Fam. BUFONIDÆ.

11. BUFO JERBOA Blgr.

Bufo jerboa Laidlaw, P. Z. S. 1900, p. 889.

Locality. Gunong Inas ("Skeat Expedition").

Previously known from Borneo.

Fam. PELOBATIDÆ.

12. LEPTOBRACHIUM PELODYTOIDES Blgr.

Leptobrachium pelodytoides Boulenger, Ann. Mus. Genova, (2) xiii. 1893, p. 345, pl. xi. fig. 3.

Locality. Larut Hills, Perak (L. Wray). Identified by Mr. Boulenger.

Previously known from Karin Hills.

13. LEPTOBRACHIUM HETEROPUS Blgr.

Leptobrachium heteropus Boulenger, A. M. N. H. (7) vi. Aug. 1900, p. 186.

Locality. Larut Hills, Perak, 3500 ft. (A. L. Butler).

Type.

Note.

RANA LATICEPS Blgr.—I have examined the frogs from Gunong Kledang, Perak, which Dr. Hanitsch recorded (Rep. Raffles Library & Museum, 1898) as *R. laticeps*, and I find they are in reality *R. hascheana* (Stol.). The claim of *R. laticeps* to a place on the Peninsula list depends, therefore, on a single specimen in the British Museum from Malacca (Mr. Hervey), and on Captain Flower's not quite positive identification of a specimen in bad condition in the Raffles Museum, from the same locality.

6. On some new Species of Earthworms belonging to the Genus *Polytoreutus*, and on the Spermatophores of that Genus. By FRANK E. BEDDARD, M.A., F.R.S.

[Received June 3, 1902.]

(Text-figures 46–54.)

The specimens which I deal with in the present communication form a part of the collection of these Annelids at the British Museum. Dr. Ray Lankester has been so good as to permit me to study these worms; and to him, as well as to Mr. E. A. Smith with whom I have corresponded on the matter, my thanks are due. The majority of the specimens were collected by Mr. S. L. Hinde in the Kenya District, at an altitude of 4000–4800 feet; a number of others, which also prove to be of considerable interest, were collected by Mr. Stuart Betton, in Lagari, British East Africa. The genus is limited in its range to Equatorial

East and Central Africa. There are at present twelve species known, of which eleven are characterized (from the original descriptions by himself and by myself) by Dr. Michaelsen in his "Oligochæta" which forms Lieferung X. of 'Das Tierreich'[1]. To these I have recently added a twelfth species, also collected by Mr. Hinde[2]. I have now some observations to record upon new species. The first of these I shall name

(1) POLYTOREUTUS KENYAENSIS, n. sp.

This new species is one of the smaller forms, and agrees in its dimensions with *P. cæruleus* and *P. violaceus*. The large series of specimens which I have examined vary somewhat in dimensions; 100 mm. in length by 5 mm. in breadth were the measurements of an average specimen among the larger ones. The species is evidently a darkly coloured one; in the spirit the specimens were purplish brown dorsally. The prostomium is epicheilous, extending about halfway across the buccal segment.

The clitellum is completely developed round the body and embraces segments xiv.–xvii. inclusive with a portion of xviii. and sometimes of xiii.

The setæ, as is usual in this genus, are at unequal distances. The two setæ of the ventral couple are wider apart than are those of the lateral couple. The nephridiopores are only plainly visible upon the clitellar segments; they lie close to the anterior margin of the segment in a line with the ventralmost of the two lateral setæ.

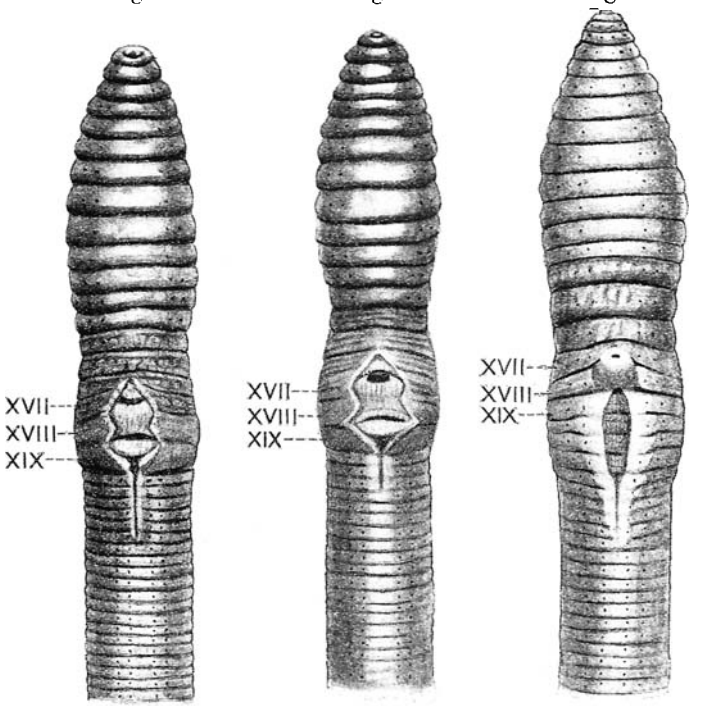
The oviducal pores are obvious upon the xivth segment; they lie near to the posterior boundary of that segment and a little ventrally to the nephridiopores.

The most striking external feature of this species is shown in the accompanying drawings (text-figs. 46, 47). The male and female pores (to the description of which I shall return presently) lie on an area which is enclosed within a raised and lip-like fold which commences upon the sixteenth segment in front, and is continued back for a variable number of segments. Anteriorly upon the xvith segment and close to the front boundary of this segment, the folds of the right and of the left side nearly or quite coalesce; they then diverge to enclose the male pore and become again approximated upon the xviiith segment and behind this pore. The larger spermathecal pore pushes the folds still further apart. Two or three segments behind this point the right and left folds again approach each other, but much more nearly, and they may even come into contact upon the last segments where they are developed, leaving merely a groove to indicate their original distinctness. This groove is generally closed posteriorly by an unpaired swelling of the integument. The whole area has thus very much the contour of a violin. I examined altogether

[1] Berlin, 1900, p. 412.
[2] "On some Earthworms from British East Africa, &c.," P. Z. S. 1901, i. p. 336.

75 fully mature examples of this species and found some variations in the extent of these lateral folds surrounding the genital area. The prevalent arrangement was that the area ended upon the xxivth segment; 29 specimens exhibited this character. But in nearly as many (24) these folds ceased to exist upon the xxiiird segment. In 18 examples the folds were more extensive, reaching to the xxvth segment. The extreme in this direction was shown by one specimen only, where the groove extended as far as the xxvith segment. On the other hand, in three specimens this genital area stopped short at segment xxii.

Text-fig. 46. Text-fig. 47. Text-fig. 48.



Text-fig. 46.—Ventral view of anterior segments of *Polytoreutus kenyaensis.*

Text-fig. 47.—Ventral view of anterior segments of an individual of *Polytoreutus kenyaensis,* with shorter perigenital area.

Text-fig. 48.—Ventral view of anterior segments of *Polytoreutus montis-kenyæ.*

The segments which bear the pores are numbered.

The single and median male pore is upon segment xvii.

The single and median spermathecal pore is wider from side to side and lies upon the boundary line of segments xviii./xix.

As to the internal structure, it is mainly the female parts of the generative system which show differences from other species.

The septa dividing segments v./xi. are thickened. The dorsal vessel is single, and the last pair of hearts are in segment xi.

The gizzard lies in segment v. The system of calciferous glands appears to be quite as in other species.

In the xith segment are the dilated chambers which form the commencement of the single pair of sperm-ducts.

The sperm-sacs of *Polytoreutus kenyaensis*, as is the case with all other species of the genus, are but a single pair and are of very considerable length. In a worm measuring 9 mm. in length the sperm-sacs were 15 mm. long. As is the case with many other species of the genus, the sperm-sacs are divided into two regions: the anterior half is a thin slender tube, while the posterior half of each sperm-sac is swollen and deeply constricted where it passes through the septa. This latter region begins at about the xxivth segment and extends to the xxxviiith. For three or four segments the slender sacs which form the anterior part of the sperm-sacs are also constricted where they traverse the septa. Latterly, the sperm-sacs show no signs of division into two sacs, they are completely blended for a tract which extends some little way forward from the posterior end.

The spermiducal glands are tubular and straight or a little coiled. I did not notice any marked division into two regions as in the spermiducal glands of *P. gregorianus*. There are here and there slight constrictions along the walls which produce irregular bulgings of the tube. In one case, and place, this bulging was so marked that the permiducal gland ended in a bifid extremity. The large bursa into which both these glands open is more or less circular in contour.

The spermathecal apparatus appears to differ from that of any other species in that it has no diverticula. It commences anteriorly not far from septum xiii./xiv. and pursues a straight course to its point of opening on to the exterior between segments xviii./xix. It is a narrow tube and flattened against the ventral body-wall, being overlaid by the nerve-cord; at the posterior end it is wider for a short space before its external orifice. Anteriorly the sac ends blindly in a rounded extremity. Into this open the two oviducts directly, and not through the intermediary of diverticula of the sac as in other species of the genus. The oviducts are slightly coiled and, as usual, thick-walled and present a very different appearance from the spermathecal sac into which they open. Traced in the opposite direction, the oviducts pass to the exterior through a rounded thick-walled chamber which Dr. Michaelsen has called the "Eitrichterblase," to which is appended a receptaculum ovorum. The latter is very much larger than the Eitrichterblase from which the oviduct runs to the external pore. Several chambers packed with spermatozoa ("Samenkämmerchen" of Michaelsen) are appended to the oviduct close to its exit from the receptaculum, as in many but not all species of *Polytoreutus*. I may observe that the oviduct is ciliated throughout, not merely that portion of it which passes from the receptaculum to the

exterior. As to the region which opens into the spermathecal sac, it seems to be an unnecessary periphrasis to call it, as Dr. Michaelsen does, a "Verbindungsschlauch." It is, to my mind, unquestionably the oviduct and corresponds exactly to that portion of the oviduct which in other Eudrilids (*e. g.* in *Stuhlmannia*[1]) opens directly into the spermathecal sac. Its cells are cubical and ciliated, and totally different from the long thin non-ciliated cells which line the spermathecal sac. Furthermore, there is no transition between the two kinds of cells that I could discover; and finally the oviduct opens by a slightly dilated mouth freely into the interior of the sac. This is, I take it, the oviducal funnel. I am inclined from these additional facts to add to the definition of the Eudrilidæ that the oviduct is characterized by the possession of two funnels, one of which opens into the receptaculum ovorum and the other into the spermathecal sac. The Samenkämmerchen are, as Michaelsen their discoverer has pointed out, diverticula of the oviduct packed with spermatozoa arranged in a regular fashion. I am disposed to consider these diverticula as corresponding to the single diverticulum upon the oviduct which is to be found in *Hyperiodrilus*, *Heliodrilus*, and *Alvania*. Spermatozoa have not, however, so far been found to exist in the latter. I found spermatophores in the spermathecæ, the description of which I postpone for the present.

(2) *Polytoreutus montis-kenyæ*, n. sp.

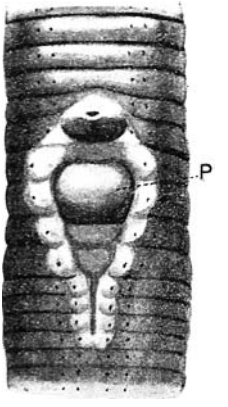
This species has a considerable similarity to the last, which is chiefly due to the fact that the genital area is surrounded by a raised ridge not unlike that distinctive of *Polytoreutus kenyaensis*. The two species are nevertheless perfectly distinct. There are both external and internal differences of structure. *Polytoreutus montis-kenyæ* is, in the first place, a smaller and more slender species than its nearest ally. It has a length of 68 mm. and a diameter of 4 mm. In its colour (in spirit), form of prostomium, arrangement of setæ, position of nephridiopores, the present species appears to agree exactly with *P. kenyaensis*. The clitellum is also much the same; it always occupies segments xiv.–xvii., and occasionally strays a little way on to segments xiii. and xviii. Externally this species is to be distinguished from *P. kenyaensis* by the position of the male pore and by the perigenital area. The male pore lies intersegmentally between xvii./xviii. This fact could be positively ascertained only upon immature specimens, of which there are a good many. In the fully adult worm, the orifice in question is borne upon a smooth conical projecting papilla, more conspicuous in some individuals than in others, but always obvious. The actual orifice when particularly conspicuous is circular in outline. This papilla shelves down into the perigenital ridges, which in this species do not extend further

[1] Beddard, P. Z. S. 1901, vol. i. p. 354, text-fig. 87, *o.d.*

forward than the xviith segment. This, as will be seen from a comparison of the drawings exhibited (*cf.* text-figs. 46 and 48, p. 192), is a striking difference between *Polytoreutus montis-kenyæ* and *P. kenyaensis*. The male orifice itself is not so conspicuous as in *P. kenyaensis*, and the female pore is much less so; it lies between segments xviii./xix.

The outline of the perigenital ridge is not so complete as in the last species. Anteriorly it is oval in contour, leaving a considerable ventral area of that shape between the two sides. The right and left folds approach each other gradually, and about the xxiiird segment are in practical contact, a furrow only being left between them. The shape of the genital area is thus more like a racquet than a violin. As I have already explained in the case of *P. kenyaensis*, the perigenital ridges of the present species are subject to some variation in their extent. But the mean about which the variation plays is a segment further back than in *P. kenyaensis*. In 26 individuals the ridges ended either upon segment xxv. or upon segment xxvi. Ten of these I refer to the latter category; but it is a little difficult to be accurate in drawing a hard and fixed line, since the groove sometimes ended upon the middle of the xxvith segment. I found no (mature) individual in which the genital area was of less extent; but in *one* specimen only it reached to the end of segment xxvii.

Text-fig. 49.



Ventral view of genital segments of *Polytoreutus montis-kenyæ*.
P, white cushion-like thickening.

The only other external character to which I have to call attention, is the very occasional presence of a white cushion-like thickening of limited extent in the ventral median line of segments xx. and xxi. I only observed this character to be well

developed in one individual which was not fully mature (text-fig. 49).

The internal anatomy of the genus *Polytoreutus* appears, so far as present observations go, to offer but little variation in the characters of the alimentary canal and the vascular system. I find that up to the xiith segment the structure of the present species is quite like that of its nearest ally. The sperm-sacs, moreover, are constituted upon exactly the same plan. In two specimens, one of the present species and one of *P. kenyaensis*, which I divided longitudinally and placed side by side for comparison, the dilated terminal region of the sperm-sacs reached back to precisely the same segment, *i. e.* the xxxviiith. There is, however, naturally some variation in the extent of these sacs.

The spermiducal glands of the present species are relatively larger than those of *Polytoreutus kenyaensis*; otherwise their contours are much the same. They do not, however, open directly into a bursa propulsoria as in that species. The gland ends, in fact, in a duct of rather narrower calibre; the ducts appear to join, and in any case the bursa propulsoria is insignificant in its dimensions. That this would prove to be the case, is really indicated by the external characters; the, comparatively speaking, inconspicuous male pore does not suggest a large muscular terminal sac such as is suggested by and co-exists with the wide and broad external male pore of *P. kenyaensis*. The two drawings exhibited herewith (text-figs. 50, 51, p. 198) show accurately the relative dimensions of the bursa propulsoria in the two species. That of *Polytoreutus kenyaensis* is fully twice the size of that of the present species. These differences are of specific value; they have nothing to do with relative maturity. In both cases, a number of segments following the median generative pores have a much thickened body-wall. The ventral region of integument thus increased in thickness corresponds to the genital area dealt with in describing the external characters of the two species. The drawing (text-fig. 50, A, p. 198) shows the pre-eminently glandular nature of this area in *P. montis-kenyæ*, where contorted whitish masses of glandular substance have largely invaded the thickness of the integument. It may be finally pointed out that the external orifice and the lumen of the bursa propulsoria in *P. montis-kenyæ* looks forward; while in *P. kenyaensis* the direction is at right angles to the longitudinal axis of the body of the worm. The most remarkable feature, however, about the male efferent apparatus of this species is the existence of a small forwardly directed diverticulum of the spermiducal gland. This diverticulum has exactly the same appearance as the main gland, but is of less calibre: it receives the sperm-duct at its free apex. It joins the main gland just where the latter passes into its duct. This structure is not, however, new to the genus. Dr. Michaelsen has already recorded in *Polytoreutus arningi*[1] a perfectly similar

[1] "Neue u. wenig bekannte afrikanische Terricolen," J.B. Hamb. wiss. Anst. xiv.

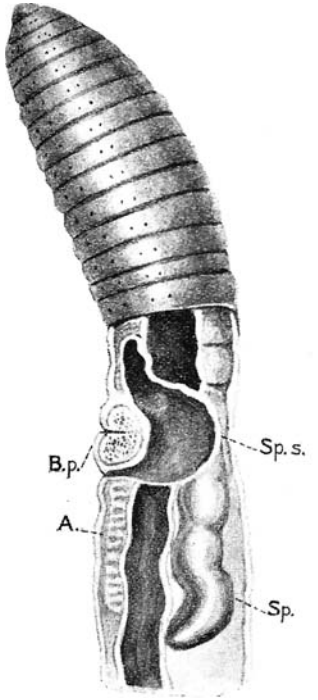
structure; but these two species stand apart in this character from the remaining species of the genus *Polytoreutus*.

This condition appears to me to throw some light upon the curious structure of the corresponding glands in *Eudrilus*. In that genus, as has been abundantly shown by others as well as by myself, the spermiducal gland of each side is really formed by the close lateral fusion of two tubes, the fusion being merely a close apposition and retention within the same muscular sheath. The lumina are distinct, and the sperm-duct opens into one only of the closely joined tubes. Moreover, one of the tubes is distinctly longer than the other. My own recent investigations upon the spermiducal glands in the young *Eudrilus* seem to show that the division of the spermiducal gland is a secondary matter, for it is single and with but one lumen in the immature worm. It may be, however, that in *Polytoreutus* an originally double spermiducal gland derived from some *Eudrilus*-like form has split into its two component halves which have acquired independence. The double character of the male orifices and the female reproductive organs in *Eudrilus*, point to its being a more primitive type of Eudrilid than the, in many respects, highly modified *Polytoreutus*. In the present species the minute structure of the two parts of the "prostate" is identical, and the sperm-duct becomes continuous with the lumen of the diverticulum about one-third way down.

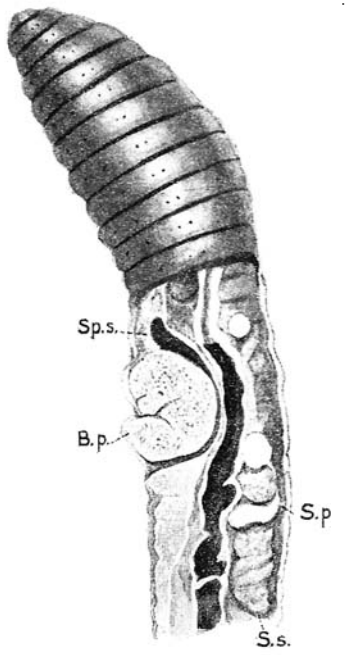
The female organs closely resemble those of *P. kenyaensis*. The spermathecal sac is single and median, and has no diverticula of any kind. At the posterior end it is, however, a little different from the spermathecal sac of the last species. The difference lies in the fact that the sac is humped up and bulged out a little way before the external orifice. Viewed laterally, the spermathecal sac is there **S**-shaped posteriorly. There is no question of diverticula. It is simply a dilatation of the sac itself. This region was packed with coagulated matter, which under the microscope was seen to consist entirely of coarse granules. I could find no trace of spermatophores. By the examination of several specimens I have convinced myself that the proximal widening of the spermathecal pouch of this species is a constant character, and distinguishes it from its ally *P. kenyaensis*. The contrast in this particular between the two species is clear from an inspection of the drawings exhibited (*cf.* text-figs. 50, 51, p. 198). Of this particular individual, I detached and made a series of sections of the anterior end of the spermathecal sac and of the egg-conducting apparatus. Though there were apparently no spermatophores in the posterior portion of the spermathecal sac, they were abundant anteriorly. The oviduct is furnished, as in the last species, with several diverticula lodging sperm. I have noted, however, the additional and interesting—if obviously to be expected—fact that free spermatozoa exist also along the course of the oviduct between the diverticula just referred to and the spermathecal sac. Their heads seem to be invariably in contact with the lining epithelium, the cilia of

which possibly attract them. I cannot therefore form an opinion as to the direction in which they were moving at the time of death. As in *P. kenyaensis*, the oviducts open straight into the median spermathecal sac at the two anterior corners.

Text-fig. 50.



Text-fig. 51.



Text-fig. 50.—Longitudinal section through genital segments of *Polytoreutus montis-kenyæ*.

A., ventral glandular area; *B.p.*, bursa propulsoria; *Sp.*, spermiducal gland; *Sp.s.*, spermathecal sac.

Text-fig. 51.—Longitudinal section through genital segments of *Polytoreutus kenyaensis*.

S.s., sperm-sac. Other letters as in text-fig. 50.

I have been able to note the histological characters of the epithelia at the point of contact. The sac is lined generally with a tall epithelium of granular appearance, the cells of which appear to break down at their free extremities to produce the granular matter with which the pouch is largely filled. At the slightly bulging corners (suggesting by their protuberance rudimentary diverticula of the median sac), where the oviducts open, the tall granular epithelium is underlain by a columnar epithelium which

is continuous with that lining the oviduct. At the sides this epithelium thins out and apparently disappears. Near to the orifice of the oviduct into the spermathecal sac, the tall granular cells disappear, so that there is a perfectly open oviducal funnel. At the actual opening of the funnel, the columnar cells are raised to form a lip surrounding the lumen. There can be no question therefore about the termination of the oviduct within the spermathecal sac in a funnel-like expansion. I could not, however, detect any cilia upon the epithelium.

(3) POLYTOREUTUS BETTONIANUS, n. sp.

Of this new species two individuals, of which one is fully adult, were collected at Lagari, British East Africa, by Mr. Stuart Betton. The worms were rather softened, so that the following account of their structure is not so full as it might otherwise have been.

The mature individual is incomplete at the posterior extremity; it measures 77 mm. by 5 mm. in diameter. The immature specimen is 93 mm. long. The colour (in alcohol) is of an uniform grey. The prostomium is procheilous, fitting into the concave anterior margin of the peristomial segment. The setæ show the usual arrangement met with in *Polytoreutus*. The clitellum occupies segments xiv.–xvii. entirely and about one-third of segments xiii. and xviii. The male pore is borne upon a prominent papilla and is intersegmental, xvii./xviii. The female pore lies between segments xviii./xix. There are no papillæ of any kind.

The alimentary tract and vascular system appear to be as in other species. The sperm-sacs of this species are unusual in their character. They are more normal speaking generally, but less normal for this particular genus *Polytoreutus*. In eight out of the twelve species already known and in the two species which have been dealt with in the present communication, the sperm-sacs commence as thin strands which pass back for a considerable distance before they acquire the more capacious dimensions usually associated with the sperm-sacs of earthworms. In *Polytoreutus bettonianus* the sperm-sacs are as wide at their commencement as they are in any part of their course. Coupled with this increase in diameter is a decrease in length. The sperm-sacs of the present species reach hardly further back than the point of opening of the spermiducal glands. The sperm-sacs are plump and sausage-shaped, of greater calibre than the spermiducal glands; they are marked by one or two deep constrictions. The two sperm-sacs are perfectly independent, and are not fused or even approximated posteriorly.

The spermiducal glands are about 14 mm. long; there is nothing remarkable in their form. Each gland is furnished with a narrower duct. A bursa propulsoria is practically absent. The female apparatus is constituted upon exactly the same plan as that of the two species just described. There is no bursa copulatrix. The spermathecal sac itself is single and median, without

any diverticula. Its calibre is rather greater than is the case with *Polytoreutus kenyaensis* and *P. montis-kenyæ*. Anteriorly the two oviducts enter it, and they are readily distinguishable from the pouch by their nacreous, indeed almost bronzy glitter, due, of course, to the thick muscular wall.

It may be convenient to embody the above-given descriptions in a short diagnosis of each of the new species of *Polytoreutus* dealt with in the present communication.

(1) **Polytoreutus kenyaensis**, n. sp.

Length 100 mm.; diameter 5 mm. Colour (in alcohol) purplish brown above. Prostomium epicheilous. Clitellum (xiii.) xiv.–xviii. Male pore xvii.; female pore xviii./xix. Genital area formed by two curved ridges meeting anteriorly on xvi. and posteriorly on xxiii.–xxvi. Sperm-sacs narrow and tubular anteriorly, wide and sacculated posteriorly, fused at extremity. Bursa propulsoria very large; spermiducal glands without duct. Spermathecal sac without diverticula; oviduct with sperm-holding diverticula; no bursa copulatrix.

Hab. Mt. Kenya region, Brit. C. Africa.

(2) **Polytoreutus montis-kenyæ**, n. sp.

Length 68 mm.; diameter 4 mm. Colour (in alcohol) purplish brown above. Prostomium epicheilous. Clitellum (xiii.) xiv.–xviii. Male pore xvii./xviii.; female pore xviii./xix. Genital ridges commencing at male pore and ending on one of segments xxv.–xxvii. Sperm-sacs narrow and tubular anteriorly, wide and sacculated posteriorly, fused at extremity. Bursa propulsoria very small; spermiducal glands with short anterior branch receiving sperm-duct and with slender duct. Spermathecal sac without diverticula; no bursa copulatrix.

Hab. Mt. Kenya region, Brit. C. Africa.

(3) **Polytoreutus bettonianus**, n. sp.

Length about 100 mm.; diameter 5 mm. Colour (in alcohol) grey. Prostomium procheilous. Clitellum xiii.–xviii. Male pore xvii./xviii.; female pore xviii./xix. Sperm-sacs of uniform, wide diameter throughout. Spermiducal glands with duct. Bursa propulsoria very small. Spermathecal sac without diverticula. No bursa copulatrix.

Hab. Lagari, Brit. E. Africa.

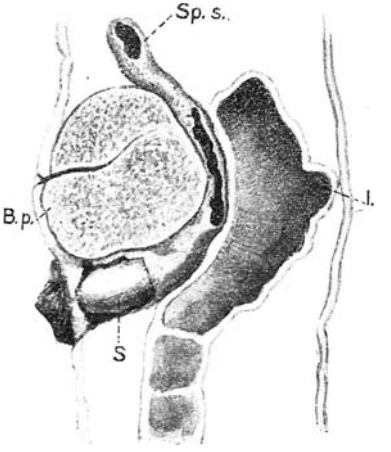
On the Compound Spermatophores of Polytoreutus.

In a communication made to this Society in 1901 [1] I dealt with the spermatophores of *Polytoreutus magilensis*, *P. violaceus*, and

[1] "On some Earthworms from British East Africa, &c.," Proc. Zool. Soc. 1901, vol. i. p. 340.

P. hindei, the only species in which, so far as I am aware, any structures of the kind have been met with or described. It may, I think, be admitted that in this genus *Polytoreutus* the spermatophores are very much like those of the Tubificidæ, and that they occur in two forms distinctive of different species of that genus. An examination of the species of *Polytoreutus* which I have named *P. kenyaensis* and *P. montis-kenyæ* has shown that the same kind of spermatophores exist, but not in great abundance, in the spermathecal sac. These spermatophores in *P. kenyaensis* are of the type characteristic of *P. magilensis*, but are smaller and more slender than in the much larger species *P. magilensis*. The spermatophores, when present, were found in the region of the spermatophore nearest to the external orifice. I never observed

Text-fig. 52.



Longitudinal section through the spermathecal sac and the adjacent region of *Polytoreutus kenyaensis*.

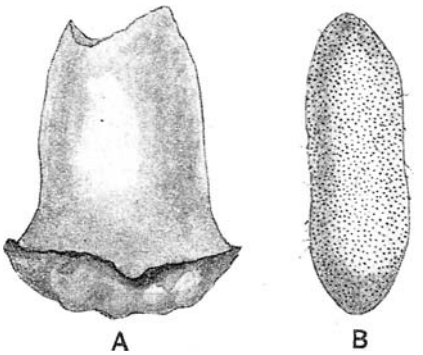
I., intestine; *S.*, spermatophoral case. Other letters as in text-fig. 50.

them to be so localized in position in the other species where these bodies occur. I failed to find in the present species, as I also failed to find in *Polytoreutus magilensis*, any indication that the spermatophores are immature forms of the same bodies in the species *P. montis-kenyæ*, *P. violaceus*, and *P. hindei*, in which two latter, it will be recollected, the chitinous sheath forming the wall of the spermatophore is much thicker. These additional facts, therefore, strengthen my earlier contention that there are two different forms of spermatophore in this genus. These facts, however, are not, so far as concerns *P. kenyaensis*, all that is to be said with respect to the spermatophoral apparatus in that species. In a few individuals out of a large number which I

examined, the wide mouth of the spermathecal sac was seen to be blocked by an irregularly crinkled mass of a brownish-yellow colour. The appearance presented was of a number of earth-particles adhering to the orifice in question. This, however, proved to be not the case; for it was possible to seize hold of the irregular mass with the forceps and draw it out of the spermathecal sac. It has then somewhat the form of an acorn (text-fig. 52) and was of about the size of a grain of millet.

When the spermathecal sac is cut open, the single spermatophore-case was seen to entirely fill the cavity of that sac, which is indeed stretched to contain it. The end of the case protruded a little way beyond the mouth, and this free end was the irregularly shaped brownish-yellow mass seen on an external inspection to

Text-fig. 53.

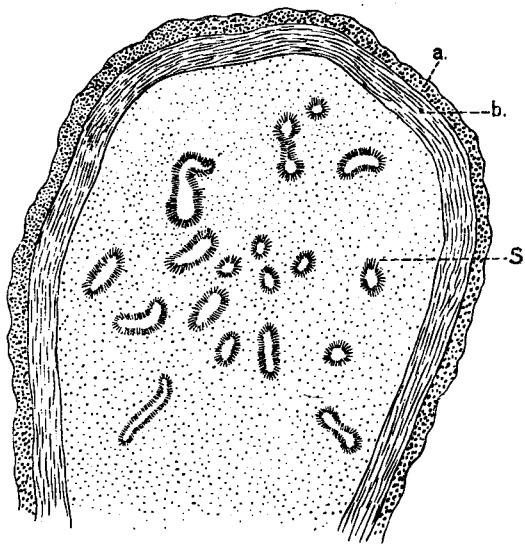


Spermatophoral case of *Polytoreutus kenyaensis*: (A) removed from spermathecal sac; (B) its contents (a mass of sperm-ropes) removed entire.

block the mouth of the sac. The part lying within the sac was smooth in appearance but hard to the touch; it gradually diminished in calibre to the end lying furthest from the mouth of the spermathecal sac. The exact measurements of the entire body were 2 mm. It seemed quite clear, even on a naked-eye inspection, that this body must be a spermatophore (text-fig. 53) (or perhaps a parasite) lying within the spermathecal sac. A study of its histological character appears to prove conclusively that this is the proper interpretation of the case. It is doubtful, however, whether it is permissible to call this body a spermatophore, seeing that the thin worm-like bodies which I have already described in this genus and in the present species seem to merit that name. We may, however, leave the consideration of this matter until after describing the histological characters of this case imbedded in the lumen of the spermathecal sac. The hard consistency of this body caused some little difficulty in procuring entire sections. However, I have not found it impossible to piece together mentally the

somewhat broken sections which were brought about by the brittleness of the walls. In longitudinal section (text-fig. 54) the case showed an oval contour, and it was nearly completely filled by a plug of matter with the following constitution :—The matrix, so to speak, of the no doubt fluid contents —fluid, that is to say, during life —was formed of granules of various sizes, which have not absorbed the borax-carmine with which the entire spermatophore had been stained. The spermatophore was not submitted for more than half an hour to the staining fluid, but in that time the spermatozoa within the case had been deeply tinted. But, as I have remarked, the granular matter was not so stained, and is therefore

Text-fig. 54.



Section through apex of spermatophoral case of *Polytoreutus kenyaensis*, highly magnified.

a, *b*, two layers of chitinous case; *S*, sperm-ropes imbedded in granular matter.

evidently to be regarded as a different substance from the imbedded spermatozoa. It is not, for example, composed of nucleated cells; or so at least it might be inferred from its non-staining qualities. The nature of this substance seems to me to be probably identical with that of the substance forming the walls of the spermatophore. I shall deal with the two together. Imbedded in this granular mass are the spermatozoa. These are not, however, loose and free from each other as in the case of the contents of some other spermatophores—for example, those of the genus *Stuhlmannia*. They consist of the regular bundles of spermatozoa which I have already referred to as "spermatophores." In sections these were

seen to be cut across in various directions, and it is plain therefore that they lie irregularly within the cavity of the spermatophore-case. The heads of the spermatozoa, where they are attached to the granular core, show a deep staining. The core itself is unstained. These sperm-ropes have no connection with the walls of the case which contains them. The latter hardly shows a definite structure in its walls, which appear from their hardness to be of a chitinous consistency. The region of the case which lies furthest away from the external orifice of the spermathecal sac has a, relatively speaking, thin wall which is divisible into two layers. The outermost layer is apparently softer than the inner layer and is darkly stained; it has a granular appearance. The inner layer is stratified longitudinally, in a direction, that is to say, parallel to the long axis of the case. It is but slightly stained, but it has a granular aspect; and here and there are darkly stained particles within its walls. At the base, the part which corresponds to the "cup" of the acorn, the walls are very thick indeed, so much so as to leave the barest chink in the way of a lumen leading to the exterior of the case. At the opposite extremity, I should say, the case is perfectly closed, and has no communication with the interior of the spermathecal sac. Where the walls are thick the process of cutting the sperm-case into sections has broken up the walls here and there into parallel strips running parallel again to the long axis of the case.

So much for the structure of the spermatophores and the enclosed sperm-ropes in *Polytoreutus kenyaensis*. In the allied *P. montis-kenyæ* the conditions were different. In none of the specimens which I examined—and these were numerous, though not so numerous as of *P. kenyaensis*—did I observe any large spermatophore lying within the spermathecal sac at the mouth. On the other hand, the interior of the spermathecal sac near to its blind end was occupied by a large number of spermatophores of the type already stated to exist in the species *Polytoreutus violaceus* and *P. hindei*. These spermatophores, that is to say, are of the same form as in *P. kenyaensis* and *P. magilensis*, but are larger and thicker, the increased size being mainly due to the fact that the heads of the spermatozoa are covered externally with a refracting and non-staining chitinous coat, which is absent in the more slender sperm-ropes of the other two species. I think that it will be convenient to retain the term sperm-ropes for the agglutinated spermatozoa of *P. kenyaensis* and *P. magilensis*, and to call spermatophores these more thoroughly finished off structures in *P. violaceus*, *P. hindei*, and *P. montis-kenyæ*. It seems to me also that the use of these different terms will serve to emphasize an essential difference between these two kinds of masses of agglutinated spermatozoa. In *P. montis-kenyæ* each mass of spermatozoa has its own chitinous case; in *P. kenyaensis* a large number of sperm-masses are enclosed within the same case. There is an analogy here with the cocoons of the Oligochæta. In some forms the cocoon contains but a single egg; in others a

considerable number are to be found in the same cocoon. Whether future investigation will show that *P. magilensis* has a large spermatophore like *P. montis-kenyæ* remains to be seen; but in the meantime I may point out that that species agrees with *P. kenyaensis* in the very conspicuous character of the spermathecal pore; while in those species with numerous and small spermatophores the external orifice of the sperm-sac is not so conspicuous.

In a former paper dealing with the spermatophores of this genus [1], I found myself unable to suggest the place of origin of these structures. I believe that I am now able to fix this with some probability. Were the spermatophores or sperm-ropes constructed by the activity of the spermiducal glands, the spermathecal sacs would only contain spermatophores or sperm-ropes already fully formed. This, however, is not the case; there are abundant and free spermatozoa, as I have already mentioned, in the diverticula of the oviduct and along the course of the latter up to and in the spermathecal sac itself. In my description of *Polytoreutus magilensis* I pointed out that free spermatozoa were to be found at the distal end of the spermathecal sac and not near to its mouth [2]. I have met with precisely the same thing in the present species. At the blind end of the spermathecal sac are numerous masses of free spermatozoa, generally in contact with a quantity of the granular matter which fills the pouch.

The facts lend themselves, indeed, to the hypothesis that the sperm from another individual gains access to the spermathecal sac, not by direct transference through the mouth of that sac, but through the oviducts, whose external pores are after all large and conspicuous, and quite as marked as are the external apertures of the spermathecæ in many other Oligochæta. At present, however, this view is not in the least pressed, for we are totally ignorant of the mode of copulation in these creatures. Again, if the spermathecal sac were a mere storage-house for the spermatophores, we should hardly expect it to be lined with the kind of epithelium which actually forms the lining of that chamber. The cells are long and granular, and at their free ends give off a loose granular secretion, into which indeed they appear to break up. In the spermathecal sac of an example of *Polytoreutus kenyaensis*, in which the mouth of the sac was plugged by no spermatophore, the sac was much occupied by actual cells which had wandered off from the lining epithelium. I take it that these later break down to form the granular matter already referred to. This granular matter in *P. montis-kenyæ* was seen to close round the spermatophores, and its appearance was quite indistinguishable from the chitinous (?) case of the small spermatophores. In some instances no demarcation could be drawn between the granular matter filling the pouch and that portion of it immediately surrounding

[1] "On some Earthworms from British East Africa; and on the Spermatophores of *Polytoreutus* and *Stuhlmannia*," P. Z. S. 1901, vol. i. p. 340.

[2] "Two new Genera and some new Species of Earthworms," Quart. Journ. Micr. Sci. vol. xxxiv. (n. s.) p. 252.

the mass of spermatozoa and forming the wall of the spermatophore. I cannot but think that the sac-secretion is responsible for the formation of the large case in which the sperm-ropes of *Polytoreutus kenyaensis* are contained. In support of this view, I may further cite the observations of Nasse [1], who found in *Tubifex* that the epithelium lining the spermatheca breaks down into a fluid or semi-fluid matter which may very possibly give rise to the coat of the spermatophore. I may finally point out that the existence of the large spermatophore of *P. montis-kenyæ* is on the whole not unlike the spermatophore of *Stuhlmannia*, the only other genus of Eudrilidæ in which up to the present spermatophores have been described. There are differences in detail, but in both the case is thicker at its open end, which lies next to the orifice of the spermathecal pouch, and the walls show a granular structure, suggestive of their origin from the breaking-down of the cells which constitute the lining membrane of the spermathecal sac.

Note on the Ovaries of Polytoreutus.

Although the ovaries in this genus have been already discovered by Michaelsen, there remain a few points connected with their relation to the efferent apparatus which have not yet been cleared up; at any rate, the descriptions of Dr. Michaelsen do not quite apply to the species which I have studied. The observations which I now record were made upon immature examples of *Polytoreutus montis-kenyæ* or of *P. kenyaensis*. In any case, the examples were collected with these two species and preserved in the same bottle with them. The possibility exists that they are the young of another species. I am not aware that this point can be settled. The earliest suggestion of the position of the ovary proves to have been wrong. Michaelsen [2] located it in the end of the diverticulum of the spermathecal sac, where the latter communicates with the oviduct. The next description of this part of the reproductive system was by myself [3], and is, as I now believe, not wholly correct. In *P. violaceus* some "small rounded cells" were noted in a sac attached to the spermathecal pouch where it comes into contact with the septum dividing segments xiii./xiv. As none of the cells were mature, it was impossible for me to be certain that this heap of cells was really the gonad; and I did not succeed in observing any connection of the sac involving the ovary with other regions of the egg-conducting apparatus. The small sac, containing what were presumed to be germinal cells, was connected with the septum by a strand of fibrous tissue. So far, therefore, the description was in agreement with that of

[1] "Beiträge zur Anat. der Tubificiden." Inaug.-Diss., Bonn, 1882.

[2] "Beschreibung der von Herrn Dr. Fr. Stuhlmann auf Sansibar und dem gegenüberliegenden Festlande gesammelten Terricolen," JB. Hamb. wiss. Anst. ix. (1) p. 39.

[3] "A Contribution to our Knowledge of the Oligochæta of Tropical Eastern Africa," Quart. Journ. Micr. Sci. xxxvi. (n. s.) p. 235.

Michaelsen [1], save that the gonad cells, instead of being within the spermathecal sac, were in a special sac closely adpressed to its walls. The next description of this gonad is by Michaelsen. In an account of several new species of the genus, Michaelsen has put on record certain facts about the ovary and its relations to other parts of the generative system. This paper contains the first positive and undoubted description of the ovary itself. In *P. usindjaensis* there is a sac ("Ovarialblase") attached to the loop of the oviduct, which Michaelsen has termed the "Eitrichterblase"; in the cavity of this are germinal cells, some of which are nearly mature ova. This is plainly shown in his figure [2]. As to the connections of this sac, the author expresses himself as follows:—"Das durch das Ovarium fast ganz erfüllte Lumen der Ovarialblase setzt sich in einen Kanal fort, über dessen inneres Ende ich mich nicht ganz genau orientiren könnte. Entweder tritt der Ovarialkanal in das Lumen der Eitrichterblase ein, nahe der Stelle, an der auch der Kanal des Receptaculum ovorum in dasselbe einmündet, oder vereint sich auch direkt mit diesem letzteren Kanal." It should be added that Dr. Michaelsen also figures a strand of connective tissue, as he has already done in *P. cæruleus*, attaching the ovarian sac to the parietes. In *P. kirimaensis* the conditions appear to be a little different. The ovary is contained in a narrow sac, which communicates by a narrow duct with the branches right and left of the spermathecal sac, near to where the oviduct also opens into that sac.

P. arningi is again different. In this species [3] there are apparently huge ovarian sacs which communicate medianly with each other. These narrow towards the septum xii./xiii., and it is here that Michaelsen would place the ovaries, though he was unable to bring forward any exact evidence of the existence of these gonads. No communication was traced between the ovarian sacs and any other part of the egg-conducting sacs and ducts.

It appears, therefore, that there are some differences between the various species of this genus *Polytoreutus* in respect of the relation of the ovaries to the rest of the female generative system. These differences may be possibly referred to two categories; and if so, it may be ultimately desirable to subdivide the genus. For in the species which possess a bursa copulatrix one arrangement prevails, and in the rest, as it appears to me, another. It is especially to the latter that I wish to draw attention in the present communication. I find that in the species examined by myself, the gonads and the ducts are probably to be compared exactly with the species *P. violaceus*, *P. cæruleus*, and *P. usindjaensis*. If this be so, then the ovary has not, up to the present, been discovered in those species. I have examined two stages in the development of the gonads and their ducts in *Polytoreutus*, one of which is

[1] "Die Regenwürmer Ost-Afrikas," in 'Deutsch-Ost-Afrika,' p. 16 &c.
[2] *Loc. cit.* pl. i. fig. 10.
[3] "Neue und wenig bekannte afrikanische Terricolen," JB. Hamb. wiss. Anst. xiv. p. 56.

much younger than the other, though outwardly no differences were to be detected. In the youngest stage the ovaries are plain, and completely fill two sacs situated on either side of the nerve-cord and at some little distance from it. These sacs are evidently those which Michaelsen discovered in *P. kirimaensis*. They also correspond exactly to the similar sacs in *Eudrilus*, in some young stages of which the sacs in question are closed sacs and have no outlet; later, of course, as is well known, they communicate with the spermathecal sac. Furthermore, these ovarian sacs, as they may be conveniently termed, correspond exactly to sacs involving the testis of each side in segment xi. I shall deal more at length with the points of likeness presently. Into each sac opens the oviduct by a conspicuous funnel, which has precisely the relations to the ovarian sac that the sperm-duct funnel has to the testicular sac (seminal sacs, sperm-reservoirs) in the same worm. Moreover, the course of the oviduct, which in this young stage has not reached the exterior, is exactly similar to the course of the sperm-duct. In both cases the funnel opens into the sac towards the centre of the body, and the duct bends sharply upwards and ceases at the body-wall at a precisely corresponding spot. The ovarian sac is not only continuous with the funnel of the oviduct. Its lumen is perfectly continuous with that of the spermathecal sac; the latter, however, in this very young specimen, is in a state of immaturity. It consists of a median sac as usual which contains no lumen; it is of inconspicuous dimensions, and runs for a short way beneath the nerve-cord. Its lateral branches, as has been said, open into the ovarian sac, and these branches have therefore for a certain distance a lumen. The development of the spermathecal sac is then, as it appears, from before backwards. I could find no trace of a receptaculum ovorum as distinct from the chambers of a cœlom already mentioned; and in any case the packing of the ovarian sac with a plug of germinal cells and developing ova shows that the time for the transference of the latter to a receptaculum was not yet ripe, and none of the ova were approaching maturity.

The existence of but one funnel seems to show that the existence of the funnels in the adult is simply a question of the division and pulling out of one branch of the single funnel. Furthermore, the fact that the ovarian sac communicates freely with the spermathecal sac, and that the receptaculum ovorum is formed later, shows that the communication in the adult between the ovarian sac and the one or the other of these two sacs is only a difference of secondary importance due to the different times at which the several cavities cease to communicate with each other. In the older stage, the relations of the various parts of the egg-conducting apparatus were further advanced and naturally different. The ovarian sac contained no ova or germinal cells at all; these are transferred *en masse* to the receptaculum, probably as the latter is formed. But the sac itself is quite evident, and communicates by a narrow chink, not at all conspicuous, with the

egg-sac. There is also an outgrowth of the ovarian sac into the thick muscular walls of the oviduct, to form a cavity which is that figured by Michaelsen in *P. usindjaensis* [1], and which is therefore, as I think, not the "Ovarialblase." This sac does not in its turn communicate with either the receptaculum or the spermathecal sac. I take it, however, to be—but this is purely theoretical—the part of the originally single cavity which is in communication with the spermathecal sac, the communication being cut off as the latter grows. There is in addition another comparison that may be made. In the case of the male organs the testicular sacs (seminal reservoirs) are, as I have mentioned, the exact homologues of the ovarian sacs, and both of them communicate with each other. The long sperm-sacs arise as an outgrowth of the septum, and their cavity communicates, not with the general cœlom of segment xi., but with the interior of the seminal reservoirs, which at that point are in contact with the posterior wall of their segment. The orifice of communication is a minute one, and immediately median of it is an ingrowth of the testicular sac into the thickness of the very thick septum which divides segments xi. and xii. The appearance of this prolongation of the testicular sac is exactly that of the prolongation of the ovarian sac just referred to; and I cannot help considering that both cavities are homologous. It would then possibly be a vestige of the spermathecal apparatus appended to the female system, the receptaculum of the latter being of course represented by the sperm-sacs. I would reiterate, however, that this is merely a suggestion. But that there is the actual likeness is a fact. Dr. Michaelsen [2] has figured a strand of "connective tissue," attaching the thickened muscular walls of the oviduct to the parietes of segment xiii. This structure exists in the worm examined by myself, but it traverses the wall of the xiiith segment and is attached to the posterior wall of segment xii.

It is not, as it might be supposed to be, a vestige of the canal connecting the cavity of the ovarian sac with that of the other parts of the egg-conducting apparatus. It is simply a thickening in the muscular attachments of the oviduct to the septa, comparable—I take it—to the "tendons" which tie the septa of this and other earthworms to the parietes: the muscular and heavy oviduct requires apparently some such fixed point. I may remark that in the worm whose immature reproductive organs I have just dealt with were germinal cells some way down the spermathecal sac, thus showing that there must have been in this specimen a communication between the ovarian sac and the spermathecal sac such as exists in younger stages. A final point to which I desire to draw attention is the fact that in the young stages the median spermathecal sac has two lateral branches, one on each side, into which the oviducts open on the one part. In the adult worm, as I have already mentioned, the spermathecal sac has no branches,

[1] "Regenwürmer," in 'Deutsch Ost-Afrika,' pl. i. fig. 19.
[2] *Ibid.* pl. ii. fig. 20 bis.

but the oviducts open one on each side of the single median sac. The arrangement with lateral branches is the most common one among the species of the genus *Polytoreutus*; and it is interesting to find them recapitulated in the young of *Polytoreutus montiskenyæ*, whose adults have not the branches in question.

7. On the Sponges collected during the "Skeat Expedition" to the Malay Peninsula, 1899–1900.

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(Plates XIV. & XV.[2])

These Sponges were kindly entrusted to me for description by Dr. S. F. Harmer, F.R.S. They were obtained by Mr. R. Evans, of Oxford, by shore-collecting in two localities:—"(i) Pulau Bidang, one of the Nine Islands group, off the coast of Kedah on the west coast of the Malay Peninsula, running N.E. from the Island of Penang; (ii) Great Redang coral islands off the coast of Trengganu State (S. of 5° 50′ N.), which again is S. of Kelantan, the largest of the East-coast States." Thus, being a shore collection, the majority of the species represented in it belong to the group Monaxonida; the remainder are Tetraxonia and Keratosa.

In dealing with the representatives of the simpler Monaxonida I have contented myself with mere description, leaving the species undetermined. In the present state of classification of these species this seems to be the only satisfactory course open to any worker not prepared to make an exhaustive study of all the species of a genus.

MONAXONIDA.

1. RENIERA sp. (Plate XIV. fig. 5.)

Sponge growing on the back of a crab, of which it conceals completely the dorsal view.

Consistency gelatinous. Measuring from 1 to 2 cm. across.

Spicules slightly bent oxeas, 0·075–0·090 × 0·003–0·004 mm.

Spongin abundant at the nodes of the spicular network. The mesh is square. Single spicules project vertically from the dermal membrane.

In one of the two specimens in the collection, but not in the other, there are a few multispicular strands in the otherwise very regular unispicular meshwork.

Pulau Bidang and Great Redang.

2. RENIERA sp. (Plate XV fig. 11.)

Sponge encrusting, growing on an encrusting Polyzoon and forming a thin sheet from 1–2 mm. in thickness. Oscula

[1] Communicated by Dr. S. F. HARMER, F.Z.S.

[2] For explanation of the Plates, see p. 221.