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## On some Perichætidæ from Japan.

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With Plate 32.

I am indebted to the kindness of my friend Mr. MASATAKA ROKUGO for a collection of earthworms from Japan, which were in a satisfactory condition for anatomical investigation, if not for histological study. Most regions of the world have been but little explored for *Oligochæta*; and Japan is one of the least known countries; I am therefore particularly grateful to Mr. ROKUGO for giving me the opportunity of adding to what is already known about the *Oligochæta* of this part of Asia. At present but two papers have been published dealing with Japanese earthworms; the first is a paper by Dr. HORST<sup>1)</sup> which contains descriptions of a series of new species of the genus *Perichæta* (or as he terms it „*Megascolex*“), among which are three species — viz.: *P. sieboldi*, *P. schmardeæ*, *P. japonicus* — from Japan. The second paper dealing with Japanese worms is much more recent; Dr. MICHAELSEN<sup>2)</sup> in a notice of the Terricolous fauna of the Azores has incidentally referred to two Japanese species — a new form, *Allolobophora japonica*, the other the ubiquitous *A. foetida*.

Finally Dr. D. ROSA<sup>3)</sup> has described a 6th species — *P. ijimeæ* — from the same country.

1) in: Notes Leyd. Mus. Vol., 5, p. 182.

2) in: Abhandl. Naturw. Ver. Hamburg, Bd. 11.

3) in: Ann. Hofmus. Wien, Bd. 6, p. 379.

*Perichæta rokugo n. sp.*

Of this very well marked new species there were four examples in the collection; I dissected three of these. Even the external characters show one important difference from the more typical members of the genus. There was no visible trace of the usually conspicuous male generative pores upon the 18th segment. In all Perichætidae which I have had the opportunity of examining, or whose structure I know from published descriptions, these pores are exceedingly obvious, and not to be overlooked; it is only in immature worms that they are invisible; as all of the four individuals in my possession are provided with a fully developed clitellum, the apparent absence of the male pores cannot be set down to sexual immaturity.

In other respects the external characters are not in any way remarkable, as will be seen from the illustration (Fig. 1). *Perichæta rokugo* is a stoutly built species, not long in proportion to its thickness. One individual had a length of 4 $\frac{1}{2}$  inches with a diameter of 6 mm.; this worm was composed of exactly 100 segments. Appended are the lengths and number of segments of the three other specimens:

A 4,7/10 . . . . 84

B 2,4/5 . . . . 67

C 3 . . . . 89.

The colour (in alcohol) is a greenish-brown — the clitellum a darker brown.

The setæ form perfectly continuous lines, as in all the other species of the genus *Perichæta* (s. s.), and are, as is also characteristic of this genus, implanted upon a distinctly marked ridge. This ridge is especially prominent upon the posterior segments of the body. The apertures visible on the ventral surface of the body are shown in Fig. 1. The only aperture that is at all conspicuous is the single median oviducal pore; the actual orifice is very minute; but it lies in the centre of a grey-coloured area surrounded by a white ring, which contrasts with the dark brown of the rest of the clitellum. The spermathecal pores lie on the boundary lines between segments VI VII and VII VIII. On the VIIIth segment, in front of the ring of setæ, is a patch of modified integument, about 2 mm in length, which bears a number of closely-set minute pores.

The internal anatomy of this species is, with the exception of one feature of importance, not remarkable in any way. The inter-segmental septa have the arrangement which is usual in this genus,

those of the gizzard segments being absent. The missing septa are those which should divide segments VIII IX and IX X. There are four recognizable septa in front of the gizzard. The first four of those lying behind the gizzard are strengthened, but their increase in thickness over those which follow is not very marked. There are the usual four pairs of dilated hearts in segments X—XIII (inclusive). The nephridia are in no way remarkable, being of the diffuse kind invariably met with in the genus *Perichæta* (s. s.); in some of the anterior segments there is a marked increase of the nephridia, which also occurs in most if not in all of the species of this genus.

The alimentary canal again is not different from the alimentary canal of other *Perichætæ*; the œsophagus widens out in the VIIth segment to form a kind of crop; the gizzard immediately follows the crop, and appears to occupy three segments; but, judging from the analogy offered by other species, it probably corresponds to two segments only, the VIIIth and IXth. Owing to the absence of the septum, which should divide segments IX X, it looks as if the gizzard extended into the Xth segment, but a careful examination of the organ itself shows that its walls become thinner and more membranous in structure before the end of the Xth segment, so that this section of the gut may be fairly regarded as belonging to the Xth segment. In segments XII, XIII and XIV the walls of the œsophagus are much thickened and pinkish in appearance; this region of the œsophagus probably corresponds to the calciferous pouches of other earthworms, which are not otherwise represented in this or other species of the genus. The large intestine commences in the XVth segment. Instead of possessing the usual pair of cæca in the XXVIth segment this species has 6 to 8 pairs of diverticula of the gut in that segment. These are shown in Fig. 4. These numerous cæca spring from the side of the intestine close to each other, the series of each side forming a straight line transverse to the longitudinal axis of the gut. Of these cæca the uppermost one on each side is very much the largest of the series. This peculiar arrangement of the cæca has been recorded before in *Perichæta*, in *P. sieboldi*, by Dr. HORST<sup>1)</sup>. Up to the present that species and the one described in this paper are the only two which show this remarkable peculiarity.

The most interesting peculiarities of *Perichæta rokugo*, however, concern the structure of the reproductive organs. The male repro-

1) loc. cit.

ductive organs are in more than one respect remarkable; the sperm-sacs lie in segments XI and XII as usual, but are not so voluminous as is often the case; they are very much less capacious than are the sperm-sacs of *P. sieboldi* for example; the four sacs form one continuous structure as is shown in the accompanying figure (Fig. 6). The testes I did not succeed in finding, as I did not examine into the structure of the animal by means of microscopical sections; the testes of earthworms are as a rule difficult to see without applying this method of investigation. As the septum between segments IX/X is wanting, the testes must be, as they sometimes are among earthworms — e. g. *Acanthodrilus annectens* — attached to the posterior instead of to the anterior wall of their segment.

The ciliated rosettes (see Fig. 7) are inclosed within the sperm-sacs; the vas deferens, where it issues from the septum bounding the XIIth segment posteriorly, is somewhat dilated. The two vasa deferentia join almost immediately and pass along the body wall in an almost straight line to the point of opening on to the exterior. The most noteworthy structural character of this new species of *Perichæta* concerns the way in which the vasa deferentia open. At the present moment no exception is known to the rule that the vas deferens in the *Perichætidae*, and for the matter of that in all the genera belonging to my family *Acanthodrilidae*<sup>1)</sup> terminates in, or near, a partly muscular and partly glandular atrium; it is only in the *Geoscolicidae* and *Lumbricidae* that a terminal copulatory organ is not usually found. I was therefore much surprised to find not the least trace of an atrium in the first specimen of *Perichæta rokugo* that I dissected. In describing the external characters I have already pointed out the apparent absence of external male pores, which are so exceedingly obvious in all other *Perichætidae* even when not fully mature. My specimens of *Perichæta rokugo* were not only quite mature as regards external characters (presence of clitellum etc.), but the internal organs of generation were also ripe. Still I thought that there might be something abnormal about this particular worm, and therefore proceeded to dissect the remaining specimens in order to discover if they were furnished with atria; in none of them however was there the faintest sign of an atrium even of the most rudimentary description. It is therefore clear that this *Perichæta* differs from all the

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1) The classification and distribution of earthworms, in: Proc. Roy. Phys. Soc. 1891.

other species of the genus in the total absence of atrium or any copulatory apparatus connected with the male pores, and is so far absolutely unique in the genus. The vasa deferentia themselves were quite obvious on account of their white colour; I traced them as far back as the XXth segment (the XXIInd in one specimen) upon which they appear to open; but I have not so far succeeded in finding the actual orifice on to the exterior. This species of *Perichæta* is therefore peculiar not only in the absence of the atrium but also in the position of the male pores, which lie several segments behind the XVIIIth, which segment as a rule bears the orifices. There are two pairs of spermathecae in segments VII and VIII, each of which consists of a largish oval pouch borne on a stalk, the duct; a long diverticulum having the form illustrated in the Figure 2, opens into the duct near to its external orifice. In the VIIth and VIIIth segments there is a mass of capsulogenous glands (Fig. 5), each borne on a longish stalk opening on to the exterior by the area already referred to on the VIIIth segment. The structure of one of these glands is shown in Fig. 3. They consist, as these glands always do, of a mass of pear-shaped cells bound together by a sheath; each individual cell is prolonged into a fine process, which serves as its duct.

The ovaries and oviducts occupy the usual position; there are two pairs of egg-sacs in segments XIII and XIV.

### *Perichæta sieboldi* HORST.

*Perichæta sieboldi* HORST in: Notes fr. Leyd. Mus., Vol. 5, p. 191.

*Perichæta sieboldi* ROSA in: Ann. k. k. Naturh. Hofmus., Bd. 6, p. 401.

The collection contained one example of this species, which is now — through the researches of Drs. HORST and ROSA — a well known form. My specimen measured  $4\frac{1}{2}$  inches in length and 7 mm in diameter posteriorly; it consisted of 74 segments. It is therefore a much smaller individual than any of those previously examined. It might be inferred that this difference was simply due to the degree of relaxation of the worms: were it not certain from the number of segments that there is really a difference in size. The examples studied by my predecessors ranged in length from 135 to 145 segments. As there is, so far as we know at present, a fixed size, only varying

within narrow limits, for each species of *Perichæta* when sexually mature, it may be that my specimen is really a distinct species. Nevertheless I cannot gather from the descriptions of either Dr. HORST or Dr. ROSA that there are any points of structure in which these forms differ. I may add to the accounts given by these two authors a few facts not referred to by either of them.

The clitellum has no setæ upon any of its three segments. This character appears to be found in all the Japanese *Perichæta*.

There is a single pair of egg-sacs (receptaculum ovarum) lying, not in the XIVth segment, but in the XIIIth. The egg-sacs are of considerable size as compared with those of *Lumbricus* for example. They are attached to the front wall of their segment, above the ovaries. It is very usual for *Perichætidae* to have two pairs of these sacs; in such cases they occupy segments XIII and XIV. It is very remarkable to find that when one pair only is present they should be those of segment XIII.

### *Perichæta nipponica* n. sp.

Of this new species I have only a single specimen. It is a slender worm, measuring about 4 inches in length by 4 mm in diameter at the head end, and consists of about 100 segments.

The clitellum has no setæ; elsewhere they form continuous rings, which, in the case of the anterior and posterior segments, are borne upon distinct ridges. The genital apertures are all very distinct; the male pores are upon the XVIIIth segment, and are separated by 14 setæ. The oviducal pore is on segment XIV. The spermathecal pores are between segments V VI, VI VII, VII VIII and VIII IX. On segments VII, VIII and IX are a pair (to each segment) of copulatory papillæ, in front of the line of setæ, and to the inside of the spermathecal pores. Upon these open whitish glands.

There are three distinct septa in front of the gizzard, of which the two first are covered on their anterior faces with dense nephridial tufts. The first 4 or 5 septa after the gizzard are stronger than those which follow. The alimentary canal has the usual characters of the genus; the gizzard lies in segments VIII and IX; the septa dividing these segments are absent, and there is no septum between IX,X. The oesophagus is thickwalled, and of a yellowish colour; it extends back as far as the end of segment XV. There are no specialized

calciferous glands. The intestine begins in the XVIth segment; but in this segment it is of less calibre than in the next in which it attains its full size. The usual pair of cæca are present.

There are 4 pairs of „hearts“ in segments X—XIII.

The sperm-sacs are in segments XI and XII. The atria are very inconspicuous but, as I have only a single specimen, it is possible that this is an individual peculiarity — the atria being simply undeveloped. On the other hand as against this view I may point to the other species of Japanese *Perichætida* described here. The atrium in this species consists merely as in *P. masatakæ* of the muscular tube which is curved; there is no trace of the glandular part of the atrium to be discovered.

The ovaries are large and lie in the XIIIth segment. I could find no egg-sacs. There are 4 pairs of spermathecae in segments VI, VII, VIII, IX. Each has a diverticulum, which has a very unusual form, illustrated in Fig. 8. The diverticulum is longer than the pouch and gives off a number of small globular sacs which show great variation in number and position. These little globular sacs alone contained sperm, and were, owing to their contents, of a chalk white colour. As they are subject to so much variation, I have not thought it worth while to give a special description of them; two varieties are figured (Fig. 8).

### *Perichæta masatakæ n. sp.*

Of this new form I have two specimens. The only complete individual is 5 inches long by 6 mm in breadth both anteriorly and posteriorly; the worm has 90 segments.

The external characters need no particular description; the only point that may be specially mentioned is the existence of copulatory papillæ on the same segments as those which bear the orifices of the spermathecae, viz. Nos. VIII and IX.

With regard to internal structure, there are three septa in front of the gizzard; the five septa following the gizzard — especially the first two of them — are strengthened and united to each other by tendinous threads. The septa between the gizzard segments are as usual wanting; the œsophagus is pinkish in colour in segments XI and XII; this region no doubt represents the calciferous pouches of other earthworms; the intestine begins in the XVth segment, and there are the usual pair of cæca in segment XXVI.

The generative organs as usual serve to distinguish the species from any other. The sperm-sacs are small and lie in segments XI and XII. The two vasa deferentia of each side join in the XIIth segment; they then pass down the body to the atria, which are as in all other species of the genus, situated in the XVIIIth segment. As in *Perichæta nipponica* the atria consist of the muscular tube alone; there was no indication of the glandular appendage to be seen. That this is normally absent in this species, as it certainly is in *Perichæta rokugo*, is rendered more than probable by the fact the two specimens were identical in this particular; in neither of them was there more of the atrium than a short and bent muscular duct into the end of which opened the vas deferens. The ovary is in segment XIII, and there is, as in *Perichæta sieboldi*, only a single pair of egg-sacs; these are in the same segment lying above the ovary of each side. The spermathecae are very small relatively to the size of the worm; they are a good deal smaller for instance than in an example of *Perichæta tokiöensis* which was actually a smaller worm. There are two pairs of them with a single diverticulum longer than the pouch; the spermathecae are in fact precisely similar in shape to the spermathecae of *Perichæta rokugo*. In the neighbourhood of the spermathecae open a series of "capsulogenous" glands, which are symmetrically arranged on either side of the body. There are four of these glands on each side; they are pear-shaped, as in some of the other species described in the present paper. Two open in the neighbourhood of each spermatheca.

### *Perichæta tokiöensis* n. sp.

This species like *Perichæta nipponica* is represented in the collection by only a single example. The worm measures  $2\frac{1}{2}$  inches in length by 6 mm diameter and is built up of 67 segments.

The clitellum is, like all the other species described in this communication, devoid of setae, and developed upon segments XIV—XVI (inclusive). The male pores are conspicuous upon the XVIIIth segment. Near to them, and to the inside, are two or three small apertures with which correspond glands. The oviducal pore is single and median upon the XIVth segment. The spermathecal pores are between segments VI/VII, VII/VIII. They are in the same line with the male pores, the pores of each side being 5 mm apart. On the

VIIIth and IXth segments, just in front of the circle of setæ and to the inside of the spermathecal pores, are paired papillæ very prominent and circular in outline.

There are three septa in front of the gizzard which constrict the œsophagus. The first septum behind the gizzard separates segments X/XI, as in all the species of *Perichæta* described here, excepting *P. sieboldi*. None of the septa are specially thickened, although the first four or five are bound together by ligamentous threads, as are the specially thickened septa of other *Perichæta*. As to the alimentary canal, the only points in which it differs from other species described here are 1) that the large intestine commences in the XVth segment, and 2) that there are only the usual two cæca in segment XXVI. There are the usual dilated perivisceral vessels in segments X—XIII, and masses of nephridia upon the anterior face of the two first septa.

The generative system presents characters which serve to distinguish the species. The sperm-sacs are not very large; they lie in segments XI and XII. The atria are well developed extending through four segments XVII—XX. They are very much broken up into lobules. Round the external orifice of the atria are a few white glands. The ovaries are in the XIIIth segment and the same segment contains the single pair of egg-sacs. There are two pairs of spermathecae in segments VII and VIII; these organs are of exactly the same form as in *Perichæta rokugo*. In common with, or in the neighbourhood of, the spermathecae are a few small stalked "capsulogenous glands"; these glands precisely resemble those of *Perichæta rokugo* in appearance. On the left side of the body in the VIIth segment two or three of them open by a common pore i. e. the copulatory papilla already spoken of; in the VIIIth segment one gland opens on to the papilla, and another opens with the duct of the spermathecae. On the right side of the body a single gland corresponds to each papilla, and another pair of glands unite to open close to, if not in common with, the spermatheca of segment VIII; one of the glands lies however in the VIIth segment, its duct perforating the septum. Probably the number and arrangement of the glands varies in individuals.

A hybrid *Perichæta* (= *P. rokugo* + *P. sieboldi*).

The question of hybridity among earthworms has never been treated of; facts have been hitherto wanting. That interbreeding should occur is probable enough; and perhaps some species showing

"intermediate characters" may be the result of such fertile crossings.

In the collection of earthworms described in the present paper was a single example of a *Perichæta*, which shows in my opinion internal evidence of being a hybrid between *Perichæta rokugo* and (perhaps) *P. sieboldi*. These two species are of about the same size, which would of course conduce toward a successful pairing; I give the facts, however, for what they are worth.

The worm shows in the first place a curious external asymmetry similar in character to what I have before seen in an *Allolobophora foetida*. The clitellum is unevenly developed on the two sides of the body. On the right side it occupies the three usual segments; but on the left side it is pushed a segment further back involving segments XV—XVII inclusive; this can have nothing to do with the hybrid character of the specimen, because in both species which I believe to have been concerned in its production, the clitellum occupies the three usual segments viz. XIV—XVI. Nor is there any internal asymmetry appearing to have a relation to this.

With regard to internal structure, the two species which I presume to be the parents of the individual described here, agree in the characters of the alimentary canal, vascular system, septa and nephridia. In all these points the supposed hybrid shows no divergencies.

The differences between the two species *Perichæta rokugo* and *P. sieboldi* are found in the spermathecae, the sperm-sacs, the sperm-ducts and the stalked capsulogenous glands of segment VIII.

The spermathecae of the supposed hybrid resemble those of *Perichæta rokugo*; so too do the sperm-sacs.

The stalked capsulogenous glands are absent from the VIIIth segment but there is a mass of perfectly similar glands — 24 in number — in the XVIIth and XVIIIth segments. This may perhaps indicate that not *P. sieboldi* but some other species is one parent.

The efferent ducts afford the principal ground upon which I base the conclusion that this individual is a hybrid between *Perichæta rokugo* and *P. sieboldi*, or a form closely allied to the last. On one side of the body (the right) the vas deferens opens into a "prostate" identical in its characters with that of *Perichæta sieboldi*; the external orifice of this gland was perfectly obvious upon the exterior of the body. On the other side there was no trace of any atrium or of its glandular appendage. The vas deferens opens some way behind the XVIIIth segment; externally the aperture was invisible. On one

side of the body, therefore, this worm agrees with *Perichæta rokugo*, and on the other with either *P. sieboldi* or some nearly related form.

#### Remarks upon the Japanese *Perichæta*.

As will be seen from the foregoing descriptions as well as from previously published descriptions, so far as they relate to the points in question, the species of *Perichæta* found in Japan show certain peculiarities, which distinguish them.

In all there is an absence of setæ from the clitellar segments; in most of them there are capsulogenous glands in the immediate neighbourhood of the spermathecæ, which are borne on long stalks; in several of them there is a tendency for the atria to become rudimentary, which tendency culminates in *P. rokugo*; in this species the atria have entirely vanished, leaving not a trace behind. Finally the receptacula ovarum are almost always a single pair, situated — a most unusual position, when there is but a single pair — in segment XIII.

The most important of these divergencies from the normal structure of the genus is undoubtedly the disappearance of the atria, associated with the alteration in the position of the male orifice. This character is a step in the direction of the *Geoscolicidæ*; but there are no other indications of an affinity in this direction. The peculiarities of the Japanese *Perichætidæ* are not universal enough among the species to allow of their being used to separate these forms as a distinct genus.

### Explanation of the Plate 32.

Fig. 1. *Perichæta rokugo*; ventral view of anterior segments, which are numbered.

Fig. 2. The same; a spermatheca.

Fig. 3. The same; one of the capsulogenous glands, magnified.

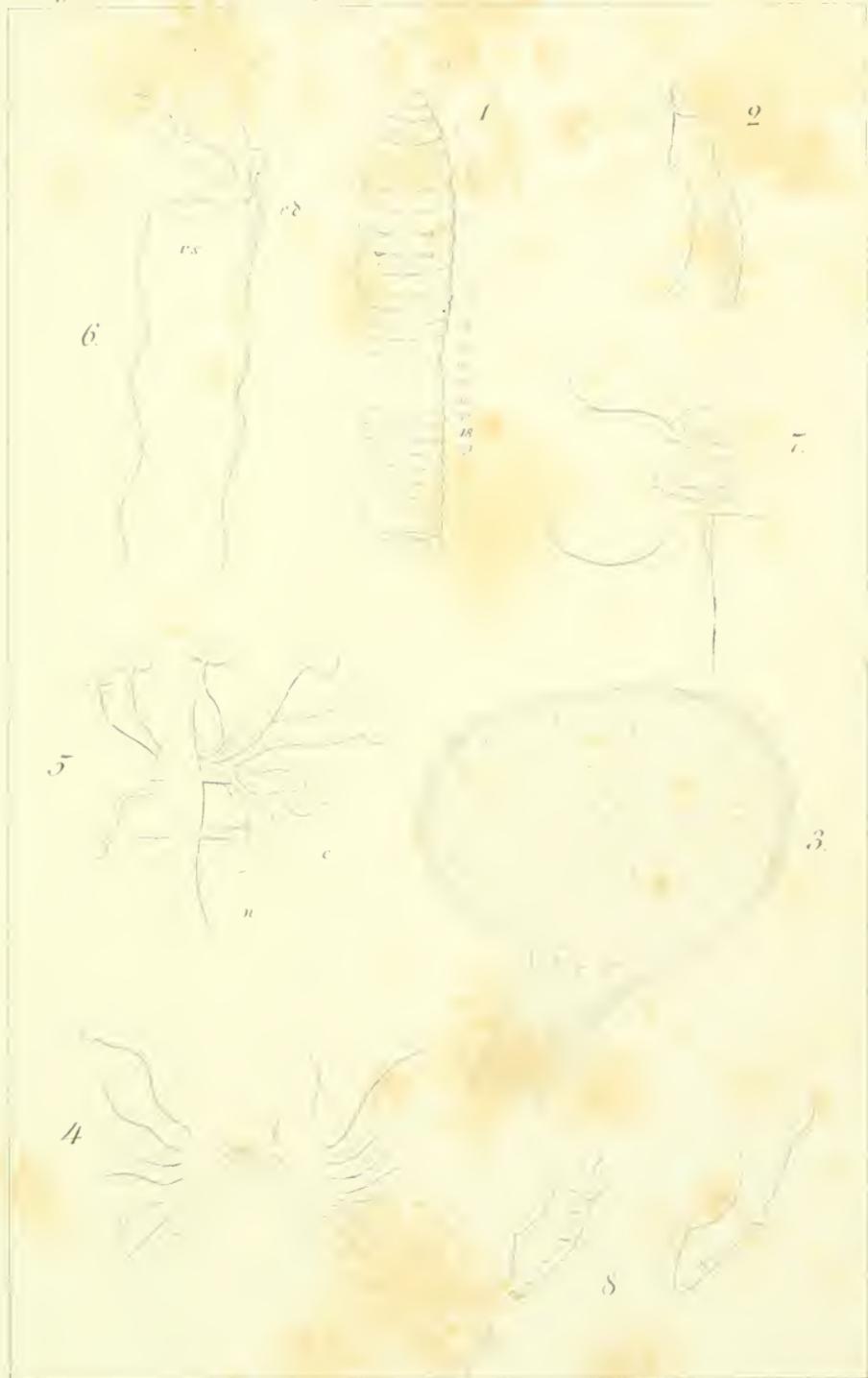
Fig. 4. The same; intestinal cæca.

Fig. 5. The same; group of capsulogenous glands (*c*) opening on to exterior beneath nerve cord (*n*).

Fig. 6. The same; sperm-sacs (*v. s*) and vasa deferentia (*v. d*); the letters *v. d* point to the dilated commencement of vas deferens.

Fig. 7. The same; sperm-sacs dissected to show funnels (*f*) of vasa deferentia.

Fig. 8. *Perichæta nipponica*; two spermathecae.



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