only with regard to the internal organisation, but also to the constitution of the somites, they must be treated separately in the consideration of the external morphology.

Apathy (1888) and Lang (1891) divide the body of a leech into

the following regions ; cephalic, clitellar, median, anal, and acetabular. These five regions are also recognisable in the case of *Orobdella*, but as the boundary between them can not be fixed but arbitrarily, I thought it better not to adopt Apathy's method strictly. In the following, the external characters of the three species of *Orobdella* will be treated successively from the head end toward the acetabulum, without putting thereby any accurate boundary between the regions above mentioned.

Head. There is no distinct line of limit that separates the head region from the rest of the body. As in all Gnathobdellids, this region passes by insensible gradations into the clitellar region, but we may regard, perhaps, the head proper as ending with the rings that form the posterior margin of the mouth. The triangular portion of the body that lies in front of the eyes was counted, in the diagnosis of the species, as the first ring, although not considered as such by some authors (Blanchard, Whitman). The second ring is characterised in all the species by the presence of two distinctly visible, yet inconspicuous, eyes; this makes it very probable, that the second ring is homologous throughout. The third ring is very broad in *Orobdella Whitmani* and is divided into two unequal portions by means of a transverse furrow; the anterior portion is as broad as the fourth ring, while the posterior is only of half that breadth. This ring of *Orobdella Whitmani* seems to correspond to the third and fourth rings of *Orobdella Ijimaï*. The fourth ring of *Orobdella Whitmani* and the fifth ring of *Orobdella Ijimaï* have two minute black dots, situated near the lateral margins of the body and representing rudimentary eyes. When viewed from underneath, the head region looks nearly the same in all the species. The whole ventral surface of this region as far as the fifth, sixth, or seventh ring, according to the species, is occupied by a wide mouth, much like the same organ of *Cylicobdella* or *Lumbricobdella* in Kennel's figures (1886). The two rings that form the posterior boundary of

the mouth are always distinct, but the furrow that separates them on the ventral surface is much less conspicuous than the one following it.

The portion of the body directly following upon the head proper may be called the neck. In this region, there seems to occur some abbreviation of the somites, though not to the same extent as in the head. Owing, however, to the completely uniform appearance of the rings, I am not able to give the manner in which this abbreviation takes place.

Clitellum. The number of the rings embraced by the clitellum is, in the three species of *Orobdella*, 12, 19, and 24 respectively. This difference is caused, not by the difference of their relative positions, but solely by the difference in the number of rings in a complete somite. In all the species, the clitellum occupies a space corresponding to three somites in length. In *Orobdella Whitmani* and *Orobdella octonaria* the number of rings in the clitellum is exactly three times that in a somite. In *Orobdella Ijimai* there is one ring more. The position of the clitellum in relation to the somites can clearly be understood from Pl. XXIX, where the corresponding somites of the three species are placed side by side. The somites X and XI, that bear the genital orifices are completely included in the clitellum, while the somites IX and XII are only partly taken in in the formation of the fore and hind portions of that organ. The somite IX has 3, 5, or 6 rings modified, according to the species. In the somite XII only one or two rings are modified, all the remaining rings lying outside the clitellum.

That in *Orobdella Ijimai* the clitellum embraces one ring too many to correspond exactly to three somites in length, seems to be worth notice. As may be understood from the figures in Pl. XXIX, the furrows that form the boundary of clitellum in *Or. Whitmani* and *Or. octonaria* fall upon the rings 31 and 49 in *Or. Ijimai*. Now, as a ring

can not be partly outside, and partly inside the clitellum, the rings mentioned are wholly taken in by it. Hence it follows, that in this species the clitellum embraces one ring more than the others.

Genital pores. The genital orifices are situated in the X and the XI somite respectively. The position which they occupy in these somites is the same in the three species. If we assume each of these somites to be divided into eight rings, as is actually the case with *Orobdella octonaria*, we find the male opening always on the fifth ring of the X somite and the female opening on the last ring of the XI. The number of the rings that separate those bearing the genital orifices is 4, 7, and 10, respectively, but this difference results again, as in the case of the clitellum, from the difference in the number of rings that make a complete somite in these species. If we put the external rings out of consideration, these orifices are found to occupy the corresponding portions of the corresponding somites. This very interesting point in their position can easily be understood by referring to the figures A, B, and C, in Pl. XXIX. The unmistakable coincidence among the species in regard to the position of the genital openings, as well as to that of the clitellum, speaks strongly for the near relationship of these three kinds of land-leeches.

Median region. It is in this region that the somites show their external constitution most clearly and without any abbreviation. As has been already stated, the leeches belonging to the present genus have no segmental papillæ that make the somites externally distinguishable, and we are compelled to refer to the internal anatomy for ascertaining their boundaries. This, however, is not very difficult in the median region, where each of the rings lodging the ganglia comes next to that on which the nephridial pores open. A comparison with other leeches belonging to the sub-order *Arhynchobdellæ* of Blanchard, tells us that the furrows between these two sorts of rings mark the limits of

the somites. By dissection, a ring that lodges a ganglion can easily be determined, and starting from it we are able to find the boundaries of the somites in a considerable portion of the body, though at the two extremities, it is almost impossible to group the rings into somites appropriately.

By this means, I found out that the three species above described had somites consisting of four, six, and eight rings, respectively. To those authors who lay much weight on the number of rings constituting a somite, from a systematic point of view, it might seem quite strange, that species differing so much should be placed in one and the same genus. But as these leeches agree in almost every other character than that of the number of the rings, I think it quite natural to regard them as members of a genus.

Hind end. The hind end presents some peculiarities that are common to all the three species. The anus opens on the dorsal surface of the acetabulum, about a ring's breadth from the posterior margin of the last ring. This latter is distinct only on the dorsal side, but enters into the formation of the acetabulum on the ventral side. Where the anus opens is marked by a transverse furrow, and in *Or. octonaria* there is still one more furrow behind the anus, so that we are apt to reckon the dorsal surface of the acetabulum as rings, if we count on that side. Thus it is clear that in these species the acetabulum is not so distinctly marked from the body as in other genera. Fig. 14, Pl. XXVIII, is a sketch of the hind end of a very large specimen of *Or. octonaria*, natural size, and serves to show that the acetabulum is here, comparatively, very small. The mode of life of these leeches seems to make the suctory function of the acetabulum less necessary, and the growth of this organ does not accompany that of the body, after the animal has attained a certain dimension.

Number of somites. By dissection we find that there are twenty-

one ganglia in the ventral chain, not counting the nerve-mass at the fore and hind extremities. Analogous to all other genera of leeches hitherto investigated, the œsophageal ganglionic mass is composed of 5 ganglia, that are clearly distinguishable, and some groups of ganglionic cells representing perhaps the rest of another ganglion. The acetabular nervous mass is made up of 7 ganglia. Adding these numbers together, we have the total of 33, a number that holds good for every member of the *Gnathobdellidæ* as well as of *Rhynchobdellidæ*. Thus *Orobdella* agrees with all other leeches in regard to the fundamental plan of the nervous system and consequently to the number of the somites.

Anatomy.

Integument. The body is enveloped in a thin layer of chitinous substance, the cuticle, under which lies a single layer of columnar cells, the epidermis. There are many unicellular glands scattered over the whole surface, some of them lying much deeper than the rest. Among the columnar cells of the epidermis, or passing through them, are found networks of capillaries, that run parallel to the external surface of the animal, in the same manner as indicated in the figures of the medicinal leech by Prof. Lankester. Within the clitellar region the number of deep-lying glands is decidedly greater than at other localities of the body.

Mouth-cavity. As these leeches are destitute of toothed jaws, the mouth leads directly into the mouth cavity, which forms an enormous space reaching behind the XIII somites (Pl. XXX, Fig. 3). In cross sections, this cavity has a triangular outline (Pl. XXX, Fig. 4) and shows, besides, some small shallow grooves on each side. Circular muscle-fibres are pretty well developed around the cavity. The salivary gland opens mostly into the anterior portion of this cavity,

but there are many of such openings scattered in the hinder part also. In form and relative size, the mouth cavity of *Orobodella* approaches that of the *Cylicobdella* and *Lumbricobdella*.

Stomach. I have examined this organ in two of the species only, namely, *Or. Whitmani* and *Or. Ijimai*; whether this organ exhibits the same character in *Or. octonaria*, I am not able to tell. In the two species that I examined, the stomach presents no difference in its general plan of structure. It is a tubular organ, the wall of which is irregularly folded, the folds being generally caused by the presence of dorso-ventral muscle-fibres. Near the hind end, where this organ communicates with the intestine, it gives off two large blindsacs, one on each side (Pl. XXX, Fig. 2). Behind this point, the stomach becomes narrower and forms a sort of funnel that opens into the next section of the alimentary canal. In the number of blind sacs of the stomach, these two species agree with *Lumbricobdella*. In many of the specimens I found pieces of earthworms in the stomach, sometimes as long as the stomach itself. From this it follows, that the mouth and the wide œsophagus serve only for swallowing, or at the most, for cutting the worms into large portions, which are then sent into the stomach whole.

Intestine. The epithelial lining of the intestine can easily be distinguished from that of the stomach by the greater height of the individual cells, which is double or more that of the cells of the latter organ. With hæmatoxylin the wall of the intestine is stained much deeper than that of the stomach. From the appearance of the contents, it might be judged that the stomach is an organ for reserving and digesting the nourishment, while the intestine is entirely devoted to its absorption. The numerous deep folds that increase the surface, and the blood vessels that surround the intestine closely, may also be looked upon as data for the above statement.

Vascular system. With regard to the vascular system, *Orobdella* seems to occupy an intermediate position between *Hirudo* and *Herpobdella* (syn. *Nepheleis*). There are four main trunks of blood vessels, that correspond to the dorsal, lateral, and ventral vessels of *Hirudo* respectively, but the blood spaces that are found anastomosing between various organs are comparatively very wide and present characters similar to those of *Herpobdella*. The wall of the lateral vessels is furnished with muscles, which makes it most probable that these vessels pulsate in the living state. The dorsal trunk is not so conspicuous as the lateral ones, having no muscular layer in its wall.

In every somite of the median portion of the body, there is one pair of large irregularly spherical blood-spaces, in which the funnels of the nephridia open. In *Herpobdella* there are two pairs, but in *Orobdella* I could find but one pair. The position of these spherical sinuses is nearly the same in the two genera; in *Orobdella* they seem to be a little nearer the ventral surface of the body than in *Herpobdella*. The blood-spaces receive their blood from the lateral vessels by means of very short transverse vessels, of which one pair is found in each somite.

Nephridia. The funnel that opens into the blood-space consists of five or six cells, forming so many spoon-shaped lobes arranged radially. Upon this funnel follows a capsule filled with small cells, analogous to that of *Glossosiphonia* (syn. *Clepsine*) (1894) but not so well developed. The funnel is thickly ciliated over the whole surface, and the lumen opens freely into the interior of the capsule. How this latter organ communicates with the remaining sections of the nephridium I am at present unable to tell, but it is probable that the intracellular canal of the nephridial string stands in connection with the lumen of the capsule. The beginning of the nephridial string certainly lies directly in contact with the wall of the capsule. The winding of the

canal is very nearly allied to that in *Herpobdella*. In both genera the nephridial canal consists of a large number of cells arranged in a single row, and perforated in the direction of the row so as to form drain pipes. For the greater part of the length, where two or three rows of cells come to touch each other, these pipes coalesce, the boundary between their walls becomes less distinct, and the whole structure appears in sections, as if it consisted of only a single row of cells perforated by two or three canals. In this respect, what I described for *Glossosiphonia* applies equally well to *Orobdella* or *Herpobdella*. A figure of the nephridium of *Herpobdella octoculata* (Linné) 1758 (= *Nepheleis vulgaris* Moq.-Tand. 1827) as reconstructed from sections by A. Graf (1893), represents the canal as running from the capsule to the bladder in a simple course, but this is decidedly false. In *Herpobdella* as well as in *Orobdella*, the canal makes at least three loops, and those portions of the different loops that come to run parallel to each other coalesce in the manner above described.

At the distal end of the nephridial canal there is a bladder-like dilatation lined with ciliated epithelium. Its shape is generally conical with the apex pointing toward the integument (Fig. 4., Pl. XXX). Whitman (1886) found that the land leech he investigated had large bladders as compared with the medicinal leech, and expressed the opinion that the large size of these organs is probably a result of adaptation to the terrestrial mode of life. As this seemed very interesting, I examined the bladder of *Orobdella* in comparison to that of *Herpobdella*, which is undoubtedly its nearest aquatic ally, but my results were all negative. *Orobdella* has only as large bladders as *Herpobdella* or even smaller than them. It is not, therefore, every form of terrestrial life that causes the enlargement of bladder but only a certain kind of terrestrial life. There are essentially only two different modes of life among the land leeches, one represented by *Hæmadipsa* and

the other by *Orobdella*. If we consider the extreme difference in the mode of life of these two genera of leeches, it is no wonder that a terrestrial abode works on various organs differently in the animals in question.

The bladder does not open directly on the outside of the integument. A portion of the epidermal layer forms a tube-like invagination at the place where the bladder opens, and serves as an evaculatory canal. Vejdovský (1883) stated that nephridial bladders are present in all the genera of leeches, even in *Glossosiphonia*, but here he reckoned this tubular portion of the dermal epithelium for the bladder, which itself is wanting. In *Orobdella* this portion is of an insignificant length and might very easily be overlooked.

Testes. The male genital elements are formed in spherical capsules arranged longitudinally on both sides of the ventral nerve-chain. There are generally 90–100 pairs of such capsules. In this respect *Orobdella* finds its nearest ally in *Lumbricobdella* which, according to Kennel (1886), has about 90–93 pairs. These capsules are divided into groups of nine or ten by the forebranch of the lateral nerves and the nephridial bladder (Fig. 8, Pl. XXX). Each capsule is lined by flat cells all around, except at one point where the testis communicates with the vas deferens. Here, the cells forming the wall of the capsule becomes higher and columnar and form a sort of ciliated funnel with the narrower end opening into the vas deferens. This latter duct runs along the outer side of the row of capsules, and after making several convolutions at the front end, joins the vas deferens of the other side and finally opens into the cavity just within the external male orifice.

About the female genital organ I have nothing specially to mention. *Orobdella* seems to be protandrous, the ovaries ripening much later than the testes. In young specimens the ovaries are very

small and the egg-cells are scarcely larger than the cells of the ovarian wall, while the spermatozoa are already distinctly formed.

The eyes. The structure of the eyes of *Orobdella* agrees almost in every point with that of *Macrobdella* communicated by Miss Merrill (1894). "The visual cells are arranged in a single layer around the axial nerve-fibres. The symmetry of this arrangement is broken at the upper end and on one side by a multiplication of the visual cells, so that the layer there may be two or three cells thick.....The visual cells contain a large crescentic or horse-shoe shaped vacuole surrounded by a layer of protoplasm, in the most thickened part of which the small nucleus is placed, as first pointed out by Prof. Whitman. The visual cells are surrounded by the pigment layer.....Over the top and at the side of the pigment cup, the epidermal cells become elongated to two or three times their normal length."

As indicated in the figure, the nerve is divided into two branches before it enters the eye. One of these branches forms the axis for the visual cells, while the other runs along the outside of the pigment cup, gives off some fibres to the scattered visual cells and ends in the cells of the epidermal layer. This peculiarity was already described by Maier (1892).

If we examine *Orobdella* externally, we find only one pair of eyes, but the sections show that there are 4 pairs of undeveloped eyes beside them, forming in all 5 pairs. It is the second pair that is externally visible. The 1st, the 3rd, and the 4th pairs of eyes have no pigment at all. The 5th pair has a small quantity of pigment, which is sometimes visible externally as minute black dots. The direction of the axis around which the visual cells are arranged is not the same in all of the five pairs. The axes rather radiate from a certain point situated in the front portion of the head-region, as pointed out by Apathy (1888 a) for the eyes of *Hirudo*.

Morphology of the first ring. That part of the body lying in front of the externally visible pair of eyes consists of one ring in *Orobdella*. This ring is however in reality the product of coalescence of a certain number of rings. That this apparently single ring is composed of at least two rings is very clearly shown by the position of the first pair of rudimentary eyes (Fig. 1, Pl. XXX). The well-developed pair of eyes of *Orobdella* corresponds, thus most probably to the first pair of eyes of *Xerobdella Lecomtei* (1892) and to the second pair of *Hæmadipsa*. In such forms as the members of *Hirudinea*, where the metameric structure of the body is modified at both ends in consequence of the division of labour, the number of the rings counted in those parts is only descriptive and should not be looked upon as data for ascertaining the homology of the rings.

Comparison with other land-leeches.

All the genera of land-leeches, including *Orobdella*, may be arranged in two groups, namely, the one containing *Hæmadipsa*, *Mesobdella*, *Xerobdella*, and the other containing *Cylicobdella*, *Lumbricobdella*, and *Orobdella*. The leeches of the first group are characterised by the presence of toothed jaws and by the semi-parasitic mode of life. They have well developed acetabulum and 4-5 pairs of eyes, that are distinctly visible externally. The second group contains, on the other hand, all those forms destitute of jaws. They live in moist localities, such as under fallen leaves and mosses or among rotten wood, and hunt after earthworms. The acetabulum is small or entirely wanting. There is only one pair of distinct eyes or none at all.

If we compare *Orobdella* with *Hæmadipsa*, we see at once how the different mode of life works differently on the general form of the body. The one living upon trees and dropping unperceived on persons or animals that pass under them, has a comparatively small and

very soft body attenuated toward the head, with a very well developed acetabulum. The other having large mouth and hunting after earth-worms has a long cylindrical body of nearly the same thickness throughout, and not so soft and distensible as that of former. The acetabulum is comparatively of little use in moving under mosses and is consequently on the way to disappear. The most important difference from the morphological point of view is in the number of rings that make one complete somite, which is 5 in *Hæmadipsa* and 4, 6, or 8 in *Orobdella*.

The two forms of land-leeches from Trinidad reported by Kennel (1886) seem to be the most nearly allied to *Orobdella*. They agree in their mode of life, which brings with it resemblance in the external form of the body. In their internal anatomy too, they present many points of agreement. How far these land leeches resemble each other and how far they differ may be summed up as in the following table:

	<i>Cylicobdella</i>	<i>Lumbricobdella</i>	<i>Orobdella</i>
Body :	cylindrical.	cylindrical.	subcylindrical.
No. of rings :	98-100.	262.	A. 88, B. 129, C. 171.
No. of rings in a somite :	—	—	A. 4, B. 6, C. 8.
Eyes :	0	0	2.
Jaws :	0	0	0.
Acetabulum :	present.	wanting.	present ; very small.
Length of the oesophagus :	$\frac{1}{8}$ the body-length.	$\frac{2}{8}$ body-length.	$\frac{1}{8}$ body-length.
Dorsal blood vessel :	wanting,	wanting,	present.
No. of round blood-sinuses in a somite :	1.	1.	1.
Nephridial funnel :	wanting,	wanting,	present.
Testes :	12 pairs,	90/93.	90-100 pairs.
No. of intesti- nal blind-sacs :	1, or wanting.	2.	2.

Orobdella agrees with *Lumbricobdella* in the number of the intestinal blind-sacs, and in that of the testicular capsules, differing from it, however, in the presence of the acetabulum. As some of the larger specimens of *Orobdella* have also a very diminutive acetabulum, the difference mentioned should not be regarded as being of such weight as to interfere seriously with the affinity of these two genera. Thus, *Orobdella* finds its nearest ally among the known leeches in *Lumbricobdella*.

*
Systematic Position.

The division of *Hirudinea* into two families, *Gnathobdellidae* and *Rhynchobdellidae* is very natural and already universally adopted, but the diagnostic characters for them have generally been based exclusively upon their well-known European representatives. Thus, for instance, Apathy (1886) gives the following three points as the distinctive marks for *Gnathobdellidae*: "1. Der Oesophagus hat einen geraden Verlauf, ohne vorstreckbaren Saugstecher. 2. Das typische Mittelkörpersomit besteht aus 5 Ringen. 3. Die äusseren Nephridialaperturen befinden sich an dem Hintersaume des 5. Ringes, und zwar, mit Ausnahme von *Hæmadipsa* an der Bauchfläche." In order to receive *Orobdella*, which can belong to no other family, two out of these three points must be erased. It is the first one only, that holds good for *Orobdella*, the second is wholly untenable, and the third has to be corrected thus:—"The external apertures of the nephridium are found at the posterior margin of the *last* ring." That they open on the ventral surface has no value whatever for diagnosis, for, so far as I know, there is no leech that has nephridial openings on the dorsal surface. Apathy divides *Gnathobdellidae* further into two subfamilies; *Nephelidae* and *Hirudinidae*. This is also very reasonable, but the characters he gives to *Nephelidae* are too limited to admit any other forms

than the genus *Nepheleis*. They are as follows:—"Die Zahl der vollständigen Somite des Körpers ist 19. Die Zahl der gesammten Ringe bis zur Haftscheibe 113 (resp. 109); die 101 Ringe, welche vom hintersten Augenpaar bis zur Analapertur gezählt werden können, sind leicht wahrnehmbar. Die Geschlechtsöffnungen sind von einander durch zwei Ringe getrennt. Auf dem VI. Somit sind nie von Augen vorhanden. Die Afteröffnung befindet sich zwischen dem ersten und zweiten Somit der Region. Die Mundöffnung erstreckt sich vom II. bis IV. Somit. Die Hinterlippe wird von dem Ringe vor dem 3. Augenpaar gebildet." It will be seen at once, that none of these characters applies to *Orobdella*.

Quite lately R. Blanchard (1894) has published an important paper on the leeches of Italy, in which he classifies them according to a new system. His classification seems to me by far more rational than the one hitherto employed, so that I do not hesitate in adopting it. I reproduce here briefly those passages that concern the classification of our new land leeches.

First of all, the Order *Hirudinea* is divided into two sub-orders, namely *Rhynchobdellæ* and *Arhynchobdellæ*. The *Orobdellæ* fall naturally into the latter group, of which the author gives the following diagnosis.

Arhynchobdellæ.

Hirudinea proboscide carentia, maxillis armata aut inermia, sanguine rubro, aquas dulces colentia vel terrestria. Corpus elongatum, vermiforme, quandoque subteres. Capula ventralis, a corpore non distincta, supra segmentata oculosque vario numero ferens. Os in fundo capulae. Cotyla disciformis a corpore distincta, maxima parte sub ventra recondita. Corpus e 26 somitis constans, extremis contractis. Clitellum a somitis IX-XI formatum. Nephridiorum 17 paria post somitos VI-XXII defluentia. An-

nulorum numerus integro apud varia genera differt. Primus annulus somiterum tam ventre quam dorso papillas segmentarias vario numero præbet. Porus genitalis masculus in somito X, vulva in somito XI hians. Ova in capsulis posita, ventri non adhærentia.

The sub-order is again divided into two families, *Gnathobdellidæ*, and *Herpobdellidæ*. The latter family, to which *Orobdeella* belongs, is characterized thus :

Fam. Herpobdellidæ.

Gula maxillis dentatis carens, quandoque tribus pseudognathis chitinosis inermibus ornata, uno medio infero, duobus lateralibus superis. Oculi 8 in duas series a pluribus annulis separatas dispositi, constantesque e duobus paribus anterioribus et duobus paribus posterioribus. Papillæ segmentariæ permultæ, non apparentes. Annuli 5-11 in somito integro, sæpius disparēs. Pori nephridiales in latere ventris hiantes. Intestinum cæcis lateralibus carens. Ova pauca in capsulis ellipticis complanatis pellucidis lapidibusque vel herbis adhærentibus posita. Habitant aquas dulces.

After describing the external features and the internal organisation of *Cylicobdella lumbricoides* Grube, *C. coccinea*, and *Lumbricobdella Schæfferi*, Kennel (1886) makes the following remark : " Aus der vorstehenden Beschreibung der drei Arten von Erdegeln geht hervor, dass dieselben zu der Gruppe von Hirudineen zu rechnen sind, welcher unsere *Nepheleis* angehört ; der Mangel der Kiefer, das Fehlen der segmentalen Darmaussackungen und des dorsalen Blutgefäßes, die schlauchförmigen Ovarien, der Mangel eines ruthenformigen Begattungsorganes, der compacte Bau der Musculatur stimmen im Allgemeinen mit *Nepheleis* überein." And my investigation on *Orobdeella* leads me to the conclusion that I have to make almost the same remark concerning this leech, which can belong to no other family than *Herpobdellidæ*.

The Family *Herpobdellidae* counts, thus, at least six genera, *Herpobdella*, *Dina*, *Trocheta*, *Cyclobdella*, *Lumbricobdella*, and *Orobdella*. To include all these genera, the above diagnosis must be altered in regard to the number of eyes and to the habit. It will run as follows:—*Hirudinea*, without proboscis, without jaws; eyes in less than 5 pairs or wholly wanting; rings without external marking that distinguishes some from the rest; number of rings in a complete somite 5–11. The other minute characters are important only in determining the genera.

The position which *Orobdella* occupies in the order *Hirudinea* is, according to the results of my investigations, that shown in the adjoining synoptical table.

Ordo. *Hirudinea*

a. Subordo *Rhynchobdellæ*

b. Subordo *Arhynchobdellæ*

1. Fam. *Gnathobdellidae*

Aquatic: gen. *Hirudo*, *Hæmopsis*, *Limnatis*, &c.

Terrestr.: gen. *Hæmadipsa*, *Xerobdella*, *Mesobdella*.

2. Fam. *Herpobdellidae*

Aquatic: gen. *Herpobdella*, *Dina*, *Trocheta*

Terrestr.: gen. *Cylicobdella*, *Lumbricobdella*,

***Orobdella*.**



Works referred to.

1820. SAVIGNY, J. C. *Système des Annélides.*
1826. MOQUIN-TANDON, A. *Monographie de la famille des Hirudinées.* Montpellier.
1828. BLAINVILLE. In *Dict. des sc. nat.*
1861. TENNENT. *The Natural History of Ceylon.*
1868. VON FRAUENFELD, G. *Zoologische Miscellen, XIV.* *Verhandl. der k. k. zool.-bot. Gesellschaft in Wien.* XVIII.
1871. GRUBE. In *Arch. für Naturgeschichte,* XXXVII.
1880. LANKESTER, E. Ray. *On the Intra-epithelial Capillaries in the Integument of the Medicinal Leech.* *Quart. Journ. of Micr. Sci.,* XX.
1883. VEJDOVSKÝ, Fr. *Excreční Soustava Hirudineí.* *Zpr. zas. kral. česk. Společnosti nauk.*
1884. WHITMAN, C. O. *The external morphology of the Leech.* *Proc. of the Amer. Acad. of Arts and Sciences,* XX.
1886. WHITMAN, C. O. *The Leeches of Japan. Part I.* *Quart. Journ. of Micr. Sci.,* XXVI.
1886. KENNEL, J. *Über einige Landblutegel des tropischen Amerika.* *Zool. Jahrb.,* II.
- 1888 a. APATHÝ, St. *Analyse der äusseren Körperform der Hirudineen.* *Mitth. a. d. zool. Station zu Neapel,* VIII.
- 1888 b. APATHÝ, St. *Süsswasser-Hirudineen.* *Zool. Jahrb.,* III. *Abth. für System.*
1890. FORBES, S. A. *An American terrestrial Leech.* *American Naturalist,* XXIV.
1891. LANG, A. *Über die äussere Morphologie von *Hementeria Ghilianii* F. de Filippi.* *Festschrift zur Feier des 50 jährigen Doctor-Jubiläums der Herren Prof. von Nägeli und von Kölliker.*
1892. MEIER, B. L. *Beiträge zur Kenntnis des Hirudineen-Auges.* *Zool. Jahrb.,* V. *Abth. f. Morph.*
1892. BLANCHARD, R. *Description de la *Xerobdella Lecomtei*.* *Mém. de la Soc. Zool. de France,* V.

1893. GRAF, A. Beiträge zur Kenntnis der Excretionsorgane von *Nepheleis vulgaris*. Jena. Zeitschr., XXVIII.

1893, a. BLANCHARD, R. Courtes notices sur les Hirudinées. VIII. Sur *Hirudo brevis* Grube (1871). Bull. de la Soc. Zool. de France, XVIII.

1893, b. BLANCHARD, R. Courtes notices sur les Hirudinées. XIII. Sur les *Hirudo cylindrica* et *H. gemmata* Blanch. (1849). Bull. de la soc. zool. de France, XVIII.

1894, a. BLANCHARD, R. Hirudinées. Viaggio di Leonardo Fea in Birmania regioni vicine. Ann. dei Mus. civ. di Stor. Nat. di Genova. Ser. 2a. Vol. XIV. (XXXIV).

1894, b. BLANCHARD, R. Hirudinées de l'Italie continentale et insulaire. Boll. dei Mus. di Zool. ed Anat. comp. Torino, IX. No. 192.

1894. MERRILL, H. B. Preliminary Note on the Eye of the Leech. Zool. Anz., XVII.

1894. OKA, A. Beiträge zur Anatomie der Clepsine. Zeitschr. f. wiss. Zool., LV.

PLATE XXVIII.

PLATE XXVIII.

- FIG. 1. *Orobdella Whitmani*. nat. size.
FIG. 2. *Orobdella Ijimaï*. nat. size.
FIG. 3. *Orobdella octonaria*. nat. size.
FIG. 4, 5, 6. Head of *Orobdella Whitmani*. $\times 3$.
FIG. 7, 8. Hind end of *Orobd. Whitmani*. $\times 3$. a, anus.
FIG. 9, 10. Head of *Orobd. Ijimaï*. $\times 3$.
FIG. 11. Head of *Orobd. octonaria*. $\times 3$.
FIG. 12. Hind end of *Orobd. octonaria*. $\times 3$.
FIG. 13. Head of a large specimen of *Orobd. octonaria*. nat. size.
FIG. 14. Hind end of the same. nat. size.
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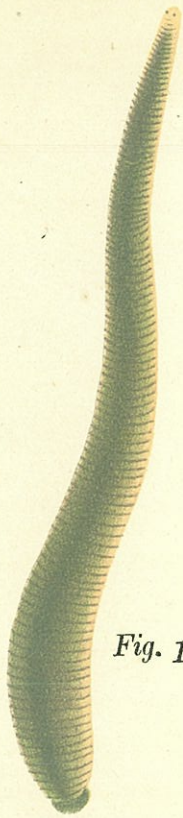


Fig. 1

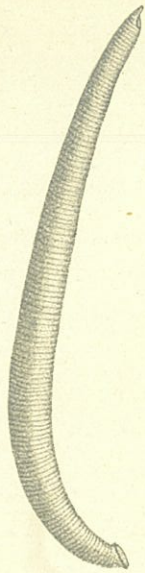


Fig. 2



Fig. 3

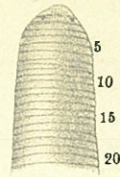


Fig. 9

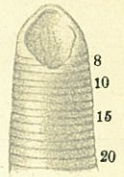


Fig. 10

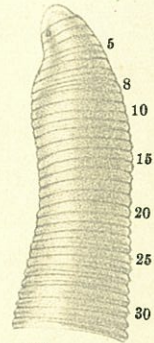


Fig. 11

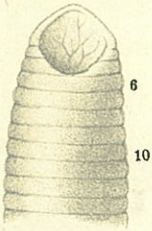


Fig. 4

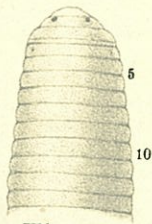


Fig. 5

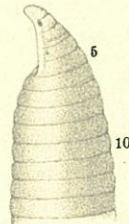


Fig. 6

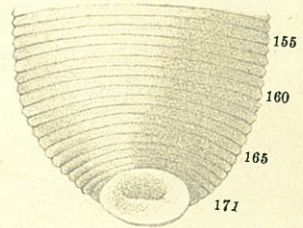


Fig. 12

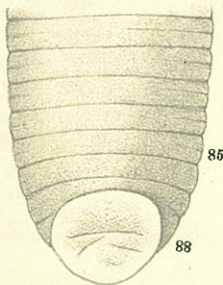


Fig. 7

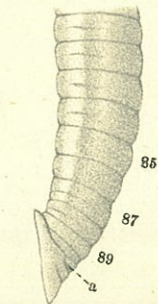


Fig. 8

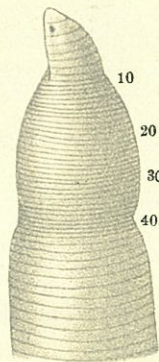


Fig. 13

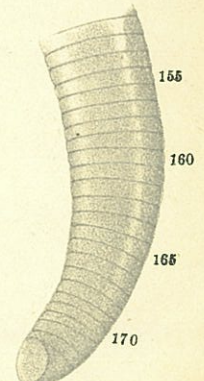


Fig. 14

PLATE XXIX.

PLATE XXIX.

- A. *Orobd. Whitmani*,
 - B. *Orobd. Ijimai*,
 - C. *Orobd. octonaria*.
cl., elitellum.
-

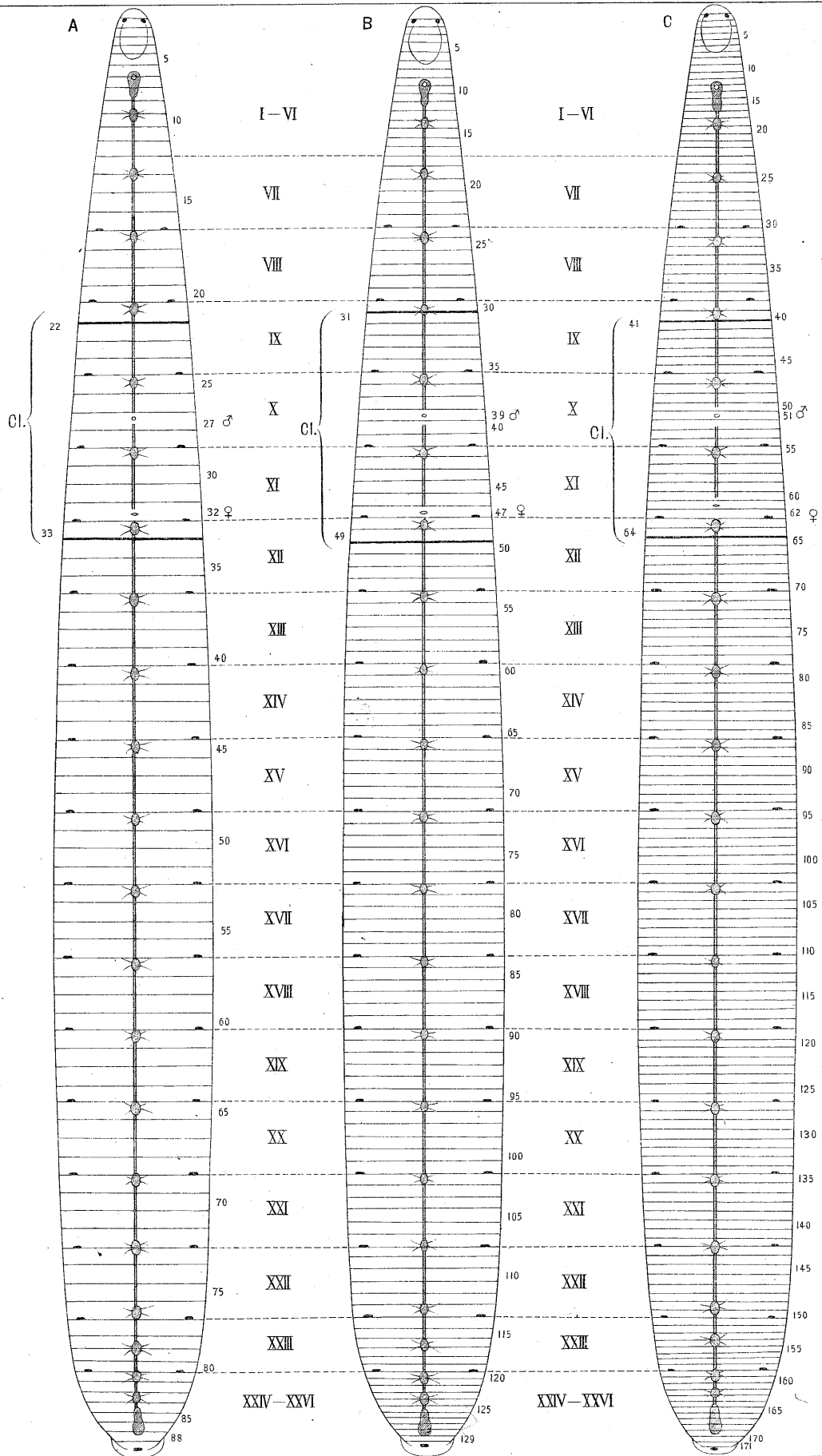


PLATE XXX.

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- FIG. 1. Horizontal section of Head region of *Orobd. Whitmani*. $\times 23$. *oc.* eyes.
oe. mouth-cavity. *n.* nerve.
- FIG. 2. Horizontal section of *Orobd. Ijimaï*. $\times 23$. *st.* stomach. *cæc.* blind sacs.
int. intestine.
- FIG. 3. Sagittal section of the front end of *Orobd. Whitmani*. $\times 5$.
- FIG. 4. Cross section of *Orobd. Whitmani*. $\times 23$. *vd.* dorsal vessel. *oe.* mouth-cavity. *vl.* lateral vessel. *nph.* nephridium. *vnph.* bladder of nephrium.
vv. ventral vessel. *n.* nerve.
- FIG. 5. Sagittal section of the eye of *Orobd. Ijimaï*. $\times 300$. *n.* nerve. *cv.* visual cells.
- FIG. 6. Section through the spherical dilatation of blood sinus, with the nephridial funnel in it. *sv.* blood sinus. *inf.* nephridial funnel.
- FIG. 7. Section through a testicular capsule. $\times 300$. *sp.* group of spermatozooids.
- FIG. 8. A portion of horizontal section of *Orobd. Ijimaï*. $\times 55$. *vv.* ventral vessel.
n. nerve. *tes.* testes. *vnph.* nephrial bladders.
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