## INTRODUCTION.

The material with which this paper is concerned was largely collected during the dry seasons of 1929-30, 1930-31 and the rainy season of 1930. An account of some Burmese material previously collected but omitted from preceding papers is also included. In the course of the study of certain species common to both India and Burma it has been necessary to deal with certain material collected in India. To avoid repetition and to save space much of this material has been incorporated within the body of the paper. That which applies solely to India is included within Appendix B at the end of the paper.

Of the various collections treated hereinafter those from the Moulmein district are the most important. Although a fairly large number of species had been recorded hitherto from this district as the result of considerable previous collecting, all of the worms had been secured either in the dry weather or at the very early or very late portions of the rainy season.

It has already been demonstrated (Gates 1930, pp. 261-262) that surface conditions may become so unfavourable for earthworms some weeks before the actual end of the rainy weather that many if not all of the endemic forms disappear. Likewise in the early portion of the rainy season some species cannot be found while other important species have not attained sexual maturity. Inasmuch as the systematist who deals with the Oligochaeta is largely concerned with the reproductive organs and associated structures this part of the year is also not propitious. The most favorable time for the collecting of earthworms would then appear to be the middle of the rainy season period neither too near its commencement nor too close to its conclusion. The latter part of July and the early part of August seem to best meet these requirements.

Only two weeks were available for travel and collecting during the rains of 1930. The best way to use this short period of time appeared to be that of concentration on some area near Rangoon, visiting only such localities as might be within easy reach of some central point by train, boat or car, and remaining in each place long enough to insure the obtaining of comprehensive results. Since the Moulmein area had not been previously visited during the rainy season and as it fulfilled the other conditions, two weeks in the early part of August were spent in and around the town of Moulmein and at three localities, each of which is about a day's journey from that town.

All of the worms previously reported from the Moulmein district were re-collected with the exceptions of *D. flexa*, *P. feae*, *P. planata* and *P. elongata*. Of these species only the first two are of zoogeographical importance and it is quite probable that these two forms do not occur in the particular localities visited. In addition to the major portion of the previously known forms, several not hitherto recorded from the Moulmein area were secured as well as new species of *Pheretima* (4), *Drawida* (2), and *Desmogaster* (1). (Certain material belonging to other families sent to Dr. Stephenson may also contain new species.)

This array of new species, from an area in which considerable collecting had already been done and from which a fairly large number of forms were already known, affords striking confirmation for the belief that conclusions as to the completeness of our knowledge of a particular area cannot be justified, until after extensive collection in that area during a favorable portion of the rainy season. It is, however, not yet clear as to just what part of the year should be considered most favorable for collecting. Included in the Moulmein material are four new species which are represented only by immature or not-quite mature specimens and this in spite of long-continued searches for fully mature specimens and the collection of large numbers of specimens. Furthermore, in spite of the concentration of effort on each of the few localities involved for periods of several days, and in spite of the fact that most of the actual work of collecting was done by a man who has had eight years training and experience in this work, several of the species are represented by but small numbers of specimens from quite definitely restricted "spots." The collections may, however, be regarded as fairly comprehensive as they include all of the genera which there is now reason to believe may be found in this portion of the province.

In the preceding paper it has already been pointed out in a general way that peregrine species are able to maintain themselves much more successfully under the changed conditions brought about by man around villages and towns than are the endemic forms. The 1930 trip furnished several interesting illustrations of this fact. In Moulmein town peregrine species were secured in large numbers, but very few endemic forms and no specimens of *P.s. manicata*. Yet on the pagoda-crowned, jungle covered ridge of hills immediately back of the town *P.s. manicata* was not only found in considerable numbers but was actually by far the commonest form. Similarly in and around the village of Kyaikmaraw, several miles from Moulmein, only peregrine forms were found but on the hills near that village *P. andersoni* was the commonest form. In the village of Chaungson and in the cultivated areas immediately surrounding that village only *P. peguana*, *P. houlleti* and *P. anomala* were found, while in the jungles but a short distance away *P. andersoni* was again found in large numbers. *Desmogaster*, the most difficult genus to find, appears to be most affected by human influences and the few forms belonging to that genus that were secured were dug up from the soil of dense jungle about fourteen miles from any village.

Much of the remaining material was collected during the dry weather. Peregrine forms alone were secured from the Shan localities up to the end of April. After several weeks of rain in May small lots of slightly greater interest were obtained. The Kengtung worms sent by Mr. Telford were collected for him also during the dry weather, probably in the month of December, by the hillsmen living in the eastern portion of the Kengtung State.

The results of the years work so far as systematics are concerned may be briefly summarized as follows :—New records for Burma of extra-Burma species, two—the Yunnanese *P. brouni* in the Shan plateau and a new variety of the Andaman Island *P. suctoria* from Lower Burma. New varieties : of older endemic species, five—three of *D.*

*longatria* and two of *E. peguanus*; of peregrine species one (*P. alexandri gracilior*). Seventeen new species belonging to the following genera: *Desmogaster* (1), *Drawida* (2), *Plutellus* (1), *Pheretima* (10), *Eutyphoeus* (3). The genus *Plutellus* has not hitherto been recorded from Burma. The confusion of two species in *D. rangoonensis* has been cleared up; the identity of *D. barwelli hehoensis*, *D. fluviatilis*, *D. tecta* and of *P. suctoria mullani* and *P. alexandri typica* demonstrated.

*Acknowledgments.*

A large share of the expenses of collection of the Burmese material was met by grants from the research funds of the University of Rangoon. The author is grateful to the University for this continuation of financial assistance. Thanks are also due to Lieut.-Col. R. B. Seymour Sewell, Director of the Zoological Survey of India, for the loan of numerous specimens from the Indian Museum collections and for the loan of books from the Museum Library. The writer also wishes to express his thanks to Mr. K. N. Sharma for the collection of specimens in Maymyo, Burma and Kalimpong, India; to Mr. J. H. Telford for the collection of specimens in Kengtung State; and to Maung Kyaw Zan for the continuation of his assistance with the illustrations.

*Additional Notes.*

Material, type and otherwise, dealt with in this and preceding papers is retained for the present in the Judson College Biological Laboratory. The figures of the porophores and the genital markings are free-hand sketches. The figures of the spermathecae and other internal structures are camera lucida drawings. References to literature incorporated within the systematic portion of the paper have not been repeated in a concluding bibliography. All of the papers referred to in the text, with one exception, are listed under the specific titles.

## SYSTEMATICS.[1]

### The *MONILIGASTRINAE.*

### Genus **Desmogaster** Rosa.

#### **Desmogaster planata,** n. sp.

Ye, August, one complete worm and anterior portions of two others from jungle by the roadside near the 14th mile post on the Ye-Tavoy road. The fragments were broken off in digging, the posterior portions not found. One of the fragments was so mangled that it died some time before preservation was possible and hence was of little use except for determining the location of the gizzards.

*External characteristics.*—Length of the complete specimen 123 mm. Greatest diameter 5 mm. Number of segments 211. There are no

[1] Except in special cases, references to the original specific descriptions are given only for species founded subsequent to the publication of Stephenson's Oligochaeta volume in the *Fauna of British India*, 1923. Reference may be made to that monograph for other specific descriptions or for lists of previous accounts.

secondary furrows on any of the segments. Segments i and ii together are longer than iii; the length of the segments increases gradually from iii posteriorly until the greatest length is attained by x or xi, from whence the segmental length decreases gradually posteriorly.

The prostomium is prolobous, attached to the roof of the buccal cavity just behind 1/2.

The worms are unpigmented except for scattered flecks of glittering black on the anterior segments.

The setae are small, first visible on iv, closely paired, *ab* and *cd* are about equal, $aa = 1\frac{1}{2}$-2 *bc*, except on the tail segments where setae *ab* are nearer together ventrally so that $aa < bc$.

There is no indication of a clitellum on any of the worms which are all, without doubt, immature.

No spermathecal pores have been found. There are however two minute papillae on the very posterior margin of viii and another pair similarly placed on ix, the papillae in line with or very slightly internal to *cd*. On these papillae presumably the spermathecal pores would later have been developed.

The paired male pores in 11/12 and 12/13 are in line with or just internal to *cd*.

A slight but definite depression in the body wall on xiv on each side, just anterior and external to *b*, probably either contains the female pore or else marks the site of its later appearance.

The nephridiopores were not seen but must be about in line with *ab*.

There are no genital markings.

*Internal anatomy.*—Assuming, in accordance with previous practice, that the spermathecae are in segments viii and ix, the septa may be described as follows—5/6-9/10 are present, stout, funnel-shaped, with the apex of the funnel directed posteriorly; 5/6 and 6/7 are displaced posteriorly; 10/11 is membranous but slightly stronger than 11/12 and the succeeding septa.

The last pair of hearts is in xi; there are also conspicuous paired lateral commissures in x-vi and just anterior to 5/6 two narrower, shorter commissures possibly belonging to iv and v. These two pairs of commissures are separated from each other by a very delicate sheet of tissue, which perhaps represents 4/5, but which is attached peripherally to the anterior face of 5/6. In addition to these commissures there is a pair of narrower, shorter dorso-ventral vessels. In one specimen this pair of commissures has been traced from the ventro-lateral trunks upwards through 11/12 to the dorsal vessel. These commissures are connected with each other by a transverse vessel which passes under the dorsal trunk.

There are nephridia in the anterior segments but they do not appear to be well preserved. Beginning with segment xxiv the nephridia are large and very conspicuous. When the worm is opened by a dorsal incision, the septa carefully cut, and the parietes pinned back, the nephridia appear as a whitish layer on the sides of the alimentary tract. In such a preparation the coelomic surface of the intestine is almost entirely concealed by the nephridia, the dorsal blood vessel and the

supra-intestinal glands. The ducts of the nephridial tubules pass into the parietes in the region of *ab*.

The supra-intestinal glands begin in segment xxiv, a pair of the yellowish brown masses in each segment, one on each side of the dorsal blood vessel, on the dorsal wall of the intestine. Each mass is composed of a number of narrow columns or threads, the columns more loosely attached to each other than in *D. doriae*.

The gizzards are four in segments xx-xxiii in each of the three specimens but the oesophagus is slightly enlarged and its wall whitened in xix or xviii and xix.

The spermathecal ampullae are small, flattened, circular discs. The spermathecal duct is loosely looped several times on the posterior face of the septum.

The testis-sacs are small, brownish protuberances from the posterior faces of 10/11 and 11/12. The prostates are flattened, strap-shaped bodies in xi and xii, 1·5-2 mm. long, erect, or bent into a slight crescent shape. There is no trace of a vas deferens at the ental end of the prostate which is bluntly rounded. The exact course of the vas deferens cannot be stated. The vas passes from the testis-sac down the posterior face of the septum with several loose loops and then into the body wall just at the base of the septum through an opening due to the separation of the longitudinal muscle fibres. In one specimen a rather delicate continuation of the vas deferens was traced under the longitudinal musculature directly to the prostate. When the prostate is pulled off from the body wall a whitish-walled tube can be seen passing through the parietes. Into this tube the continuation of the vas (?), mentioned above, appears to pass.

An ovarian chamber of inverted U-shape is probably present but was opened by the dorsal incision in each case. In one worm the peri-oesophageal annulus and the sub-oesophageal chamber, which are internal to and ventral to a characteristic ovarian chamber, were both recognized. The ovisacs extend into xiv or xv.

*Remarks.*—One of the specimens has an abnormality towards the anterior end—segment xvii on the right side begins in the region of the mid-dorsal line and passes around in a spiral fashion ending in the mid-dorsal line as segment xix on the left side. An extra pair of setae was observed on one segment of another specimen, the extra setae dorsal to *cd*.

Two species of *Desmogaster* have been found hitherto in Burma. One of these, *D. albalabia*, has two pairs of spermathecae like *D. planata*. The two species are differentiated by the presence or absence of genital markings, the characteristics of their prostates and the number and position of the gizzards. *D. albalabia* has conspicuous genital markings externally, *D. planata* apparently does not. There are three to five gizzards in segments xiv-xix in *D. albalabia*, while there are four gizzards in xx-xxiii in *D. planata*. In *D. albalabia* the prostates are sessile but in *D. planata* the prostates are elongate. In this latter respect *D. planata* somewhat resembles *D. doriae* where the prostates are also elongate. In the latter species however the prostates are circular in cross section and pass visibly into a vas deferens at their ental ends.

The condition of the ental ends of the prostates of *D. planata*, *i.e.*, the apparent absence of a continuation of the ental end of the prostate into a vas deferens is similar to that of the prostates of *H. livida*. The characteristic supra-intestinal glands are found in *D. planata*, *D. sinensis* [1] and in *D. doriae* but are lacking in *D. albalabia*, although present in *H. livida*.

## Genus **Drawida** Mich.

*Drawida* is a rather large genus, certainly much the largest genus of the family Moniligastridae. As frequently happens in large genera difficulties arise in the identification of species. This is especially true in this genus when dealing with the older species which have not recently been studied. In some cases descriptions of these species are quite inadequate for present day purposes. The systematic difficulties are enhanced by an apparent lack of genital markings which in other genera are so often specifically characteristic. According to Stephenson (1923, p. 125) "Genital markings are found comparatively rarely" in this genus. Fortunately this statement does not apply to the Burmese species of the genus, nearly all of which have some sort of genital markings. In view of the rarity of genital markings in this genus they may be expected to be, when present, of considerable systematic value. With this in mind considerable attention has been paid in this and preceding papers to the genital markings of these worms. The results have not yet proved as useful as had been expected and for several reasons. Foremost among these is the fact that the genital markings are not always specifically characteristic. Thus for instance certain parietal gland markings characterize both varieties of *D. tumida* as well as certain varieties of *D. longatria*. Furthermore the extreme variation in number and position of the markings makes specific characterization in this respect difficult or inadvisable until after large numbers of specimens have been examined. Then again in a few of the species the markings have a rather vague appearance, lacking sharp or definite outlines. This latter may possibly be due to poor preservation, to abnormality or to immaturity in which case the study of further specimens may be expected to remove this difficulty.

In spite of these considerations evidence is accumulating which will perhaps eventually enable more accurate definitions in terms of genital markings. This may not only apply to species but also to varieties. Thus for instance in *D. tumida* paired or unpaired markings are apparently always present in *aa* on some of segments ix-xiii in variety *deleta*, but almost always lacking in variety *typica*, the two varieties for the present being distinguished mainly by the presence or absence of an oval marking anteriorly on each side of segment x. When

[1] The supra-intestinal glands of *D. sinensis* were not mentioned in the original description of the species. These glands in this species begin behind the gizzard region and are paired masses attached to the intestine as in *D. doriae*, but each glandular mass is whitish instead of yellowish brown or brownish, the masses smaller relative to the size of the worm than in *D. planata* and *D. doriae* and consisting of a small number (3-6) of the thread-or column-like strands. The nephridia of *D. sinensis* are quite conspicuous but are narrowly tubular and restricted to the anterior portion of the segment.

large enough series of specimens have been studied similar characterizations of the varieties of *D. longatria* will probably in many cases be possible.

But whether or no these accessory genital markings prove to be of major importance there are other externally visible structures which have been largely overlooked or neglected hitherto that appear to be of considerable significance, *i.e.*, the copulatory structures with which the male pores are associated. The organization at the ectal end of the deferent male apparatus varies considerably. In the simplest condition observed in the Burmese forms the male deferent apparatus ends with a small male pore on the general epidermal level without any trace of copulatory apparatus. This condition characterizes *D. peguana.* In another species, *D. rangoonensis,* the worm is able to elevate or protrude those portions of the epidermis that bear the male pores as slight cones bearing at their tips the male pores. This presumably is of some assistance in placing the spermatozoa in the vicinity of the spermathecal apertures. In another species, *D. flexa,* the worm does not protrude its male pores but the margins of segments x and xi in the vicinity of the male pores are capable of slight protrusion and when so protruded and apposed tightly to each other form another type of copulatory structure.

In the large majority of Burmese species of the genus there is developed at the ectal end of the male deferent duct a definite copulatory apparatus. This apparatus assumes a wide variety of forms, each of which appears to be definitely characteristic. This is not only true of species, *vide D. hehoensis,* where the copulatory structures enable instant identification, but is also sometimes true of varieties. Thus in *D. longatria,* which has a number of varieties, many of which at least appear to be of geographical significance, the varieties are to be distinguished at present mainly by the characteristics of the copulatory apparatus.

In the past these copulatory structures have not been as carefully described as their diversity and systematic importance warrant. In fact in some specific descriptions they are scarcely mentioned. As an illustration of what may happen in the absence of exact descriptions of these structures may be mentioned the case of *D. b. hehoensis* and *D. fluviatilis.* These two forms were searched for on several occasions in their original localities and were found but not recognized and would probably have for ever remained unrecognizable, or else been confounded with other forms if the original specimens had not been still available and in condition for study.

In the papers on Burmese worms these copulatory structures have been referred to as porophores, male porophores, and penial tubules, and an attempt has been made to describe these structures as carefully as possible. This has not however been done satisfactorily in all cases and it has been necessary several times in the present paper to revise the descriptions of these structures. The systematic value of the copulatory structures is enhanced by the fact that in preserved specimens the copulatory porophores are, as a rule, either conspicuously protuberant or otherwise readily visible.

Another point of importance from the standpoint of the systematics of this genus is the location and characterization of the male pore itself. The position varies: it may be elevated beyond the general surface level on some sort of a porophore or it may not be so elevated at all. It may be located in the intersegmental furrow 10/11 as in *D. peguana*, or on the posterior margin of x as in *D. rangoonensis*, or on the anterior margin of xi as in *D. spissata*. The size of the pore also varies; it may be small and hard to find or larger and readily recognizable as in *D. abscisa*.

This discussion might be further extended but these few paragraphs will be sufficient to show the necessity for careful attention to the structures mentioned as well as for the production of exact descriptions and accurate figures.

On several occasions (*vide D. caerulea* and *D. constricta* in Gates 1930) two groups of forms apparently belonging to the same species have been collected in which the points of difference are of such a character as to be capable of interpretation either as varietal distinctions or as representing different stages in development. A decision between these two possibilities on the basis of the material available has been difficult and the tentative determinations made in respect to the two species just mentioned are not regarded as satisfactory. In these circumstances it is necessary to discover what may be the indications of the completion of sexual growth; whether or not the structures involved, such as atria and prostates, assume a characteristic specific or varietal conformation early in development or whether there are changes other than in relative sizes as growth proceeds.

Several times during the past year it has been possible to identify correctly immature specimens of various sizes of several species (*vide* accounts of *D. hehoensis*, *D. peguana*, etc. hereinafter.) Although there is not yet available sufficient information to afford final answers to all of the questions involved, the study of these immature specimens seems to show:—(1) that the atria and prostates and even sometimes the copulatory structures assume characteristic shapes fairly early in development, (2) that the ovisacs and spermathecal ampullae are not represented by more than slight rudiments until some time after the atria and prostates have assumed their characteristic shapes.

### **Drawida abscisa**, n. sp.

*Drawida rangoonensis*, part, Gates, *Rec. Ind. Mus.* XXVIII, p. 146 (1926).
*Drawida rangoonensis*, part, Gates, *Rec. Ind. Mus.* XXXII, p. 291 (1930).

Sandoway, October, several specimens.
Bassein, October, several specimens.
? Namkham, May, after the beginning of the rains, 11 immature specimens.
? Kutkai, May, 4 immature specimens.

*Description of the type-specimen, external characteristics.*—Length 51 mm. Greatest diameter 2½ mm. Segments not counted, incomplete posteriorly. Unpigmented except on the clitellum which is deep red. The clitellar colouration extends from the posterior part of ix onto the anterior part of xiv.

There are non-functional, pore-like depressions in the inter-segmental furrows from 4/5 posteriorly. The nephridiopores are about in line with *d* or very slightly dorsal to *d*, except on viii, where the nephridiopores are displaced dorsally.

The setae begin on ii, are closely paired, $ab=cd$, $aa<bc$, *dd* about equal to one half the circumference.

The spermathecal pores are minute, in 7/8, just internal to *c*. On the anterior margin of viii and on the posterior margin of vii in the vicinity of the spermathecal pore and concealed within the intersegmental groove is a small, smooth, glistening area in the shape of an oval, each oval with two minute circular greyish spots.

The male pores are conspicuous apertures in *bc*, but nearer *b* than *c*, on antero-posteriorly flattened, slightly protruding, flap-like porophores in 10/11 which are cut off sharply from both x and xi.

The female pores are in 11/12 about in line with *b*.

Aside from the male porophores, and the glandularity around the spermathecal pores, the only other genital markings are a pair of small, round, whitish areas, vaguely demarcated, on ix about in the region of *ab*.

*Internal anatomy.*—Septa 5/6-8/9 are slightly thickened. The last pair of hearts is in ix. The gizzards are four in xiii, xiv, xv, and xvi.

The testis-sacs are small, kidney-shaped, placed vertically with the ventral portion projecting through 9/10 into ix. The vas deferens is perhaps a trifle wider than usual, long, and coiled into a mass of loops which is about the same size as the testis-sac above it. The prostates are erect and columnar but with the ental end bent over slightly, surface coarsely granular, with a short fragile stalk without granulations.

Segment xi is reduced to a typical, inverted U-shaped ovarian chamber which is filled with large round transparent cysts. The ovisacs extend into xv and are also filled with similar cysts. The spermathecal ampullae are very small, represented only by slight, ovoid swellings of the ends of the spermathecal ducts. The ducts are coiled into a number of short loops loosely attached to the posterior face of 7/8. The atria are large, flattened, saccular, structures in vii, in contact with each other dorsally over the oesophagus and at the other end narrowing gradually as they pass into the septum. In shape and size the atria are almost exactly the same as in *D. rangoonensis*.

*Remarks.*—The length varies from 42-78 mm., the greatest diameter from $2\frac{1}{2}$-4 mm. The number of segments of four specimens selected at random:—116, 117, 131, 137 The nephridiopores of viii are displaced dorsally in all the specimens.

Setal interval *aa* is usually much less than *bc*; $aa : bc :: \frac{1}{2} : 1\frac{1}{2}$, represents the most frequently observed ratio.

The male pores are much more readily visible in every one of these specimens than in most Burmese species of the genus. The male porophores also appear to be characteristic. All of the specimens have the oval glandularity on vii and viii on each side of the spermathecal pore, each oval area having one or two circular, grey spots. Between the longitudinal and circular muscle layers there is a mass of whitish

glandular material for each of the spots. Sometimes these glandular masses are large enough to project through the longitudinal musculature into the coelom.

The gizzards are four in xiii-xvi (4 worms) or in xiv-xvii (1).

The testis-sacs are usually kidney-shaped, and may be confined to x or may project ventrally into ix. The coiled portion of the vas deferens about equals the size of the testis-sac above it. The shape of the prostate varies somewhat and the glandular portion may be bent slightly in various ways. A non-glandular stalk is always present.

In every one of the specimens dissected the spermathecal ampullae are very small. From the evidence furnished by immature specimens of other species this should indicate that these specimens had not attained full sexual maturity. Other structures however appear to have attained their full development; the reproductive pores are definitely developed and readily recognizable, the atria are large, the ovisacs and ovarian chambers large and distended with material. Clitellate specimens of *Drawida* collected as late in the season as were these specimens have without exception until finding of these worms had well developed spermathecal ampullae. If these specimens are at a stage at which all the sexual organs are fully developed then the small size of the spermathecal ampullae is a specific characteristic that will be useful in distinguishing this species from *D. rangoonensis*.

*Drawida abscisa* may be distinguished from *D. rangoonensis* with which it had been previously confused by its definite male porophores, the larger size of the male pores, and the size and shape of the testis-sacs.

The Namkham specimens are not mature, either lacking any trace of clitellar pigmentation, or having the clitellar pigmentation only slightly developed. In these specimens the setal interval *aa* is about equal to *bc*. Otherwise the characteristics of the Namkham worms are the same as those of the more nearly mature southern specimens.

### **Drawida caerulea** Gates.

*Drawida caerulea*, Gates, *Rec. Ind. Mus.* XXVIII, p. 143 (1926).

Madauk, September, several specimens.
Nyaunglebin, September, several specimens.
Pazunmyaung, September, one specimen.

All of these specimens are of the same type as those referred to in the previous paper as the southern forms. There is no indication in any of these specimens of the development of those characteristics typical of certain northern forms which were referred to in the previous paper as "fully mature."

### **Drawida flexa** Gates.

*Drawida flexa*, Gates, *Proc. U. S. Nat. Mus.* LXXV, 10, p. 10 (1929).

The ectal end of the deferent male apparatus was not satisfactorily described in the original account. No specimens of this species have since been collected and the only specimen now available for examination is the type-specimen. In this worm the male pores are not located on porophores but are on the intersegmental furrow 10/11 which is

continued straight across what appear at the first glance to be male porophores. The margins of x and xi in the immediate vicinity of the male pores on each side are tumid and protuberant in such a way as to suggest a shortly conical male porophore, but the real male pore cannot be seen until these lip-like protuberances from the margins of x and xi have been separated from each other.

The nephridiopores of viii are displaced dorsally. The setal interval *aa* is smaller than *bc*, not larger as stated in the original description. There is a small, papillaceous area on the posterior margin of vii on each side, immediately dorsal to the spermathecal pore.

The surface granulation of the prostate is continued clear to the point where the prostate passes into the parietes, *i.e.*, there is no stalk. The vas deferens is short and with very few loops.

## **Drawida gracilis** Gates.

*Drawida gracilis*, Gates, *Ann. Mag. Nat. Hist.* (9) XVI, p. 660 (1925).

Taungdwingyi, April, 16 specimens.
Rangoon, January, 6 specimens.

The original account of this species was based upon six specimens collected in Rangoon in March, 1924. A few immature specimens were collected from the same locality in November and December 1924 and January 1925, but in spite of intensive and extensive searches in and around Rangoon town during the last six years, no further specimens of the species were found until January 1931 when 6 immature specimens were collected near Kamayut. In the meanwhile a few specimens, also immature, had been secured from Taungdwingyi in the central dry zone. Only three specimens from the present lots are mature enough to show the male and female pores.

The length varies from 50-165 mm., the greatest diameter from 2-3 mm. The prolobous prostomium is attached to the roof of the buccal cavity in the vicinity of 1/2 and has a conspicuous antero-posterior ventral groove.

FIG. 1.—*Drawida gracilis* Gates. Spermathecal atrium and portion of spermathecal duct, × *ca.* 25.

The ventral setae (setae *a* and *b*) of segments ii-ix are larger than the lateral setae. The ventral setae of v, vi, and vii are very strikingly thickened and conspicuously projecting from the parietes. The ventral setae of viii and ix are larger than the lateral setae of their segments but much smaller than the ventrals of vii. Seta *b* of segments iii-ix emerges from the parietes posterior to seta *a* of the same segment on each side, but most conspicuously so on segments v to vii.

Genital markings are not well developed. There may be a pair of indistinctly outlined glandular areas in the epidermis on the anterior half of x, the posterior half of x, or the anterior half of xi. The outer margins of these areas are in line with the outer margins of the conical

male porophores, the inner margins extend internal to the inner margins of the male porophores but do not meet midventrally.

The spermathecal apertures of the present specimens are small round pores in 7/8, in line with seta *c*, each pore surrounded by a tiny, tumid, lip-like swelling of the epidermis. The female pores are in 11/12 in line with *b*.

The vas deferens is elongate, looped, with the loops often in three rounded masses, one just under the testis-sac in x, one in ix on the anterior face of 9/10, and a third on the floor of x. The prostates are stout-walled, conical or columnar-shaped structures, each with a flower-like crown of short, transparent lobes, into the centre of which the vas deferens passes. The cavity of the prostate is like an inverted Y The atria are erect, tubular structures in vii.

This species may be readily distinguished from all other Burmese species of *Drawida* by the blackened and hypertrophied ventral setae on v to vii. Even very immature specimens, 50-60 mm. in length, can be readily recognized by this characteristic.

In the smallest specimens, measuring 50-60 mm. in length and with a diameter of 2 mm. at the region of greatest thickness, the male porophores are already visible. They may be described as conical, ventral projections, seated across 10/11, half of the porophore apparently belonging to x and half to xi, the intersegmental furrow 10/11 ending abruptly against the base of the porophore. The vas deferens and the prostates are characteristic but the ovisacs are lacking and the spermathecal ampullae are not developed, the ampulla represented only by a very slight spherical enlargement of the ental end of the duct.

## **Drawida hehoensis** Steph.

*Drawida barwelli hehoensis*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 324 (1924).
*Drawida fluviatilis*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 325, pl. xxi, fig. 3 (1924).
*Drawida tecta*, Gates, *Rec. Ind. Mus.* XXVIII, p. 148 (1926).
*Drawida tecta*, Gates, *Rec. Ind. Mus.* XXXII, p. 293 (1930).

### *Material examined.*

*Indian Museum Collections:—Drawida barwelli* (Bedd.) var. *hehoensis.* Heho plain, 8. iii. 22, 3 specimens. (Stephenson's original material) W 1108/1. *Drawida fluviatilis* Steph. Along the White-Crow stream near Yaungwhe, Southern Shan States, Burma. Dr. S. L. Hora. Cotypes. W 1110/1. Two specimens, one very small. *Judson College Collections:—Drawida tecta* Gates. Type and cotype specimens from Yaungwhe. *D. tecta*, Taungyi. *D. tecta*, Maymyo, June, 49 specimens, immature.

Several years ago an attempt was made to find *Drawida barwelli hehoensis* and *D. fluviatilis* in the vicinity of Yaungwhe, at or near which place the original material of these two forms was secured. A considerable number of specimens of a species of *Drawida* was secured but the genital markings of these worms were so different from the descriptions given by Stephenson for his forms that a new species, *D. tecta*, was erected for the new material. Later attempts at finding Stephenson's two forms also resulted unsuccessfully. This repeated failure to find the worms led to a suspicion that there might have been

a confusion of forms somewhere. Examination of the descriptions of the three forms showed that two of the three had a rather unusual development of the posterior setae in common. Thus the posterior setae of *D. b. hehoensis* "are relatively very large at the hinder end" (Steph. 1924, p. 324), while in *D. tecta* "Posteriorly the setae project conspicuously and are nearly twice as long as the anterior setae but of the same diameter" (Gates, 1926, p. 149).

*Drawida tecta*, however, has a distinctively typical development of the ectal end of the male deferent apparatus, consisting of a slender penial tubule which is buried in a deep, round, well-like depression in the parietes, opening externally in the intersegmental furrow 10/11 in *bc*. This penial tubule is not ordinarily visible, both it and the depression in which it is contained being covered over by an anteriorly-directed, flap-like protuberance from the anterior margin of segment xi. To find the penis the marginal flap must be pushed back. There is nothing in the description of *D. b. hehoensis* to indicate the presence of any such copulatory apparatus. All three specimens of *D. b. hehoensis* do, however, have this characteristic development of the ectal end of the male deferent apparatus. In other respects also the three worms from the Indian Museum are similar to those worms hitherto known as *D. tecta*. Certain slight differences between the two descriptions can be explained by the immaturity of the Indian Museum specimens. *Drawida tecta* is therefore a synonym of *D. b. hehoensis*.

The type-specimen of *D. barwelli* (Bedd.) has not been available for examination, but worms belonging to the Indian Museum collection and identified by previous Oligochaetologists as *D. barwelli* are quite evidently specifically distinct from the Burmese forms and lack the characteristic penial tubule. *D. b. hehoensis* therefore becomes a distinct species which must have the name *D. hehoensis*.

The two cotype specimens of *D. fluviatilis* also have the characteristically developed copulatory apparatus which is recognizable even in the very small 22 × 2 mm. specimen. The larger specimen is probably not quite mature but resembles in all points of importance *D. hehoensis*. *D. fluviatilis* therefore also falls into the synonymy of *D. hehoensis*.

Stephenson's material, with the possible exception of the type-specimen which I have not seen, was immature and in addition the preservation was not of the best. The brief diagnosis given below is therefore based largely on the author's large series of specimens which are fully developed.

*Diagnosis.*—Spermathecal pores in 7/8 in line with or slightly internal to *c*. Female pores in 11/12 in line with or very nearly in line with *b*. The male pores are at the end of penial tubules imbedded in round, well-like excavations in the parietes which open externally in 10/11 in *bc*, the opening of the excavation covered over by a tumid protuberance from the anterior margin of xi. The gizzards are three to four in segments xiv to xix. The testis-sacs are constricted by 9/10 and in addition may be prolonged anteriorly and posteriorly into beaks and tails. The vas deferens is short and coiled into a few loops in x and passes into the prostate at or near to the ental end. The prostates are elongate, erect and columnar or variously bent, surface coarsely granular with

a short smooth stalk. Segment xi is reduced to a U-shaped ovarian chamber. The oviscas are large and may extend into xiv. The spermathecal duct is enlarged slightly in 7/8 and the parietes.

*Additional remarks.*—The worms collected last June at Maymyo differ from worms from previous localities in several particulars which may be briefly summarized as follows :—The length varies from 24-45 mm., the greatest diameter from 2-3½ mm. There are no traces of a clitellum on the majority of the specimens, others have a faint pinkish colouration on the clitellar segments. The spermathecal pores are large relative to the size of the worms. The penial tubule and the cavity in which it lies are characteristic, but, as a rule, both the posterior margin of x and the anterior margin of xi in the vicinity of the penis on each side are protuberant and have to be separated before the male porophore can be made out. The protuberances from xi are slightly more developed than those from x. In a few of the specimens the parietal excavation in which the penial tubule is usually contained is everted so that the copulatory tube projects conspicuously from a slight conical swelling. (This eversion of the penial chamber has never been observed in the typical specimens.) The gizzards are three in xii-xiv (1), xiii-xv (2), or four in xiii-xvi (3). The prostates are dandelion shaped, *i.e.*, with an erect, narrowly-columnar stalk bearing on its ental end a crown of transparent lobules into which the vas deferens passes. The spermathecal ampullae are small, spherical, or flattened and oval. The spermathecal duct is coiled into a number of loose loops under the spermathecal ampulla and as it passes into the septum 7/8 is enlarged into a small, pine-cone-shaped atrium.

Some of the differences between these specimens and the typical forms from Yaungwhe may be explained as due to the immaturity of the Maymyo specimens. The small size of the spermathecal ampullae, the faint development of the clitellar colouration, and the small size of the worms may be regarded at least as indications of immaturity. The prostates are, however, quite different from those of the typical worms. If, as appears to be the case elsewhere, the prostates are quite characteristic even at an early stage of development, then the Maymyo form will have to be treated as a distinct variety.

## **Drawida longatria** Gates.

*Drawida longatria*, Gates, *Ann. Mag. Nat. Hist.* (9) XVI, p. 50 (1925).

In the preceding paper attention was called to the similarities between this species and *D. tumida* and it was pointed out therein that practically all that is necessary to derive the former from the latter is to increase by varying amounts the length of the prostates, the vasa deferentia, and the spermathecal atria. In spite of a wide variation in the shape and characteristics of the male porophores, and in the number and positions of the genital markings in this species, the atrium is always characteristically elongated even in immature specimens, so that there is no difficulty in discriminating between the two species, even when the external markings and the male porophores are closely similar as is sometimes the case.

## Variety **typica.**

*Drawida longatria typica*, Gates, *Rec. Ind. Mus.* XXXII, p. 286 (1930).

Shwegyin, September, a large number of specimens.
Madauk, September, a number of specimens.
Nyaunglebin, September, a number of specimens.
Pazunmyaung, September, a number of specimens.

A small specimen, 60 mm. in length and 4 mm. in diameter, from Nyaunglebin very closely resembles externally *D. tumida typica*, having a ridge with a male porophore and a genital marking almost exactly the same in appearance as characterizes *D. t. typica* in *bc* on each side, extending across segments x and xi. The internal anatomy is the same as in typical specimens of *D. longatria.*

The collections made at one of the localities mentioned above contained mature specimens of *D. longatria typica* and three immature specimens of a species of *Drawida.* Two of the three specimens were tentatively identified as *D. longatria* by the external markings. On dissection all three proved to be *D. longatria*, having the characteristically elongate spermathecal atrium. As only *D. l. typica* was found at this locality it is probable that all three worms belong also to this variety.

The largest specimen is 80 mm. long and 3 mm. in diameter. The male porophores are characteristic but small. There are slight indications of the beginnings of parietal glands on vii posteriorly and viii anteriorly in region of *cd.* The atria are characteristic and apparently fully elongate. The prostates are elongate and coiled but slender. The testis sacs are small; the vasa deferentia are elongate and coiled into masses about the size of the testis sacs. The ovisacs are minute, almost thread-like. The ovarian chamber is empty. The gizzards are in xv-xviii.

The medium-sized specimen is 40 mm. long and 3 mm. in diameter. The positions of the male porophores are indicated by very slight projections from the posterior margin of x on each side. The atria are conspicuous spherical masses of coils but do not fully occupy the coelomic cavity of vii. The testis sacs are small; the vasa deferentia are coiled into masses about the size of the testis sacs. The ovisacs are minute rudiments as in the previous specimen. The gizzards are in xv-xviii.

The smallest specimen is 30 mm. long and 3 mm. in diameter. There are no traces of genital markings or male porophores. The atria are characteristic but the mass of coils on each side is only about half the size of those in the previous specimen. Testis sacs and vasa deferentia as in the two previous specimens. No ovisacs were found. Gizzards in xvi-xviii.

## Variety **deminuta.**

*Drawida longatria deminuta*, Gates, *Rec. Ind. Mus.* XXXII, p. 287 (1930).

Magwe, April, seven specimens.

These specimens have a thin, bluish line in the mid-dorsal region which is especially noticeable from the clitellar region posteriorly. This appearance is due to a thinning or perhaps an entire absence of the longitudinal musculature in a very narrow mid-dorsal region. The thinness

of the parietal wall is especially striking when viewed from the coelomic face at the intersegmental furrows and results in an appearance like that of dorsal pores. No coelomic fluid can, however, be squeezed out through the body wall at these points.

Variety **planata,** n. var.

Shwegyin, September, a number of specimens.
Paung, September, several specimens.

Length 85 to 195 mm. Diameter 4 to 6 mm. The nephridial pores on the majority of the specimens are in line with *d ;* in the remaining specimens in *cd.* On segments xi to xiv the nephridial pores are larger than usual and readily visible, even to the unaided eye. The sperma-

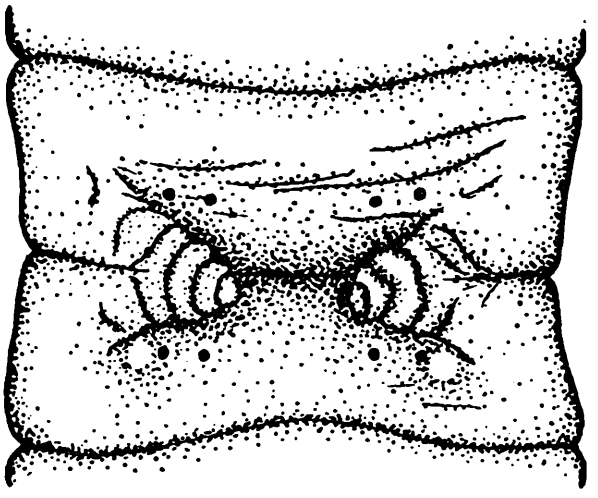

Fig. 2.—*Drawida longatria planata,* n. var. Ventral view of segments x and xi, showing the male porophores.

thecal pores are in line with *c,* or just internal to *c.* The parietes at the posterior margin of vii and the anterior margin of viii in the immediate vicinity of the spermathecal pore is slightly swollen and protuberant but there are no traces of genital markings on the surface. The intersegmental groove between segments vii and viii is more deeply sunk in the vicinity of the spermathecal pore than elsewhere.

The male porophores may be described as furrowed triangular elevations without a definitely demarcated basal line and with the apex, which bears the male pore, pointed directly towards the mid-ventral line. Although the porophore is protuberant from that portion of the parietes to which it is attached the mid-ventral region of segments x and xi is retracted so that the porophores are contained within a deep depression and hence do not protrude beyond the general level of the ventral surface. In spite of the differences in the descriptions the porophores of this variety are not in reality so strikingly different from those of variety *typica.* In the latter variety the porophore is conspicuously protuberant from the general level of the ventral surface, while the condition prevailing in variety *planata* suggests a *typica* porophore bent over on its inner or mid-ventral face and fused to the parietes thereby, with a simultaneous retraction of the mid-ventral region. The large ovoid body at the end of *typica* porophore is in *planata* much reduced, no longer definitely ovoid, and rotated so that the male pore faces the midventral line.

The genital markings are not sharply delimited and are located as follows:—

| | |
|---|---|
| I. On the middle annulus of xi, just external to *b*, on each side a small round marking. On the middle annulus of ix, about in the region of *ab* a similar small round marking on each side, with setae *a* and *b* either pushed to the posterior edge or included within the limits of the marking | 7 specimens. |
| II. As in I but in addition a single round marking on the middle annulus of x on the right side, just external to *ab* and in line with the marking on xi | 1 specimen. |
| III. As in II but here the single additional genital marking is on the left side | 1 specimen. |
| IV. As in I but with the two additional markings of II and III | 1 specimen. |
| V. As in IV except that the pair of markings on ix are lacking | 2 specimens. |
| VI. As in V but in addition a single, slightly larger, round marking on the anterior annulus of viii in *aa* | 1 specimen. |
| VII. Only the two markings on xi present | 3 specimens. |

The genital markings are the external faces of parietal glands of the *longatria* type but which do not, in these specimens, project conspicuously into the coelom.

The internal organization is similar to that of variety *typica* except that the gizzards seem to have a tendency to occupy a more posterior position. In the specimens dissected the gizzards are as follows:— xviii-xxi (4 specimens), xviii-xxii (1), xix-xxii (4), xx-xxii (1), xxi xxiii (1).

There are no parietal glands of the characteristic *longatria* type projecting into the coelom in segments vii and viii, but in several specimens there are slight glandular masses in the parietes in the vicinity of the spermathecal pores.

### Variety **tortuosa**, n. var.

Chaungson, August, a number of specimens.

Length 60-130 mm. Greatest diameter 3-5 mm. Unpigmented. Segments x-xiii have a light orange colouration. Setal intervals *ab* and *cd* are equal, *aa* is either slightly less than or about equal to *bc*. The spermathecal pores are definitely internal to *c*. The male pores are in *bc* nearer to *b* than to *c*. The female pores are in line with *b*. The male porophores are tiny, teat-like projections posteriorly from the rims of the genital markings that extend across 10/11.

The genital markings are of two slightly different sorts. One type consists of round, slightly protuberant, paired areas, each marking with a whitish or cream coloured rim surrounding a circular greyish depression in which is located a pore. Each worm has one pair of these markings on 10/11, in *bc* but nearer *b* than *c*, with intersegmental furrow 10/11 ending against the papilla. As previously mentioned, the male porophores are located posteriorly on the rims of these markings. Approximately one-third of the specimens have a second similar papilla (but of course lacking the male porophore) on x on each side immediately anterior and very slightly external to the marking that bears the male

porophore. The two markings of a side may be quite separate from each other with a deep groove between or the margins of the two markings may be in contact, or the two markings may be fused so that there is a single, elongately oval, rather diagonally placed area containing two greyish depressions (and of course the male porophore posteriorly). Approximately another one-third of the worms have three markings on each side, two as before and a third, also on x, just anterior to but in line with the other two. In all of these specimens the three papillae are distinctly separate from each other.

The other genital markings are slightly smaller, not so clearly demarcated, nor so protuberant from the surface of the body. Each worm has at least two markings of this type while many of the specimens have several pairs, but the grouping of the markings differs from one animal to another so that no two worms are alike in this respect. The markings occur on segments vii-xii in the following positions :—

Segment vii.

Middle annulus, in mid *bc* on each side. (1)
Posterior annulus, in mid *bc* on each side. (1)
Posterior annulus, in *cd* on each side. (1)

Segment viii.

Anterior half, in mid *aa*. (1)

Segment ix.

Anterior annulus, in mid *aa*. (2)
Anterior annulus, in mid *bc* on each side. (3)
Anterior half, 1 pair in mid *bc* on each side. (3)
Middle annulus, in mid *bc* on each side. (6)
Middle annulus, in mid *aa*. (1)
Posterior half, in mid *aa*. (1)

Segment x.

Anterior annulus, in *ab* on each side. (2)
Anterior annulus, in mid *aa*. (3)
Anterior half, 1 pair in *aa*. (1)
Middle annulus, 1 pair in *aa*. (2)

Segment xi.

Anterior annulus, in mid *aa*. (2)
Anterior annulus, in *ab* on each side. (2)
Anterior half, in *ab* on each side. (2)
Middle annulus, just internal to *a*, one on each side. (1)

Segment xii.

Anterior half, one pair in *aa*. (1)
Middle annulus, just internal to *a*, one on each side. (1)
(The figures in parentheses denote the number of specimens having genital markings on the location mentioned).

The gizzards are three to five in segments xvi-xxi as follows:—xvi-xix (1 specimen), xvi-xx (1), xvii-xx (1), xviii-xx (1), xviii-xxi (4), xix-xxi (2).

The vas deferens is looped into a mass of closely compacted coils on the posterior face of 10/11. This mass of coils is larger by 2-4 times the size of the testis sac. The testis sacs may be kidney-shaped, unconstricted by 10/11; elongate, constricted or unconstricted'; ovoid, or spherical. A considerable portion of the testis sac may extend through 9/10 into ix or the testis sac may be confined to x. The prostates are elongate:—wound into a tight spiral coil, twisted into a loose spiral, erect and antero-posteriorly flattened, columnar, or variously bent. Frequently the prostates extend through the oesophageal annulus of xi into xii. The ental end of the prostate is usually a trifle larger than the ectal end. When wound into a tight spiral, as in the majority of specimens dissected, the vas deferens passes into the interior of the spiral close to the parietes and is not thenceforth visible unless the spirally coiled prostate is unwound. When the prostate is not tightly wound into a spiral the vas deferens can be seen to pass directly into the prostate near its ectal end.

The atria are large and characteristic and end abruptly without trace of ental enlargement. One atrium straightened out as much as was possible without stretching measured over 140 mm. in length, which is about 30 mm. more than the length of the worm. The ovarian chamber is large and distended. The ovisacs may extend posteriorly as far as xvi.

Each genital marking is the external face of a spherical parietal gland, the glands here smaller than in other varieties of this species. They may be completely covered over by the musculature or may project through the musculature into the coelom.

### Variety **verrucosa,** n. var.

**Tharrawaddy, 3 anterior fragments.**

These worms were collected some six or seven years ago before the significance of the wide range of variation in the male porophores and genital markings of this species had become evident. No attempt was made at that time to secure more than the three fragments and the variety has not been found since. It is not possible, therefore, to give a complete description of the distinctive varietal characteristics of this worm.

On each of these specimens there is on each side in *bc*, an elongate area with bluntly rounded ends, extending laterally nearly to *c*, internally nearly to *b*, and antero-posteriorly from just behind the setae of xi to just behind the setae of x. This area is definitely marked off from the rest of the body surface by a distinct circumferential groove against which intersegmental furrow 10/11 ends quite abruptly. On this area is a small, slightly protuberant, anteriorly directed porophore. The male pore is at the tip of the porophore and hence faces anteriorly in this variety. Each porophore-bearing plate or area contains in addition one or two small circular greyish spots which indicate the presence within the tissues of the plate of the *longatria* parietal glands.

Other genital markings are numerous. There are 13, 15, and 17 on these specimens. These markings have a thick, whitish rim with a

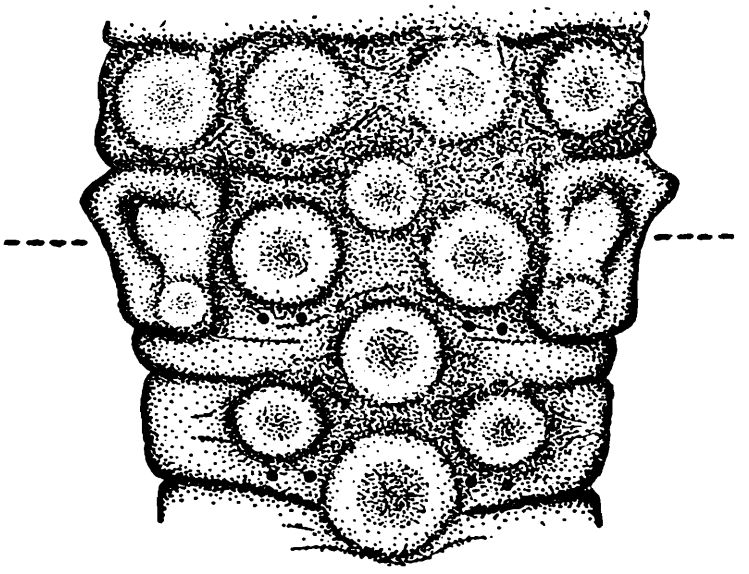

Fig. 3.—*Drawida longatria verrucosa*, n. var. Ventral view of segments x, xi, and xii, showing the male porophores and the genital markings. The dotted line indicates the position of 10/11.

dark greyish, depressed centre and are found in various locations on segments vii-xii.

This variety lives in the same locality together with *D. l. typica*.

### **Drawida nepalensis** Mich.

Namkham, May, 4 specimens.
Kyaukme, May, 6 specimens.

### **Drawida peguana** Gates.

*Drawida peguana*, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 316 (1925).

Kya In, August, several specimens.
Ye, August, several specimens.
Moulmein, August, two specimens.
Martaban, August, several specimens.
Syriam, September, several specimens.

There are no male porophores in this species, the male pores are small round apertures in intersegmental furrow 10/11.

The genital markings on vii, viii, x and xi indicate the presence of special integumentary glandular masses. These glands do not, however, project into the coelom but are confined to the parietes between the longitudinal and circular muscle layers. They are most easily found by stripping off the longitudinal muscles from the coelomic face of the integument.

A considerable fraction of the Chaungson specimens have a reddish to purple colouration instead of the blue hitherto regarded as characteristic of this species.

*D. peguana* is the only species of *Drawida* in Rangoon that has a blue pigment. It is therefore possible to identify individuals of this species long before sexual maturity has been attained. Several immature pecimens have been examined. 1. 46 × 2mm. 2. 50 × 2mm.

Both specimens are without any indication of a clitellum, or of genital markings. No reproductive apertures are visible. The position of the male pore is indicated however by a minute, dark dot in the intersegmental furrow 10/11. There are no spermathecal ampullae or ovisacs. The testis sacs are almost entirely confined to x. The prostates are erect and characteristically club-shaped. The vasa deferentia are characteristic. Spermathecal atria are present; small, but similar in shape to the atria of a fully mature specimen.

3. 53 × 3 mm. This specimen has minute finger-shaped ovisacs in xii. The spermathecal ampullae are indicated as small, rounded enlargements of the ental end of the spermathecal ducts. In this as well as in the preceding specimens the ental end of the prostate appears to be slightly larger relative to the rest of the gland than in fully mature individuals.

4. 85 × 4 mm. This specimen has recognizable male pores, indications of the appearance of spermathecal pores, and a slight whitening of certain spots ventrally on segments where genital markings may be found in the adults. The ovisacs are about the same size as in the preceding specimen but the spermathecal ampullae are slightly larger. The testis sacs are larger than in the preceding individuals and project more conspicuously into ix. There is no indication of a clitellum and female pores were not recognized.

### **Drawida rangoonensis** Gates.

*Drawida rangoonensis*, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 320 (1925).
*Drawida rangoonensis*, part, Gates, *Rec. Ind. Mus.* XXVIII, p. 146, fig. 2 (1926).
*Drawida rangoonensis*, part, Gates, *Rec. Ind. Mus.* XXXII, p. 291 (1930).

**Moulmein, August, several specimens.**

Earthworms from three separate localities have been referred to this species. Re-examination of the material from all of these localities shows that two distinct forms have been confused. So far as can be discovered from the material now on hand (type and cotype specimens), only the original form *D. rangoonensis* occurs in Rangoon. The original account based on these specimens may therefore be regarded as accurate, so far as it is complete. The two batches of material from Bassein and Sandoway comprise the two different forms which were not differentiated. The data in the second and third papers, mentioned above, should therefore be disregarded as representing a composite account, based on two different forms. The second species is described elsewhere in this paper as *D. abscisa*. An amended description of the species is subjoined.

*External characteristics.*—Length 40-92 mm.; greatest diameter 2½-4 mm. Number of segments of seven specimens selected at random: 160, 161, 161, 162, 163, 164, 167 Unpigmented except on the clitellar segments which are dark red.

Setae *ab* and *cd* are closely paired, setal intervals *aa* and *bc* vary relative to each other from one worm to another—*aa* : *bc* :: 1¾-1 : 1½, *dd* is about equal to one-half the circumference; setae on the preclitellar segments slightly enlarged.

The spermathecal pores are in 7/8 in line with *c* or very slightly internal to *c*. The male pores are on the posterior margin of *x*, in *bc*,

but nearer to *b* than *c*. The female pores are in 11/12 in line with *b*. The male pores are not as a rule readily visible, but are recognizable in some specimens and in others have been located by tracing the prostatic lumen through the parietes.

There are no definitely marked off or protuberant genital papillae or male porophores. In practically all of the specimens there are indistinctly delimited white areas on the ventral side of the clitellar segments. These areas may be more or less rounded and paired in *bc*, or unpaired and transversely elongated in *aa* or mid *bc* to mid *bc*, on ix, x, xi, and xii. These markings appear to represent merely an absence of the clitellar pigmentation for the epidermis of these markings does not seem to be appreciably thickened. In several specimens small masses of glandular material have been found internal to these markings, between the circular and longitudinal muscular layers. The only markings occurring on all the specimens are the paired whitenings of the posterior margin of segment x near 10/11 immediately external to *b*. On these areas are the male pores. In many of the specimens there is a distinct, rather deep depression in *bc*, on the middle third of segment x on each side, but this depression is not definitely marked off by grooves or furrows. When these depressions are present, there is always a slight elevation of the whitened areas on the posterior margin of x as slightly conical protuberances, but these rather vaguely protuberant cones bear no furrows nor are they delimited or circumscribed in any way by furrows. Some of the specimens with the depressions and the elevation of the male pore-bearing areas also have a slight appearance of ridging immediately external to these markings, the ridged appearance slight, confined to x or extending across both x and xi. It is this condition which was described in the original account of the type specimen.

In specimens with the depressions on x the region immediately surrounding the spermathecal pore is tumid and slightly wrinkled.

The nephridiopores of viii and ix are displaced dorsally, the pores of viii more so than those of ix.

*Internal anatomy.*—The gizzards are three or four in xiii to xviii. There is a closed ovarian chamber. The ovisacs are large, filling xii or xii and xiii. The spermathecal ampullae are large, and filled with an opaque whitish material. The spermathecal ducts are narrow and thrown into several small coils under the ampullae on the posterior face of 7/8. The atria are large, flattened, hollow sacs, gradually increasing in width entally, in contact dorsally over the oesophagus.

The testis sacs are large and extend into both ix and x but the larger portion of each sac is in x. The vasa deferentia are wide, long, each vas coiled into a closely compacted mass of loops, in size nearly equal to that portion of the testis sac which is confined to x. The prostates are erect, columnar; surface coarsely granular, the granulations extending clear to the parietes so that there is no coelomic stalk. The prostates may be slightly bent or twisted. The vas defereus passes into the prostate near the ental end.

*Remarks.*—With the exception of most specimens of *D. hehoensis* and some few specimens of *D. caerulea* worms belonging to species of *Drawida* that have an external copulatory apparatus die, when treated

by methods in use in this laboratory, with the copulatory apparatus protuberant and therefore in a position in which it could function in copulation. In other words the worms may be regarded as fixed in an "attitude" more or less closely resembling that taken at the time of copulation. Similarly specimens of *D. rangoonensis* with the male pore-bearing areas slightly elevated and with depressions and ridges may also be regarded as fixed in an "attitude" of copulation. If this be correct then these worms are able to produce rudimentary semblances of copulatory structures even though definitely developed and demarcated protuberant organs are lacking.

It should be noted that although large numbers of specimens of *D. peguana* have been examined no suggestion of a condition similar to the attitude of copulation of *D. rangoonensis* has ever been found.

## **Drawida rara** Gates.

*Drawida rara*, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 321 (1925).
*Drawida rara*, Gates, *Rec. Ind. Mus.* XXVIII, p. 146, fig. 2 (1926).

Kya In, August, a number of specimens.
Ye, August, fifteen specimens.
Chaungson, August, a number of specimens.
Moulmein, August, a number of specimens.
Syriam, September, a number of specimens.

All of the specimens from the Moulmein district have one or two pairs of genital markings on x, one pair on the posterior third of the segment, the other pair, when present, in the middle third of the segment. These markings are in line with or very slightly external to the male porophores. A very few specimens have in addition transversely elongate, oval markings.

The male porophore may be described as a thin basal plate with a circular outline, from the centre of which projects a small, teat-like structure bearing at its end the male pore. The basal portion of the porophore is here flatter than has been observed in previous specimens.

The alimentary tract of xii and xiii in many of the worms is whitish, but actual gizzards were found in these segments in only one specimen. The gizzards are three to four in segments xii-xviii as follows :—

| | |
|---|---|
| 4 in xii-xv | 1 specimen. |
| 3 in xiv-xvi | 2 specimens. |
| 4 in xiv-xvii | 9 specimens. |
| 3 in xv-xvii | 4 specimens. |
| 4 in xv-xviii | 3 specimens. |

The only trace of an atrium in any of the specimens examined is a very slight, rather conical enlargement of the end of the spermathecal duct buried in the tissues of septum 7/8 and the parietes.

An immature specimen, 35 mm. long and 2 mm. in diameter, has characteristic male porophores but no other external genital markings. The spermathecal ampullae are not yet developed and ovisacs and atrial enlargements of the ectal ends of the spermathecal ducts are not yet recognizable, but the testis sacs, vasa deferentia and the prostates are miniatures of the conditions in the mature forms.

**Drawida sepulta,** n. sp.

Chaungson, August, several specimens.
Martaban, August, several specimens.
Kya In, August, a large number of specimens. (This species is the commonest worm in this locality).
Shwegyin, September, a number of specimens.

*Description of the type-specimen. External characteristics.*—Length 116 mm. Greatest diameter 6 mm. Number of segments 212. Unpigmented. On segment viii there are two secondary furrows, one anterior to and one posterior to the setae of the segment, on the posteriormost annulus of the segment there is a single tertiary furrow. On ix there are two secondary furrows as on viii; secondary furrows are lacking on the remaining segments.

There are no dorsal pores.

The setae begin on ii, are closely paired, *ab*=*cd*, posterior to the clitellum *aa* : *cd* : : $1\frac{1}{2}$ : 2, *dd* is perhaps slightly greater than one-half of the circumference.

The nephridiopores are in line with setae *d*.

Segments ix-xiii are orange coloured.

The spermathecal pores in 7/8 are fairly conspicuous apertures about in line with *c*. On the posterior margin of vii, close to 7/8 on each side, a short but quite definite transverse furrow marks off an anterior spermathecal lip which is further sub-divided into slightly swollen lobes or tubercles by shorter longitudinal furrows. On the anterior margin of viii there is on each side, in the vicinity of the spermathecal pore, a slight swelling and lobulation of the parietes but there is no transverse furrow to mark off a definite lip.

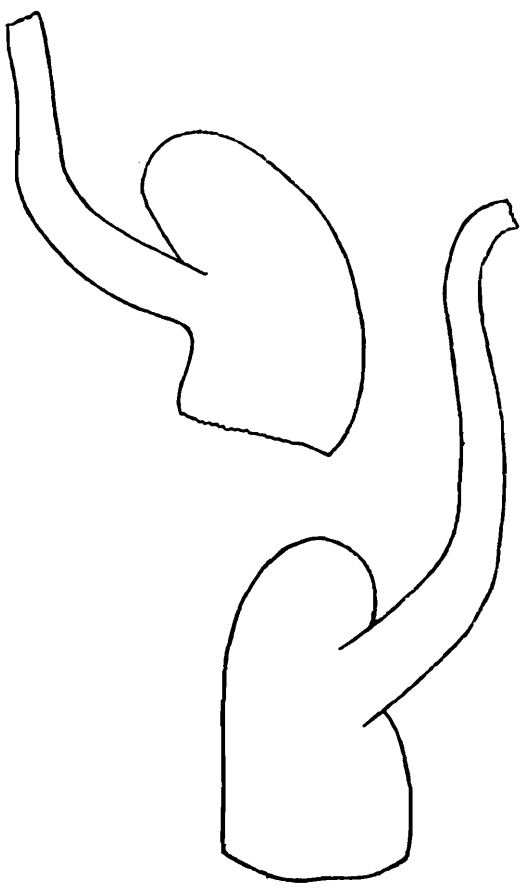

Fig. 4.—*Drawida sepulta,* n. sp. Spermathecal atria with portion of spermathecal duct, × *za.* 27.

The male pores are located at the tips of anteriorly directed, slightly flattened, conical porophores in *bc*, but nearer to *b* than *c*. These porophores represent a projection on each side from the margins of both segments x and xi, the intersegmental furrow 10/11 ending abruptly against the base on each side of the porophore, which extends from about *a* into *bc*. Judging from the position of the porophores in relation to 10/11 the porophores belong more to xi (*ca.* 2/3) than to x.

The female pores are in 11/12 in line with *b*.

Just anterior to each porophore on x and just posterior on xi there is a whitish glandular-like patch, not clearly demarcated. The anterior patch is depressed slightly below the general level of the parietes and covered by the male porophore. On the posterior third of viii and on the posterior third of ix is a slightly protuberant, cream-coloured, transversely elongate thickening of the epidermis, not very sharply demarcated from the rest of the parietes. The more anterior of these extends to mid *bc* on each side, the more posterior marking reaches nearly to *c* on each side.

*Internal anatomy.*—Septa 5/6-8/9 are present and thickened. The gizzards are four in xvi-xix. The last pair of hearts is in ix.

The testis sacs are somewhat kidney-shaped and extend into both ix and x but are not constricted by 9/10. The vas deferens is long and coiled into a mass of closely compacted loops which is smaller than the testis sac. The prostates are sessile, circular patches with a granular surface into the centre of which the vas deferens passes.

The ovarian chamber is large, swollen, filled with a yellowish material, and is in shape like a U inverted over the oesophagus. The ovisacs are large, extending into xiii on the left side and into xii on the right side. The spermathecal ampulla is ovoid. The duct is slightly thicker than is usual in this genus, coiled into a number of loose loops under the ampulla, passing ventralwards the duct enters 7/8 in which it is slightly widened. Emerging through 7/8 into vii the duct passes into the posterior face of a short, stout atrium that projects upright into vii against the anterior face of the septum.

*Remarks.*—The length of mature specimens varies from 80-130 mm. and the diameter from 5-6 mm. The buccal cavity of segment i is everted in all of the specimens and the prostomium is softened, but so far as can be determined it is prolobous and attached as is usual in this genus. Dorsal pores are lacking. In many of the specimens there is a mid-dorsal line of bluish appearance which in crossing an intersegmental furrow occasionally causes an appearance like that of a dorsal pore but no functional dorsal pores are demonstrable. The nephridiopores are in line with *c*, *d*, or in the region *cd*.

The spermathecal pores are in line with *c*, or slightly internal to *c*. A short transverse furrow about 1 mm. long is always present (except in immature specimens) posteriorly on vii on each side, marking off an anterior spermathecal lip. The lip so demarcated by this short furrow protrudes more or less, and may or may not be lobed.

There is little variation in the appearance of the male porophores which are always anteriorly directed, the male pore located at the tip and facing anteriorly. At the base of the porophore there are usually

several furrows, variously placed, but never completely circumferential, which produced a wrinkled appearance.

The genital markings are not definitely outlined. As in the type-specimen they consist of more or less circular whitish patches, one immediately anterior to and another immediately posterior to each male porophore. The narrow, median, transversely elongated, slightly protuberant markings vary in their position and number. There are usually two or three per worm, located on the anterior, third or half portions of viii, ix and x, or the posterior third or half portions of viii and ix. They may extend laterally on each side to *a*, *b*, mid *bc*, or *c*. There is no special coelomic glandular mass associated with these markings, the appearance of the genital marking due to a slight cream coloured thickening of the epidermis.

The setal interval *aa* is apparently always smaller than *bc* on segments behind the clitellum, *dd* is equal to one half the circumference or perhaps a trifle more.

Septa 5/6-8/9 are thickened and attached normally or dislocated posteriorly only very slightly. Anterior to 5/6 there are five to seven septa-like sheets of tissue, the posteriormost attached to the anterior face of 5/6 very close to its parietal periphery, the penultimate sheet attached to the parietes just anterior to 5/6. All of these sheets are funnel shaped but unlike 5/6 and other septa these are attached to the oesophagus anterior to their parietal attachment so that the funnel is directed anteriorly.

The gizzards are three to five in xiii to xix as follows :—

| | |
|---|---|
| 5 in xiii-xvii | 1 specimen. |
| 4 in xiv-xvii | 4 specimens. |
| 5 in xiv-xviii | 2 specimens. |
| 3 in xv-xvii | 1 specimen. |
| 4 in xv-xviii | 6 specimens. |
| 3 in xvi-xviii | 1 specimen. |
| 4 in xvi-xix | 1 specimen. |
| 4 in xvi-xix, with rudimentary gizaards in xiv and xv | 1 specimen. |

The prostates are circular, sessile patches on the body wall. The granulations may be readily rubbed off revealing a firmer conical body into the end of which the vas deferens passes. The coiled mass of closely compacted vas-deferens loops varies in size but is never as large as the testis sac. The testis sacs extend into ix but are not sharply constricted by 9/10.

The spermathecal duct is 10-14 mm. long, slightly thicker than usual, thrown into a number of loose loops on the posterior face of 7/8. The duct passes, gradually widening, into the septum and then ventrally, reaching its greatest thickness just as it passes through the septum into the atrium. The atria are always of the same appearance. The ovisacs may extend in a moniliform fashion as far back as xiv or xv, constricted by the septa.

The sub-neural trunk is large and passes out from under the nerve cord on either the right or the left side and then anteriorly as the ventro-lateral trunk of that side. The ventro-lateral trunk of the other side

breaks up into a number of small branches in the region of segments x-xiv. Usually one of these small branches can be traced posteriorly into the subneural trunk. In segment x a conspicuous branch from each ventro-lateral trunk passes dorsally and through 9/10 into the heart of ix of its side just before the latter passes into the dorsal blood vessel. In x just before passing through 9/10 these branches from the ventro-lateral trunks are connected with each other transversely over the oesophagus. Just anterior to 5/6 the dorsal blood vessel may be twisted into a spherical mass of loops ; uncoiled this looped portion may measure as much as 10 mm. in length.

Immature individuals 60-75 mm. long and about 4 mm. in diameter were collected. These are readily recognizable as the spermathecal ducts, atria, prostates, testis sacs, and vasa deferentia are all characteristic. These specimens have no ovisacs and the spermathecal ampulla is represented only by a very short, slightly elongated widening of the free end of the spermathecal duct.

An abnormal specimen lacks the male porophore on the left side, but a faintly visible pore in 10/11 probably represents the male pore. A flat, whitish mass on the left side of the posterior face of 10/11 probably represents a testis sac. The ental end of the vas deferens is enlarged into a transparent funnel, the ectal end passes into a minute conical rudiment of a prostate over 10/11. The left vas deferens is much shorter and has fewer loops than the right.

## **Drawida tumida** Gates.

*Drawida tumida*, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 12, fig. 4 (1929).

### Variety **typica.**

*Drawida tumida typica*, Gates, *Rec. Ind. Mus.* XXXII, p. 294 (1930).

Moulmein, August, a number of specimens.
Kya In, August, a number of specimens.
Ye, August, a number of specimens.
Chaungson, August, a number of specimens.
Kyaikmaraw, August, several specimens.

One specimen from Chaungson is very much larger than any individual of this species found hitherto, having a length of 153 mm. and a diameter anteriorly of 6 mm.

The spermathecal pores are either in line with *c* or just internal to *c*.

Not all of the present specimens have the very markedly protuberant ridges in *bc* on each side of segments x and xi hitherto regarded as characteristic of this variety. When the ridge is lacking the male porophore and the characteristic *typica* papilla of x, which are otherwise on or a part of the ridge, protrude separately from the general body surface. In either case the anterior, oval marking is placed at an angle to the ventral surface so that its inner or midventral margin rests on the parietes, while its lateral or external margin is pushed up from the general level of the body by a region which bears 3 or 4 short antero-posterior furrows. This papilla first appears on the anterior half of x but as growth takes place it may extend backwards into the posterior half,

Intersegmental furrow 10/11 ends abruptly against the base of the protuberant male porophore which is grooved usually by 2 or three circumferential furrows. The porophore may be roughly conical in shape or may be compressed into a sort of flattened base from which protrudes a teat-like portion bearing the male pore. The male pore faces ventrally or internally towards the midventral line.

In five of the Chaungson specimens the ridge is shortened so that the anterior oval marking is pushed backwards and fused to the base of the male porophore.

A very small number of specimens have no further genital markings. The large majority have in addition paired laterals (*a*) on the posterior annulus of vii in mid *bc*, or (*b*) on the posterior annulus of vii in the region of *cd*, or (*c*) on the anterior annulus of viii in mid *bc*, or (*d*) on the posterior annulus of vii and the anterior annulus of viii in mid *bc*. Five specimens have other additional papillae as follows :—

1. (*a*) a single median papilla on ix.
2. (*c*) paired medians on x, single median on xii, single median on xiii.
3. (*d*) paired medians on xi, single median on xii.
4. (*a*) paired medians on xi.
5. (*a*) single median on xii.

The gizzards are in xvi-xxii as follows :—xvi-xix (1 specimen), xvii-xx (3), xvii-xxi (3), xviii-xxi (2), xix-xxii (1).

The atria of a number of specimens of both varieties have been examined. The atrium is thin walled, tubular, the ectal portion next to the parietes is usually wrinkled or twisted, the ental portion straight. The atria of variety *typica* are, on the whole, slightly longer than those of variety *deleta*.

### Variety **deleta.**

*Drawida tumida deleta*, Gates, *Rec. Ind. Mus.* XXXII, p. 295 (1930).

Kya In, August, a large number of specimens.
Ye, August, a number of specimens.
Chaungson, August, a number of specimens.
Moulmein, August, a number of specimens.
Kyaikmaraw, August, several specimens.

The ridges usually present on *typica* are entirely lacking here. The male porophores are seated across 10/11 as in specimens of *typica* without the ridges. All specimens of this variety have genital markings on one or more of the segments ix-xiii and often in addition markings on vii or viii. The markings on ix-xiii are in *aa* and may be paired or (and) unpaired. When paired the markings may be separated from each other by a narrow strip of normal epidermis on the midventral line, or the margins of the two markings may be in contact with each other midventrally, or the two markings may be grown into each other so that there is a single transversely oval area containing two greyish depressions. In this later case the parietal glands are distinctly separate from each other internally. The markings on vii and viii are paired and lateral in position.

The gizzards are four or five in segments xvi-xxi as follows :—xvi-xx (1 specimen), xvii-xxi (8), xviii-xxi (6).

## The *MEGASCOLECINAE.*

### Genus **Plutellus** E. Perr.

### **Plutellus ambiguus,** n. sp.

**A single specimen, locality and date of collection unknown.**

*External characteristics.*—Length 85 mm. Diameter throughout 1 mm. Dark grey both dorsally and ventrally from head to tail, with a slight greenish tinge.

The prostomium is prolobous.

The first functional dorsal pore is in 7/8.

No secondary annulations noted. The first three segments are short, segment iv slightly longer, the length increasing gradually to segment viii, segments viii-xii are long, the length decreasing from xiii posteriorly.

Clitellum not recognizable.

The nephridiopores are rather noticeable considering the size of the worm and are either located in the intersegmental furrows or very close to them in the mid-lateral line.

Setae are not visible externally. Anteriorly at least, on the middle third of the segment, where a setal circle would be located if present, there is on each segment a ring of tiny spots, very hard to see, the spots suggestive of the tips of very fine setae. The ring of spots is on a slightly raised ridge around the segment as are the perichaetine setae. Posteriorly eight setae in four pairs were doubtfully recognized but the

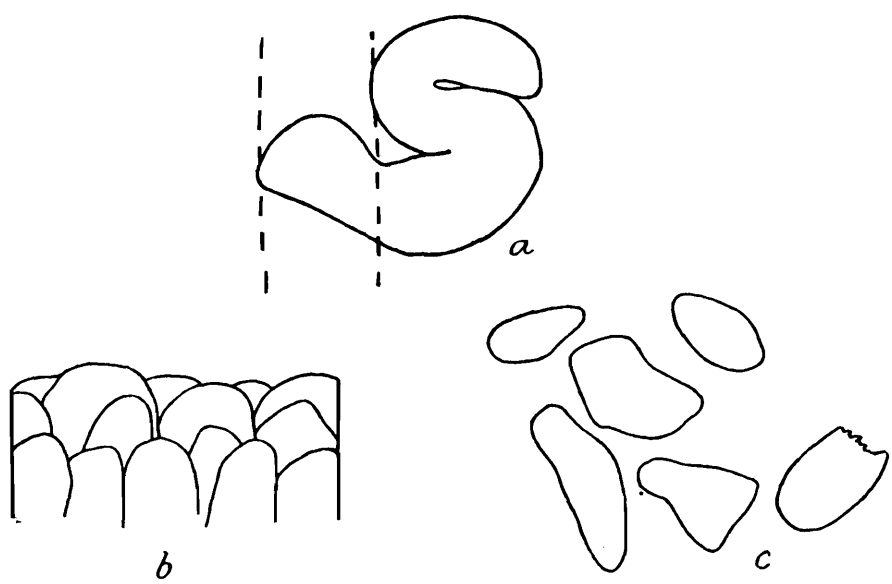


FIG. 5.—*Plutellus ambiguus*, n. sp. *a*. Prostate, × *ca.* 20. The dotted lines indicate position of 17/18 and 18/19. *b*. Margin of prostate after clearing, ×*ca.* 325. *c*. Fragments of prostate after teasing, × *ca.* 325.

perichaetine appearance of the segments persists. After cutting open and pinning out the specimen setal sacs were visible in xx and a few succeeding segments. These sacs were located in the ventral parietes some distance from the nerve cord, only two sacs on each side per segment. The tail portion of the worm, about 20 mm. in length, was then removed, the intestine cleaned out, the parietal tissues soaked in

lactophenol and then mounted. In this preparation every segmental annulus showed more than eight setae, but many of these setae are small and thorn-shaped and may be regarded as immature setae in process of formation. After counting out the thorn setae there remained in many segments 12-16 setae. There are, however, only eight of the characteristic setal sac apertures per segment visible on the inner face of the parietes. It would therefore appear that the setae additional to the lumbricin number are fully grown, reserve setae. This was confirmed by an examination of the cuticle, which was stripped off from the remainder of the worm and examined under the high power of the microscope. On each segmental annulus of the cuticle there are eight invaginations, arranged in four pairs. These are the invaginations lining the setal follicles. The worm then apparently has four pairs of setae per segment with a setal formula (derived from the cuticular invaginations) as follows :—$ab<cd<bc<aa$.

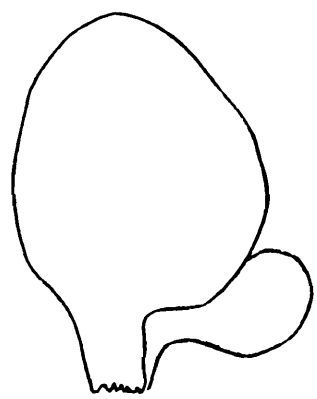

FIG. 6.—*Plutellus ambiguus*, n. sp. Spermatheca, × *ca.* 75.

After stripping off the cuticle the perichaetine-ridged appearance of the epidermis is even more striking than before. On the cuticle on each segmental annulus in line with the setal invaginations is a rather regularly spaced row of tiny, opaque, oval spots, each spot about the same size as or a trifle larger than the apertures of the follicular invaginations. These opaque spots on the cuticle correspond to the points on the epidermis that produce on the segments the perichaetin appearance.

The spermathecal pores are four pairs in 5/6-8/9, about the same distance apart from each other as the papillae on 17/18.

Male and female pores were not recognized.

The genital markings consist of three, unpaired, median areas. Two of these are protuberantly rounded, transversely oval cushions, one across 11/12 and one across 12/13. At the centre of each of these markings is a pair of pore-like depressions. The posterior area is located on the posterior half of segment xvii and the anterior half of segment xviii. This area is slightly swollen, the intersegmental furrow 17/18 lacking thereon, the anterior border rounded and convex, the posterior, border perfectly straight. At the outer end on each side and about in line with 17/18 is a small, round tubercle, which appears to bear a pore. Immediately behind the straight, posterior margin of this marking is a deep, transverse groove, which may possibly contain the male pores.

*Internal anatomy.*—All septa from 5/6 posteriorly are present, 5/6 is thick, 6/7-8/9 much thicker, 9/10-11/12 thickened, but not so much so as 6/7-8/9, 12/13 and succeeding septa gradually thinner.

The gizzard is in v, elongate, slightly over 1 mm. in length, well developed, and relative to the size of the worm, large. The intestine begins in xv and is sacculated, *i.e.*, its walls are sharply constricted by the septa laterally. No calciferous glands or typhlosole were found.

The last pair of hearts is in xiii. The commissure of the right side is small, that of the left side much larger and filled with blood, but instead of passing ventrally into the ventral trunk this left commissure appears to pass through 12/13 anteriorly. The right commissure of xii is also much larger than the left and similarly appears to pass anteriorly through 11/12. Unfortunately both of these vessels were very brittle and in attempting to trace their courses both were broken.

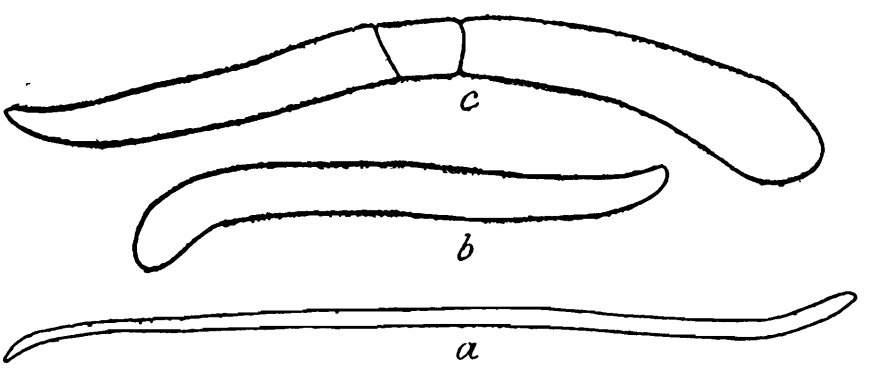


FIG. 7.—*Plutellus ambiguus*, n. sp. *a*. Penial seta, × *ca.* 200. *b, c*. Hypertrophied setae from segment xxiii, × *ca.* 200.

The excretory organs are meganephridia, a single pair per segment, located on the floor of the coelomic cavity near the nerve cord. The nephridia of xiii and xiv are small, those of xv and succeeding segments much larger. In the tail segments the nephridia are again small. The nephridium from the left side of xv was removed and mounted but was not well preserved.

The seminal vesicles are very small structures on the posterior faces of septa 10/11 and 11/12 at the sides of the oesophagus. The male funnels and the testes are free in x and xi in the usual locations. The vasa deferentia were not seen. The prostates are flattened, strap-like rather thin structures arising in xviii and extending through xviii and xix, looped as shown in the figure, and with the larger portion of the gland in xix. The surface is coarsely granular. The prostatic duct is wholly in xviii, it emerges from the anterior end of the prostate, is looped into a small U facing anteriorly and then passes in a nearly straight line into the parietes; whitish, glistening and slightly enlarged ectally.

The left prostate was sectioned but the sections unfortunately are not good. The gland consists apparently of a single layer of large cells, each cell densely packed with granules and without a nucleus. No epithelial layer was visible either lining the lumen or surrounding the gland. The lumen as seen in transverse section is of a flattened irregularly oval shape. The other prostate was cleared in lactophenol. The margin has an irregular edge which might be said to be minutely lobulated, each of the lobulations being the outer border of one of the

granule-filled cells. When teased with needles the gland readily comes apart into cell-like fragments.

Passing into the parietes together with the prostatic duct and immediately posterior to it is a short stumpy sac. This sac was removed from the right side. It contained two penial setae, one of which lacked its outer point. The setae are about ·41 mm. long and about ·005 mm. in diameter at the region of greatest thickness. The setae are very slender, more so than the other setae, nearly straight, with a very slight bend at the tip and a slightly more marked bend at the inner end, with the angle of the bend opposite to that of the bend at the tip. Ornamentation of several tiny spines located near the tip which are exceedingly difficult to see.

The ovaries are masses of long egg strings in xiii. The eviduct funnels which are in the usual locations are smaller than the male funnels. The spermathecae are four pairs in segments vi-ix, each spermatheca opening anteriorly. The ampulla is oval, the duct is short and almost entirely confined to the body wall and has on its inner side a single diverticulum. The right spermatheca from segment ix is figured. There are minute ovisacs (?) in xiv attached to the posterior face of 13/14 at the sides of the oesophagus.

The left nephridium of segment xxiii is lacking but in its place there project into the coelom rather conspicuously two rounded masses of tissue. One of these was eventually got out and proved to be a hypertrophied setal sac or follicle containing three setae. One of these, the shortest, a mere thorn, is about 90 micra long, the medium-sized seta is about ·25 mm. long and the other about ·38 mm. long. The setae are almost straight, with a very slight bend at each end. The greatest diameter of the largest seta is about ·042 mm. No ornamentation could be made out.

*Distribution* and *Occurrence.*—This worm became separated from its label which has not been found, so that the locus of origin cannot be definitely stated. The worm was probably collected somewhere in the Chindwin Valley during the month of August.

*Remarks.*—The genus *Plutellus* has not been previously recorded from Burma although it occurs in India. Quite probably the genus has been overlooked by many collectors because of the small size of the species.

## Genus **Notoscolex** Fletcher.

### **Notoscolex birmanicus** Gates.

*Notoscolex birmanicus*, Gates, *Ann. Mag. Nat. Hist.* (9) X, p. 609 (1927).

Maymyo, June, several specimens.

None of these specimens are fully mature but are readily recognizable as *birmanicus* by the club-shaped projections at the anterior ends of the seminal furrows which seem to be quite characteristic. Although a gang of coolies dug for worms for more than a week no specimens of the other species of Maymyo *Notoscolex* were found.

The present specimens all have faintly indicated clitella. The longest specimen is 415 mm. in length and is incomplete posteriorly.

**Notoscolex** species ?.

Namkham, May, two immature specimens.

These two specimens were obtained after rain had been falling for several weeks. They are both obviously immature but do not seem to

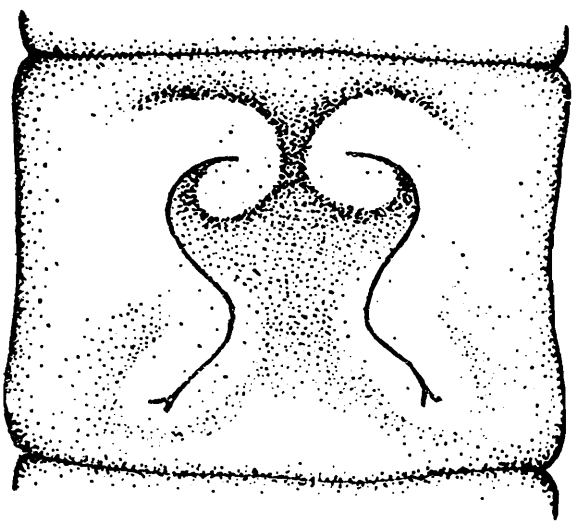

FIG. 8.—*Notoscolex* species ? Portion of ventral surface to show the seminal grooves.

resemble previously collected immature forms. This is included here because of its significance in extending the range of distribution of the genus *Notoscolex*.

## Genus **Megascolex** Templeton.

**Megascolex mauritii** (Kinberg) 1867

Taungdwingyi, April, a number of specimens.
Magwe, April, a large number of specimens.

## Genus **Pheretima** Kinberg.

All of the endemic species of the genus *Pheretima*, as well as a large proportion of the specimens belonging to the peregrine species of the same genus with which this portion of the paper is concerned, were collected either in the Shan Plateau or in the hills which extend in a southerly direction from that plateau into the Tenasserim division.

Some of the species are based on immature or not-quite mature specimens. All of the specimens of *P. immerita* are quite immature ; the spermathecae still concealed within the musculature of the body wall, the reproductive organs rudimentary, and the clitellar glandularity undeveloped. The colour and general appearance of the worm are quite characteristic and enable the species to be recognized at a glance when the specimens themselves are compared with individuals of other Burmese species. Futhermore genital markings are present and sufficiently developed to enable description of these peculiar specific qualities. These markings are quite characteristic and without variation in appearance, number, or position. Thus in spite of very evident immaturity we have a sounder knowledge of this species than we have of the single-specimen species, *P. kengtungensis*. The specimens of the other species concerned are more nearly mature and, though clitella may

be lacking or only partially developed, there is reason for believing that the species are adequately characterized. In this connection it should be remembered that the genital markings may appear, at least as rudiments, long before the clitella begin to develop so that it is often possible to identify earthworms belonging to species having characteristic genital markings some time before the worms become fully mature. Immature material from the Shan plateau belonging to several distinct species but which cannot be identified with previous species or adequately characterized has been left out of consideration.

In the specific descriptions reference is frequently made to the "numbers of the setae between the spermathecal pore lines" or the "numbers of the setae between the lines of the spermathecal pores." These lines are fictions, conceived as representing lines passing through consecutive spermathecal pores of a side. The setal numbers referred to are the numbers of the setae that can be counted on the segments concerned between these lines. If the spermathecal pores are large the lines are taken as passing through the centres of the epidermal apertures. If a worm has only one pair of spermathecal pores the lines are supposed to pass through the spermathecal pores concerned in such a way as to be parallel with an imaginary mid-ventral line. The counts of the ventral setae between these imaginary lines, already made, indicate that there is a rather definite relationship between the number of setae in the areas involved and the positions in which the spermathecal pores develop. This characteristic (or relationship) has been found most useful in differentiating varieties of a species as will be evident from the examples given herewith. In variety *typica* of *P. alexandri* the numbers of the setae between the spermathecal pore lines are :—

| | |
|---|---|
| On vi | 9—12 |
| On vii | 10—12 |
| On viii | 12—14 |

In variety *gracilior* of *P. alexandri* the numbers of the setae between the spermathecal pore lines are :—

| | |
|---|---|
| On vi | 13—18 |
| On vii | 15—20 |
| On viii | 17—22 |

On one specimen of *P. suctoria* from the Andamans the numbers of the setae between the spermathecal pore lines are :—

| | |
|---|---|
| On vi | 10 |
| On vii | 10 |
| On viii | 11 |

In variety *manicata* of the same species the numbers of the setae between the spermathecal pore lines are :—

| | |
|---|---|
| On vi | 24—27 |
| On vii | 24—32 |
| On viii | 25—32 |

In variety *typica* (?) of *P. hawayana* the numbers of the setae between the spermathecal pore lines are :—

| | |
|---|---|
| On vi | 4—8 |

In variety *lineata* of the same species the numbers of the setae between the spermathecal pore lines are :—

On vi . . . . . 19—25

Some of the older species of the genus are either incompletely described or inadequately illustrated or both. The fusion or separation of forms on the basis of such unsatisfactory accounts should be avoided. When there is reason for believing that systematic changes are necessary the actual material involved should be examined. Such examination would for instance have prevented the fusion of *Pheretima campanulata* with *Pheretima houlleti* or the identification of specimens of *Pheretima alexandri typica* from Bombay as *P. suctoria*. Unfortunately many of those who have written on the earthworms have neglected to indicate where the material they studied has been deposited. It is to be hoped not only that future publications will contain some indication of this sort but also that past omissions may be rectified whenever this is possible.

**Pheretima alexandri** (Beddard) 1900.

*Amyntas alexandri*, Beddard, *P. Z. S. London* (1900), p. 988, figs. 1-3.
*Pheretima lignicola*, Stephenson, *Rec. Ind. Mus.* VIII, p. 399, fig. 17 (1914).
*Pheretima lignicola*, Gates, *Rec. Ind. Mus.* XXXII, p. 314 (1930).

In a previous paper (Gates, 1930, p. 314) it was pointed out that *P. lignicola* Steph. 1914 is quite possibly the same as *P. alexandri* (Beddard) 1900, which latter species was based upon a single and probably immature specimen. Stephenson, after examination of Beddard's specimen which is in the British Museum, states (*in litera*) that "*P. lignicola* Steph. is quite certainly *P. alexandri*."

During the course of a study of some of the minor characteristics of this species it became evident that the Burmese worms, hitherto identified as belonging to this species, comprise two distinctly different forms with easily recognizable, distinguishing characteristics. While the differences between the two forms are constant so far as can be dis-

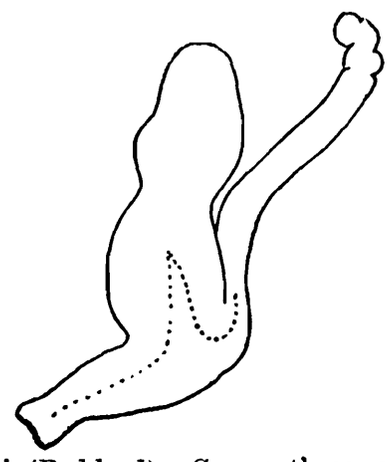

FIG. 9.—*Pheretima alexandri* (Beddard). Spermatheca of immature specimen, × *ca.* 25. The dotted lines indicate position of the cavities.

covered from the material on hand, they are not of such importance, in face of the other numerous similarities to warrant separation of the two as distinct species. One of these forms, that which is found most frequently, appears to be the same as the worms studied by Stephenson and Beddard and will be referred to below as variety *typica*. The other

form which is much rarer will be described under the varietal name *gracilior*.

The colour of both varieties varies considerably. Most commonly the worms are characterized, especially on the anterior portion of the dorsum, by a dark bluish-grey colouration, but other specimens may have a reddish or brownish colouration of the dorsum. The red colour may be as deep as in *P. anomala* or lighter to pinkish. The brownish colouration ranges from a light yellowish brown to a deep brown almost like that of *E. foveatus*.

No structure definitely recognizable as a prostomium has been made out in any specimen of either type. When the buccal cavity is not everted, the buccal edge of the first segment presents a lobed appearance. The furrows that mark off the lobes begin posteriorly on i, at varying distances from 1/2 but never at that intersegmental furrow; these furrows pass anteriorly over the edge of the peristomium and turn inwards into the buccal cavity. The number of these furrows vary from 14-21. The dorsal grooves may rarely be slightly deeper than the ventral grooves. Occasionally two mid-dorsal lobes are slightly more protuberant than the others, the two lobes together about equivalent in size to an ordinary *Pheretima* prostomium. Several worms which at first glance appeared to have a prostomium were found on closer examination to have merely a much swollen mid-ventral or mid-lateral lobe.

The spermathecal pores are minute, surrounded by circular greyish areas, slightly different in appearance from the remainder of the epidermis. The margins of the segments in the vicinity of the spermathecal pores may or may not be whitened. In either case the locations of the pores on mature specimens are readily visible to the unaided eye. Stephenson's earlier specimens were apparently not quite mature.

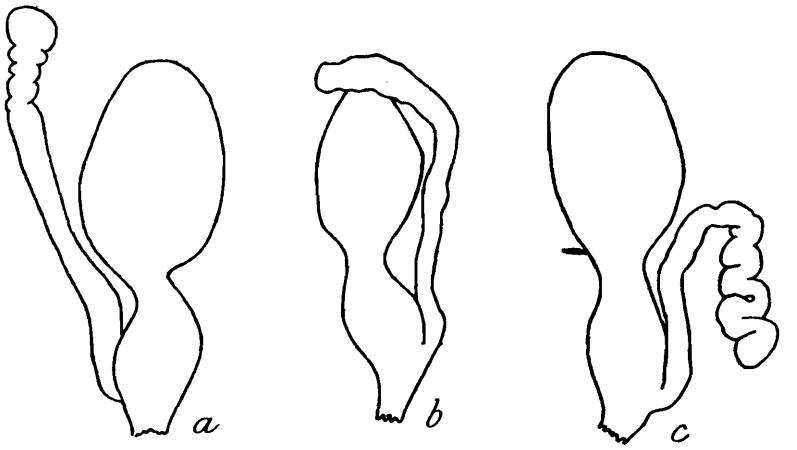


Fig. 10.—*Pheretima alexandri* (Beddard). Spermathecae, × *ca.* 11. *a*. From a Burmese specimen. *b*. From right side of viii of Indian Museum specimen labelled *P. suctoria*. *c*. From right side of viii of another specimen with the same label.

The first dorsal pore is in 12/13 in nearly all of the specimens of both varieties (96 specimens); in 11/12 in three specimens of *gracilior* and one specimen of *typica*.

The male pores are minute, in the setal circle of xviii. In the immediate vicinity of each pore is a pair of small, rather crescent-shaped, greyish areas, one immediately anterior to and one immediately pos-

terior to the male pore, the concave margins of these markings directed towards the male pore. These greyish markings are not as readily visible in *typica* as in *gracilior* due to a slight retraction or depression of the area on which they are located, but they can easily be seen in immature specimens of the former before development of the parietal ridge.

In variety *typica* a circular area bearing the greyish markings and the male pore is slightly depressed below the level of the rest of the parietes and surrounded by a swollen, whitish, U-shaped ridge, so placed that the opening of the U faces the mid-ventral line. This ridge extends through the region between the setae of xvii and the setae of xix. The dorsal pigmentation extends latero-ventrally clear to the margin of the ridge, the whiteness of which is in contrast to the greyish appearance of the ventral surface.

In variety *gracilior* the ridge is usually lacking but the area occupied and enclosed on *typica* by the ridge may here be described as slightly protuberant in a roughly conical fashion, the greyish markings and the male pore on the end of the protuberance.

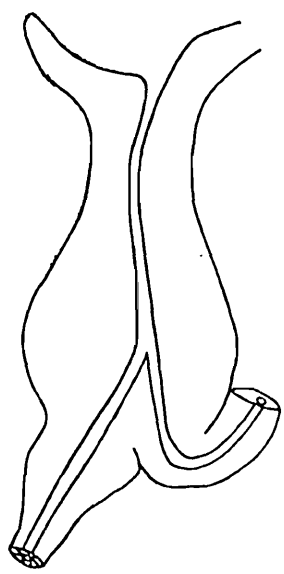

FIG. 11.—*Pheretima alexandri* (Beddard). Spermathecal duct of mature specimen after clearing, × *ca.* 25.

Setae are not visible on the last two, three, or four segments, although there is a slight, whitish, equatorial stripe around each of these segments. When setae are present on the fourth from the last segment they may be in a completely circumferential circle or there may be only a few large setae projecting conspicuously from various locations.

| Setae not visible externally— | |
|---|---|
| On the last two segments | 1 specimen. |
| On the last three segments | 22 specimens. |
| On the last four segments | 8 specimens. |

Dorsal pores may be present between all of the last few segments (about half of the specimens) or may be lacking between the last two segments.

The intestine begins in segment xvi and the intestinal caeca arise in segment xxvii in all specimens examined.

Septa 4/5-7/8 are present, 4/5 thin, each succeeding septum increasingly thickened.

## Variety **typica.**

*Pheretima lignicola*, Stephenson, *Rec. Ind. Mus.* VIII, p. 399, pl. xxvii, fig. 17 (1914).
*Pheretima lignicola*, Stephenson, *Mem. Ind. Mus.* VI, p. 99 (1915).
*Pheretima lignicola*, Stephenson, *Rec. Ind. Mus.* XII, p. 335 (1916).
*Pheretima lignicola*, Stephenson, *Mem. Ind. Mus.* VII, p. 223 (1920).
*Pheretima lignicola*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 61 (1925).
*Pheretima lignicola*, Stephenson, *Rec. Ind. Mus.* XXXI, p. 238, fig. 7 (1929).
*Pheretima suctoria*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 434, fig. 1 (1922).
*Pheretima suctoria*, part, Stephenson, Oligochaeta (*Fauna British India Series*), p. 311 (1923).
*Pheretima suctoria mullani*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 340 (1924).
*Pheretima suctoria mullani*, Stephenson, *P. Z. S.* (1925), p. 893.

The following material from the collections in the Indian Museum has been examined :—

Tube ZEV 6067/7. *P. lignicola*, sp. nov.
Tube W 33/1. Malabar Hill, Bombay.
Tube ZEV 6577/7. *P. lignicola* Stephenson. Thinganyinyaung to Myawadi, Lower Burma, 900 feet. Dr. F. H. Gravely.
Tube 331/1. *P. lignicola* Stephenson. N. B. Kinnear. Bombay, 1914.
Tube W 330/1. *P. lignicola.* Wimberleyganj, Andamans.
Tube W 1168/1. *P. suctoria.* Bombay. Prof. J. P. Mullan. (9 specimens).

The specimens mentioned in Stephenson's paper of 1925 are in the British Museum and have not been available for examination but since they were collected by Prof. Mullan, who was also the donor of the Indian Museum specimens from the same locality, the probability is that they belong to variety *typica*. The specimens referred to in Stephenson's 1929 paper have also not been available for examination. The figure of the spermatheca in this paper shows a thickened muscular duct characteristic of variety *typica*.

The following material from the Judson College collections has been examined :—

Kya In, August, a number of specimens.
Ye, August, a number of specimens.
Martaban, August, several specimens.
Maymyo, August, several specimens, K. N. Sharma.
Shwegyin, September, one specimen.
Rangoon, June, July, August, September, a number of specimens collected in each month.

The length of mature individuals varies from 105-165 mm. ; the greatest diameter from 4—7 mm. ; the greatest diameter of fully mature Burmese specimens varies from 6—7 mm.

The number of segments varies from 90-130 ; in 16 Burmese worms selected at random, from 125-130.

The numbers of the setae between the spermathecal pore lines are as follows :—

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | . | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 10 | 10 | 11 | 11 | 10 | 10 | 9 | 10 | 10 |
| vii | . | 12 | 12 | 12 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 12 | 11 |
| viii | | 14 | 14 | 13 | 12 | 13 | 14 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 12 |
| vi | . . | 9 | 10 | 12 | 10 | 11 | 11 | 9 | 10* | 9* | 9* | 9* | | | | | |
| vii | . | 12 | 12 | 14 | 12 | 12 | 12 | 12 | 11 | 10 | 11 | 10 | | | | | |
| viii | . . | 13 | 13 | 14 | 13 | 13 | 14 | 13 | 13 | 12 | 12 | 13 | | | | | |

* Indicates Indian Museum specimens labelled *P. suctoria.*

The numbers of the setae between the male pores on xviii are :—

| | | | |
|---|---|---|---|
| 9 | 1 specimen. | 13 | 26 specimens,(‡2) |
| 10 | 7 specimens. | 14 | 33 specimens,(‡2) |
| 11 | 21 specimens,(‡3) | 15 | 7 specimens. |
| 12 | 42 specimens,(‡2) | 16 | 3 specimens. |

(‡) Indicates Indian Museum specimens labelled *P. suctoria.*

The number of setae per segment is slightly lower in this variety than in *gracilior.* No extended counts have been made but the numbers on segment xvii vary from 59-63.

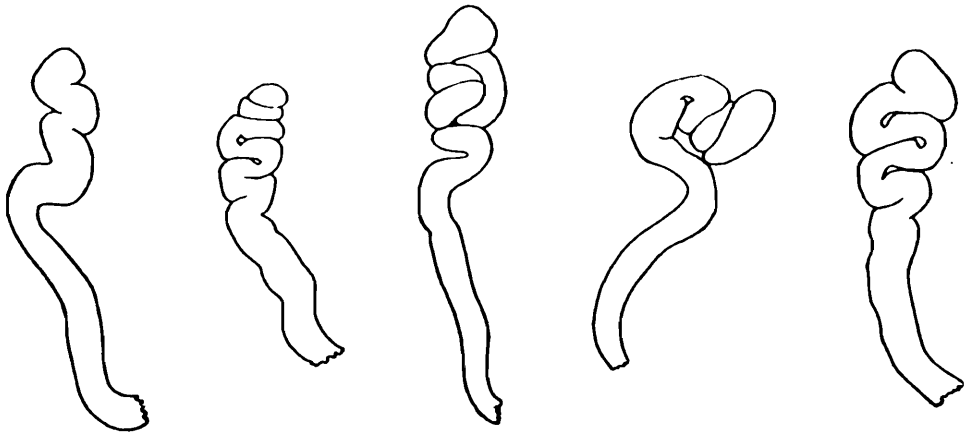

FIG. 12.—*Pheretima alexandri* (Beddard). Diverticula of spermathecae from different specimens, × *ca.* 11.

The seminal vesicles of x and xi are small and lateral in position. The posterior pair of vesicles does not push 12/13 posteriorly. The testis sacs of x are unusually elongate in a flattened vertical fashion on the anterior face of 10/11.

The spermathecal ampulla is usually longer than the duct and is sharply deliminated therefrom. The duct is conspicuously thickened in a squat, rounded fashion, the thickening more noticeable ectally than nearer to the ampulla. ("The duct. .is shining, very stout and muscular, rather broader in its distal two-thirds than nearer the ampulla." Stephenson, 1914, p. 401). The lumen of the diverticulum is continued within the muscular wall of the duct for some distance before opening into the lumen of the duct (*see* fig. 11 ). There is considerable variation in the characteristics of the diverticulum within both varieties (*see* fig. 12 ).

The following brief diagnosis will enable ready recognition of this variety :—Number of setae between the spermathecal pore lines, 9-14 ; number of setae between the male pores on xviii, 9-16. Seminal vesicles small and lateral. Spermathecal duct much thickened and muscular, especially ectally.

*Distribution.*—N. E. Assam, and Bombay, India ; Andaman Islands ; Moulmein District, Myitkyina District, Maymyo, Shwegyin and Rangoon, Burma. This variety is doubtless widely spread throughout the province of Burma but it is not now possible to state which of the Burmese records of *P. lignicola* refer to the variety *typica.*

*Remarks.*—In the course of the study of this species the variety of a particular individual has been ordinarily determined by counting the

number of setae between the male pores. If the number of the setae between the male pores was between 9 and 14 the specimen was then

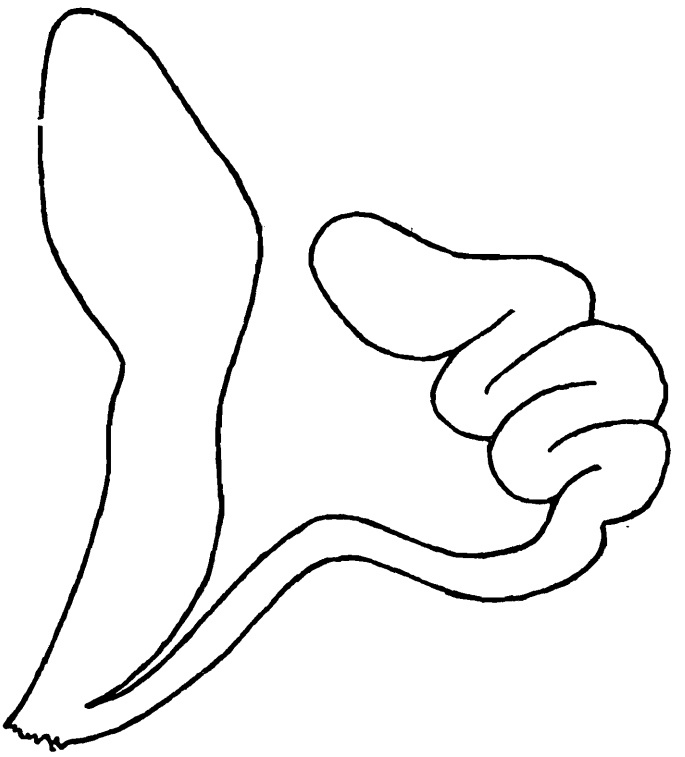

Fig. 13.—*Pheretima alexandri* (Beddard) variety *gracilior*, n. var. Spermathecae, × *ca.* 22.

regarded as *typica*. When the number of setae between the male pores was more than 14 the number of setae between the spermathecal pore lines were counted. If the number of setae on the latter location was between 9 and 14 the specimen was also regarded as *typica*. If, however, the number of setae between the spermathecal pore lines on viii was greater than 14 the specimen was considered to be *gracilior*. All specimens of *gracilior* have been dissected and the higher numbers of setae between the spermathecal pore lines have always been found to be associated with a lack of muscularity of the spermathecal duct. One of every five specimens identified as *typica* has been dissected, and every one so dissected has been found to have the increased muscularity of the spermathecal duct. This constitutes a rather striking demonstration of the value of setal-number-characteristics in relation to the reproductive apertures for taxonomic purposes.

A specimen of this variety from Maymyo has a small, bilobed mass of tissue, projecting from the left side in 5/6. This proved to be a small but characteristically formed spermatheca with the thickened muscular duct, a rather small ampulla, and a diverticulum nearly as long as the combined lengths of the ampulla and duct. Just dorsal to the spermatheca there is a weak spot in the integument through which a probe penetrated on very slight pressure. This weak spot is due to the absence of the muscular layers underneath the epidermis. Presumably the body wall had been ruptured in such a way as to allow the spermatheca to protrude after which the rupture had been closed by epidermal regeneration without restoration of the muscle layers in the damaged spot. The spermatheca had been exposed long enough to develop a dark

brownish-black colour, due to the presence of large numbers of fine granules in the outer surface of the ampulla.

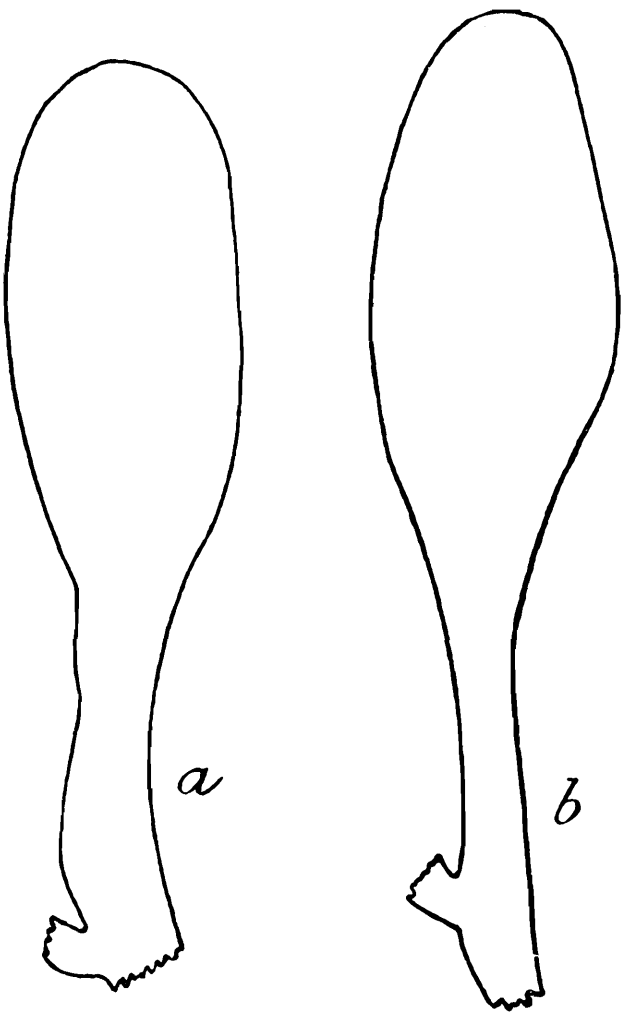


FIG. 14.—*Pheretima alexandri* (Beddard) variety *gracilior*, n. var. Spermathecal ducts and ampullae, × *ca.* 22.

Stephenson described the genital markings of his variety *mullani* as follows:—

" On segment xviii, taking up the whole length of the segment are a pair of circular disc-like areas with well defined margins; the interval between these discs is less than the diameter of one of them, and shows seven setae intervening. There are also one or two setae on the inner and outer edges of the discs, *i.e.*, the setal ring is continued a little way into the discs at each side. The male pore is situated at the centre of the disc on a tiny papilla; and a faint ridge runs transversely across each disc in the line of the setae and of the male pore; behind the ridge, and also transverse in direction, is a slight depression." (1922, p. 434.) Later, " The male pores are at the centre of the characteristic discs on segment xviii (not on their outer border), and scarcely a quarter of the circumference apart; a faint ridge runs transversely across each disc; twelve to fourteen setae intervene between the male pores, the setal ring being continued a little way on to the disc on each side." (1924, p. 340).

In the already dissected specimen of *P. s. mullani* the discs are markedly protuberant. In the other specimens the discs are less protuberant

or actually sunk below the general level of the external parietal surface. In some of the specimens there is immediately anterior to and posterior to the male pore a small depression on the surface of the disc, each de-

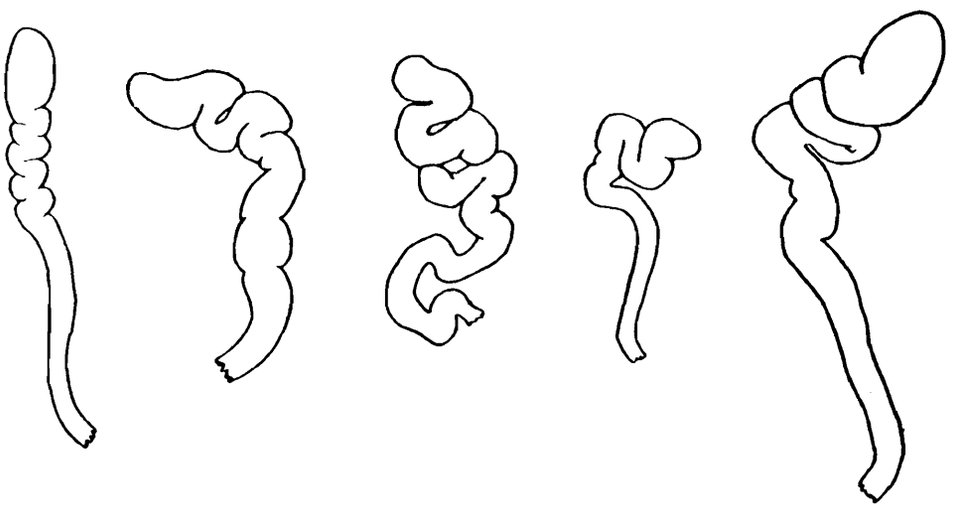

Fig. 15.—*Pheretima alexandri* (Beddard) variety *gracilior*, n. var. Diverticula of spermathecae from different specimens, × *ca.* 11.

pression equivalent to one of the greyish, crescentic areas previously mentioned. In those specimens in which the discs are sunk most deeply there are slight indications of the U-shaped ridge around each disc. The differences between the appearance of the male region of the specimens of *P. suctoria mullani* and that usually characteristic of *P. lignicola typica* may be explained as due to differences in development, differences in the physiological condition of the organs concerned, or to diversity in technique of killing and fixing the worms.

Comparison of Stephenson's description above with Michaelsen's account of *P. suctoria* will show that the differences between the descriptions of the genital markings of *P. suctoria* from the Andamans and *P. s. mullani* from Bombay are slight. After comparison of the accounts of both authors with the specimens they described, it is difficult to say how the descriptions can be improved. But in spite of this, the genital markings of the two worms are distinctly different from each other, much more so than the descriptions indicate. Comparison of specimens labelled *P. s. mullani* with *P. suctoria* and *P. lignicola* shows at first glance that the genital markings of *P. s. mullani* are quite similar to those of *P. lignicola* and totally unlike those of *P. suctoria.*

Exact description of genital markings is often exceedingly difficult. Even when the published accounts may be regarded as fairly accurate, identification of specimens therefrom is, as may be seen from the foregoing, fraught with possibilities of error. The difficulty may be obviated by adequate illustrations and by more careful attention to other characteristics of systematic importance such as the setal-number-relationships to the reproductive apertures. Either of these alone, in the case under discussion, would probably have been sufficient to prevent the confusion of species. It is needless to say that adequate illustrations and accuracy in regard to minor details is of special importance when dealing with a genus composed of a large number of more or less closely allied species.

### Variety **gracilior**, n. var.

Chaungson, August, a number of specimens.
Moulmein, August, a number of specimens.
Kyaikmaraw, August, several specimens.
Rangoon, June to November, a number of specimens.

The length varies from 130-160 mm.; the greatest diameter from 6-8 mm., the number of segments of 14 specimens selected at random from 123-141.

The number of setae per segment is slightly higher in this than in the preceding variety. No extended counts have been made but on segment xvii the number of setae varies from 72-78. The numbers of the setae between the male pores on xviii are as follows :—

| | | | |
|---|---|---|---|
| 16 | 1 specimen. | 22 | 9 specimens. |
| 17 | 1 specimen. | 23 | 4 specimens. |
| 18 | 4 specimens. | 24 | 2 specimens. |
| 19 | 3 specimens. | 25 | 2 specimens. |
| 20 | 4 specimens. | 26 | 4 specimens. |
| 21 | 6 specimens. | 28 | 1 specimen. |

The numbers of the setae between the spermathecal pore lines are as follows :—

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | 13, | 14, | 17, | 16, | 13, | 18, | 14, | 16, | 17, | 15, | 15, | 15, | 14, | 15, | 15, | 13, | 14. |
| vii | 16, | 17, | 18, | 17, | 16, | 20, | 18, | 18, | 19, | 17, | 17, | 16, | 15, | 17, | 17, | 17, | 16. |
| viii | 17, | 19, | 22, | 18, | 17, | 23, | 19, | 20, | 20, | 19, | 18, | 18, | 17, | 19, | 18, | 19, | 17. |

The seminal vesicles of xi and xii are large and either in contact with each other dorsally or in contact with the dorsal blood vessel. The posterior pair of seminal vesicles push 12/13 back into contact with 13/14. The testis sacs of x are more rounded and much more protuberant from the anterior face of 10/11 than in the preceding variety, and do not correspondingly extend so far up dorsally at the sides of the oesophagus as do those of *typica*.

The spermathecal ampulla is, as a rule, not so sharply constricted off from the duct as in *typica*; the duct is slender and lacks the basal muscularity. The diverticulum is usually longer in this variety than in *typica*, the looping often much looser, less compacted, more irregular, and when the loops are arranged in a single zig-zag plane, the length of the limbs of the loops is usually longer than in *typica*.

The following brief diagnosis will enable this variety to be quickly identified :—Number of setae between the spermathecal pore lines, 13-22; number of setae between the male pores, 16-28; seminal vesicles large. Spermathecal duct not especially thickened in its basal portion.

This variety is not represented in the collections of the Indian Museum and may not occur in India. Variety *gracilior* is much rarer than *typica* and in Rangoon is found only infrequently. Variety *typica* was not found at Chaungson while *typica* alone was found at Ye and Kya In.

### **Pheretima andersoni** Mich. 1907.

Kyaikmaraw, August, a number of specimens, none fully mature.
Kya In, August, 1 specimen. (A number of specimens that cannot be identified probably also belong to this species.)
Chaungson, August, a large number of specimens, none clitellate.

Numerous long-continued searches in the three localities entirely failed to produce fully mature specimens. Karen villagers, who seemed to be very well acquainted with the jungle and its life, recognized this worm but maintained that clitellate forms could not be secured until the month of October, at which time the worms came out onto the surface in large numbers. In reply to questions as to what happened to the worms after coming out to the surface, the invariable answer was that they wandered about until they "strangled." Considerable questioning and argument entirely failed to break their attitude that clitellate forms could not be found until October.

Definitely identified specimens all have small rudiments of the genital papillae. These markings are much more completely developed in the worms from Kyaikmaraw than in the worms from the other two localities. The male organs are more fully developed than the female organs.

The single recognizable specimen from Kya In is rather small. The other worms from that locality are much larger—longer and thicker—but the colour and general appearance of the worms is exactly the same as in the recognizable specimen.

In these other specimens from Kya In the seminal vesicles are represented by shortly stalked knobs projecting from the posterior faces of the proper septa. The prostates are small, the ducts straight. The spermathecae are not visible until after removal of the longitudinal musculature.

The collar of oesophageal glands just behind the gizzard consists of a number of flaps, each of the flaps much larger relatively than in fully mature adult forms. The coelom of a number of segments from xviii posteriorly of these specimens is filled with parasites, the presence of which may be responsible for the delay in sexal development as compared with the smaller recognizable specimen which lacks the parasites.

### **Pheretima anomala** Mich. 1907.

Moulmein, August, a number of specimens.
Chaungson, August, a number of specimens.
Kya In, August, a number of specimens.
Maymyo, August, several specimens, K. N. Sharma.
Paung, September, several specimens.
Nyaunglebin, September, several specimens.
Pazunmyaung, September, several specimens.

### **Pheretima birmanica** (Rosa) 1888.

Maymyo, August, 3 specimens, K. N. Sharma.

### **Pheretima browni** Steph.

*Pheretima browni*, Stephenson, *Rec. Ind. Mus.* VII, p. 274 (1912).

Kutkai, May, 3 nearly mature specimens.

The material on which this species was based was collected in Tengyueh, in the province of Yunnan, China, not far distant from the Burmese border. Stephenson's specimens were badly preserved and consequently his description of the species is brief. *P. browni* does not seem to have been met with elsewhere, so far as can be determined from the literature available locally.

The first dorsal pore is in 11/12, the spermathecal pores in 7/8 and 8/9, the divided bilobed condition of the prostates, and the spermathecal conformations are as described by Stephenson.

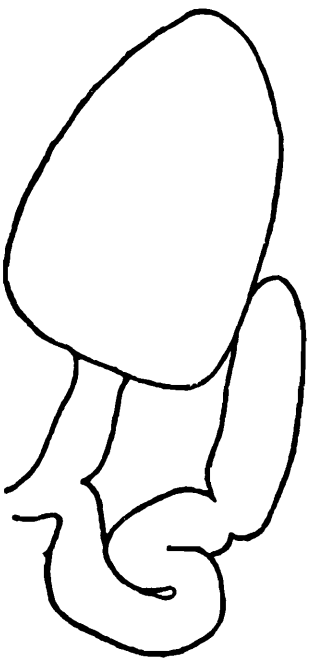

FIG. 16.—*Pheretima browni* Steph. Spermatheca, × *ca.* 22.

The Kutkai specimens are not in a satisfactory state for detailed study but a few notes may be given to indicate minor points of difference from the previous account.

The dorsum anterior to the clitellum is bluish grey, the rest of the body practically unpigmented, except for the clitellum which is reddish. The prostomium is epilobous but without a transverse furrow at the end of the prostomial tongue on i.

The numbers of setae between the copulatory chamber apertures on xviii are 9, 10, 11 ; between the spermathecal lines on viii, 12, 12, 14.

Septa 5/6, 6/7 and 7/8 are thickened ; 8/9 is represented by a ventral fragment only ; 9/10 is lacking.

The testis sacs of x appear to be entirely distinct from each other but the testis sacs of xi meet in the midventral line. The copulatory chambers are small, for the most part imbedded in the parietes, only a small portion visible in the coelom. The prostate ducts are slender, fragile, nearly straight.

There are large nephridial masses in segments v and vi.

**Pheretima campanulata** (Rosa) 1890.

'Kya In, August, a number of specimens.
Ye, August, a number of specimens.
Chaungson, August, a number of specimens.
Moulmein, August, a large number of specimens.
Maymyo, August, a number of specimens, K. N. Sharma.
Shwegyin, September, a number of specimens.
Paung, September, a number of specimens.
Nyaunglebin, September, a number of specimens.
Pazunmyaung, September, a number of specimens.
Syriam, September, two specimens.

This species originally founded by Rosa for Burmese worms collected by Fea was later confused with *P. houlleti*. Due to this confusion there

are no reliable records as to the distribution of *P. companulata*, but the probability is that the species is fairly widely distributed. Thanks

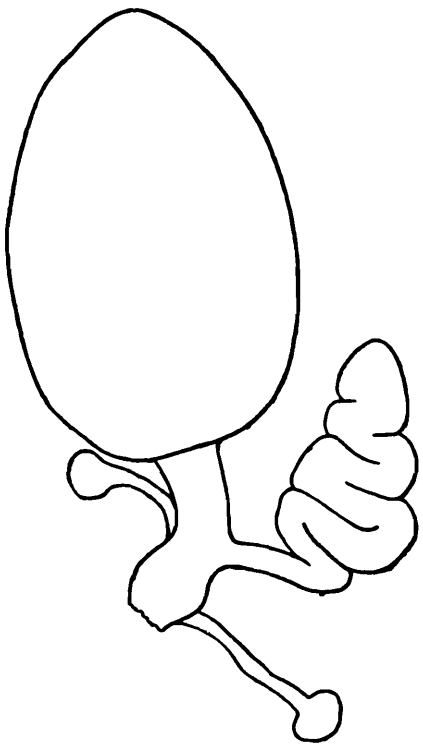

FIG. 17.—*Pheretima campanulata* (Rosa). Spermatheca, × *ca.* 11.

to the kindness of Mr. Sharma, it has been possible to examine a series of worms belonging to this species from Kalimpong, near Darjiling, India. The Indian specimens differ from the Burmese forms in so many ways as to necessitate a new variety. The description of this variety may be found in the appendix to this paper.

## **Pheretima doliaria**, n. sp.

Mong Ko, Kentung State, N. S. S. 4 specimens, all with surfaces more or less abraded.

*Description of the type-specimen. External characteristics.*—Length 92 mm. Greatest diameter 5 mm. Number of segments about 130. Colour: dorsally reddish to dark reddish grey; ventrally whitish; clitellum yellowish brown.

The prostomium and first segment have been so eroded that no statement can be made in regard to the prostomium.

The first dorsal pore is in 12/13, the pores of 13/14 and 16/17 are functional.

The setae begin on ii. The setal circles appear to be complete, without dorsal or ventral breaks, the setae regularly spaced and nearly the same distance apart from each other dorsally as ventrally. There are four setae between the male genital markings on xviii. There are 59 setae on segment xx. No indications of the presence of setae on the clitellum were observed.

The clitellum is annular and covers segments xiv-xvi, extending from 13/14 to 16/17; intersegmental furrows and dorsal pores lacking.

The spermathecal pores are not definitely recognizable, but appear to be located in 7/8 and 8/9, widely separated.

The female pore is single.

The male pores are minute, diagonal slits in line with the setae of xviii.

The male genital markings consist of a pair of elongately oval, diagonally placed areas on xviii, separated by 4 setae, with the anterior ends directed towards the mid-ventral line and the posterior ends directed laterally. Each area is 1·5 mm. long and ·5 mm. wide, and is surrounded by a narrow but deep and completely circumferential furrow. Outside of this furrow are other incompletely circumferential furrows. The posterior third of the oval area is separated from the anterior two-thirds by a furrow and bears the male pore.

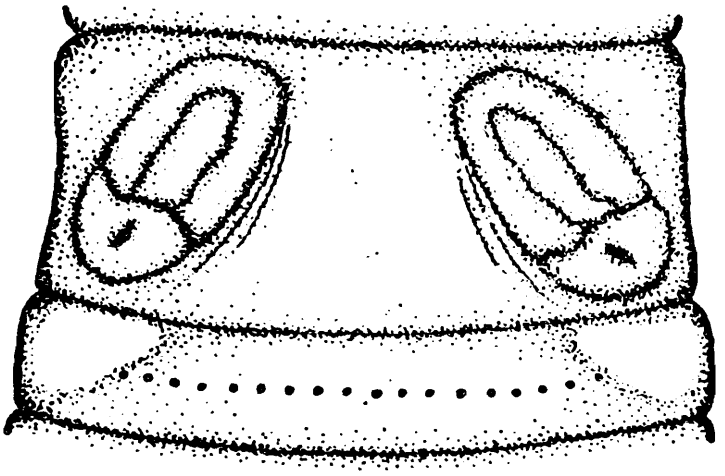

FIG. 18.—*Pheretima doliaria*, n. sp. Ventral view of segments xviii and xix to show male areas and one pair of genital markings.

*Internal anatomy.*—Septa 4/5, 5/6, 6/7 and 7/8 are present, membranous; 8/9 and 9/10 are absent; 10/11 also appears to be absent, no trace of it having been observed, but if the septum be present and very fragile it may have been ruptured in opening the worm and hence not recognizable; 11/12 and succeeding septa are present, membranous.

The gizzard is elongate. The alimentary canal does not begin to enlarge into a characteristic intestinal condition until in segment xxi. The intestinal caeca are simple, long, bent under the intestine in xxiii, but long enough to reach into xix.

The last pair of hearts is in xiii. The heart-commissures of ix-xiii all pass into the ventral vessel.

The testis-sacs of x and xi are in contact and do not appear to be separated by a septal sheet of tissue. The testis sac of x appears to be single but with a bilobed anterior margin. The seminal vesicles are two pairs, the posterior vesicles at least twice as large as the anterior vesicles and pushing 12/13 posteriorly into contact with 13/14. The posterior seminal vesicles are attached normally to the posterior face of 11/12, but the vesicles of xi are attached directly to the lateral margins of the testis sacs of x. The prostates are large, extending from xvii into xxiii on the left side and from xvi into xxiii on the right side. The prostates are broken up into a number of small lobes. The prostatic ducts are long, the ectal portion of each duct greatly thickened and muscular. The ducts extend through segments xviii-xx. There is no trace of a copulatory chamber. The vasa deferentia are small but readily traced.

The ovaries and oviduct funnels are in the usual positions in xiii. The oviducal funnels are relatively large, elongate, and thick-lipped. The spermathecae are in vii and viii but pass into the parietes posteriorly.

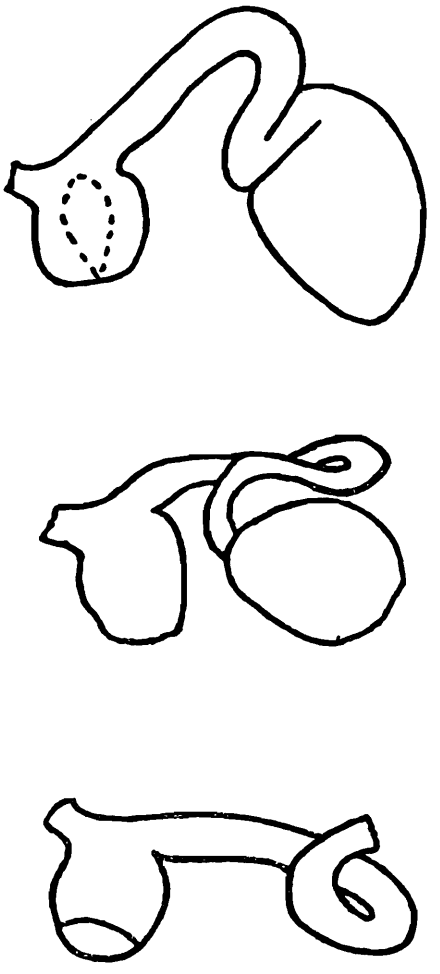

Fig. 19.—*Pheretima doliaria*, n. sp. Spermathecal ducts with all or part of diverticulum from three specimens, × *ca.* 22.

The duct is very short and sunk into the ventral face of the ampulla and is not visible until the spermatheca is pulled off from the parietes. The diverticulum is short, with a narrow ectal portion and an enlarged ental part which is more or less ovoid.

*Remarks.*—The length varies from 81-129 mm. The greatest diameter from 4-5 mm. The number of segments, 117, 129, 131. The prostomium when recognizable is small and epilobous, about $\frac{1}{4}$, but without a transverse groove at the end of the prostomial tongue on i. The first dorsal pore is in 12/13 in all the specimens.

There are three setae between the male genital markings on each of the three remaining specimens. Due to abrasion of the cuticle and epidermis the number of setae between the spermathecal pore lines on viiii cannot be stated positively, but as far as can be seen, counting setal pits when the setae are lacking, the numbers are as follows :—20, 20, 21.

The spermathecal pores are minute in 7/8 and 8/9, on tiny, transversely oval protuberances in the intersegmental furrows. The genital markings of all specimens are as described for the type.

The first definitely recognizable septum posterior to the gizzard is 11/12, 10/11 if present is very thin and not quite normal in its attachments. In two of the three specimens studied no trace of 10/11 was

found, but, as previously observed, this may have been due to the rupturing of a very fragile membrane in opening the worms. In the third specimen a delicate membrane adhering closely to the seminal vesicles of xi but which could, with care, be separated off was found to pass internally to the oesophagus immediately behind the commissures of x, on each side. This membrane, attached to the oesophagus laterally and dorsally as a normal septum, could not be traced to the parietes and appears to pass laterally around the seminal vesicles and then to the anterior face of 11/12. If this sheet of tissue represents 10/11, segment xi is reduced to a U-shaped chamber inverted over the oesophagus and attached to the anterior face of 11/12.

The oesophagus from segment xii posteriorly has a brownish colouration on its outer, coelomic face, the colour deepening posteriorly, the

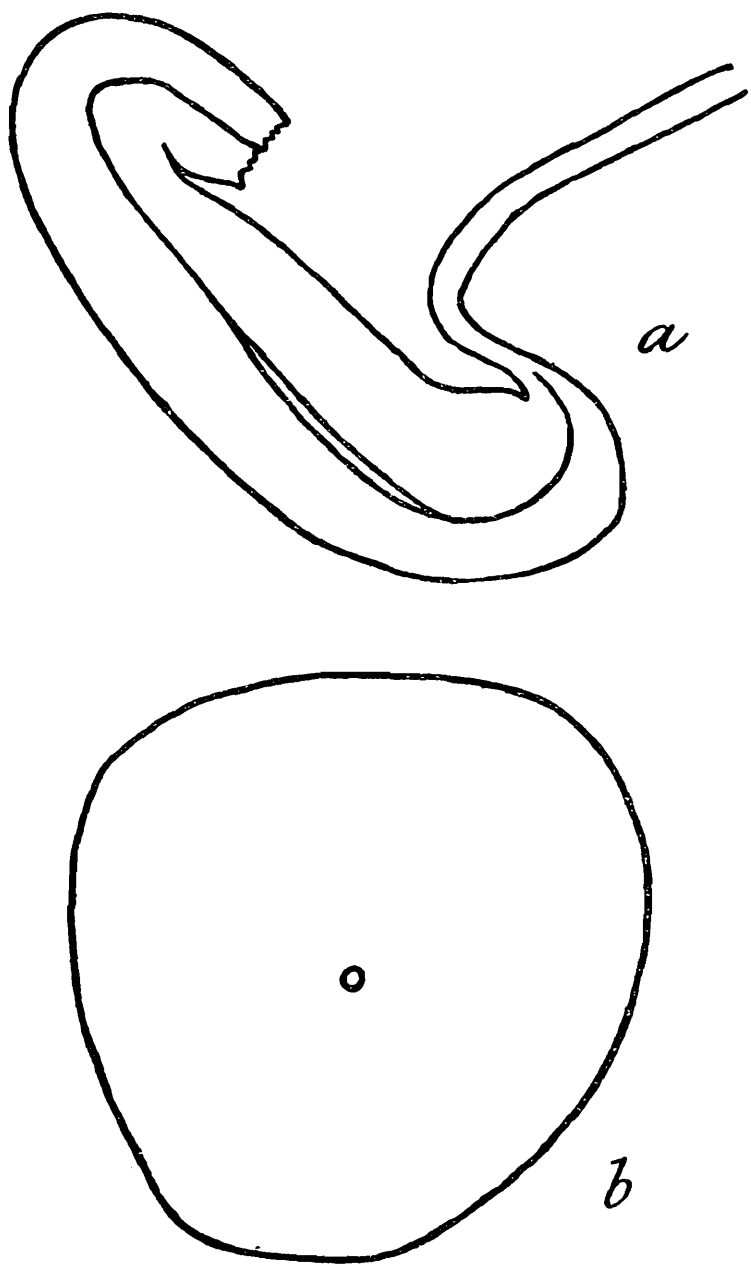


FIG. 20.—*Pheretima doliaria*, n. sp. *a*. Portion of prostatic duct cleared to show lumen, × *ca.* 22. *b*. Transverse section of the muscular portion of the prostatic duct to show relative size of wall and lumen, × *ca.* 65.

intestinal wall a very dark reddish brown. The alimentary canal does not begin to widen conspicuously until in the region of segments xx-xxiii,

the portion of the canal extending through segments xii-xxiii of much the same thickness of wall, diameter of lumen, and appearance of the luminal and coelomic walls. If the widening and saccularity mark the beginning of the intestine, that portion of the alimentary tract may then be said to commence in the region of segments xx-xxiii. Immediately anterior to the points of origin of the intestinal caeca there is a stout, tough ridge projecting into the intestinal lumen, completely circular, except mid-dorsally, where it ends on each side against the typhlosole. The typhlosole is large relative to the size of the worm and consists of a series of very large flaps, each flap bent upwards into a doubled condition and then pushed into a conical shape, the doubled flap of one segment fitting into that of the next segment, etc., as a series of cones. The intestinal caeca are simple, long enough to reach into xviii or xix but usually bent under the intestine in the region of xxiii-xxiv. The typhlosole begins just in front of the region where the intestinal caeca arise.

The testis sacs of xi can be readily separated from the testis sacs of x without breaking their walls. No trace of a septum between the sacs of the two successive segments was found. The testis sacs of xi are distinctly separate from each other and apparently without transverse connection. The sacs of x are connected with each other by a narrow tubular passage.

The prostates are large and extend through segments xvi or xvii into xx or xxi. The prostatic duct lies in segments xviii-xx or xxi. The duct is 5-7 mm. long and may be said to consist of four portions. The entalmost portion is slender, about 2½-3 mm. in length and is succeeded by a portion of about the same length with tremendously thickened muscular walls. The next portion of the duct is also muscular but is not as thick as the second portion. The ectalmost portion of the body wall is narrow. The cavity of the duct is very narrow, widened in only one part of the highly muscular portion. This latter must function as a highly efficient ejaculatory bulb. Copulatory chambers are lacking. The epidermis of the male genital marking is thickened but there is no attached glandularity protruding through the musculature into the coelom.

The two pairs of spermathecae are in segments vii and viii in all specimens. The diverticulum arises from the inner face of the spermathecal duct (*i.e.*, the face towards the nerve cord), its ental end is enlarged into a spheroidal or ovoidal shape. The duct is short, stout, cask-shaped, with a thick wall but a fairly wide lumen in the cask-shaped portion ; the parietal portion of the duct much narrower and with a smaller lumen.

### **Pheretima elongata** (E. Perr.) 1872.

Hsipaw, May, 18 specimens.
Nyaunglebin, September, a number of specimens.
Pazunmyaung, September, several specimens.

### **Pheretima exigua** Gates.

*Pheretima exigua*, Gates, *Rec. Ind. Mus.* XXXII, p. 310 (1930).

Kya In, August, one specimen.
Ye, August, one specimen.

## Pheretima gemella, n. sp.

Ye, August, 22 specimens.

*Description of the type-specimen. External characteristics.*—Length 76 mm. Greatest diameter 5 mm. Number of segments 102. Colour: dorsally light bluish grey anterior to the clitellum, brownish posterior to the clitellum, fading posteriorly to a light brownish yellow; ventrally whitish.

On each of segments ix-xiii there are two secondary furrows, one immediately anterior to and the other immediately posterior to the setae of the segment.

The first dorsal pore is in 11/12.

The setae begin on ii; the setal circles are without a ventral break, a dorsal break when present of varying width. The setae are slightly closer together ventrally than dorsally. Number of setae on viii between the spermathecal pore lines-26, on xviii between the apertures of the copulatory chambers-12, on xix between the apertures of that segment-14, on segment xx-49.

The clitellum is annular and extends from 13/14 to 16/17, but is probably not fully developed as intersegmental furrows and dorsal pores are still visible. Scattered setae are visible ventrally on xiv and xvi. The clitellum is brownish in colour.

The spermathecal pores are small, four pairs in 5/6-8/9, about one half or slightly more of the circumference apart from each other. The pores are located within the pigmented region but the margins of the segments in the immediate vicinity of the pores are whitened so that the locations of the pores are readily visible to the unaided eye.

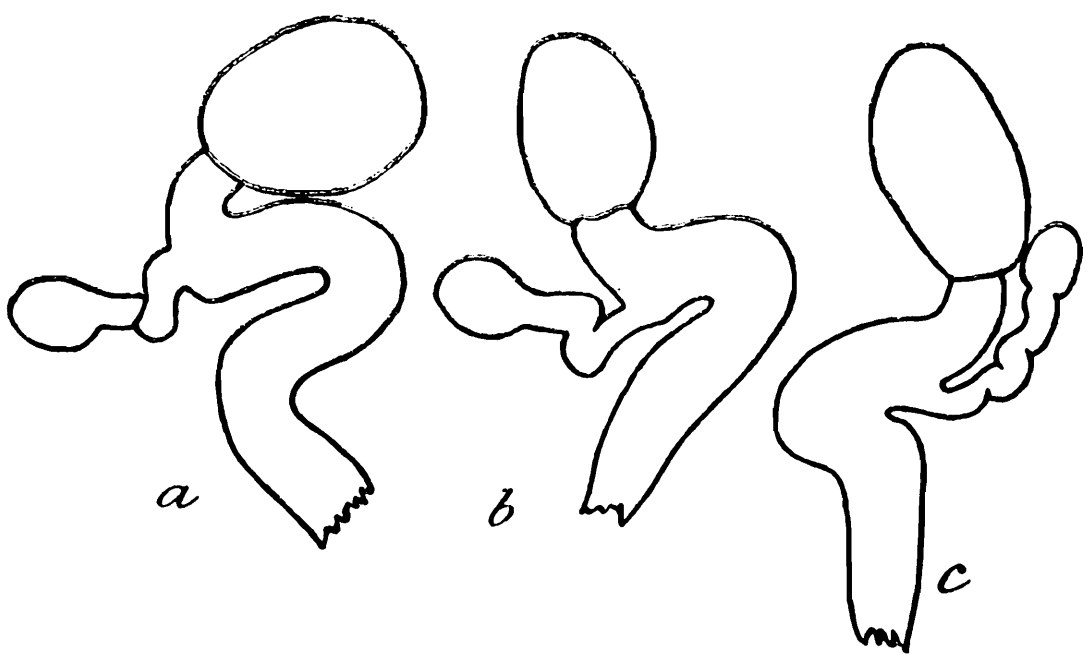


FIG. 21.—*Pheretima gemella*, n. sp. *a*. Spermatheca from the right side of ix of the type specimen, × *ca.* 22. *b*. Spermatheca from a much smaller specimen, × *ca.* 22. *c*. Spermatheca from the right side of viii of another specimen, × *ca.* 22.

The female pore is a single, minute aperture at the centre of a small, transversely oval, tumid protuberance on xiv.

The apertures of the copulatory chambers are transversely elongated slits in the setal circle of xviii with the wrinkled anterior and posterior

margins of the pores in contact with each other. The apertures are located on slight conical protuberances which are not sharply marked off from the rest of the parietes. There is a pair of similar but slightly smaller apertures in the setal circle of xix.

Other genital markings are of two rather similar sorts. The larger markings are small, round, whitish protuberances, each with a greyish central depression, located on the posterior portions of vii and viii in contact with the intersegmental furrows. There are five on viii, one papilla just external to and one just internal to each spermathecal pore of 8/9, and a single asymmetrical papilla about 5 setal distances internal to one of the spermathecal pores. The markings on vii are two, one on each side, just internal to the spermathecal pore. The markings of the second type are smaller, slightly protuberant tubercles arranged in a row immediately in front of the setal circles of vii and viii, five on vii and six on viii.

*Internal anatomy.*—Septa 5/6-7/8 are present and slightly thickened, 8/9 and 9/10 are absent.

The intestine begins in xv; the intestinal caeca arise in xxvii; they are simple, tubular, and extend into xxiii.

There are hearts in x-xiii and on the left side of ix.

The seminal vesicles are small, vertically elongate, paired bodies in xi and xii. The prostates are small, extending through xvii and xviii. The prostatic duct is short and nearly straight, resting on the roof of the copulatory chamber, into the inner face of which it passes. The copulatory chamber is a large, transversely elongate, dome-shaped structure protruding conspicuously into xviii. In xix on each side there protrudes into the coelom a smaller erect body of a somewhat similar sort.

The spermathecae are four pairs, each having a long duct thickened ectally after junction with the diverticulum, with a small, flattened, oval-shaped ampulla. The diverticulum consists of a short, looped or twisted tubular portion with thick walls and narrow lumen, and a thin-walled, flattened, oval, ental enlargement.

The ovaries (?) are hypertrophied acinous bodies as large as the seminal vesicles and in contact dorsally with the ventral blood vessel. Each ovary is composed of large, ovoid, whitish or transparent bodies.

On the parietes in the region of ix-xi there are a few, whitish, ovoid cysts.

In segments vii and viii there are on the parietes small, rounded bodies, one for each of the external genital markings on these two segments, the bodies next to the setal circles smaller than those in the region of the intersegmental furrows.

*Remarks.*—The length varies from 40-92 mm., the diameter in the thickest portion from 3-6 mm., the number of segments from 100-105. The first dorsal pore is in 11/12 in 17 specimens. On three specimens there is a doubtfully functional pore in 10/11, the first definitely functional pore in 11/12. On two specimens the first definitely functional pore is in 12/13 with a doubtfully functional pore in 11/12.

The setal circles may or may not have a dorsal and ventral break of varying width, but the ventral break is usually lacking. The

numbers of the setae between the spermathecal pore lines on viii are :—

30, 29, 27, 29, 29, 31, 29, 29, 30.

The number of the setae between the apertures of the copulatory chambers on xviii are :—

12, 14, 12, 15, 13, 13, 12, 13, 15, 13, 13, 12, 12, 12, 14.

The numbers of the setae between the apertures of xix of the same specimens are :—

x,* x,* 14, x,* 15, 15, 15, 16, 17, 15, 15, 15, 13, 14, 16.

* Cannot be accurately counted.

The numbers of the setae on segment xx of six specimens picked at random are :—

57, 55, 54, 55, 54, 54.

The buccal cavity of all of the specimens is everted ; the prostomium is probably epilobous, about $\frac{3}{4}$, with a middorsal median furrow dividing the tongue into two portions.

None of the specimens are fully mature. The type-specimen is the only worm with characteristic glandularity of the epidermis on the clitellar segments. In a few other specimens the clitellar segments are lighter in colour than the other segments but without any trace of special glandularity. Two of the smallest specimens had not yet formed the apertures to the copulatory chambers on xviii ; seven specimens have the apertures of the copulatory chambers but lack the apertures of xix. (There is on the posterior half of xix on most of these worms, in contact with the setal circle a pair of minute papillae, each papilla marked off from the parietes by a very slight furrow the papilla located at or very near the position of the aperture when present). Thirteen specimens, including the type-specimen, have paired apertures on both xviii and xix. These apertures are exactly similar in external appearance to the apertures in the setal circles of the post-clitellar segments of *P. anomala.*

The vascular commissures in segments ix-xiii all pass into the ventral trunk.

The anterior testis sacs are rounded, the testis sacs of xi antero-posteriorly elongated. The seminal vesicles are small, elongated in a dorso-ventral fashion and not lobed. The copulatory chamber has a light greyish lining and hanging down into its cavity an elongate structure with a greyish glistening appearance, which is continuous with the prostatic duct and which bears at its ventral end a tiny pore. The gland (?) projecting into the coelom of xix on each side is similar to the copulatory chamber but is smaller, the protuberance from the roof is shorter and thicker than in xviii and without a pore at the ventral end.

The vasa deferentia of a side come into contact in xii but pass back into xviii without fusing, joining the prostatic duct as the latter emerges from the prostate gland.

The ovaries of all specimens dissected are hypertrophied, each ovary composed of masses of ovoid-shaped bodies with contents quite

unlike those of the normal ova of earthworms. Each of the larger (older) of the ovoid bodies contains a single nucleated body, presumably a parasitic protozoan. These parasites are disc-shaped, convex on one side with a well-marked central depression on the other side. A ridged cuticle can be made out in some cases. The nucleus is large, spheroidal, and perfectly transparent except for one or two rather large endosomes. The endosomes have a single central vacuole or several smaller vacuoles irregularly scattered through the endosome. Structures which doubtless represent the oviduct funnels have been found but they are either very poorly preserved and macerated or very abnormal.

On all, except the type-specimen, there is a cask-shaped, whitish swelling of the body involving segments ix-xi. In this region the intersegmental furrows are either poorly developed or practically invisible, while the body wall is thin and transparent. Some or all of the ventral setae of x have dropped out of some of the specimens. The antero-posterior length of x is greater than that of either ix or xi and may be twice the length of either of those two segments. Through the transparent body wall of this region there are visible whitish masses. These masses are composed of cysts which may be present in such large numbers and crowded so closely together as to almost entirely cover the parieties internally.

There is no record in any of the literature available locally of parasitism of earthworm ovaries by protozoa. The parasitic infestation has practically resulted in the castration of these specimens from the standpoint of the femaleness of the worms. The spermathecae appear to be stunted and abnormal, a condition which may have been produced as a result of the castration. The worms themselves, except the type-specimen, have a rather abnormal appearance. The living worms also had a rather unnatural appearance which suggested almost at first sight the adjective "diseased." The type-specimen, by far the most healthy looking specimen, seems to have recovered somewhat from the attack, or perchance the attack was less severe in this particular case. Thorough search of the localities in and near Ye where these worms were secured failed to yield more normal looking specimens of this species.

### **Pheretima hawayana** (Rosa) 1891.

#### Variety **typica** (?).

Namkham, April and May, 23 specimens.

All previous specimens of this species collected in Burma belong to a variety described under the name *lineata*. The present specimens differ from the previous worms in a number of points of minor importance.

*External characteristics.*—Length 60-112 mm. Diameter 3-4 mm. Number of segments 71-91 ; many of the specimens have lost the tail portion and many have a new regenerating tail. Colour : brownish,

greyish brown, sometimes with a slight reddish tinge. The prostomium is epilobous, about ½; in all except three of the specimens without a transverse furrow at the end of the prostomial tongue on i. The first dorsal pore is in the following positions :—

9/10 (1 worm), 10/11 (21), 12/13 (1).

The ventral setae on ii-vii are enlarged and widely separated; on viii and ix less widely separated, on xiii, xvii and succeeding segments small, closely crowded and without a ventral break. Behind the clitellum the setae are more widely separated dorsally than ventrally and with a slight dorsal break. The numbers of the setae between the male pores on xviii are :—

10 (1 worm), 11 (1), 12 (5), 13 (1), 14 (1).

The numbers of the setae between the spermathecal pore lines on vi are :—

4, 7, 7, 7, 8, 8, 8, 7, 7, 7.

The clitellum is brownish, reddish, or yellowish; without dorsal pores or annular furrows but with ventral setae always present on

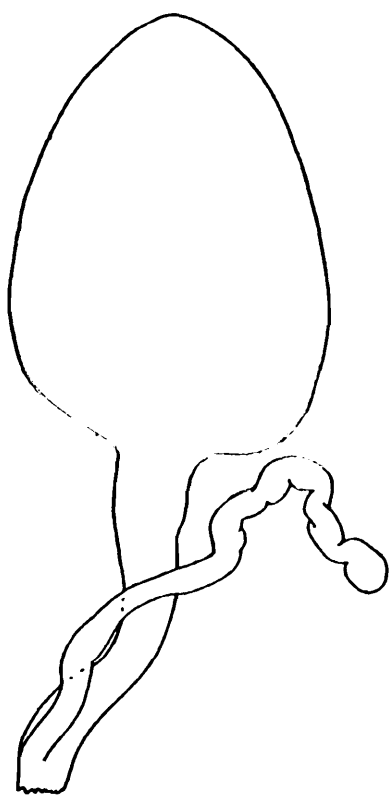

FIG. 22.—*Pheretima hawayana* variety *typica* (?). Spermatheca, × *ca.* 19.

xvi, sometimes present also on xv. The clitellum extends over the anterior two-thirds or three-quarters of xvi, xv, and the larger portion of xiv, but does not reach 13/14 dorsally on a number of the specimens.

The spermathecal pores are three pairs in 5/6—7/8, in all but one specimen in which there are four pairs of pores in 4/5—7/8.

The male pore is a minute aperture on a tiny tubercle in the setal circle. The tubercle is surrounded by a deep, circular groove, outside

of which there are 3-5 diamond-shaped, concentric grooves, the long axis of the diamond antero-posteriorly.

The post-clitellar genital markings are all on xviii posterior to the setae of that segment, internal to the male pores, often with the an-

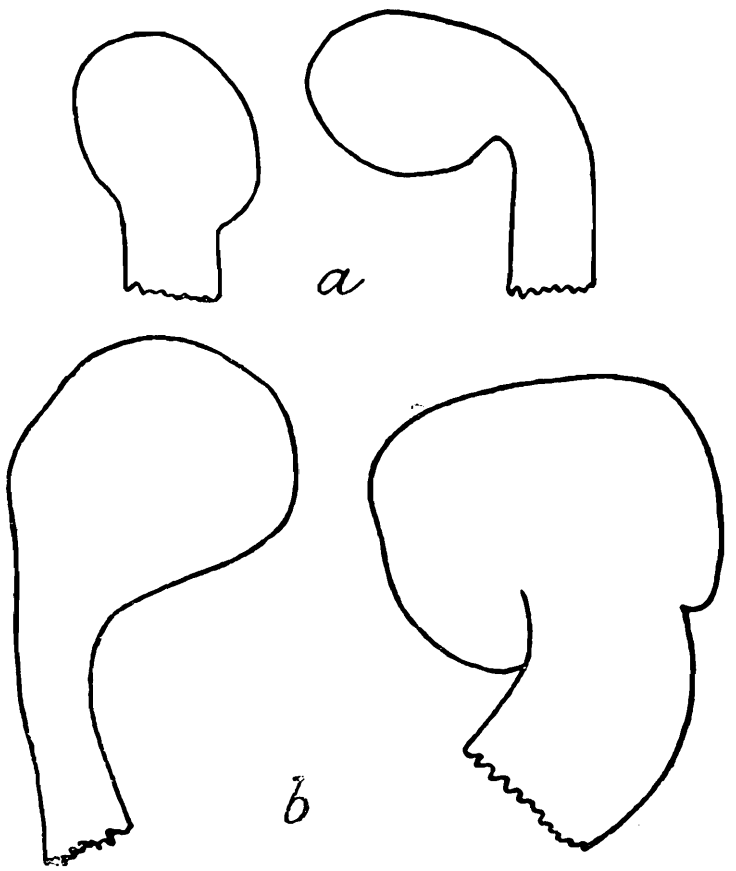


Fig. 23.—*Pheretima hawayana* variety *typica* (?). *a*. Glands from the spermathecal region, × *ca.* 38. *b*. Glands from the prostatic region, × *ca.* 38.

terior margins of the markings in contact with the ridge bearing the setal circle. Each marking is a round, dark, greyish spot with a pore (?) at its centre. The markings are present as follows:—

| | |
|---|---|
| One on each side | 5 specimens. |
| Two on each side | 9 specimens. |
| Two on the right side and one on the left side | 3 specimens. |
| Two on the left side and one on the right side | 1 specimen. |
| Three on each side, the three papillae forming the points of an equilateral triangle | 1 specimen. |
| Three on each side, in transversely linear arrangement | 2 specimens. |
| Four on the right side and three on the left side | 1 specimen. |
| Six on the right side and four on the left side | 1 specimen. |

In variety *lineata* the genital markings are smaller, less conspicuous, closer to the male tubercle and often within the region containing the concentric furrows that surround the male tubercle, anterior to the setae of xviii and xix and posterior to the setae of xviii. In the present variety the genital markings are outside of the concentric furrows surrounding the male tubercle, and confined to the posterior portion of segment xviii.

Pre-clitellar genital markings are lacking on 12 specimens : on the remaining specimens there are markings located on the posterior halves of segments vii and viii as follows :—

| | |
|---|---|
| One pair on vii | 2 specimens. |
| One pair on viii | 3 specimens. |
| Two pairs on viii | 2 specimens. |
| One on the left side of vii | 1 specimen. |
| One on the left side of vii, one pair on viii | 1 specimen. |
| One pair on the left side and one on the right side of vii | 1 specimen. |
| One on the right side of vii, one on the left side of viii | 1 specimen. |

In variety *lineata* the pre-clitellar papillae are on the anterior halves of the segments concerned, median in position, rarely also on lateral positions and paired.

*Internal characteristics.*—Septa 5/6—7/8 are thickened, 8/9 is represented by a ventral rudiment only, 9/10 is absent. The intestinal caeca have ventral lobulations, *i.e.*, slight incisions of the ventral margin. The last hearts are in xiii. The large heart of ix, and the heart-commissures of xi, xii and xiii, like the commissures of x; connect the supra-oesophageal blood vessel with the ventral blood vessel. There are nephridial masses in v and vi.

The testis sacs are large, the anterior pair conspicuously projecting in a diverging fashion from the anterior face of 10/11, but not in contact with each other except in the mid-ventral line against the base of 10/11. The posterior pair of testis sacs are in contact mesially but do not reach forward to 10/11. The testis sacs of both segments appear to be in communication *inter se* transversely. The vasa deferentia of a side come into contact on the anterior face of 12/13.

The ovaries are large and leaf-like. On the posterior face of 12/13 on each side of the oesophagus is a small club-shaped body, the enlarged end dorsally, the stalk passing down underneath the ovary.

The prostates extend through segments xvii-xxii, each gland with two main lobes of many smaller lobules. The prostatic duct is about 5 mm. long, thinner both ectally and entally than in its middle portion, curled into a U- or an S-shape.

In xviii there are stalked glands, one for each external marking, the gland roughly spherical in shape. There are smaller club-shaped glands in vii and viii, one gland for each of the external genital markings.

The spermathecae have a long slender duct, equal or nearly equal in length to the ampulla. The tubular diverticulum is long and slender with the ental end slightly widened.

### Variety **lineata.**

*Pheretima hawayana lineata*, Gates, *Rec. Ind. Mus.* XXVIII, p. 154 (1926).

Kutkai, May, 4 specimens.
Taungyi, April, 44 specimens.
Mong Ko, Kengtung State, N. S. S., 7 specimens.

All of the worms collected during three days in the middle of April at Taungyi belonged to this variety.

Length 67-100 mm. Diameter 4-4½ mm. Number of segments: 93, 93, 92, 87, 93, 88. Dorsally a greyish brown pigment is present. The first dorsal pore is in 10/11 in all but two specimens in which it is in 11/12.

In the Taungyi specimens the clitellum does not reach either 13/14 or 16/17. In the Kengtung specimens the clitellum reaches 13/14 but not 16/17 on three specimens; in two specimens it reaches 16/17 but not

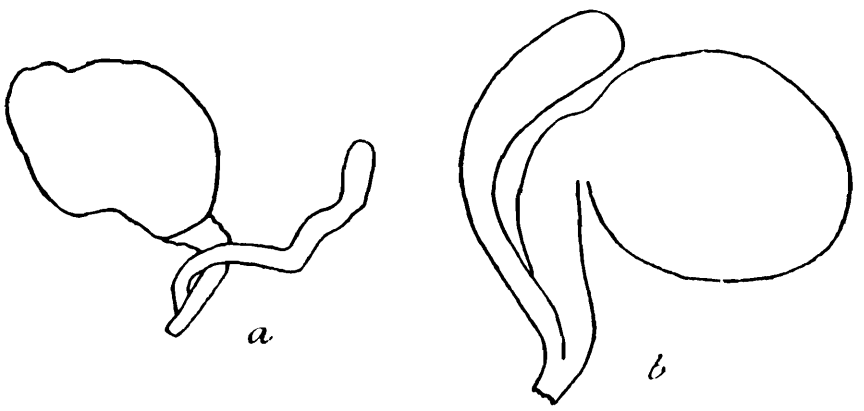


Fig. 24.—*Pheretima hawayana* variety *lineata*. *a*. Spermatheca, × *ca*. 11. *b*. Spermatheca, × *ca*. 19.

13/14; while in three of the specimens it reaches neither intersegmental furrow. Setae are present on the clitellum, at least ventrally on segment xvi; in one specimen 16 setae were counted on this location.

There is a ventral break in the setal circles from xvii posteriorly for varying distances. The numbers of setae on segment xx are :—

46, 48, 48, 49.

The numbers of the setae between the male pores on segment xviii are :—

12, 13, 13, 10, 12, 11, 13, 10, 12, 14, 15, 15, 14, 16, 17.

The numbers of the setae between the spermathecal pore lines on vi are :—

22, 21, 22, 22, 21, 23, 21, 19, 23, 23, 24, 24, 25, 25, 23.

The spermathecal pores are widely separated, minute apertures on tiny tubercles in 5/6 and 6/7.

All except four of the worms have the characteristic median preclitellar papillae. The four specimens from Kutkai entirely lack papillae, while two of the Mong Ko specimens have, in addition to the median papillae, paired papillae on vii or vii and viii but also anterior to the setae of the segments concerned.

The testis sacs of x are large, rounded, protuberant structures, projecting anteriorly from 10/11 and apparently without transverse communication. The testis sacs of xi are also large, about the same size as those of x and projecting laterally to the sides of the oesophagus, the sacs of this segment larger than the anterior seminal vesicles which are small and lateral in position. The testis sacs of xi are also without recognizable transverse communication. The seminal vesicles of xii are about twice the size of those of xi. The prostates extend through xviii-xxii or xxiii; the duct is short, fairly stout and nearly straight.

**Pheretima heterochaeta** (Mich.) 1891.

Namkham, April and May, 12 specimens.
Kalimpong, India, September, 25 specimens, K. N. Sharma.
Maymyo, August, 4 specimens, K. N. Sharma.

Length of the Namkham specimens, 80-170 mm.; of the Kalimpong specimens 45-134 mm. Greatest diameter of the Namkham specimens 3-6 mm.; of the Kalimpong specimens 3-5½ mm. Number of segments 90-113. Colour: dorsally brownish with a distinct but fine white stripe around each of the post-clitellar segments, the setae located on this stripe; clitellum reddish.

The first functional dorsal pore is in 11/12 in all of the specimens, but four of the Kalimpong worms have in 10/11 a non-functional pore-like depression resembling a dorsal pore.

The ventral setae of segment x are small, more closely crowded, and less protuberant than the setae of preceding and succeeding seg-

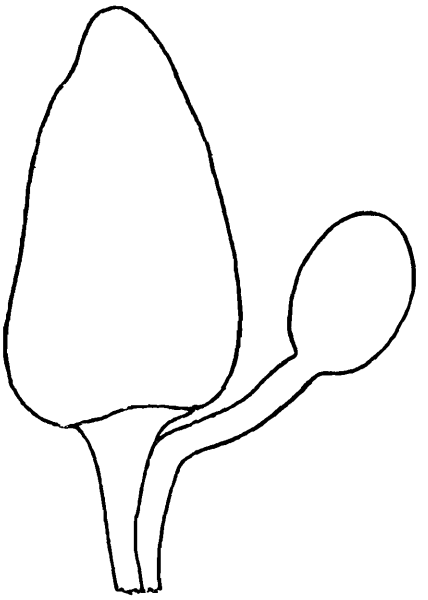

FIG. 25.—*Pheretima heterochaeta* (Mich.). Spermatheca, × *ca.* 19.

ments in all of the worms. There are slight but distinct dorsal and ventral breaks in the setal circles on the post-clitellar segments of all of the specimens, the breaks diminishing in size posteriorly. The numbers of the setae on segment xx of ten of the Kalimpong specimens are:—

45, 45, 45, 46, 47, 47, 48, 48, 49, 50.

The numbers of the setae between the male pores are:—

| | Number of worms from Kalimpong. | Number of worms from Namkham. |
|---|---|---|
| 11 | .. | 3 |
| 12 | 6 | 5 |
| 13 | 9 | 4 |
| 14 | 10 | .. |

The numbers of the setae between the spermathecal pore lines are as follows:—

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | 8, | 8, | 8, | 9, | 8, | 8, | 8, | 7, | 7, | 8, | 8, | 7, | 8, | 8, | 8, | 7, | 8, | 8, | 7, | 7. |
| vii | 11, | 10, | 11, | 11, | 11, | 12, | 10, | 10, | 9, | 11, | 10, | 11, | 10, | 10, | 11, | 9, | 10, | 10, | 10, | 9. |
| viii | 12, | 11, | 12, | 13, | 11, | 12, | 13, | 13, | 11, | 12, | 12, | 13, | 13, | 12, | 13, | 12, | 12, | 12, | 11, | 11. |

(Specimens 1-15 are from Kalimpong, 16-20 from Namkham.)

The clitellum is annular, extending from 13/14 to 16/17

The spermathecal pores are four pairs in 5/6-8/9, each pore small, located on a very tiny tubercle in the intersegmental furrow.

The female pore is single, in the mid-ventral line on xiv, at the centre of a circular or transversely oval whitish area.

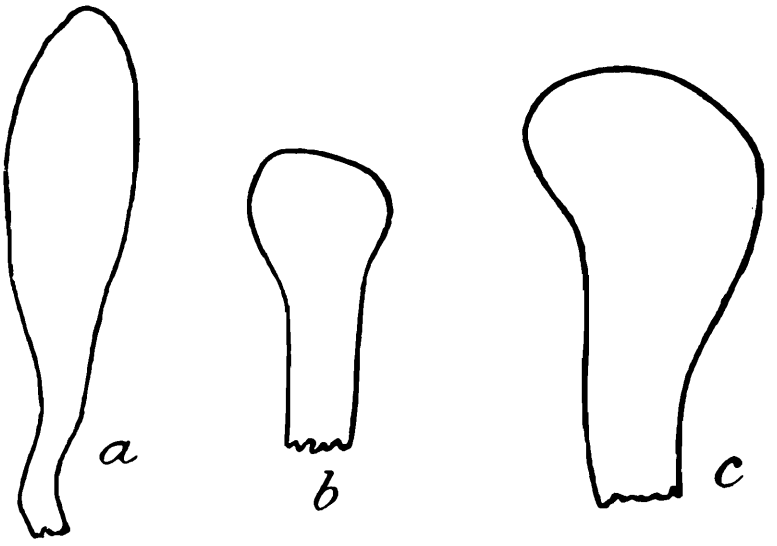


Fig. 26.—*Pheretima heterochaeta* (Mich.). *a*. Gland from the prostatic region, × *ca.* 38. *b*, *c*. Glands from the spermathecal region, × *ca.* 38.

The male pores are small, in the setal circles of xviii; each pore located on a small, transversely oval, glistening tubercle in the setal circle. The oval male area is at the centre of a very slightly swollen region with 3-6 concentric grooves surrounding the oval area. Setae are sometimes included between these circumferential grooves, internal to the male pore. The male papillae may project conspicuously or may be very slightly sunk into the epidermis. On the Namkham worms there are visible one or two additional minute pores on the male areas, these pores sometimes on tiny protuberances.

The genital markings are entirely confined to the pre-clitellar segments in both batches of worms; markings present on every worm but one. The markings are small, rounded, protuberant tubercles, each tubercle with a central depression containing a pore. The markings may be on the anterior halves of the segments concerned (Namkham worms), or on both the anterior and posterior halves of the segments concerned (Kalimpong worms). The anterior markings are just anterior to the setal circles, the posterior markings on the posterior margins of the segment immediately anterior to the spermathecal pore tubercles. The locations of the markings are as follows :—

Namkham specimens.

| | |
|---|---|
| On vii and viii | 4 worms. |
| On vii, viii and ix | 2 worms. |
| On viii, left vii, and right ix | 1 worm. |
| On vii, viii and left ix | 2 worms. |
| On viii and right vii | 1 worm. |
| On left vii and right viii | 1 worm. |
| No genital markings | 1 worm. |

Kalimpong specimens.

| | |
|---|---|
| On vi and vii anteriorly, and vi, vii, and viii posteriorly | 1 worm. |
| On vii anteriorly and vi, vii, and viii posteriorly | 1 worm. |
| On vii and viii anteriorly and vi, vii and viii posteriorly | 15 worms. |
| On vii and viii anteriorly and vii and viii posteriorly | 3 worms. |
| On vii and viii anteriorly and right vi, vii and viii posteriorly | 3 worms. |
| On viii anteriorly | 1 worm. |
| On right vii anteriorly | 1 worm. |

(In this table the segmental number alone indicates the presence of a pair of papillae on that segment. A segmental number preceded by right or by left indicates a single papilla on the particular side mentioned.)

In segments vi-viii there are stalked glands projecting into the coelom, one gland for each external marking. The gland may have a spherical head or may consist of two or more lobes. In segment xviii on each side there is ordinarily a single, stalked gland of similar appearance, rarely two or three such glands. These glands are usually buried under the longitudinal musculature, only rarely projecting into the coelom. The stalked glands are much smaller when the prostates are present than when they are lacking. The prostates are lacking in the majority of specimens dissected, and when present are small and confined to xviii. A well developed prostatic duct is always present, extending through xvii-xviii or xviii-xix.

No ovisacs were observed in any of the specimens dissected.

The glands in xviii have not been observed previously.

### **Pheretima houlleti** (E. Perr.) 1872.

Moulmein, August, a number of specimens.
Ye, August, a number of specimens.
Chaungson, August, a number of specimens.
Martaban, August, a number of specimens.
Kya In, a number of specimens.
Kya In Seik Kale, August, a number of specimens.
Maymyo, August, 20 specimens, K. N. Sharma.
Shwegyin, September, a number of specimens.
Paung, September, a number of specimens.
Nyaunglebin, September, a number of specimens.
Pazunmyaung, September, a number of specimens.

### **Pheretima immerita,** n. sp.

Mong Ko, Kengtung State, 8 specimens.

*External characteristics.*—Length 85-110 mm. Greatest diameter 4-5 mm. Number of segments 92-114. Colour: ventrally whitish; dorsally brownish red, except a narrow, yellowish white stripe on the middle of each segment where the setal circles are located.

The prostomium is prolobous but not separated from i by a transverse furrow.

The first dorsal pore is in 12/13 in all the specimens; one specimen has a non-functional pore-like depression in 11/12.

The setae begin on ii, are closely and regularly spaced, without a break ventrally; irregularly spaced dorsally. There are 50-55 setae

on segment xx. The numbers of the setae between the male pores on xviii are :—

| | | | |
|---|---|---|---|
| 17 | 1 worm. | 22 | 3 worms. |
| 19 | 1 worm. | 24 | 1 worm. |
| 21 | 1 worm. | 27 | 1 worm. |

The numbers of the setae between the spermathecal pore lines on vii are :—

| | | | |
|---|---|---|---|
| 26 | 1 worm. | 28 | 4 worms. |
| 27 | 1 worm. | 30 | 1 worm. |

There is no trace of a clitellum, the setal circles of xiv-xvi are unbroken ventrally except on xiv, where 2-4 setae are lacking in the region of the mid-ventral line.

The spermathecal pores are minute, round, pin-prick-like apertures in 6/7 and 7/8 at the edge of the pigmented region laterally.

No definitely recognizable female pores are visible, but there is a small depression in the mid-ventral region of xiv in the setal circle of most of the specimens and in this depression several setae are lacking.

The positions of the male pores are indicated by slight transversely oval depressions in the setal circle of xviii on each side, the depressions

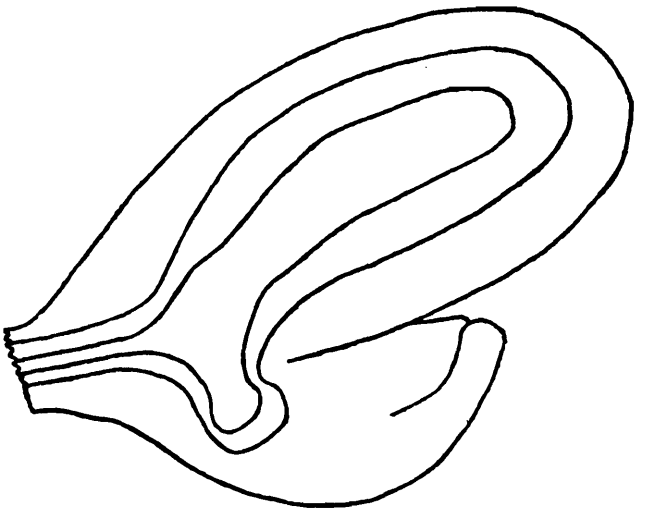

Fig. 27.—*Pheretima immerita*, n. sp. Spermatheca, × *ca.* 110.

widely separated. These markings represent a region in the setal circles where 5-10 setae are lacking. A tiny marking at the centre of the oval area indicates the future position of the male pore. There are usually 5-10 setae in the region from the site of the male pore to the mid-dorsal line.

The genital markings are :—(1) a pair of tiny, transversely oval, whitish areas on 17/18, each of these markings slightly internal to the position of the male pore ; (2) a pair of round, whitish areas on the posterior half of vii, each area internal to the lines of the spermathecal pores. Each of the pre-clitellar markings has a central depression containing a pore.

*Internal anatomy.*—Septa 5/6-10/11 are all present, thin and membranous, 11/12-14/15 slightly thickened and muscular. The sheet of tissue that represents septum 9/10 is attached to the parietes at its periphery together with 10/11, but is attached to the oesophagus anteriorly

to the oesophageal attachment of 10/11, so that there is a small chamber between the two sheets of tissue containing a segment of the oesophagus, the hearts of x, and the testis sacs of x.

The gizzard is elongate, pushing 8/9 posteriorly. The intestine begins in xv posteriorly or in xvi. The intestinal caeca extend from xxvii into xxiv, the dorsal margin in xxvi and xxv is incised so that short finger-shaped lobes project dorsally. The typhlosole is represented only by a minute rudiment for a short distance behind the intestinal caeca.

The last pair of hearts is in xiii, all the hearts of ix-xiii pass into the ventral trunk. The hearts of xi-xiii have been traced to both the dorsal and the supra-oesophageal vessels.

There are nephridial masses in v and vi. There are conspicuous paired masses of blood glands, one on each side of the dorsal blood vessel just anterior to the septum in each segment. These masses are especially large just behind the region of the intestinal caeca.

The anterior testis sacs are transversely ovoid. The testis sacs of xi are elongated, continuous with each other posteriorly across the mid-ventral line but separated anteriorly. The testis are small, round discs in the usual locations. The seminal vesicles are small, flattened, paired bodies on the posterior faces of 10/11 and 11/12. The prostatic ducts are nearly straight, the prostate glands represented by several lobes of tissue at the ental end of the prostatic duct into which the vas deferens passes. The prostatic duct is slightly enlarged after passing into the longitudinal muscle layer.

The ovaries and oviduct funnels are in the usual locations in xiii. The spermathecae are only slightly developed and are concealed within the parietes between the longitudinal and circular muscle layers, but may be dissected out after removal of the longitudinal muscle fibres.

There is a slight development of glandular tissue under the longitudinal muscles, over the site of the genital markings on vii. The longitudinal muscle layer of this form is unusually thick and rigid.

### **Pheretima jacita,** n. sp.

Ye, August, 5 specimens.

*Description of the type-specimen. External characteristics.*—Length 127 mm. Diameter in the thickest portion 6 mm. Number of segments about 127 (two spiral abnormalities in the posterior portion of the body). Colour: dorsally, anterior to the clitellum bluish grey, posterior to the clitellum brownish; ventrally very light greyish. The animal when alive had a very marked greenish iridescence.

The prostomium is large, conspicuously protuberant, epilobous, about $\frac{1}{4}$, without a posterior transverse furrow at the end of the prostomial tongue on i.

Segments x-xiii have secondary furrows, none of which are completely circumferential.

The first dorsal pore is in 12/13.

The clitellum extends probably from 13/14 to 16/17, but the epidermal glandularity characteristic of an adult *Pheretima* has not yet made

its appearance and the peculiar clitellar colouration is indicated only on segments xv and xvi.

The setae begin on ii, are small, closely crowded both dorsally and ventrally, but slightly further apart dorsally. There is no ventral break in the setal circles; there may or may not be a slight dorsal break. There are 21 setae between the male pores on xviii, 80 setae on segment xx, and about 30 setae between the spermathecal pore lines on viii. There are 20 setae visible ventrally on segment xvi, and setae can be made out with difficulty in other positions on this segment and on xiv and xv, but they do not project as conspicuously as on the ventral portion of xvi.

The spermathecal pores are represented by minute greyish spots, in 5/6-7/8, about one-half of the circumference or slightly less apart. The actual apertures are not yet formed.

The female pore is single, on the centre of a transversely oval protuberance in the setal circle of xiv.

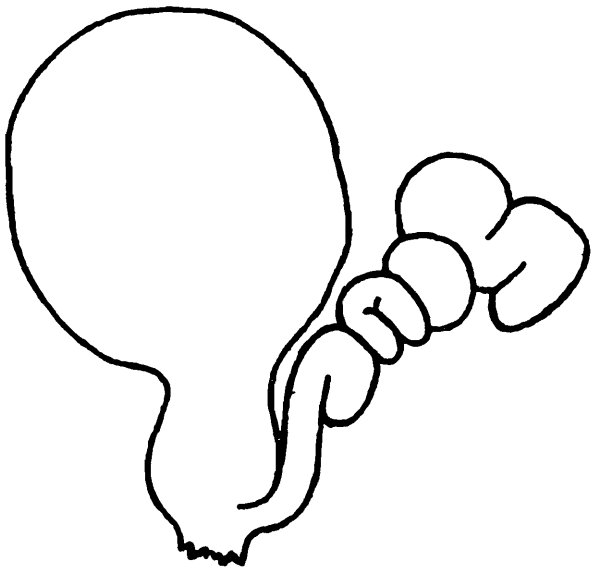

Fig. 28.—*Pheretima jacita*, n. sp. Spermatheca, × *ca.* 22.

Each male pore is located on a minute tubercle at the end of a very slight conical protuberance and has tiny anterior and posterior lips; the posterior lip with two lobes. The conical protuberance is located on a flat, elongately oval, greyish area in the setal circle of xviii, which does not reach either to 17/18 or to 18/19, and which is surrounded by three more or less complete concentric, circumferential furrows. There are no other copulatory markings.

*Internal anatomy.*—Septa 4/5-7/8 are present, 6/7 slightly thicker than 7/8; 8/9 and 9/10 are absent.

The gizzard is large, elongately tubular and fills the space between the septa 7/8 and 10/11. The intestine begins in mid xv. The intestinal caeca are compound and arise in xxvii. The caecum of the right side consists of five, elongate, finger-like tubes which extend into xxv. The dorsal-most "finger" is the largest; it has four ventrally directed pockets on its ventral margin and incisions on its dorsal margin marking off smaller pockets or lobes. Passing ventrally the fingers become slenderer and shorter.

There are masses of acinous blood glands and of nephridia in segments v and vi.

There are hearts in x-xiii and in right ix. The hearts of xi-xiii open into both the dorsal and the supra-oesophageal trunks.

The testis sacs are in conical posteriorly-directed pockets of the septa 10/11 and 11/12, so that the testis sacs of x appear to lie in xi, while those of xi appear to be in xii. The seminal vesicles are very large, those of a segment in contact dorsally over the dorsal blood vessel, the anterior pair pushing 10/11 forward and the posterior pair pushing 12/13 and 13/14 back into contact with 14/15. The prostates are in xviii-xxi, with thick, stumpy lobes. The prostatic duct is shiny, thick, short, and bent into the form of a U with the opening of the U directed ventrally towards the parietes. There are no copulatory chambers.

The ovaries and oviduct funnels are in the usual positions in xiii, the oviduct funnels narrow and elongate in a vertical dorso-ventral direction. The spermathecae are small, the duct shorter than the ampulla. The diverticulum passes into the anterior face of the spermathecal duct close to the parietes. The duct diminishes in diameter below the junction with the diverticulum. The diverticulum when straightened out is longer than the ampulla and duct together.

*Remarks.*—The lengths vary from 68-127 mm., the greatest diameter from 6-7 mm. The number of segments from 58-107 None of the worms are fully mature and probably all, except the type-specimen, had lost more or less of the tail portion. All of the specimens are abnormal, each worm having 1-3 spiral abnormalities, some of which, on two of the specimens, are anterior to the clitellum.

The prostomium is short and broad and is provided with a transverse furrow at the end of the prostomial tongue on only one specimen.

The first dorsal pore is in 12/13 in all five specimens.

The colour varies from bluish grey to reddish brown to light brownish.

The numbers of the setae on segment xx are :—

84, 85, 85, 88.

The numbers of the setae between the male pores on xviii are :—

19, 19, 20, 21.

The compound intestinal caeca consist of 5-12 elongate " fingers " which may or may not be lobed on their dorsal or ventral margins. The intestine begins in xv or xvi.

All of the hearts of ix-xiii pass into the ventral trunk. The four dissected specimens show very clearly the two vessels passing from each heart into the two dorsal trunks in segments xi-xiii. The hearts of x apparently pass only into the supra-oesophageal vessel.

The testis sacs are, so far as can be discovered, without antero-posterior or transverse connections. The seminal vesicles are always large.

Three other species of *Pheretima* from the Indian Empire have spermathecal pores in 5/6-7/8, *P. hawayana, P. insolita and P. birmanica.* From the first the present species may be distinguished by the absence of genital markings, from the second by the presence of the male pores on xviii, and from the third by the absence of copulatory chambers.

**Pheretima kengtungensis,** n. sp.

Mong Ko, Kengtung State, one specimen.

*External characteristics.*—Length 108 mm. Greatest diameter 4 mm. Number of segments 109. Colour: dorsally reddish brown; ventrally whitish; clitellum greyish.

The prostomium and the first segment are not normal, the condition of these two structures suggests healing after injury.

The first dorsal pore is in 12/13.

The setae begin on ii, and are regularly spaced both dorsally and ventrally, the setal circles without dorsal or ventral break. There are about 68 setae on segment xx. There are about 16 setae between the spermathecal pore lines on viii, but the epidermis has been abraded and this number may not be quite correct. No setae are visible ventrally on xviii between the apertures of the copulatory chambers, but there are six spots in the epidermis that resemble setal pits.

The clitellum is annular, extending from 13/14 to 16/17, without dorsal pores or intersegmental furrows; no setae are visible.

The spermathecal pores are medium-sized slits in 7/8 and 8/9.

The female pore is single at the centre of a round, whitish area on the mid-ventral region of xiv.

The apertures of the copulatory chambers are large, round openings with wrinkled margins.

There are no genital markings.

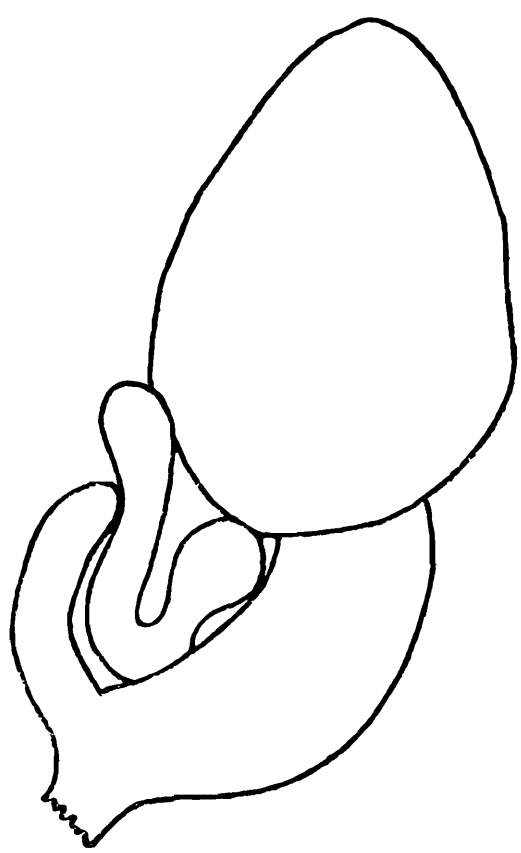

FIG. 29.—*Pheretima kengtungensis*, n. sp. Spermatheca, × *ca.* 22.

*Internal anatomy.*—Septa 5/6-7/8 are slightly thickened but membranous, 8/9 and 9/10 are absent.

The intestine begins in xv. The simple intestinal caeca extend from xxvii into xxiv, where they are bent under the intestine but are long enough to reach into xxii.

The last hearts are in xiii; the hearts of ix-xiii all pass into the ventral vessel.

The vasa deferentia come into contact in xii and fuse anteriorly in xiii, the fused vasa are large relative to the size of the worm, and loose on the coelomic floor. The testis sacs are paired in x and xi; they appear to communicate *inter se* across the mid-ventral line. The paired seminal vesicles of xi and xii are in contact dorsally over the dorsal blood vessel; the vesicles of xii about twice the size of those of xi, and pushing 12/13 posteriorly into contact with 13/14. The prostrates extend from xvi or xvii into xxi. The prostatic duct is about 7 mm. long, the ectal half thicker than the ental half; variously twisted or coiled. The duct appears to pass into the body wall at the edge of the copulatory chamber, but if this latter structure be pushed carefully towards the nerve cord after cutting a few connective tissue fibres, the duct can be seen to pass into the roof of the copulatory chamber. This chamber is elongately oval, pushing 17/18 anteriorly and 18/19 posteriorly; it is thick-walled and contains a narrow, antero-posterior cavity into which there projects a short but rather stout penial continuation of the prostatic duct. This penial projection is continued distally into a tiny thread.

The ovaries and oviduct funnels are in the usual positions in xiii, the lips of the funnels large and tumid. The spermathecal ampulla is slightly longer than the duct which is stout (except of course the parietal portion). The diverticulum is elongate, about as long as the duct and ampulla together, but is bound to the duct region in several loops by strands of connective tissue. The duct is constricted off from the ampulla. The ental end of the diverticulum is slightly enlarged and ovoid.

### **Pheretima longicauliculata,** n. sp.

Tolo Senca village, Mong Yang district, Kengtung State, near the Chinese border. Altitude about 3,000 feet. Dry season, 11 specimens.

*Description of the type-specimen. External characteristics.*—Length about 170 mm. Greatest diameter 7 mm. Number of segments 138. Colour: dorsally dark bluish to greyish blue; ventrally greyish; clitellum dark greyish blue.

The prostomium is epilobous, about $\frac{1}{2}$, without a transverse furrow posteriorly at the end of the postomial tongue on i.

The first dorsal pore is in 12/13; there is no functional pore between segments xiii and xiv although there is a dark greyish mark indicating the former position of a pore at that place.

The setae begin on segment ii, on which there are only four, all ventral, $aa=2ab$. The setae are closely crowded both dorsally and ventrally, a dorsal and ventral break lacking, except on segments vii and viii ventrally. There are 36 setae between the spermathecal pore lines on segment vi; 29 setae between the male pores on xviii and about 96 setae on segment xx. There are three faint, whitish lines present on the clitellum which indicate either presence of setae or the former positions of setae now lost.

The clitellum is annular and covers segments xiv-xvi. There are no intersegmental furrows or dorsal pores. The clitellum ends posteriorly with the dorsal pore belonging to the intersegmental furrow 16/17, although 16/17 is not visible. Anteriorly furrow 13/14 is not visible and the clitellar glandularity extends slightly anterior to the vestige of the dorsal pore of 13/14 and hence probably onto xiii.

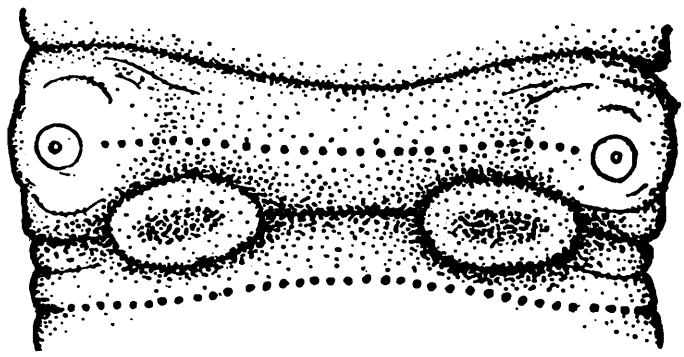

Fig. 30.—*Pheretima longicauliculata*, n. sp. Ventral view of segments xviii and xix showing male areas and genital markings.

The spermathecal pores are four pairs in 5/6-8/9, each pore a minute opening on a tiny, transversely oval, whitish area in the intersegmental furrow. The ventral distance between a pair of the spermathecal pores decreases passing posteriorly.

The female pore is single, in the mid-ventral line of xiv, a trifle anterior to the supposed setal circle of xiv.

The male pores are minute, each at the centre of a small, circular area, nearly $\frac{1}{2}$ mm. in diameter in the setal circle, the area surrounded by a narrow but deep and completely circumferential furrow. This circular marking is situated on a slight, blunt protuberance from the parietes.

The genital markings are three pairs of transversely oval, slightly raised areas, one pair on each of 18/19, 19/20 and 20/21. Each marking has a greyish margin, a slightly concave, whitish centre, and occupies a space represented by about 9-10 intersetal distances. The markings are about $1\frac{1}{4}$ mm. apart mid-ventrally.

In addition on each of segments vii and viii there is a transversely elongated, smooth, glistening area with bluntly rounded ends; the areas in the region of the setal circles and making a break therein. These areas are not in reality markedly different from the rest of the parietes and are without definitely demarcating grooves or lines.

*Internal anatomy.*—Septum 4/5 is present and membranous; 5/6 is slightly muscular; 6/7 and 7/8 thicker still; 8/9 and 9/10 are lacking; 10/11 and 11/12 are muscular; 12/13 and succeeding septa membranous.

The gizzard is elongate, narrowed anteriorly, posterior end enlarged and flange-shaped. The oesophagus immediately posterior to the gizzard bears four, antero-posteriorly flattened, flap-like glandular structures, one dorsally, one on each side laterally, and one ventrally. The intestine begins in xv. The intestinal caeca are simple, flattened and strap-shaped, extending from xxvii into xxiv where they are bent under the intestine, but long enough to extend into xx.

The last pair of hearts is in xiii. All the commissures of segments ix to xiii pass into the ventral trunk; the commissures of x are unusually large.

There is a single (?) bilobed testis sac on the anterior face of 10/11. There is a single (?) elongate testicular chamber in xi, extending from 10/11 to 11/12. The seminal vesicles are paired in xi and xii, each vesicle in xii about twice the size of the corresponding vesicle in xi. The prostates are small and confined to segment xviii, each gland composed of three major lobes of unequal size. The ducts are thick, muscular and bent into a hairpin shape with the limbs in apposition. The duct relative to the size of the prostate is large and long. The vasa deferentia of a side come into contact in xii and unite, the united ducts large and readily traced.

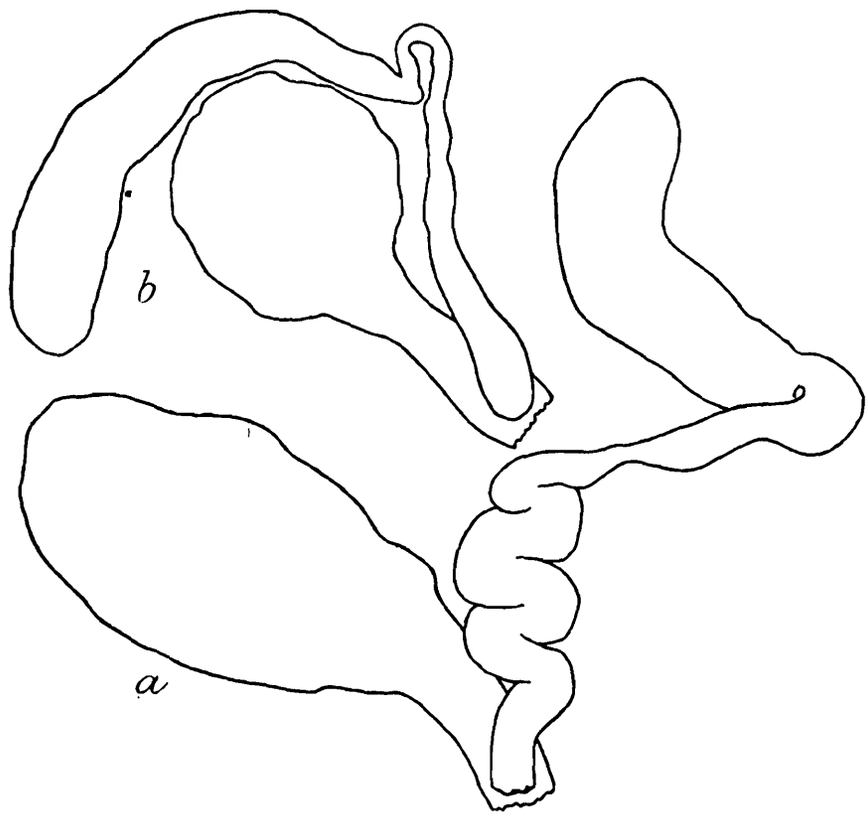


FIG. 31.—*Pheretima longicauliculata*, n. sp. *a*, *b*. Spermathecae, × *ca.* 11.

The ovaries and oviduct funnels are in the usual locations in segment xiii, the oviducal funnels elongate. The spermathecal duct is short and stoutish; the ampulla rather small and roughly spherical; the diverticulum much longer than the combined lengths of duct and ampulla, the ectal portion rather attenuated, the ental portion widened and elongately saccular.

There are paired, whitish, glandular masses protruding into the coelom in segments xix, xx, and xxi, the anterior pair of glands also projecting slightly into the posterior portion of xviii.

*Remarks.*—The length varies from 140-244 mm., the greatest diameter from 7-10 mm. The number of segments of four specimens:—137, 138, 139, 140. The first dorsal pore is in 12/13 in all of the eleven specimens, but in two worms there is a non-functional pore-like depression in 11/12.

None of the worms have a functional pore in the region of 13/14. Intersegmental furrows 13/14 and 16/17 are not visible on any of the worms. Some specimens have no trace of a dorsal pore in the region of 16/17, others have a non-functional vestige of a pore in that region, others have a functional pore.

The setae begin on segment ii in all of the specimens but there are only 4-7 setae on that segment, all ventral. The numbers of the setae on segment xx vary from 96-106. The numbers of the setae between the male pores on xviii are :—

| | | | |
|---|---|---|---|
| 24 | 2 specimens. | 28 | 2 specimens. |
| 26 | 4 specimens. | 29 | 1 specimen. |
| 27 | 1 specimen. | 31 | 1 specimen. |

The numbers of the setae between the spermathecal pore lines are :—

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| vi | 39, | 38, | 39, | 38, | 38, | 38, | 36, | 37, | 39, | 38, | 39. |
| vii | gl. | gl. | gl. | 40, | gl. | gl. | gl. | gl. | gl. | gl. | gl. |
| viii | gl. | gl. | gl. | gl. | gl. | gl. | gl. | gl. | gl. | gl. | gl. |

There is no dorsal or ventral break in the setal circles except ventrally on segments vii and viii. As indicated above all of the specimens except one have the special glandularity (gl.) of a mid-ventral area in the region of the setal circles of vii and viii as in the type-specimen.

The male and female pores are minute, round apertures, the spermathecal apertures a trifle larger than the other pores and transversely slit-shaped. As in the type-specimen the spermathecal pores of 5/6 are further apart than in succeeding furrows, each succeeding pair of pores slightly closer together ventrally than the preceding. The

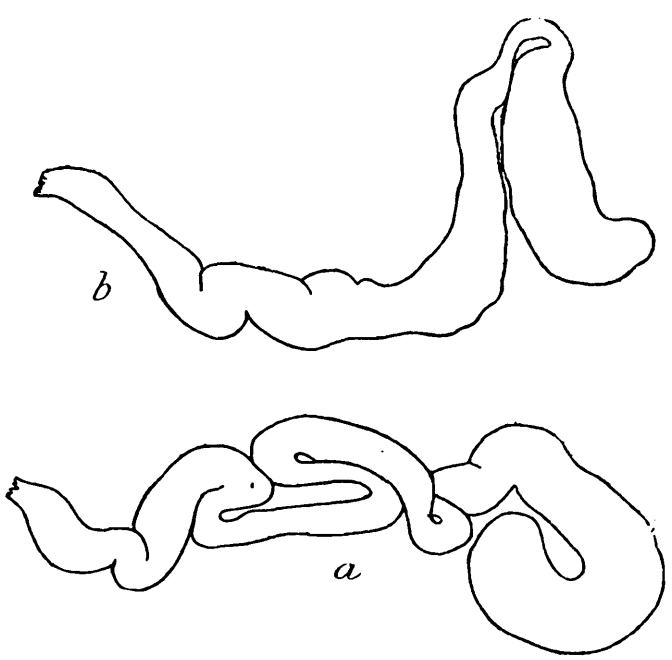


Fig. 32.—*Pheretima longicauliculata*, n. sp. *a*, *b*. Spermathecal diverticulae, × *ca.* 11.

male pore markings are as in the type-specimen, except that there may be more definite, completely or incompletely circumferential furrows on the protuberance bearing the male pore, in addition to the deep furrow marking off the round area containing the male pore.

The genital markings are on furrows 18/19-21/22 as follows :—

| | |
|---|---|
| 18/19, 19/20, 20/21 | 7 specimens. |
| Right 18/19, 19/20, right 20/21 | 1 specimen. |
| Right 18/19, 19/20, 20/21 | 1 specimen. |
| Left 19/20, left 20/21, left 21/22 | 1 specimen. |
| Left 18/19, 19/20, 20/21 | 1 specimen. |

(When neither right nor left is indicated a pair is present.)

The two markings of a pair are about 1¼-2 mm. apart, this distance greater than the width of the markings. The outer ends of the genital markings are internal to the male pores.

The heart-commissures of xi-xiii have been traced to the dorsal and the supra-oesophageal vessels, the heart-commissures of x only to the supra-oesophageal vessel.

There are large masses of nephridial tubules in v and vi.

The testis sac of x appears to be a single chamber, no trace of a partition separating the contents into two portions could be found, but the anterior margin has a pronounced bilobed appearance as if there were two sacs. Similarly there appears to be but a single testis sac in xi, no trace of a partitioning membrane having been found. The seminal vesicles of xii are at least twice as large as the vesicles of xi, and push 12/13 and 13/14 back into contact with 14/15. Each vesicle of xii is usually composed of two lobes. The prostates are small, confined to xviii as in the type, the gland having two or three major lobes ; the duct 6-7 mm. long and bent into a hairpin shape with the limbs approximated. There are no copulatory chambers.

The spermathecal ampulla is rather small, spherical to ovoid in shape ; when spherical the length about the same as that of the duct or perhaps a trifle longer ; when ovoid 1½-2 times the length of the duct. The duct is stoutish but does not appear to be muscular and is always thicker than the ectal end of the diverticulum. The diverticulum is elongate, 1½-3 times the combined lengths of the duct and ampulla. The ectal end of the duct in all specimens examined passes into the anterior face of the spermathecal duct within the longitudinal musculature. This portion of the diverticulum may be slightly enlarged and of nearly the same diameter as the duct or it may be much narrower. The next portion of the diverticulum may be looped into a regular zigzag, spirally coiled, slightly twisted, or nearly straight. The ental portion is always widened and elongately saccular. The middle portion of the diverticulum is sometimes widened as much as entally, or again this part of the diverticulum may be reduced in size and almost thread-like.

The glandular collar around the oesophagus behind the gizzard may be a completely unbroken ring, or the margin may be more or less deeply indented at several places, or the indentations may be deepened so that the collar consists of four distinct flaps, usually the dorsal and ventral flaps smaller than the two lateral flaps. The typhlosole is small and short.

In the largest specimen a very delicate membrane was found attached to the oesophagus just anterior to the large commissures of x in a septal fashion, but which was attached to the anterior face of 10/11 after passing around the outer edge of the testis sac. The sheet could not be

traced to the parietes either laterally or ventrally. It may possibly represent a rudiment of septum 9/10.

The three circles on the clitellar region may or may not indicate the presence of clitellar setae. After stripping off the longitudinal musculature from the inner face of the parietes there appear to be visible three rows of setae protruding through the circular muscle layer. But when this layer is stripped off and examined with the microscope only empty holes or holes filled with a granular deposit can be found. No setae were found in caustic potash preparations of the clitella of two worms, but a bit of clitellar epidermis from a third worm soaked in lactophenol contained two small setae which were of the usual sigmoid type.

### **Pheretima mamillana**, n. sp.

Ye, August, eight specimens.

*Description of the type-specimen. External characteristics.*—Length 132 mm. but incomplete posteriorly ; greatest diameter 7 mm. Number of segments 97. Colour : dorsally, anterior to the clitellum bluish grey, posterior to the clitellum reddish brown to brownish ; ventrally greyish ; clitellum reddish brown.

The prostomium is combined pro- and epilobous, but the lateral furrows on i extend posteriorly beyond the transverse furrow only very slightly.

On segments viii and ix there is a single secondary furrow posterior to the setae of the segment ; on segments x-xiii there are two secondary furrows, one anterior to and one posterior to the setae of the segments. There are additional slight furrows on some segments but none are completely circumferential.

The first dorsal pore is in 12/13.

The setae begin on ii ; they are more closely crowded ventrally than laterally or dorsally ; dorsal and ventral breaks are both present in the setal circles behind the clitellum but the breaks are small—$aa=1\frac{1}{4}$-$2 \times ab$, $zz=1\frac{1}{4}$-$2 \times yz$. On viii between the lines of the spermathecal pores there are 24 setae ; on xviii between the apertures of the copulatory chambers there are 10 setae ; on segment xx there are 49 setae. Setal circles are indicated on the clitellum.

The clitellum is annular, extending from 13/14-16/17 (3). The former positions of the dorsal pores are indicated by non-functional pore-like depressions.

The spermathecal apertures are in 6/7-8/9, about one-half of the circumference apart, at the edge of the pigmented region ; pores large, with wrinkled margins, readily visible to the unaided eye.

The female pore is a single, minute opening in the setal circle of xiv, at the centre of a small, transversely oval area.

The apertures of the copulatory chambers are transversely elongate slits in the setal circle of xviii ; the lips in contact, the margins wrinkled and in the immediate vicinity of the slits whitish. There are no genital markings.

*Internal anatomy.*—Septa 4/5-7/8 are present, each septum very slightly thicker than the preceding, but none greatly thickened ; 8/9 and 9/10 are absent.

The gizzard is elongate, the posterior end larger than the anterior end. The intestine begins in xvi. The intestinal caeca are simple, finger-shaped; they extend from xxvii into xxiv where they are bent under the intestine, but are long enough to reach into xx.

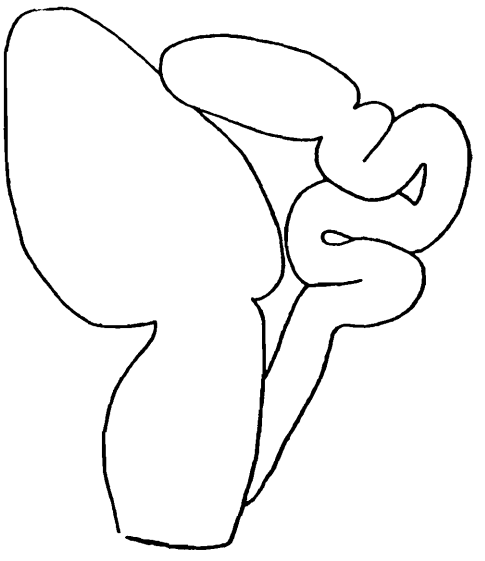

FIG. 33.—*Pheretima mamillana*, n. sp. Spermatheca, × *ca.* 20.

The last pair of hearts is in xiii; the commissures of x are closely bound to the sides of the oesophagus on the anterior face of 10/11; right commissure of ix alone present. The hearts of xi-xiii open into both the supra-oesophageal and the dorsal blood vessels, the branch to the supra-oesophageal vessel larger than that to the dorsal blood vessel in each segment; the commissures of x have been traced only to the supra-oesophageal vessel.

On the posterior face of the pharyngeal bulb there are two rather conspicuous masses, composed of closely-packed, ovoid bodies.

In segment xxviii and each succeeding segment there is a pair of flattened, lobed, whitish glands, one on each side of the dorsal blood vessel on the anterior face of the septa. There are large masses of nephridia in v and vi.

The ovaries and oviduct funnels are in the usual positions. The spermathecal ampulla is heart-shaped, longer than the duct from which it is sharply delimited. The tubular diverticulum is longer than the combined lengths of ampulla and duct, is looped into a zigzag arrangement or variously coiled; the ental end is enlarged and elongately ovoid.

The testis sacs are paired in x and xi, those of x rounded, those of xi antero-posteriorly elongated. The seminal vesicles of xi and xii are medium sized and in contact dorsally with the dorsal blood vessel. The prostrates are small, extending through xvii and xviii, divided almost completely into two portions by 17/18. The prostatic duct is short and stoutish and passes directly into the centre of the dorsal face of the large copulatory chamber. A rounded lobe of softer tissue projects from the side of the copulatory chamber. The vas deferens is thicker in xii than in the succeeding segments, in xviii it passes externally along the anterior face of the copulatory chamber and into the prostatic duct as the latter emerges from the prostate.

*Remarks.*—The first dorsal pore is in 12/13 in all eight specimens. None are complete posteriorly, all have lost a portion of the tail at some time previous to collection.

The setae are few in number, fairly large, not closely crowded. The numbers of the setae between the apertures of the copulatory chambers on xviii are :—

| | | | |
|---|---|---|---|
| 10 | 6 specimens. | 12 | 1 specimen. |
| 11 | 1 specimen. | | |

The numbers of the setae between the lines of the spermathecal pores on viii are :—

| | | | |
|---|---|---|---|
| 22 | 3 specimens. | 24 | 2 specimens. |
| 23 | 3 specimens. | | |

The numbers of the setae on segment xx are :—

| | | | |
|---|---|---|---|
| 47 | 2 specimens. | 50 | 1 specimen. |
| 48 | 1 specimen. | 52 | 1 specimen. |
| 49 | 1 specimen. | 53 | 2 specimens. |

The commissures of ix-xiii all pass into the ventral blood vessel. All dissected specimens show very clearly the dorsal bifurcation of the commissures to pass into the supra-oesophageal and dorsal trunks, the branch passing into the supra-oesophageal vessel always larger than the other.

A typhlosole is present but is not large nor extensive.

The spermathecal ampulla varies from spherical or ovoid to heart shaped ; it is always longer than the duct from which it is sharply delimited. The duct is thick and does not narrow as it passes into the parietes. The tubular diverticulum always arises from the outer face of the spermathecal duct and is usually looped in a definitely zigzag fashion ; it is usually longer than the combined lengths of the duct and ampulla and always has an elongately ovoid, hollow, ental enlargement. The oviducal funnels are elongated in a vertical direction on the anterior face of 13/14.

There seems to be a communication between the testis sacs of a side but no transverse connection between sacs of a segment was made out. Hanging down into the cavity of the copulatory chamber from its roof is a large mamma-like papilla. The male pore may be directly on the end of this papilla or sunk in a small pocket on the end of the papilla. Also protruding into the cavity of the copulatory chamber is a smaller, round tubercle with a tiny pore. This tubercle is beneath the sessile gland that projects into the coelom from the wall of the copulatory chamber.

### **Pheretima nugalis,** n. sp.

Kyaikmaraw, August, three specimens.

*Description of the type-specimen. External characteristics.*—Length 27 mm. Diameter in the thickest portion 2½ mm. Number of segments 83. Colour : dorsally, anterior to the clitellum brownish, posterior to the clitellum very light greyish brown ; ventrally greyish ; clitellum brownish.

The prostomium is epilobous, about ½.

The first dorsal pore is in 5/6.

The clitellum is annular, extending from 13/14-16/17 (3): no setae or intersegmental furrows are visible; the former positions of the dorsal pores indicated by non-functional depressions.

The setae begin on ii, are more closely crowded ventrally than laterally or dorsally. There is no ventral break in the setal circles, there may or may not be a dorsal break of varying width.

The spermathecal pores are one pair, in 5/6, about one-third of the circumference apart, on tiny oval protuberances on the intersegmental furrow.

The female pore is a single, minute aperture in a depression in the mid-ventral line on segment xiv.

The male pores are minute, in the setal circle of xviii, on small, transversely oval, flat, greyish areas in the setal circle but which extend nearly to 17/18 and 18/19. There are no other genital markings.

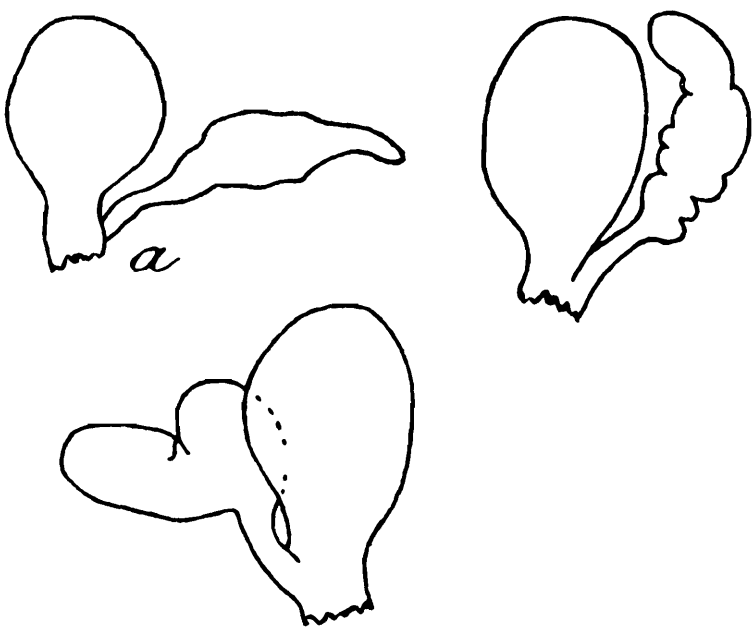


FIG. 34.—*Pheretima nugalis*, n. sp. Spermathecae, × *ca.* 22. *a*. from the type-specimen.

*Internal anatomy.*—Septa 4/5-7/8 are present, 6/7 and 7/8 perhaps slightly thickened; 8/9 and 9/10 are absent.

The intestine begins in xv. The intestinal caeca are simple, short, extending from xxvii into xxv.

There are paired hearts in x-xiii and a single heart in the left side of ix.

The seminal vesicles are large, two pairs, the anterior pair pushing 10/11 forwards into contact with 7/8. In xvii the (relatively) large, readily visible vasa deferentia pass up on to the intestinal face of the prostates from whence, until junction with the prostatic ducts, they are partly buried in the prostatic tissues. The prostatic duct emerges from the gland in xix, is looped and passes into the parietes in xviii. There are no copulatory chambers.

The ovaries and oviduct funnels are in the usual positions in xiii. The spermathecae are, relative to the size of the worm, very large; in contact dorsally over the oesophagus. The duct is short, fairly stout,

shorter than the ovoid ampulla. The diverticulum is longer than the combined lengths of the duct and ampulla and consists of an ectal, narrow, tubular portion and an elongate, ental saccular portion.

*Remarks.*—Lengths of the other two worms: 26 and 28 mm. Diameter 2 mm. Number of segments 70 and 77. The first dorsal pore is in 5/6 in both specimens.

The setal circles are unbroken ventrally, and may or may not be broken dorsally. There are 6-10 setae between the male pores on xviii. It has not been possible to determine accurately the setal numbers on the various locations of these specimens.

The prostates are relatively very large and extend through segments xviii-xxiv; the duct emerges from the gland in xix, xx, or xxi; the vasa deferentia are continued posteriorly on the intestinal faces of the prostates, as in the type-specimen, to the point of emergence of the prostatic duct. The duct is either straight or looped into a U-shape.

The anterior seminal vesicles are large and fill the space between the gizzard and the parietes of segments viii, ix and x.

### **Pheretima ornata** Gates.

*Pheretima ornata*, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 20 (1929).

Kutkai, May, 6 specimens, all secured in the latter part of the month, after several weeks of heavy rain.

### **Pheretima peguana** (Rosa) 1890.

Moulmein, August, a number of specimens.
Ye, August, a number of specimens.
Chaungson, August, a large number of specimens.
Martaban, August, a large number of specimens.
Kya In, a large number of specimens.
Kya In-Seik Kale, several specimens.
Kyaikmaraw, several specimens.
Shwegyin, September, a number of specimens.
Paung, September, a number of specimens.
Syriam, September, a number of specimens.

The numbers of the setae between the spermathecal pore lines on a number of specimens picked at random are as follows:—

| | |
|---|---|
| vii | 22, 19, 23, 20, 24, 20, 23, 19, 19, 22, 21, 21, 21, 23, 23. |
| viii | 24, 21, 25, 21, 25, 21, 24, 18, 24, 24, 23, 22, 23, 25, 24. |

The numbers of the setae between the apertures of the copulatory chambers on xviii of the same worms are:—

12, 10, 10, 10, 12, 10, 11, 8, 10, 9, 11, 10, 11, 13, 12.

In a collection of 100 specimens of this species collected from a number of localities the position of the first dorsal pore is as follows:—

| | |
|---|---|
| First dorsal pore definitely in 12/13 | 90 specimens. |
| First dorsal pore in 12/13, but with a non-functional pore-like depression on the anterior margin of xii in the mid-dorsal line | 4 specimens. |
| First functional dorsal pore in 12/13, but a very definite pore-like structure in 11/12, through which no fluid exudes when the worm is placed under pressure | 5 specimens. |
| First functional dorsal pore in 11/12, smaller than the succeeding pore in 12/13 . . . | 1 specimen. |

## **Pheretima planata** Gates.

*Pheretima planata*, Gates, *Ann. Mag. Nat. Hist.* (9) XVII, p. 411 (1926).

Shwegyin, September, a number of specimens.
Madauk, September, a number of specimens.
Nyaunglebin, September, a number of specimens.
Pazunmyaung, September, a number of specimens.

## **Pheretima posthuma** (L. Vaill.) 1868.

Prome, April, several specimens.
Taungdwingyi, April, several specimens.
Moulmein, August, a number of specimens.
Chaungson, August, a number of specimens.
Kya In, August, a number of specimens.
Pazunmyaung, September, several specimens.

The numbers of the setae between the spermathecal pore lines on a number of specimens picked at random are as follows :—

| | |
|---|---|
| vi . . | 39, 37, 39, 40, 38, 40, 37, 38, 40, 36, 40, 38, 40, 39, 39. |
| vii . | 39, 39, 40, 40, 39, 41, 42, 39, 41, 38, 40, 39, 42, 44, 42. |
| viii . . | 38, 38, 40, 39, 39, 40, 38, 38, 40, 36, 41, 38, 38, 43, 38. |

The numbers of the setae between the copulatory markings of xvii of the same worms are :—

17, 17, 16, 18, 18, 18, 20, 19, 17, 18, 19, 18, 17, 19, 17.

The numbers of the setae between the male pores on xviii of the same worms are :—

19, 17, 19, 19, 19, 21, 20, 19, 19, 17, 20, 20, 19, 20, 18.

The numbers of the setae between the copulatory markings of xix of the same worms are :—

18, 16, 16, 18, 17, 19, 19, 17, 19, 19, 19, 19, 19, 20, 18.

In a collection of 100 specimens of this species collected from a number of localities the position of the first dorsal pore is as follows :—

| | |
|---|---|
| First dorsal pore definitely in 12/13 | 95 specimens. |
| Pore-like depression in 12/13 but no fluid exudes therefrom when this region is put under compression, the first functional dorsal pore in 13/14 | 3 specimens. |
| First dorsal pore definitely in 13/14 | 2 specimens. |

## **Pheretima referta,** n. sp.

Mong Ko, Kengtung State, 1 specimen.

*External characteristics.*—Length 122 mm. Greatest diameter 5 mm. Number of segments 109. Colour: dorsally, bluish grey anterior to the clitellum, reddish brown to brownish posterior to the clitellum; clitellum greyish.

The prostomium is large, epilobous, but without the transverse furrow across the posterior end of the prostomial tongue on i.

The first dorsal pore is in 12/13.

The setae begin on ii; the setal circles are without definite dorsal or ventral breaks. There are about 21 setae between the lines of the

spermathecal pores on viii and ix. There are 5 setae between the genital markings on xviii. There are about 59 setae on segment xx.

The spermathecal pores are minute, on very small conical protrusions in 8/9.

Only one female pore is visible, but the epidermis is so roughened in the mid-ventral region of xiv that it is impossible to state definitely whether or not there is more than one pore.

The male pores are minute in the setal lines of xviii.

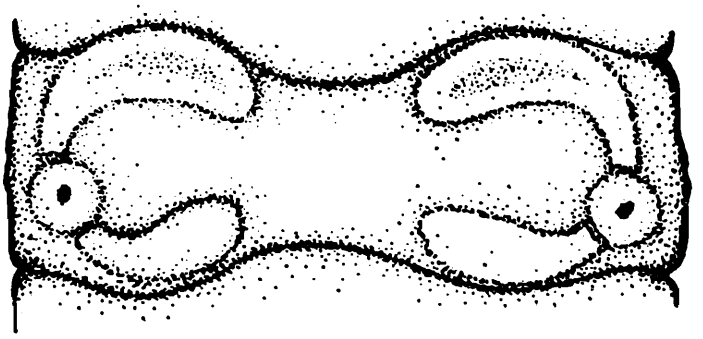

Fig. 35.—*Pheretima referta*, n. sp. Ventral view of segment xviii.

The genital markings are a single pair. Each marking is rather U-shaped with the openings of the U's facing each other across the mid-ventral line and consists of the following parts :—(1) An anterior, flat, whitish, slightly crescentic area on xvii posterior to the setae of that segment, the concavity of the crescent facing posteriorly. (2) A similar area but with the concavity facing anteriorly on the posterior portion of xviii and perhaps extending slightly on to xix. (3) A narrower, whitish, curved area connecting the other two portions of the marking and forming the base of the U. This latter part of the marking is slightly thickened near its junction with the posterior crescent and very slightly elevated and bears thereon the male pore. The crescentic areas are slightly elevated above the general level of the surface and contain a transversely elongate, central depression. Intersegmental furrows 17/18 and 18/19 end against the outer side of the genital markings and are not visible ventrally.

*Internal anatomy.*—Septa 5/6 and 6/7 are slightly thickened but are membranous ; 7/8 is thin and membranous and is pushed forward by the spermathecal ampullae ; 8/9 and 9/10 are lacking ; 10/11 is represented by a ventral rudiment only but the dorsal portion, if present, may have been ruptured in opening the animal.

The transition between the oesophagus and the intestine is gradual, the gut not enlarged and saccular like a characteristic intestine until segment xx, perhaps slightly wider in xv than in xiv ; from xiv posteriorly the coelomic face of the gut is reddish as posteriorly. The intestinal caeca are simple, extending from xxvii into xxi.

The hearts of x-xiii have been traced to the supra-oesophageal vessel only. Hearts present on both sides ot ix, the right heart larger ; all commissures of ix-xiii pass into the ventral trunk.

The seminal vesicles are very large ; the posterior pair push 12/13, 13/14 and 14/15 back into contact with 15/16 ; the anterior pair extend away forward along the sides of the gizzard. The anterior testis sacs are rounded. The relationships of the posterior testis sacs have not

been made out. The prostates are large, extending through xvi-xxiii, with numerous deeply incised lobes both dorsally and ventrally. The prostatic duct is 5-6 mm. long with a short, whitish, ental portion and a thicker, pinkish, ectal portion. There are no copulatory chambers.

The ovaries and oviduct funnels are in the usual locations in xiii, the lip of the funnels thick and tumid.

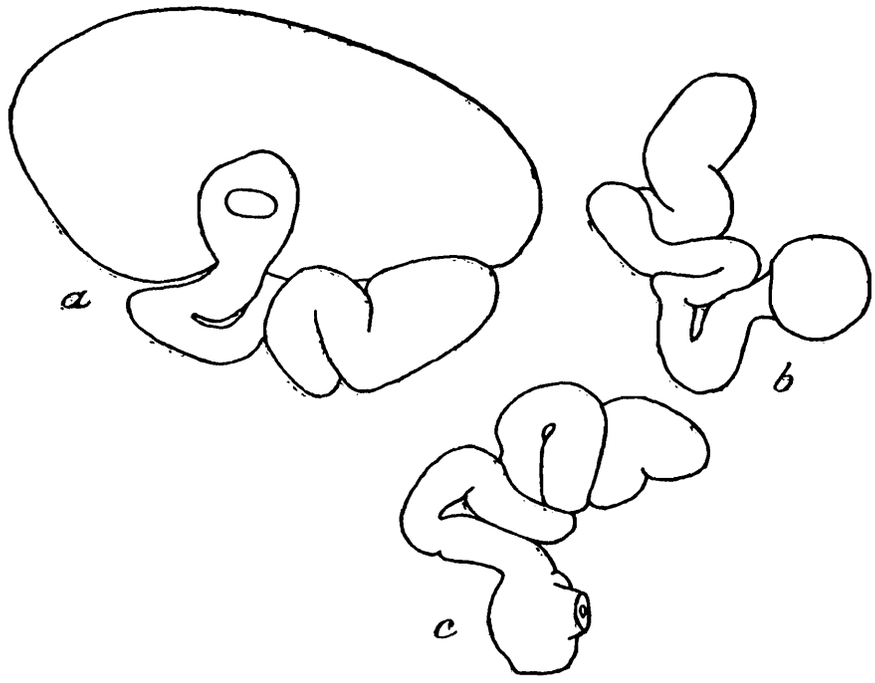


Fig. 36.—*Pheretima referta*, n. sp. *a*. Spermatheca, ventral side, × *ca*. 11. *b*. Diverticulum and duct viewed from the other side after dissecting off ampulla, × *ca*. 11. *c*. Diverticulum, × *ca*. 11.

The spermathecal ampulla are very large, extending between the levels of intersegmental furrows 6/7-8/9, elongately ovoid, entirely covering over the ducts and diverticula. The duct is short, almost confined to the parietes, and is so fragile that when the ampulla is pushed to one side the duct breaks off. The diverticulum is elongate, tubular, looped, the loops bound by connective tissue to the under surface of the ampulla, the ectal portion muscular, the ental portion slightly enlarged and ovoid.

*Remarks.*—On first opening the animal one is impressed by the appearance of the almost continuous row of whitish structures comprising the spermathecae, the seminal vesicles and the prostates extending from 6/7-23/24.

There are no Burmese species of *Pheretima* with a single pair of spermathecal pores in 8/9. The present worm may either be regarded as new or as a dithecal variant of some species that has more than one pair of spermathecae. There is a certain amount of evidence for this latter as the present specimen is quite similar in some ways to *P. doliaria*. The genital markings of both worms are quite characteristic and so distinctly different from each other that it has seemed preferable for the present to treat the single specimen as a distinct species. [The genital markings of Burmese species of *Pheretima* are as a rule quite typical and less variable (in conformation but not numbers and positions) than other taxonomic characteristics.] The more important points of

difference between *P. referta* and *P. doliaria* are :—*P. referta* has one pair of spermathecal pores in 8/9, *P. doliaria* two pairs in 7/8 and 8/9. The prostatic duct of *P. doliaria* is very much thicker in a portion of its extent and more highly muscular than is the duct of *P. referta*. The genital markings are distinctly different. The following minor points of difference may also be mentioned :—The prostomium of *P. referta* is much larger than that of *P. doliaria*. The spermathecae and seminal vesicles of *P. referta* are much larger than those of *P. doliaria*.

### Pheretima rimosa, n. sp.

Mong Ko, Kengtung State, 8 specimens.

*Description of the type-specimen. External characteristics.*—Length 116 mm. Greatest diameter 5 mm. Number of segments 111. Colour : dorsally light reddish ; ventrally whitish ; clitellum yellowish brown.

Segments vi-xiii each have two secondary furrows, one anterior to and the other posterior to the setae ; segments ix-xiii have in addition tertiary furrows which, as a rule, are not completely circumferential.

The prostomium is epilobous, about $\frac{1}{2}$ ; there is no posterior transverse furrow at the end of the prostomial tongue on i.

The first dorsal pore is in 12/13 ; there are functional pores in 13/14 and 16/17.

The setae begin on ii but can be recognised only on the ventral side of that segment. From iii posteriorly the setal circles are, as a rule, without dorsal or ventral break ; the spacing is regular, the setae slightly further apart on the pre-clitellar segments both dorsally and ventrally

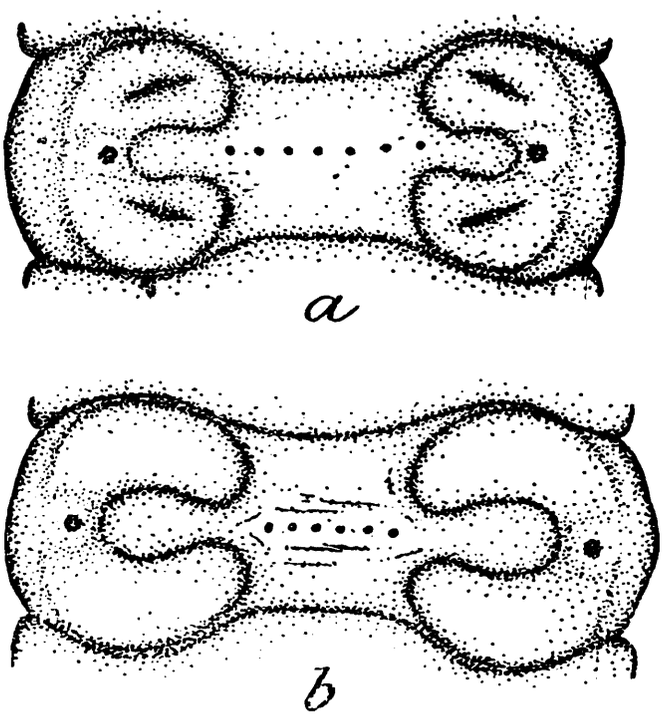


Fig. 37.—*Pheretima rimosa*, n. sp. *a*. Genital markings. *b*. Genital markings of worm from second batch.

than on the post-clitellar segments. Posterior to the clitellum the setae are slightly closer together ventrally than dorsally. The ventral setae of segments ii-xiii and the dorsal setae of iii-ix are slightly larger

than elsewhere. The numbers of the setae between the spermathecal pore lines are:—on vi-12, on vii-13, on viii-14. Between the genital markings on xviii there are 7 setae. There are about 44 setae on segment xx.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking.

The spermathecal pores are four pairs on vi, vii, viii and ix, on the anterior margins of the segments, very close o the intersegmental furrows; each pore a minute, transverse slit; the pores of a pair widely separated.

The female pore is single.

The male pores are round, minute apertures in the setal circle of xviii.

The paired genital markings are slightly eroded so that an exact description is impossible. Each marking appears to be thickly crescent-shaped, greyish, antero-posteriorly placed on a slightly protuberant region of xviii; intersegmental furrows 17/18 and 18/19 slightly displaced anteriorly or posteriorly by the markings. Towards the outer margin of the marking and in line with the setal circle is the male pore. On each marking there are two diagonally placed fissures, one anterior to and one posterior to the male pore; the mid-segmental ends of the fissures pointing towards the male pore, the distal ends of the fissures pointing towards the mid-ventral line.

*Internal anatomy.*—Septa 4/5-8/9 are all present, membranous, 8/9 is attached to the dorsal blood vessel immediately behind the vessels passing from the dorsal trunk to the gizzard; 9/10 is apparently present ventrally only; 10/11 is present but very delicate; 11/12 and 12/13 are slightly thickened but membranous.

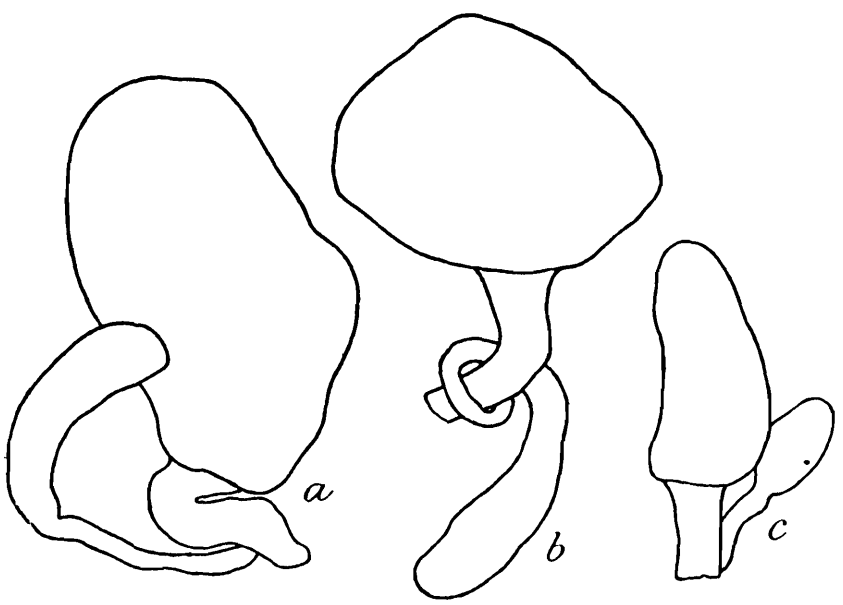


FIG. 38.—*Pheretima rimosa*, n. sp. Spermathecae, × *ca.* 11. *a.* and *b.* from the first group. *c.* from the second group.

The gizzard is elongate. The intestine begins in xv. The intestinal caeca extend from xxvii into xxv where they pass under the intestine, but are long enough to reach into xxiii. The ventral margins of the caeca are slightly lobed.

The last pair of hearts is in xiii. All the heart-commissures of ix-xiii pass into the ventral vessel.

There is a rather large glandular (?) mass in v on each side, extending from 4/5 to 5/6. There are nephridial masses in v and vi on the anterior faces of 5/6 and 6/7.

The testis sac of x has a bilobed anterior margin. The sacs of both x and xi rather large. The seminal vesicles are large ; the anterior pair pushes 10/11 and 8/9 anteriorly so that the vesicles appear to be in contact with the posterior portions of the sides of the gizzard. The posterior pair, which are about the same size as the anterior pair, pushes 12/13 back into contact with 13/14. The prostates are large, extending from xv to xix on the right side and xvi to xxi on the left side. Each gland is composed of a number of lobes, each of which is subdivided into smaller lobules. The duct is confined to xviii ; it is moderately thick throughout and looped. There are no copulatory chambers.

The ovaries and the oviduct funnels are in the usual places in xiii. The last two pairs of spermathecae are in viii, the posterior-most pair opening posteriorly. The diverticulum arises from the anterior face of the bent duct which is shorter than the ampulla. The diverticulum is elongate but not equal to the combined lengths of the ampulla and duct. The ectal portion is narrowly tubular, the ental portion slightly thicker. The ampullae are saccular.

*Remarks.*—The length varies from 100-122 mm. ; the greatest diameter from 4½-5 mm. ; the number of segments from 113, 114, 114, 114, 119, 113. The first functional dorsal pore seems to be in 12/13 in all eight specimens, but in five worms there is a very evident pore-like depression in 11/12, although no fluid can be squeezed through at that point.

A dorsal break may be present in the setal circles but is slight and variable ; there may also be a ventral break on a few segments immediately posterior to the clitellum. The numbers of the setae between the spermathecal pore lines are :—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| vi . . . | 12, | 14, | 14, | 12, | 13, | 12, | 13, | 12. |
| vii . . . | 12, | 15, | 16, | 12, | 15, | 13, | 11, | 13. |
| viii . . . | 14, | 16, | 15, | 13, | 16, | 14, | 12, | 14. |

The numbers of the setae between the genital markings on xviii are :—

| | | | |
|---|---|---|---|
| 5 . . . . . | 1 worm. | 8 . . . . . | 2 worms. |
| 6 . . . . . | 2 worms. | 10 . . . . . | 2 worms. |
| 7 . . . . . | 1 worm. | | |

The numbers of the setae on segment xx are :—

44, 47, 44, 48.

The genital markings are as described for the type-specimen. (The figure is a composite of what can be made out on the least damaged specimens.)

The septa are as in the type-specimen :—8/9 present in all dissected specimens

The typhlosole is very small. The ventral margins of the intestinal caeca are always lobed.

There appears to be but a single testis sac in each of segments x and xi. The testis sac of xi when pulled back from 10-11 has a bilobed anterior margin similar to that of the testis sac of x.

There is a mass of glandular material around the base of the prostatic duct between the longitudinal and the circular muscle layers. There is also over the region of each of the genital marking fissures, between the two muscle layers, a mass of non-muscular material which may also be glandular.

## *Addendum.*

4 additional specimens presumably from the same locality.

Number of segments 104, 108, 108, 111. The first functional dorsal pore in all four specimens is in 11/12.

Setae are recognizable on segment ii only ventrally, but there are indications of the presence of a complete setal circle as in the other specimens. No setae are definitely visible on the clitellum but all four specimens have 3 rings of minute spots where setae should be located if present. The setae between the spermathecal pore lines can be counted on only one specimen on which they are :—

| | |
|---|---|
| vi . . . . . | 14 |
| vii . . . . . | 14 |
| viii . . . . . | 15 |

The numbers of the setae between the male pores are :—6, 8, 8, 11.

The setae on segment xx number about 46.

Spermathecal pores are not definitely recognizable but the epidermis is slightly swollen in the regions about the places where the pores should be located.

There is a pair of genital markings on xviii, each marking crescent-shaped but without fissures ; the concavities of the crescents directed ventrally. The male pores are located on these markings as in the other specimens.

Septum 8/9 is present in all of the specimens. The typhlosole is even smaller than previously. There is a pair of characteristic glandular masses in v as in the other specimens.

There is a single testis sac in each of segments x and xi, the sacs are nearly empty, containing only the male funnels and a pair of small button-like testes. The seminal vesicles are small and lateral in position in both xi and xii. The prostates are small, confined to xviii or extending through xviii-xix only ; or entirely lacking (in two specimens). The prostatic duct is U-shaped.

The last two pairs of spermathecae are always in viii. The spermathecal duct is straight, lacking the bend that is characteristic in the previous specimens.

The clitellum of these specimens appears to be fully formed and except for the invisibility of the spermathecal pores all seemed externally at least to be fully mature. The small size and certain other characteristics of the reproductive organs strongly suggest that the specimens are immature. The position of the first dorsal pore, one segment anterior to its location in the other specimens, is of interest.

## Pheretima suctoria Mich.

### Variety typica.

*Pheretima suctoria*, Michaelsen, *Mitt. Nat. Mus. Hamburg* xxiv, p 165, fig. 12 (1907).

*Pheretima suctoria*, Michaelsen, *Mem. Ind. Mus.* I, p. 196, fig. 19, pl. xiii, fig. 28 (1909).

*Pheretima suctoria*, part, Stephenson, Oligochaeta (*Fauna British India Series*) p. 311 (1923).

Material examined : 1 tube of worms from the Indian Museum labelled "*P. suctoria*, Michlsn Andaman Island. ZEV. 2828/7. Types.

The tube contained : 1 immature specimen ; two mature but abraded specimens ; and 1 mature specimen in good condition. This latter specimen was dissected. The type-specimen and possibly some other specimens studied by Michaelsen are not in the Indian Museum collections.

Length 140 mm. Greatest diameter 7 mm. Number of segments 121. The first dorsal pore is in 12/13.

Setal circles are without ventral break but a dorsal break of varying width is present on some of the segments. The setae of segments ii-ix are larger and straighter than on x and succeeding segments and more widely separated both dorsally and ventrally. Posterior to the clitellum the setae are more closely crowded ventrally than dorsally. Between the lines of the spermathecal pores the numbers of the setae are :—on vi-10, on vii-10, on viii-11. On xviii between the genital markings there are 5 setae. On segment xx there are about 66 setae.

The clitellum is annular, extending from 13/14-16/17 (3).

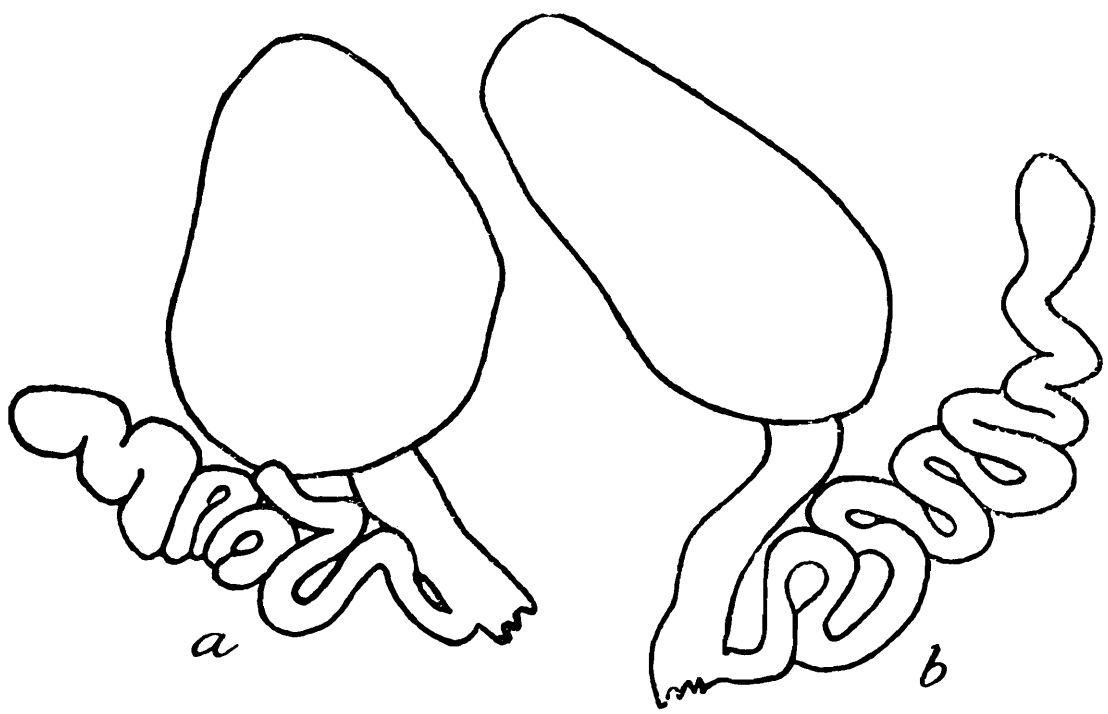


Fig. 39.—*Pheretima suctoria* Mich. Spermathecae from the cotype specimen, × *ca.* 22. *a.* from the left side of ix. *b.* from the left side of viii.

The spermathecal apertures are minute pores in the intersegmental furrows, there are no traces of pore tubercles.

The male pores are not visible but are located presumably on the greyish central portion of the round areas in the setal circle of xviii. These round areas are external and very close to, but not in actual

contact with the genital markings. The external margins of the genital markings are indented very slightly opposite the smaller male markings. The inner margins of the genital markings are not indented by the setal circle. The surface of the large genital markings is coarsely granular, the granulations or tubercles a light transparent greyish, surrounded by furrows of a darker greyish appearance. These markings extend only to 17/18 and 18/19 but dislocate those furrows slightly in an anterior or posterior direction.

Septa 5/6-7/8 and 10/11 are slightly thickened; 11/12-13/14 are slightly thicker.

The intestinal caeca are long, flat, strap-shaped; with dorsal and ventral margins slightly incised; extending from xxvii into xxii. There are large hearts in x.

The prostates are small, extending through xvii-xix or xviii-xix. The prostatic duct is short, straight or looped; it appears to pass into the coelom gland or "cushion" internal to the large genital markings, but in reality merely indents the external margins of the glands. The vasa deferentia are extended across the dorsal face of the cushions.

There are paired, vertically elongated sacs on the posterior face of 13/14; ovisacs according to Michaelsen. The spermathecal duct is slender, the diverticulum slender and looped; the loops may or may not be arranged in one plane as illustrated in the figures.

The account above differs in some points from the description of the species given by Michaelsen. To enable comparison both with the preceding and the subsequent accounts an excerpt is given herewith of Michaelsen's description (1909).

"Setae all nearly of equal size. Circles of setae continuous, in general of equal density, only on the anteclitellar segments dorsally somewhat further apart than ventrally. Numbers of setae on the anterior segments vary greatly: 25-38-v, 35-58-x, 60-70-xiii, 75-xix, 80-xxvi."

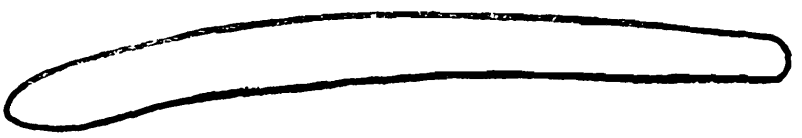

FIG. 40.—*Pheretima suctoria* Mich. Ventral seta from a pre-clitellar segment of the cotype specimen, × *ca.* 90.

"Copulatory organs, apparently always constant, and similar in all mature specimens examined by me; a pair of great, circular or transversely oval areas on the 18th segment in the zone of setae, placed medially between the male pores. The papillae of the male pores project a little over the lateral borders of these areas, and the rim-like zone of the setae over the medial borders. The diameter of the areas is somewhat larger than the distance between them, which bears 4 to 8 setae. The border of each of these areas is sharply marked. The surface is smooth and somewhat depressed or elevated, and shows a dark ground colour with numerous lighter spots which are situated so densely that the ground colour is reduced to a reticulation."

"At the distal part of this duct enters a very long and very thin tube-like diverticulum, the proximal end of which is slightly swollen. The diverticulum is irregularly bent and curved, nearly coiled. *In*

*situ* it does not reach the tip of the main pouch, but if extended it would be two or three times as long as the main pouch."

### Variety manicata, n. var.

Chaungson, August, a number of specimens.
Moulmein, August, a number of specimens.

*External characteristics.*—Length 56-111 mm. Diameter 4-6 mm. Number of segments 68-95. Colour: dorsally reddish brown, brownish, greyish blue; ventrally whitish; clitellum reddish brown.

The prostomium is medium-sized, epilobous, about ½ or slightly more; the posterior transverse furrow at the end of the prostomial tongue on i is lacking.

The first dorsal pore is usually in 12/13, rarely in 11/12, more rarely in 13/14.

The clitellum is annular, extending from 13/14 to the setae of segment xvi in every one of the specimens (55).

The setae begin on ii; are present on the penultimate and in some cases apparently on the ultimate segment. Both anterior and posterior to the clitellum there is no ventral break in the setal circles; a dorsal break may or may not be present, the break, when present, small and not occurring regularly on successive segments. None of the setae project conspicuously, in fact quite the opposite, and none appear to be enlarged. The setae are slightly closer together ventrally than dorsally, both anterior and posterior to the clitellum. Setae are present on xvi, at least ventrally, but cannot be recognized dorso-laterally and dorsally on many of the specimens. The number of setae between the lines of the spermathecal pores varies:—on vi from 24-27, on vii from 24-32, and on viii from 25-32. The number of setae between the genital markings of xviii varies from 6-9. The number of setae on segment xx varies from 64-72.

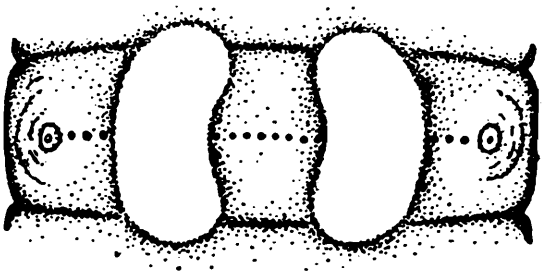

Fig. 41.—*Pheretima suctoria* variety *manicata*, n. var. Genital markings on xviii.

The spermathecal pores are minute, grey dots in 5/6-8/9, at the centres of tiny, round, whitish areas, which sometimes appear to protrude slightly as tiny tubercles. There may or may not be a conspicuous whitening of the margins of the segments in the vicinity of the spermathecal pores.

A definitely recognizable female pore can be made out on 32 of the specimens; in each of these worms the pore is single, a minute grey dot surrounded by a tiny but distinct ring of whitish tissue at the bottom of the greyish depression in the mid-ventral region of xiv.

The male pores on xviii are small, like pin pricks, at or near to the centres of round, smooth-surfaced, greyish areas in the setal circles. The

greyish circular area is not definitely circumscribed by a completely circumferential furrow, but there are usually several grooves at or near to the edge of these areas. The male markings are external to the copulatory markings by $\frac{1}{2}$-$\frac{3}{4}$ mm. Between the copulatory markings and the male markings there is a space for 3-4 setae, but none can be definitely recognized in that area, although in several specimens there are one or two small, dark spots that may be the outer tips of setae.

The other genital markings are a pair of elongately oval areas on xviii, internal to the male pores. These markings are slightly protuberant beyond the general surface level, and are surrounded by a greyish circumferential groove. The surface when moist appears smooth but when dry gives the impression of an exceedingly fine-granular surface, although the individual granulations are not visible even with higher powers of the binocular. The markings extend antero-posteriorly to 17/18 and 18/19, or slightly onto xvii and xix, rarely to the setal circles of xvii and xix, or more rarely through the setal circle of xix. In the latter case the setae may be pushed posteriorly or may be lacking on the region occupied by the markings. These genital areas always extend further onto xix than onto xvii. Markings confined to xviii are nearly round, those extending further are narrower.

Bits of cuticle from the ventral portion of xviii were stripped off and examined with the microscope. The cuticle immediately around the male pore is thickened into an opaque ring. From this ring the cuticle is invaginated into the interior of the parietes as a hollow tube, which

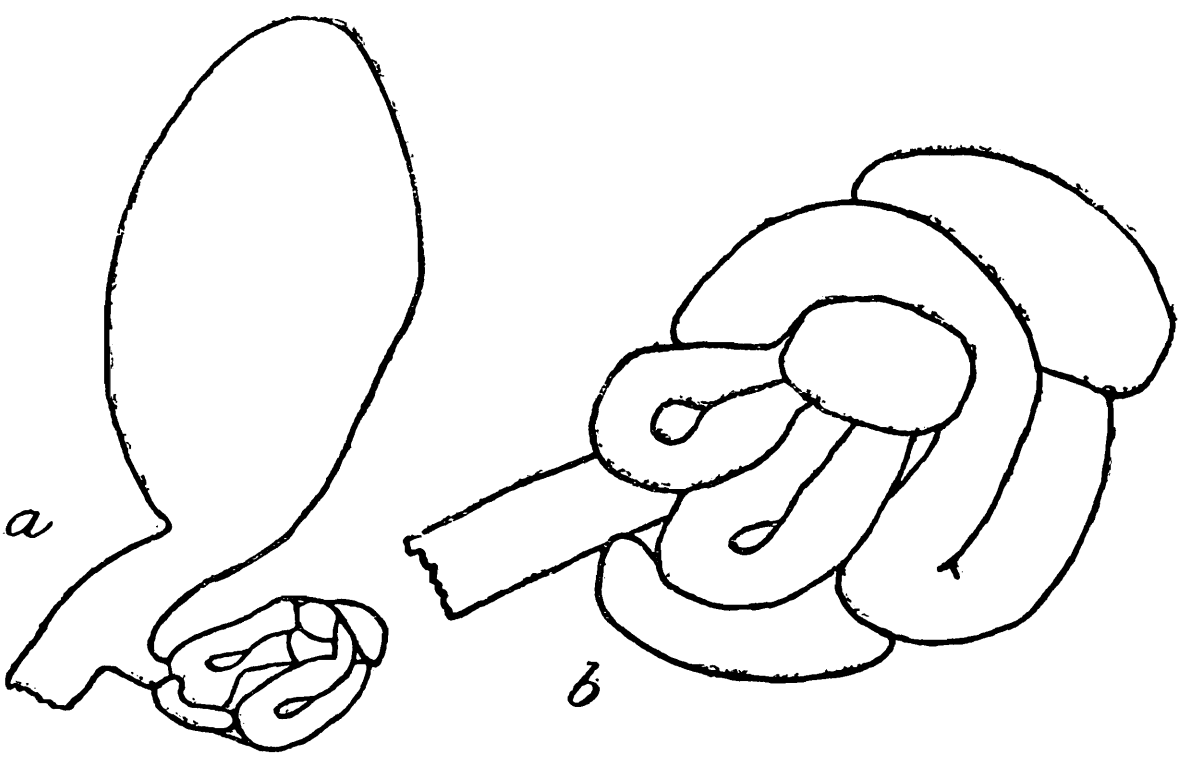


Fig. 42.—*Pheretima suctoria* variety *manicata*, n. var. *a*. Spermatheca, × *ca*. 22. *b*. Spermathecal diverticulum, × *ca* 45.

appears to be thickened in a spiral or annular fashion, but this appearance may be due to wrinkling of the delicate cuticular tube. Over the region of the large genital markings the cuticle is pierced by a closely crowded array of diamond-shaped pores.

*Internal anatomy.*—Septum 4/5 is present, thin; 5/6-7/8 are slightly thickened; 8-9 and 9-10 are lacking; 10/11 and 11/12 are invaginated in such a way that the testis sacs appear to lie within segments xi and xii instead of x and xi.

The intestine begins in xv or xvi. The intestinal caeca extend from xxvii into xxv or xxiv. Each caecum consists of 7-11 finger-shaped, whitish or yellowish processes. On each side of the intestine in xxviii close to 27/28 there is, in many specimens, a vertically elongated, antero-posteriorly narrowed outpocketing of the intestine, of the same colour as the caeca in the preceding segment. The edges of this pocket may be slightly incised or there may be quite definite short and stumpy lobes. More rarely still a rudimentary structure of a similar sort can be seen in xxix. The typhlosole is either absent or represented by a very slight ridge running through a few segments behind the region of the caeca.

The last pair or hearts is in xiii, all the hearts of x-xiii and the single heart of ix pass into the ventral blood vessel. There are masses of acinous glands on the muscular cords passing through segments v and vi.

The seminal vesicles are large. Those of xi push 10/11 forward so that it embraces the sides of the posterior portion of the gizzard; the posterior pair push 12/13 and 13/14 back into contact with 14/15. The prostates are large, extending through xvi-xxi; edges much incised. The prostatic duct is 4-7 mm. long, usually bent into a sort of S shape, thickened ectally just before passing into the parietes. There are two flattened glands on the coelomic floor of segments xvii-xix, over the site of the genital markings. The external margin of these glands bulges outwards so that the prostatic duct appears to pass into the parietes in contact with the parietal margin of the gland, but the bulging portion can be pushed back showing the duct passing into the parietes at a distance from the edge of the gland.

The ovaries and oviduct funnels are in the usual positions; there are no ovisacs in xiv. The spermathecal ampulla is elongate and longer than the duct, which is narrowed as it passes into the parietes, and constricted as it reaches the epidermis. The diverticulum consists of a short narrow stalk and a slightly thicker ental portion. Part of the stalk and all of the remainder of the diverticulum is coiled into a closely-compacted spherical mass of loops.

The Burmese worms differ from the Andaman Island specimens in the following characteristics:—

1. Larger number of setae between the lines of the spermathecal pores, lack of enlarged setae, more even and regular arrangement of the setae on segments ii-x.
2. Smaller extent of the clitellum.
3. Greater separation of the male-pore-areas from the genital markings; larger extent of the genital markings. Differences in the surface granulation of the markings.
4. Composite nature of the intestinal caeca.
5. Absence of ovisacs.
6. Coiling of the spermathecal diverticulum into a spherical mass.

No Burmese specimens have been found approaching the Andaman Island worms with regard to any of these characteristics. After examination and comparison of the actual specimens from both localities it has seemed preferable to treat the Burmese form as a distinct variety of the former. If this be correct, *P. suctoria* is the first species of zoogeographical significance common to both the Andamans and Burma. The occurrence of a form common to those two localities in the Tennaserim division rather than in the Arakan hill regions or the area between these two latter localities is of peculiar interest.

The genital markings of *P. suctoria* are somewhat similar to those of *P. papilio*, but the latter species differs from the former in the anterior position of the first dorsal pore and the size and shape of the spermathecal diverticulum. The genital markings of *P. defecta* are also somewhat similar to those of *P. s. typica*, but the former species may be distinguished from the latter by the larger number of setae between the genital markings and the greater number of setae per segment.

## Genus **Perionyx** E. Perr.

### **Perionyx excavatus**, E. Perr. 1872.

Prome, April, several specimens.
Taungdwingyi, April, several specimens.
Maymyo, May, June, August, several specimens in each month. August specimens, K. N. Sharma.
Moulmein, August, a number of specimens.
Ye, August, a number of specimens.
Martaban, August, a number of specimens.
Kyaikmaraw, August, a number of specimens.
Kya In, August, a number of specimens.
Shwegyin, September, several specimens.
Nyaunglebin, September, several specimens.
Pazunmyaung, September, several specimens.
Kalimpong near Darjiling, India, September, a large number of specimens, K. N. Sharma.
Kodaikanal, S. I., April and May, several specimens in each month.

## The *OCTOCHAETINAE.*

## Genus **Octochaetus** Beddard.

### **Octochaetus birmanicus** Gates.

*Octochaetus birmanicus*, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 55 (1925).

Moulmein, August, a large number of specimens.
Martaban, August, a large number of specimens.
Shwegyin, September, a large number of specimens.
Nyaunglebin, September, a large number of specimens.
Pazunmyaung, September, a large number of specimens.
Syrian, September, a number of specimens.

### **Octochaetus lunatus** Gates.

*Octochaetus lunatus*, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 24, fig. 12 (1929).

Namkham, May, 1 specimen.
Moulmein, August, several specimens.
Ye, August, several specimens.
Chaungson, August, a number of specimens.
Kyaikmaraw, August, a number of specimens.
Maymyo, August, 4 specimens, K. N. Sharma.
Shwegyin, September, several specimens.

The Namkham specimen was found towards the end of May only after considerable rain had fallen.

## Genus **Eutyphoeus** Mich.

### **Eutyphoeus annulatus**, n. sp.

Sagaing, August, 22 specimens, many softened and slightly stretched.

*Description of the type-specimen. External characteristics.*—Length 68 mm. Greatest diameter 5 mm. Number of segment 92. Colour: ventrally whitish; dorsally, anterior to the clitellum bluish, posterior to the clitellum brownish; clitellum reddish.

The pro- stomium is combined pro- and epilobous with the epilobic furrows reaching nearly to 1/2.

On segment v there is a single secondary furrow, posterior to the setae of the segment; on vi-xiii there are two secondary furrows per segment, one anterior to and one posterior to the setae; segments viii-xii have a slighter tertiary furrow on each of the secondary anterior and posterior annuli of the segments.

The first dorsal pore is in 11/12.

The setae begin on ii; are eight per segment; anterior to the clitellum $ab<cd$ which is slightly less than $bc<aa$; posterior to the clitellum *ab* and *cd* are about equal and less than $bc<aa$, *dd* greater than one-half the circumference. The setae of the tail segments do not appear to be larger than those of the preceding segments, nor do they project more conspicuously.

The clitellum extends from just anterior to 13/14 to mid xvii. The clitellar thickening of the epidermis is lacking in a narrow mid-ventral region where the epidermis is so thin that through it the muscles are visible. Setae are present but dorsal pores and intersegmental furrow are lacking.

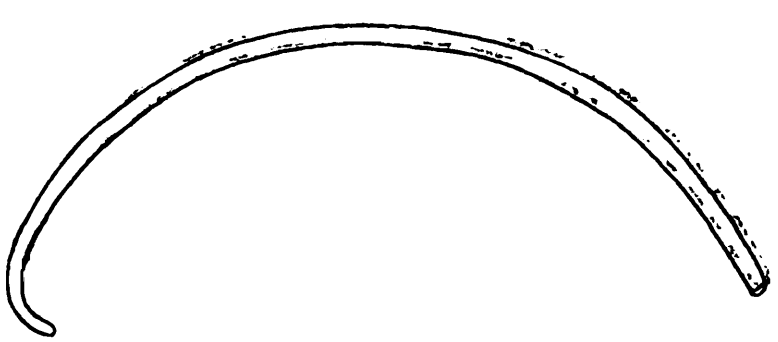

Fig. 43.—*Eutyphoeus annulatus*, n. sp. Penial seta, × *ca.* 35.

The spermathecal pores are small, one pair, in 7/8, in line with *c*, each pore overhung by a small, rounded flap of turgid tissue from the posterior margin of vii. The female pores are both present small but readily visible, each pore just anterior to *a*.

There is a small vestibular pore on each side about in line with *b*. This pore is small, and located at the bottom of a lateral depression. The margins of the pore are in contact with each other. Each depression is surrounded by a U-shaped, slightly protuberant ridge, the apertures of the U facing each other across the midventral line. The anterior arms of these ridges are continuous across the mid-ventral line with each other, but the posterior arms are not continuous, each arm ending about at *a*. Laterally the bottom of the U reaches nearly to *c*. There is a short, conical, penial tube concealed within each small, narrow vestibulum.

The genital markings are transversely placed, oval papillae, each papilla glistening, with a convex surface, surrounded by a distinct circumferential groove, groove and papilla in a slight depression in the parietes. The papillae are located posteriorly on the left side of x, on the right and left sides of xi, on the right side of xii, and on the right and left sides of xv. The papillae of xv extend internally more towards *a* and externally less beyond *b* than do the preclitellar papillae.

*Internal anatomy.*—Septa 4/5 and 5/6 are present, both rather thin, 6/7 and 7/8 are absent; 8/9, 9/10 and 10/11 are displaced posteriorly together, 11/12 does not seem to be visible at all.

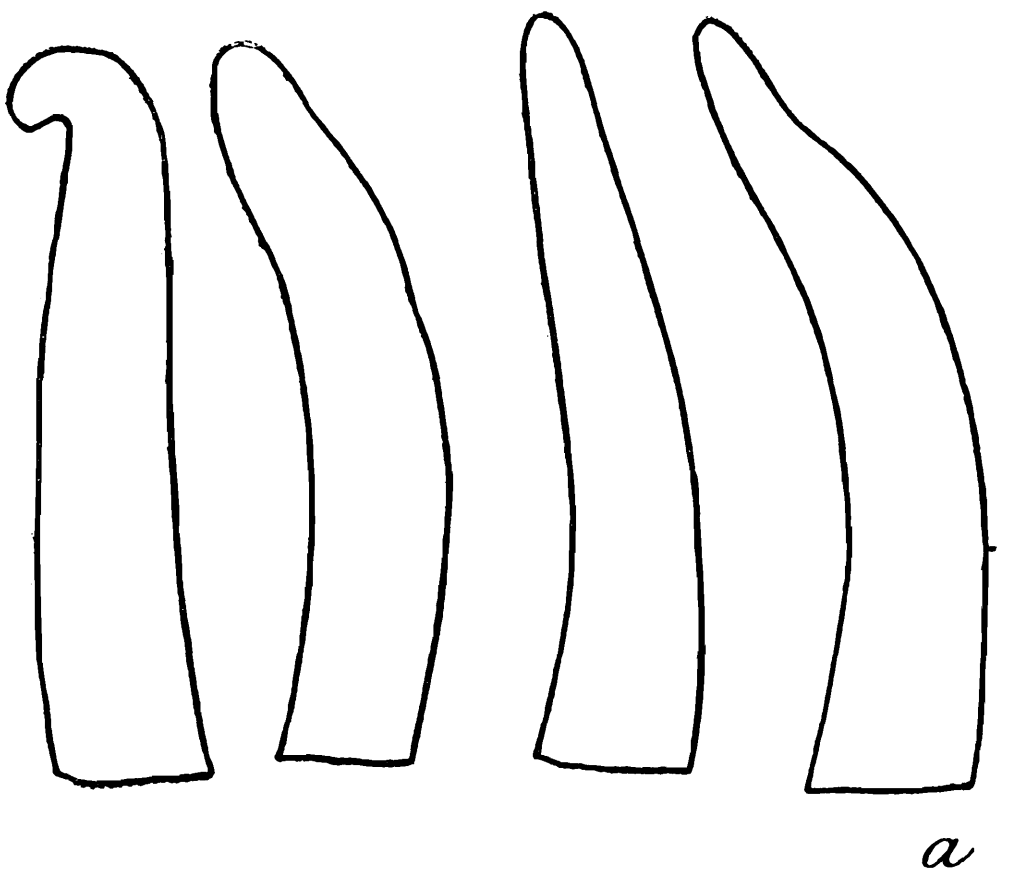


FIG. 44.—*Eutyphoeus annulatus*, n. sp. Tips of penial setae, × *ca* 670. *a*. immature seta.

The gizzard is short and stout. There are calciferous glands with the usual structure in xii. The intestine begins in xv. No lateral intestinal caeca were observed.

The dorsal blood vessel gives off two pairs of commissures behind the gizzard which belong to segments vii and viii, and one pair of commissures anterior to the gizzard belonging to segment vi and then passes through 5/6 and 4/5 and is continued forward onto the pharyngeal mass. The last pair of hearts is in xiii. The hearts of xi are not closely bound down to the oesophagus.

There appears to be a pair of testis sacs protruding from under the oesophagus, to the posterior border of each of which a seminal vesicle is attached. The anterior border of these sacs (?) is not attached, so far as can be seen in the dissection, to the posterior face of 10/11. The vesicles are large and extend anteriorly to 10/11 and posteriorly push 12/13 back into contact with 13/14. The coiled, brownish, tubular prostates lie in segments xvii-xix. The duct is short, whitish. The vas deferens is enlarged posterior to the prostatic duct into a bulbus ejaculatorius. The penial setae are not spirally coiled but are widely crescent-shaped or bow-shaped.

The ovaries and oviduct funnels are in the usual positions. The oviduct funnels are small but thick-lipped. The ampulla of the right spermatheca is relatively very large, that of the left spermatheca smaller and with a corrugated surface. The duct is short and stout but not confined to the body wall; there is a right and left finger-shaped diverticulum from the duct.

There are dome-shaped masses of glandular tissue projecting into the coelom from the ventral parietes over the genital papillae.

*Remarks.*—The length of other specimens varies from 65-90 mm., and the greatest diameter from 4-5 mm. The first dorsal pore is in 11/12 in all the specimens, but in some worms there is a small pore-like, dark mark in 10/11 that may represent a vestigial dorsal pore. The setal intervals are as in the type-specimens, except that *ab* is usually very slightly smaller than *cd*; *dd* is greater than one-half of the circumference in all of the specimens. The clitellum extends from somewhere on the posterior half of xiii to mid xvii. The spermathecal pores are in line with *c* or just internal to *c*.

The appearance of the male region on xvii varies from a condition in which the limbs of the U-shaped ridges are continuous across the mid-ventral line enclosing a transversely depressed area at the bottom of which are the vestibular pores, to a condition in which there are no well marked ridges or vestibula but in which the conical penes protrude from level areas, through conditions in which there are two completely separate U-shaped ridges, two depressions and two vestibula.

The preclitellar genital markings are on the posterior halves of the segments and in the region of *bc*. The clitellar markings are presumably on the posterior halves of the segments concerned but intersegmental furrows are lacking. The post-clitellar markings seem to be located across the intersegmental furrows in such a way as to extend antero-posteriorly nearly to the setae of the two segments concerned, but rarely the intersegmental furrow involved is quite evidently displaced at least laterally by the marking. These markings extend internally more towards *a* and externally less into *bc* than do the anterior markings.

The variation in numbers and location of the genital papillae may be best indicated in tabular form.

| | Segment. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ix. | x | xi. | xii. | xiv. | xv | xvi. | xix. | xx. | xxi. |
| 1 | .. | r. 1 | r. | .. | .. | r. 1 | | .. | .. | |
| 2 | r. | 1 | r. | .. | r. | r. 1 | .. | .. | .. | |
| 3 | .. | r. 1 | 1 | .. | .. | 1 | .. | .. | .. | |
| 4 | .. | r. 1 | r. | .. | .. | r. 1 | .. | .. | .. | .. |
| 5 | .. | r. 1 | r. | .. | | r. 1 | | .. | .. | .. |
| 6 | r. | 1 | 1 | | .. | r. 1 | | | | .. |
| 7 | .. | 1 | r. 1 | | .. | 1 | .. | | .. | .. |
| 8 | | 1 | r. 1 | r. | .. | r. 1 | | .. | .. | |
| 9 | .. | r. | 1 | | .. | r. 1 | .. | | | |
| 10 | | | 1 | | .. | r. 1 | .. | .. | .. | .. |
| 11 | .. | .. | 1 | | .. | r. 1 | .. | .. | .. | |
| 12 | | .. | | .. | 1 | r. 1 | .. | .. | | .. |
| 13 | .. | r. 1 | .. | .. | .. | r. 1 | .. | r. | | .. |
| 14 | .. | r. | 1 | .. | | r. 1 | .. | 1 | .. | .. |
| 15 | | r. | r. | .. | .. | r. 1 | r. | r. 1 | 1 | |
| 16 | .. | r. 1 | r. | | | r. 1 | .. | r. 1 | .. | .. |
| 17 | | r. | .. | .. | r. | r. 1 | .. | r. 1 | 1 | |
| 18 | .. | r. 1 | r. 1 | .. | .. | r. 1 | .. | .. | r. 1 | |
| 19 | .. | r. | r. | .. | .. | r. 1 | .. | .. | r. 1 | .. |
| 20 | | 1 | 1 | .. | .. | r. 1 | .. | .. | r. 1 | . |
| 21 | .. | r. | r. 1 | .. | .. | r. 1 | .. | .. | .. | 1 |

(In this tabular statement r indicates the presence of a papilla on the right side of the segment noted and 1 indicates the presence of a papilla on the left side of the segment noted.)

One specimen has no genital markings aside from the vestibular ridges.

No lateral intestinal caeca have been found in any of the specimens dissected. There are 4-6 median, ventral caeca. There are 6-8 pairs of whitish supra-intestinal glands in the middle region of the body.

On opening the worm from the dorsal side there appear to be present paired testis sacs, but after removing the oesophagus there is seen to be but a single, median, ventral, dumb-bell-shaped testicular chamber or sac, the rounded ends of which protruding from beneath the oesophagus produce the appearance of the presence of two sacs. The hearts of xi are free (*i.e.*, not bound down to the oesophagus) and enter the testicular chamber just before passing into the ventral trunk.

The prostates are 18-22 mm. long, the duct 4-6 mm. long, coiled, marked off from the gland by a sharp constriction. The penes are short but distinctly conical structures. The penial setae are not spirally curved but bow- or crescent-shaped. The outer ends of all of the setae examined from a number of specimens, including even the shortest reserve setae, are softened. In the least softened setae there appears to be nothing noteworthy about the tips which end in a gradually narrowing simple point without a terminal spine. The setae are ornamented with closely-set circles of crowded teeth or spines, the ornamentation beginning almost at the very tip. Each seta usually has one, two, or three annular constrictions, much lighter in colour thar the rest of the seta, producing a jointed or segmented appearance.

The spermathecal ampuila is always very large relative to the size of the worm. The ampulla is usually full of a pasty material but even when quite empty is still large. The diverticula are usually finger-shaped, but sometimes are bilobed, trilobed, or even berry-like. The duct is best described as barrel-shaped.

Two specimens have in v a pair of very small but commissure-like branches from the dorsal blood vessel but these being fragile and transparent were not traced.

Practically all of the specimens lack the clitellar thickening of the epidermis in the mid-ventral line.

The external markings, the characters of the spermathecal diverticula and the penial setae resemble in varying degrees those of *E. sejunctus*. It is just these characteristics upon which the discrimination of species has been based (Stephenson, 1923, p. 428). The differences between the two forms in regard to these three structures do not seem at first to be very important. The penial setae of *annulatus* are not spirally coiled ; the diverticulum of *annulatus* is more apt to be finger-shaped, that of *sejunctus* rounded or knob-like or consisting of two or more similar rounded knobs ; the genital markings are much the same in appearance and structure but are in slightly different positions. If only these differences be taken into consideration it might be considered desirable to treat the present forms as a variety of *sejunctus*. But the worms from Sagaing differ from *sejunctus* in a number of other characteristics such as :—in the possession of pigment, location of the spermathecal pores in line with or near to *c* instead of *b*, the more ventral position of *cd* posteriorly, and the absence of a well-developed pair of lateral intestinal caeca. Both forms have been found hitherto only in single localities and so far as the majority of characteristics are concerned the worms of one locality do not vary significantly from the conditions described in the type. In view of these facts it seems preferable at the present time to regard the two forms as distinct species.

Both *E. annulatus* and *E. sejunctus* are somewhat similar in the characteristics of the genital markings to *E. rarus*, but the latter is as a rule much larger and has a distinct spine at the tip of the penial seta. *E. annulatus* and *E. sejunctus* seem to be more like *E. assamensis* than any other species known at present. (*E. assamensis*, Katlicherra, S. Cachar, Assam ; Stephenson, 1924, p. 262). From the latter the Burmese species may be distinguished by the presence of the pair of commissures belonging to segment vi and the continuation of the dorsal blood vessel anteriorly.

### Eutyphoeus cochlearis, n. sp.

Pakokku, July, a number of specimens.
Anidaung, July, a number of specimens.
(Monywa, July, several immature specimens probably belonging to this species.)

*Description of the type-specimen. External characteristics.*—Length 197 mm. Greatest diameter 9 mm. Number of segments 211. Colour : dorsally brown ; ventrally greyish ; clitellum brownish. Prostomium combined pro- and epilobous.

On each of segments ii-iv there is a single secondary furrow posterior to the setae of the segment; on v there are two deep secondary furrows and two slighter tertiary furrows; on vi and vii there are three deep furrows, the third in reality a tertiary groove on the third of the secondary annuli; on viii there are three deep furrows and two slighter furrows; on ix there are four furrows, all approximately of the same depth; on x-xii there are three furrows of which two are on the posterior portion of the segments; on xiii and succeeding segments there are two furrows.

The first dorsal pore is in 11/12.

The setae are eight per segment, beginning on ii, $ab < cd < bc < aa$; *dd* is greater than one-half of the circumference.

The clitellum extends from mid xiii to 17/18.

The spermathecal pores are small relative to the size of the worm, located in 7/8 in *bc*, slightly nearer to *b* than to *c*. A female pore is present on the left side only. The peni-setal pores are at the tips of minute whitish knobs on the bottom of the median vestibular depression just external to the line of setae *b*.

The vestibular aperture is a single, transversely elongate opening on xvii extending into mid *bc* on each side. The posterior margin of the aperture is nearly straight but the anterior margin is twice indented by slightly tumid posterior projections of the anterior lip. The vestibulum is deep laterally but in the midventral line is shallow so that there appears to be a rounded longitudinal ridge dividing the vestibular cavity into two portions. The anterior and posterior margins of the vestibular aperture are whitened, but the brown pigment extends clear to the lateral margins.

The single genital marking is a roughly circular, whitish, glistening, mid-ventral area extending antero-posteriorly from the setae of xv to the setae of xvi and externally to just beyond the line of *b*. Seta *a* of the right side of xv is included within the area and seta *b* of the right side of xv is in the slight groove that marks off the area circumferentially.


FIG. 45.—*Eutyphoeus cochlearis*, n. sp. Tips of penial setae. *a*, *b*. × *ca.* 340. *c*. × *ca.* 325.

*Internal anatomy.*—Septa 4/5 and 5/6 are present and thickened, the latter more than the former; 6/7 and 7/8 are lacking; 8/9, 9/10, and 10/11 are thickened and dislocated posteriorly together; 11/12 does not seem to be present.

The gizzard is short and stout, width greater than length, and with a slight posterior flange. The intestine begins in xv. There are calciferous glands of the usual sort in xii. No lateral intestinal caeca have been found.

Large tufted masses of nephridia adhere to the parietes in iii.

The last pair of hearts is in xiii; the hearts of xi are bound down to the oesophagus by a thin sheet of connective tissue attached to the oesophagus just posterior to the hearts which passes anteriorly to fuse with 10/11. There are two pairs of hearts belonging to segments vii and viii under 8/9. The dorsal blood vessel is continued anterior to the hearts of vii as a short stump which ends abruptly without trace of further continuation onto the dorsal surface of the gizzard.

The testicular chamber is median and largely under the oesophagus but whitish material extends dorsally between the hearts of xi and the posterior face of 10/11 onto the dorsal surface of the oesophagus. The vas deferens is much thicker in segments xii and xiii than in the succeeding segments. In xvii the vas is enlarged into a bulbus ejaculatorius. The coiled, tubular prostates are reddish brown, the coiled, narrower duct is whitish. There is a peni-setal sac containing a number of penial setae in xvii on each side. The seminal vesicles are large and extend from 10/11 to 12/13 pushing 12/13 back into contact with 13/14.

The ovaries and oviduct funnels are in the usual positions in xiii. The spermathecal ampullae are large and flattened, the spermathecal ducts short. On the right and left sides of each duct is a diverticulum composed of a number of small seminal chambers.

On each side of the nerve cord, projecting slightly into the coelom from the parietes, is a pinkish mass of tissue into which the prostatic duct, peni-setal sac, and the bulbus ejaculatorius pass.

*Remarks.*—The length of other specimens varies from 144-230 mm. and the greatest diameter from 6-9 mm. The first dorsal pore is in 11/12 in the majority of the specimens, in 12/13 in two specimens, a pore doubtfully present in three specimens. The genital marking of other specimens differs from that of the type only in the transverse diameter, being sometimes longer than the antero-posterior length so that the marking has a transversely oval instead of a circular shape.

The extent of the clitellum and the setal relationships are as in the type-specimen. The interval *ab* may be one-half or less that of *cd*; *dd* is always greater than one-half of the circumference.

The spermathecal pores in all but one specimen appear to be a trifle nearer to *b* than to *c*. The female pore is single, on the left side in every specimen. The vestibular apertures may be more or less widely open than in the type.

No lateral intestinal caeca have been found. There are 3-6 median, ventral caeca beginning about at segment xxxiii. The dorsal blood vessel always projects anteriorly slightly beyond the commissure of vii as a more or less roughly conical stump.

The prostatic ducts may be 4-6 mm. long, not sharply constricted off from the gland, increasing gradually in thickness towards the parietes. The number of reserve penial setae is large, as many as 11-13 have been found in the specimens dissected. The setae are 3-4·4 mm. long, variously bent, but all with a spoon-like tip. The ornamentation consists of

circles of closely placed spines or teeth, beginning almost on the very tip of the setae.

There are four thickenings of the ventral body wall in the vestibular region, one on each side on the anterior wall and one on each side on the posterior wall of the vestibulum. The two thickenings of one side project into the coelom as a single mass into which the peni-setal sac, the prostatic duct and the bulbus ejaculatorius pass. The thinner portion of the ventral parietes in the midventral line is thrown into an antero-posterior ridge dividing the vestibulum into two deep lateral portions. In this deeper portion is the slight protuberance which bears the peni-setal pore.

There are always two diverticula on the spermathecal duct, but the number of seminal chambers in each diverticulum, and the conformation of the diverticula varies considerably. There is a flattened thickening of the parietes over the genital marking, which does not project conspicuously into the coelom.

The immature specimens from Monywa apparently belong to this species but differ therefrom in that the dorsal blood vessel may be continued forward onto the gizzard and anteriorly, sometimes with a commissure on the right or the left side of vi, in one specimen with a pair of commissures in vi. The length of the Monywa specimens is 105-160 mm.

This species is very similar to *E. excavatus*, differing from it in the absence of the lateral intestinal diverticula, the absence of the anterior genital marking on 14/15, the presence of a diverticulum on the inner face of the spermathecal duct, and the sculpturing of the ectal end of the penial setae into a spoon-shape. The genital marking on 15/16 and position and shape of the vestibular pore are as in *excavatus*.

The type and a cotype specimen of *E. excavatus* have been re-examined. There is a diverticulum on the external face of the spermathecal duct only, in both specimens; all of the penial setae even the very short reserve setae lack the spoon-like hollow of the tip. The ornamentation of spines is more sparse on the setae of *excavatus*, the spines or teeth not aggregated into such completely circumferential circles as in *cochlearis*.

The relationship between *cochlearis* and *excavatus* is curiously similar to that between *E. foveatus* and *E. spinulosus*. Both *cochlearis* and *foveatus* resemble their twin species in shape and appearance of the vestibular aperture and the vestibulum, both *cochlearis* and *foveatus* differ from their twin species in having two spermathecal diverticula instead of one, and both differ from their twin species in the characteristics of the penial setae. Both *cochlearis* and *foveatus* have but one genital marking, while their cospecies *excavatus* and *spinulosus* have two genital markings. The resemblance ends here for the single marking of *foveatus* occupies the same area as the two markings of *spinulosus*, while the single marking of *cochlearis* is in the same position as the posterior of the two markings of *excavatus*.

### **Eutyphoeus foveatus** (Rosa) 1890.

Moulmein, August, several specimens.
Syriam, September, a number of specimens.

**Eutyphoeus peguanus** Gates.

*Eutyphoeus peguanus*, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 323 (1925).
*Eutyphoeus peguanus*, Gates, *Rec. Ind. Mus.* XXXII, p. 336 (1930).

*Diagnosis.*—First dorsal pore usually in 11/12. Female pores paired. Clitellum from the posterior portion of xiii to mid xvii or 17/18. Spermathecal pores in 7/8 in line with *b*, in *bc*, or in line with *c*. Small paired vestibular apertures on xvii, vestibula small. Genital markings large, paired, more or less rounded ; on segments xvi, xvii, xix, xx, xxi, xxii.

Metandric, but often with more or less rudimentary male funnels in x. The first pair of commissures is anterior to the gizzard and belongs to segment vi, the dorsal vessel as a rule not continued into v. Lateral paired and ventral unpaired intestinal diverticula. Penial setae ornamented with transverse rows of fine spines, tip with a knob, rounded, pointed, or variously bent.

The number of the subintestinal diverticula varies from one worm and one variety to another. The setal intervals also vary considerably, not only from one specimen to another, but from one region to another of a single worm. There are usually ten pairs of supra-intestinal glands in five successive segments in the middle of the body, but twelve pairs in six successive segments have been found. Sometimes the pair of glands of one side of a segment are fused so that they cannot be separated from each other, but a slight double lobing of the margin indicates the double origin. The condition of the vas deferens also varies, in some specimens it appears to be single, in others distinctly double for more or less of its extent.

Worms belonging to this species have been placed in five varieties (Gates, 1930). Recently collected specimens that do not belong to any of the preceding varieties necessitate the naming of two more. These seven varieties fall into two groups according to the presence or absence of a *tumidus* type of male porophore and according to the position of the vestibular apertures in relation to the markings of xvii.

The *typicus* group.

Worms belonging to this group have the vestibular pores on the posterior half of the genital markings of xvii, and on the outer or external half of that portion. Four varieties—

Variety *simplex*, Rangoon, Mergui, Mandalay, Chindwin Valley, Myitkyina. Post-clitellar genital markings lacking.

Variety *promotus*, Rangoon, Myitkyina. Post-clitellar genital markings on xix.

Variety *typicus*, Rangoon, Myitkyina. Post-clitellar genital markings on xxi.

Variety *postremus*, n. var. Syriam. Post-clitellar genital markings on xxii.

The *tumidus* group.

Variety *tumidus*, Toungoo. Post-clitellar genital markings on xix.

Variety *similis*, Moulmein district. Genital markings on xvi and usually on xxi.

Variety *praecox*, n. var. Shwegyin. Genital markings on xvi and xx.

## Variety **similis.**

*Eutyphoeus peguanus similis*, Gates, *Rec. Ind. Mus.* XXXII, p. 342 (1930).

Moulmein, August, 43 specimens.
Chaungson, August, 14 specimens.
Kya In, August, 30 specimens.
Ye, August, 18 specimens.

This variety had been previously found only at Kawkareik in the Moulmein district. All of the new localities are also in that district.

There is a greater range of variation in the location of genital markings here than has been found hitherto in any of the varieties of this species, as may be seen from the following table.

| | Number of specimens from | | | |
|---|---|---|---|---|
| | Moulmein. | Chaungson. | Kya In. | Ye. |
| 1. Normal | 35 | 10 | 18 | 5 |
| 2. xvi, xvii, right xxi | 2 | .. | 2 | 1 |
| 3. xvi, xvii, left xxi | 2 | .. | 2 | 7 |
| 4. xvi, xvii, right xx, left xxi | .. | .. | 1 | .. |
| 5. xvi, xvii, left xx, right xxi | .. | .. | 2 | .. |
| 6. xvi, xvii, right xx, right xxi | .. | .. | 1 | .. |
| 7. right xvi, xvii, left xxi | .. | 1 | .. | .. |
| 8. xvi, xvii, xx | .. | .. | 1 | 1 |
| 9. xvi, xvii, xx, left xix. | .. | .. | 1 | .. |
| 10. xvi, xvii, xx, right xix | .. | .. | 1 | .. |
| 11. xvi, xvii, xx, left xv | .. | .. | 1 | .. |
| 12. xvi, xvii, right xv | .. | 1 | .. | .. |
| 13. xvi, xvii | 4 | 2 | .. | 4 |

In the table above: normal means there are paired marking on segments xvi, xvii, and xxi. A segmental number alone means that there is a pair of genital markings on that segment in the usual position. A segmental number preceded by right or left means that the genital marking is present only on the side specially mentioned and is lacking on the opposite side of the same segment.

The spermathecal pores are wide, in *bc*, the slit extending nearly to but not quite reaching either of the setal lines; the centre of the slit appears to be slightly nearer to *b* than to *c*, individual variations from this position are all in a direction towards *b*.

The male funnels in x are quite rudimentary, knob-shaped, never with large crenellated margins, sometimes entirely absent. When present these funnels sometimes lack a posterior continuation into a vas deferens. The deferent duct is often provided with a rather conspicuous, greyish longitudinal line dividing the otherwise whitish cord into two unequal portions, one of which is much thicker than the other. The thinner portion may be lacking posteriorly even when present anteriorly.

There are usually 20-30 of the unpaired, median intestinal caeca.

## Variety **postremus**, n. var.

Syriam, September, 15 specimens. (Three of these specimens are quite small but are definitely recognizable even though obviously immature.)

On the whole this variety seems to be larger than *similis*, mature specimens ranging up to 195 mm. in length. The spermathecal pores

have their centres in line with *c*, just internal to *c*, or in *bc* but nearer *c* than *b*. The markings on segment xxii may be depressed in such a way as to produce a sucker-like appearance, or they may be flat, or they may protrude slightly, or they may protrude quite conspicuously. The shape of the markings is much the same as the post-clitellar markings of other varieties in the *typicus* group. The markings on xvii are slightly longer than wide; the vestibular pore located on the posterior half and the outer quarter of that half. The pore may be on the general surface level or it may be slightly raised on a conical protrusion. On the posterior lip of the vestibular pore there is a small tubercle with one or two lobes. The epidermis in the mid-ventral region between the clitellar markings may be glandular and protuberant, the protuberance fused to the male markings to produce a dumb-bell-shaped papilla.

There are 10-14 ventral intestinal caeca and 10 pairs of supra-intestinal glands on the intestine in the middle of the body. The male funnels of x are large and readily visible.

### Variety **praecox**, n. var.

Shwegyin, September, a number of specimens.
(Immature specimens from Nyaunglebin and Pazunmyaung probably belong to this variety.)

The spermathecal pores are in *bc*, wide, reaching nearly to both *b* and *c*. The vestibular pores are just external to *b*, the apertures larger than in *postremus*. The markings on xvii are of the *tumidus* type, conical protrusions, but sometimes with the appearance of being seated on larger flat-surfaced areas similar to those of the *typicus* group.

The ventral intestinal caeca are 12-17. There are ten pairs of supra-intestinal glands in the middle of the body. The male funnels of x are vestigial, knob-like. A thin greyish line divides the vas deferens into two longitudinal portions of unequal thickness.

## **Eutyphoeus pusillulus**, n. sp.

Ye, August, one fully mature specimen.

*External characteristics.*—Length 32 mm. Greatest diameter, in the clitellar region, 3 mm. Number of segments 80. Unpigmented. The prostomium is combined pro- and epilobous, about $\frac{1}{2}$, but the epilobic furrows are close together on i so that the tongue is very narrow.

On each of segments vi-x there are two secondary furrows, one anterior to and one posterior to the setae of the segment.

The first dorsal pore is in 10/11.

The setae are eight per segment; they begin on ii; $ab < cd < bc \backsim aa$; *dd* is greater than one-half of the circumference.

The clitellum begins behind the setae of xiii and extends to 17/18, intersegmental furrows and dorsal pores lacking, setae present. The clitellum is reddish brown in colour and distinctly protuberant. The brownish colouration is lacking mid-ventrally in a narrow region, which is slightly wider posteriorly than anteriorly; in this region the epidermis appears to be thinner than elsewhere on the clitellar segments.

The spermathecal pores are in 7/8 about in line with *b*.

The female pores are paired on xiv, each pore in line with *a*, each pore at the centre of a slightly protuberant, whitish, transversely oval, glandular area, which extends from mid *ab* nearly to the mid-ventral line. The longitudinal mid-ventral whitish area ends anteriorly against these two markings.

The peni-setal pores are on xvii, each pore about in line with *b*. The pore is surrounded by a slight, whitish rim, pore and rim at the bottom of a very slight concavity, the body wall around the concavity whitened and slightly tumid. The brownish colouration ends just external to these markings which form a rounded base of an elongately triangular mid-ventral marking, ending against the markings that bear the female pores.

*Internal anatomy.*—Septa 4/5 and 5/6 are present and thickened, the latter more than the former; 6/7 and 7/8 are lacking; 8/9, 9/10 and 10/11 are thickened and displaced posteriorly together; there is no trace of 11/12 on the lateral and dorsal parietes but there is a delicate septum-like sheet of tissue attached to the ventral parietes shortly behind 10/11. This sheet of tissue is attached to the oesophagus like a septum, but laterally and dorsal to the dorsal blood vessel bends forward and comes into contact with the posterior face of 10/11, so that the commissures of xi are pressed against the oesophagus as in many of the metandric species of the genus. This sheet of tissue forms with 10/11 a median chamber ventral to the oesophagus with dorso-lateral extensions around the sides of the oesophagus which include the commissures belonging to segment xi. This chamber is the equivalent of the testicular chamber of other species of this genus, but there is here no trace of the male funnels or testicular material that should be present. Aside from the commissures the chamber is empty.

The gizzard is large, the thickness greater than the length. There is a pair of typical calciferous glands in xii. The intestine begins in xv. No lateral intestinal caeca were observed. There are six pairs of supra-intestinal glands in 3 successive segments beginning about 23 mm. from the anterior end.

The dorsal blood vessel is continued forwards at least into v, there is a pair of commissures belonging to vi anterior to the gizzard, and two pairs of commissures belonging to segments vii and viii just behind the gizzard under 8/9. The last pair of hearts is in xiii.

There are tufted masses of nephridia adherent to the parietes in iii. Posterior to the clitellum there are three lines of nephridial tubules on each side, one attached to the parietes about in the region of *a*, another about in the region of *c*, and another dorsal to *c*.

There are small, loose whitish masses in xii, but nothing that is definitely recognizable as a seminal vesicle. There is a pair of large, rounded male funnels in x and a pair of medium-sized seminal vesicles in ix. The vasa deferentia pass backwards as an opaque cord on each side into xvii where they pass external to the prostatic duct; turning in towards the nerve cord they are slightly enlarged into ejaculatory bulbs as they pass into the parietes. There is no trace of deferent ducts leading into the mid-ventral chamber that represents a reduced segment xi. The prostates are short and flattened, the ducts much narrower

than the prostates from which they are sharply constricted; the ducts are coiled.

Setal sacs are present with penial setae. The sac was removed from the right side and one unbroken seta was obtained. This is about ·65 mm. long and about 20 micra thick at the region of greatest thickness; the shaft is nearly straight, with one bend towards the outer end, the tip probably slightly softened, ornamented with broken circles of very fine spines or teeth.

The spermathecal ampullae are spherical in shape. The duct is practically confined to the body wall. There is a single diverticulum on the outer side of each duct, one diverticulum is knob-shaped, the other is slightly more elongate and bent. The ovaries and oviduct funnels are in the usual locations in xiii.

*Remarks.*—Three days collecting in and near the town of Ye failed to bring in another specimen of this species. With only the type-specimen available for study there are several questions in connection with the species that must remain unanswered for the present.

All species of this genus found hitherto have been either holandric or metandric. In *E. pusillulus* we have apparently a proandric worm but derived not from a purely holandric form but from a holandric condition in which the metandric development had already begun (*i.e.*, the reduction of segment xi to a mid-ventral chamber). It is, however, also possible that this worm belongs to a holandric species in which segment xi has been reduced but which still retains the anterior pair of testes, funnels and seminal vesicles. In this case the present specimen is abnormal, the posterior pair of testes, funnels and seminal vesicles having failed to develop or having been lost, perhaps through parasitic castration.

Like the holandric Burmese species of the genus, *E. pusillulus* has its first dorsal pore in 10/11.

The clitellum of this specimen is unusually well developed for the genus. In *Eutyphoeus* the clitellum is not usually markedly protuberant even at the height of sexual activity, but here the clitellum is conspicuously protuberant resembling the condition found in specimens of Lumbricidae or *P. corethrurus* killed at the height of sexual activity.

### **Eutyphoeus sejunctus** Gates.

*Eutyphoeus sejunctus*, Gates, *Rec. Ind. Mus.* XXXII, p. 349 (1930).

The vestibular pores are small, usually open, *i.e.*, the lips are not in contact with each other. There is here very little to suggest the protuberant ridge that characterizes *E. annulatus*. There is, however, a thickening of the parietes internally immediately over the vestibulum, the thickening continued into the coelom as an erect protuberant structure described as a "column" in the original account of the species. This column may be thickly flap-shaped, columnar, or elongately or shortly conical. It is present in all specimens examined and seems to be characteristic of the species.

The anterior pre-clitellar genital markings are so placed that they cover the female pores when two worms are in copulatory juxtaposition.

As in *E. annulatus* there is no trace of septum 11/12. The testicular chamber is a median, dumb-bell-shaped structure under the oesophagus, attached to the posterior face of 10/11 only in the mid-ventral line under the oesophagus, the ends of the testicular chamber rounded and free so that when the worm is opened by a mid-dorsal incision there appear to be two testis sacs.

The spermathecal diverticula are usually rounded and knob-like with a single seminal chamber, sometimes bilobed, sometimes elongate as in *annulatus* and either straight or bent at right angles. The spermathecal ampullae and ducts are smaller both absolutely and relative to the size of the worms than in *annulatus*.

## The *GLOSSOSCOLECINAE*.

### Genus **Pontoscolex** Schmarda.

### **Pontoscolex corethrurus** (Fr. Müll.) 1890.

Hsipaw, May, several specimens.
Kyaukme, May, 4 specimens.
Moulmein, August, a number of specimens.
Ye, August, a number of specimens.
Chaungson, August, a number of specimens.
Martaban, August, a number of specimens.
Kyaikmaraw, August, a number of specimens.
Kya In, August, a number of specimens.
Nyaunglebin, September, several specimens.
Pazunmyaung, September, several specimens.
Syriam, September, several specimens.

## The *MICROCHAETINAE*.

### Genus **Glyphidrilus** Horst.

### **Glyphidrilus papillatus** (Rosa) 1890.

Mong Kung, April, a number of specimens.
Namkham, April and May, a large number of specimens.
Maymyo, May and June, a number of specimens.
Rangoon, June, July, August, September, and October, 92 specimens.
Maymyo, August, several specimens, K. N. Sharma.

In the Northern Shan States during April and the early part of May before the rains began this species was the only one that could be secured in any numbers. A very few specimens of certain other species were found after long searching. But *G. papillatus* was found in considerable numbers in almost every permanently moist bit of ground,—on the banks of the Shweli River, on the banks of the Nam Seri River, along irrigation ditches leading from the hills to the various Shan villages in the Namkham Valley, in buffalo wallows, and in swampy spots into which the water from irrigation ditches had leaked.

The genital papillae are round or transversely oval markings, which develop originally on the posterior half of the segments concerned but which may later grow forward anteriorly so as to occupy all of the space between two successive intersegmental furrows. The papilla consists of a wide, flat, whitish rim and a central greyish depression from which protrudes a rounded, white tubercle. The median papilla or papillae

are in *aa* : the lateral papillae in *bc* near *b*, in mid *bc* or near *c* ; in the region of *cd* but extending internal to *c* which is included in the rim. Genital markings in the latter position are practically dorsal.

The position of the genital papillae varies considerably from one specimen to another. In the Rangoon series the papillae are located as follows :—

Median single papilla in *aa*.

| On segment. | Number of specimens. | On segment. | Number of specimens. |
|---|---|---|---|
| xi | 27 | xxiii | 1 |
| xii | 58 | xxiv | 1 |
| xiii | 59 | xxv | 13 |
| xiv | 18 | xxvi | 8 |
| xv | 7 | xxvii | 16 |
| xvi | 9 | xxviii | 13 |
| xvii | 16 | xxix | 2 |
| xviii | 24 | xxx | 2 |
| xix | 3 | xxxi | 1 |
| xx | 1 | xxxii | 1 |
| xxi | 1 | xxxiii | 1 |
| xxii | .. | | |

Paired median papillae in *aa*.

| On segment. | Number of specimens. | On segment. | Number of specimens. |
|---|---|---|---|
| xii | 1 | xxv | 4 |
| xvii | 1 | xxvi | 11 |
| xviii | 1 | xxvii | 11 |
| xix | 3 | xxviii | 3 |
| xx | 6 | xxix | 1 |
| xxiv | 1 | | |

Paired lateral papillae in *bc*.

| On segment. | Number of specimens. | On segment. | Number of specimens. |
|---|---|---|---|
| xii | 7 | xxi | 31 |
| xiii | 11 | xxii | 30 |
| xiv | 44 | xxiii | 9 |
| xv | 74 | xxiv | 7 |
| xvi | 86 | xxv | 4 |
| xvii | 92 | xxvi | 19 |
| xviii | 60 | xxvii | 8 |
| xix | 50 | xxviii | 1 |
| xx | 47 | | |

Everyone of the specimens had a pair of lateral papillae on xvii. A majority of the specimens had in addition paired laterals on one or more of segments xv, xvi, xviii and xix, as well as unpaired medians on xii and xiii.

The number of papillae also varies considerably from one worm to another. The largest number of papillae found on a single worm was 40, on specimen 50 there are paired laterals on segments xiii-xxvii, and single medians on xi-xiii and xxvii-xxxiii. The smallest number of

papillae found was 8 on specimen 5 which has three pairs of laterals on xv-xvii, and median unpaired papillae on xi and xviii.

The ridges or " wings " also vary somewhat in their extent and segmental location. In the Rangoon series the wings are located as follows :—

| On segments. | Number of specimens. | On segments. | Number of specimens. |
|---|---|---|---|
| xviii-xxiii | 1 | xix-xxv | 1 |
| xviii-xxiv | 12 | xix-xxvi | 1 |
| xviii-xxv | 2 | xix-xxvii | 4 |
| xviii-xxvi | 19 | xxi-xxv | 3 |
| xviii-xxvii | 2 | xxi-xxvi | 16 |
| xix-xxiii | 4 | xxiii-xxvi | 5 |
| xix-xxiv | 1 | (Without wings | 21) |

The clitellar colouration extends over segments xvii-xxxiv in all specimens on which its limits were noted.

That portion of the specific definition of this species which deals with the genital markings should be changed to read as follows :—" Wings " begin on xviii-xxiii and extend onto xxiii-xxvi. Genital papillae :—unpaired medians on xi-xxi and xxiii-xxxiii ; paired medians on xii, xvii-xx, xxiv-xxix ; paired laterals on xii-xxviii.

## The LUMBRICIDAE.

### Genus **Bimastus** Moore.

### **Bimastus parvus** (Eisen) 1874.

Maymyo, June, 51 specimens.

This species was found in Burma for the first time about a year ago at Kalaw. Like Kalaw, Maymyo is a hill station where many of the common European garden plants are grown.

## REFERENCE.

Stephenson, J. The Oligochaeta. Oxford, 1930.

## APPENDIX.

### A. *List of localities.*

Burmese village names may be repeated from one district to another or even within the same district. To avoid future confusion in records of distribution a list is appended herewith of towns or villages from which or near which the earthworms mentioned in the preceding portion of the paper were collected, together with some indication as to location, direction, and (when known) altitude.

Ahmerst District.

Martaban—about 170 miles from Rangoon by rail.

Moulmein—across the river from Martaban.

Chaungson—on Bilugyun Island opposite Moulmein.

Kya In—on the Zami Chaung branch of the Attaran River about 70 miles from Moulmein.

Kya In Seik Kale—the landing place for Kya In, which is about two miles inland from the river bank.
Kyaikmaraw—about 15 miles from Moulmein.
Ye—about 190 miles from Moulmein in a southerly direction towards Tavoy.

Tharrawaddy District.
Tharrawaddy town 69 miles from Rangoon by rail.

Pegu District.
Nyaunglebin—93 miles by rail from Rangoon.
Pazunmyaung—98 miles from Rangoon.
Maduak—104 miles from Rangoon.
Paung—about 1 mile from Nyaunglebin, south.
Shwegyin—in Toungoo district but near Nyaunglebin.

Hanthawaddy District.
Syriam—near Rangoon.

Sagaing District.
Sagaing—on the right bank of the Irrawaddy below Mandalay.

Pakokku District.
Pakokku—on the right bank of the Irrawaddy about 105 miles below Mandalay.

Lower Chindwin District.
Monywa—on the left bank of the Chindwin River about 76 miles from Pakokku.
Anidaung—on the right bank above Monywa.

The Shan States.
Maymyo—423 miles from Rangoon by rail.
Kyaukme—491 miles from Rangoon.
Hsipaw—510 miles from Rangoon.
Lashio—561 miles from Rangoon.
Kutkai—about 50 miles from Lashio towards the Chinese frontier.
Namkham—on the Chiense border, about 132 miles from Lashio.
Taungyi.
Mong Kung—about 60 miles from Lashio on the road to Taungyi.
Mong Ko—Kengtung State.
Tolo Senca—Mong Yang district of Kengtung State near the Chinese border, ca. 3,000 ft.

Magwe District.
Taungdwingyi—about 293 miles from Rangoon by rail.
Magwe—on the left bank of the Irrawaddy River, about 50 miles by road from Taungdwingyi.

## B. *Notes on some Indian Earthworms.*

The worms with which this portion of the paper is concerned were collected at Kalimpong by Mr. K. N. Sharma, at Agarru-Narasapur taluq, West Godavery District by K. John, and at Kodaikanal, Palni Hills, South India. The collecting at Agarru was done in the month of April, that at Kodaikanal during April and May. With but few excep-

tions which are represented by very limited numbers of specimens, the worms secured at the two latter localities belong to peregrine species.

**Megascolex mauritii** (Kinb.) 1867

Agarru, April, several hundred specimens.

**Pheretima campanulata** (Rosa) 1890.

Variety **penetralis,** n. var.

Kalimpong, near Darjiling, India, September, 26 specimens, K. N. Sharma.

Length of mature specimens with clitella 107-144 mm. Greatest diameter 4-6 mm. Number of segments 113-129. Colour: dorsally brownish, obscured anterior to the clitellum by a bluish grey. The clitellum is reddish or brownish.

The first dorsal pore is in 11/12 in every one of the specimens; 5 worms have a distinct but non-functional pore-like depression in 10/11.

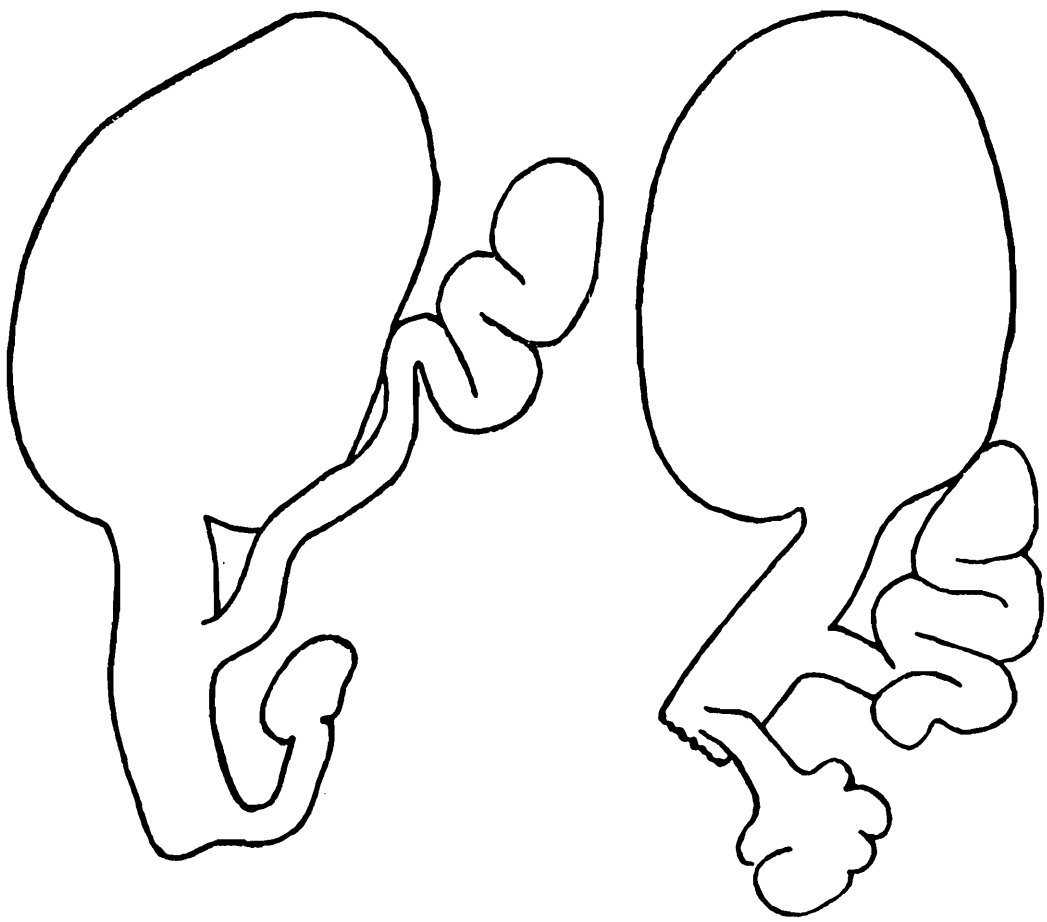

FIG. 46.—*Pheretima campanulata* variety *penetralis*, n. var. Spermathecae, × *ca.* 22.

The clitellum is annular, extending from 13/14 to 16/17.

The setae begin on ii, are located on a very fine but distinct, white, equatorial stripe running completely around each segment. Behind the clitellum there may or may not be a dorsal break in the setal circle, the break when present varying in width; there is no definite ventral break in the setal circles posterior to the clitellum. On segments ii-vii or viii the setae are few, especially ventrally, rather widely spaced, but none are much enlarged. On segments viii or ix to xiii the setae are

rather evenly spaced, the ventral setae more protuberant than the dorsal and apparently also slightly larger. The setae are more numerous and of course more closely crowded ventrally than dorsally. The numbers of the setae on segment xx of five worms picked at random are as follows :—

| | | | |
|---|---|---|---|
| 51 | 1 specimen. | 53 | 1 specimen. |
| 52 | 2 specimens. | 56 | 1 specimen. |

The numbers of the setae between the apertures of the copulatory chambers on xviii are as follows :—

| | | | |
|---|---|---|---|
| 7 | 1 specimen. | 9 | 12 specimens. |
| 8 | 7 specimens. | 10 | 6 specimens. |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| vii | 13- | 12- | 13- | 12- | 13- | 13- | 14- | 13- | 12- | 12- | 12- | 12- | 13- | 12- | 13- |
| viii | 17- | 16- | 17- | 17- | 16- | 17- | 15- | 15- | 17- | 15- | 17- | 17- | 16- | 16- | 16. |

The spermathecal pores are three pairs in 6/7-8/9, the pores large (when compared with the size of the pores of other species of the genus, as for instance *P. heterochaeta*), the margins of the pores slightly wrinkled.

The apertures of the copulatory chambers are round openings in the setal circle of xviii, the margin of the apertures minutely lobed.

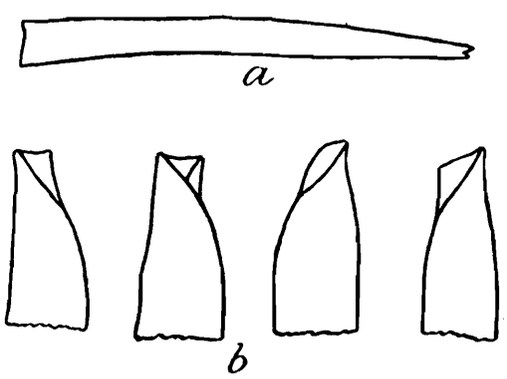


Fig. 47.—*Pheretima companulata* variety *penetralis*, n. var. *a*. Penial seta, × *ca.* 80. *b*. Tips. of penial setae, × *ca.* 335.

All but two of the specimens lack external pores to the stalked glands of the spermathecal segments. In these two specimens the pores of the stalked glands are located as follows :—

1. One pair of pores on vii, in contact with the furrow 6/7 anteriorly, each pore slightly internal to the spermathecal pore. One pair on viii anteriorly, similarly located, in line with the pores on vii.
2. One pair of pores anteriorly on viii as in the preceding specimen.

Two specimens lack a single spermathecal pore (and a spermatheca) ; on the right side of 8/9 of one specimen, on the left side of 8/9 of the other. Another specimen has a spiral abnormality involving segments xviii and xix.

The seminal vesicles of xi are large and in contact dorsally over the dorsal blood vessel. The seminal vesicles of xii are small, vertically elongate, strap-shaped bodies, attached by their bases to the posterior face of 11/12 at the sides of the oesophagus.

The spermathecal diverticulum usually arises from the inner face (*i.e.*, the side towards the nerve cord) of the spermathecal duct, in a

few specimens from the outer face. Associated with each spermatheca are at least two stalked glands, which may or may not be partially or wholly imbedded within the longitudinal musculature. On each side of segments vii and viii there are two of these glands, the stalk of one gland passing into the spermathecal duct on its anterior face, the stalk of the other gland passing into the spermathecal duct on its posterior face. The junctions of the gland stalks and of the spermathecal duct are within the parietes so close to the epidermis that it is rather difficult to remove the spermathecae of these segments with the glands still attached to the spermathecal duct. There are usually more than two of the stalked glands attached to the ducts of the spermathecae of ix; the number of the glands varies from three to six. The junctions of the stalks with the spermathecal duct appear to be slightly higher up in this segment for it is easier to remove these spermathecae from the parietes with the glands still attached to the duct.

The intestinal diverticula are elongated, simple sacs extending from xxvii forward into xix or xx, or bent under the intestine in xxiii or xxiv.

The penial setae are nearly straight or slightly sigmoid. The outer tip of these setae is not provided with a spine as in *P. c. typica*, but the tip is here bifid in a fashion similar to that of certain of the clitellar setae of *P. houlleti*. A short region near the tip is ornamented with short rows of fine spines. The two worms with external pores for their stalked glands (as *P. c. typica*) have penial setae with bifid tips. The length of the penial setae varies from ·47 mm. to ·63 mm.

Length of penial setae.

| | |
|---|---|
| Specimen 1 | ·63 mm.<br>·62 mm. |
| Specimen 2 | ·57 mm.<br>·47 mm.<br>·58 mm. |
| Specimen 3 | ·55 mm.<br>·53 mm.<br>·62 mm. |

## **Pheretima heterochacta** (Mich.) 1891.

Kodaikanal, Palni Hills, South India. 60 specimens.

While engaged in the study of some of the species included in the preceding portion of this paper it became evident that there was considerable need for a character or characteristics that could be used to accurately discriminate between varieties of a species. After working with several characters with little or no success it finally began to appear that certain setal characteristics might answer this purpose at least so far as the genus *Pheretima* is concerned. These characteristics are the number of setae between the male pores or copulatory chamber apertures and the number of setae between the lines of the spermathecal pores. The value which these characteristics seem to have in this connection has already been indicated in the introductory remarks concerning the genus *Pheretima* and in the discussions of some of the species of that genus. The number of setae between the male apertures has already been used to some extent by systematists but there seems to have been

no attempt to use the number of setae between the lines of the spermathecal pores for systematic purposes.

Although the evidence presented in the preceding portion of this paper tends to show that the latter characteristic in particular may be of considerable significance for systematic purposes, the objection may be raised that the specimens examined are, in most cases, from single localities or very small areas, and that if individuals from a number of different localities were to be examined there might be found such an amount of variation as to vitiate whatever value the character at present appears to have. It is, therefore, desirable that a number of specimens from widely separated localities should be examined in order to determine the extent of individual variation of the characteristics under discussion. The first opportunity that has arisen for such examination has been furnished by collections of *P. heterochaeta* from widely separated localities in South India, North India, Burma and China. The results of this examination are included in the table below. As the position of the first dorsal pore and the locations of the genital markings are also considered to be of systematic value, these characters were noted and this information has been included in the table in order to give some idea as to the extent of variation of these characteristics.

| Number of specimen. | Number of setae between the male pores. | Number of setae between the lines of the spermathecal pores on VI. | On VII. | On VIII. | First dorsal pore. | PRE-CLITELLAR GENITAL MARKINGS. | | Locality. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Pre-setal markings. | Post-setal markings. | |
| 1 | 12 | 8 | 8 | 10 | 11/12 | 0 | 0 | South India. |
| 2 | 12 | 8 | 11 | 12 | 11/12 | 0 | 0 | |
| 3 | 15 | 11 | 13 | 15 | 11/12 | viii. | L vii. | |
| 4 | 15 | 10 | 13 | 14 | 11/12 | vii-viii. | vi-vii-vii. | |
| 5 | 14 | 8 | 10 | 11 | 11/12 | vii-viii. | 0 | |
| 6 | 13 | 9 | 12 | 12 | 11/12 | R vii-viii. | 0 | |
| 7 | 15 | 8 | 10 | 12 | 11/12 | vii-viii. | R vi-vii-viii. | |
| 8 | 12 | 9 | 11 | 12 | ?11/12 | vii-viii R ix. | 0. | |
| 9 | 12 | 8 | 10 | 13 | 11/12 | vii-viii. | vii-viii. | |
| 10 | 14 | 8 | 10 | 12 | ?11/12 | vii-viii. | vi-vii-viii. | |
| 11 | 13 | 8 | 11 | 13 | ?11/12 | vii-viii. | vi-vii-viii. | |
| 12 | 14 | 8 | 11 | 12 | 11/12 | vii-viii. | 0. | |
| 13 | 12 | 10 | 11 | 12 | 11/12 | vii-viii. | 0. | |
| 14 | 14 | 8 | 10 | 12 | 11/12 | R vii-viii. | vi-vii-viii. | |
| 15 | 14 | 8 | 10 | 12 | 11/12 | R viii. | vii-viii. | |
| 16 | 14 | 8 | 11 | 13 | 11/12 | vii-viii. | L vi-vii-viii. | |
| 17 | 12 | 8 | 12 | 11 | 11/12 | R vii-viii. | vi-vii-viii. | |
| 18 | 12 | 8 | 10 | 11 | 11/12 | vii-viii. | vii-viii. | |
| 19 | 11 | 8 | 10 | 13 | ?11/12 | vii-viii. | vi-vii-viii. | |
| 20 | 12 | 8 | 10 | 12 | ?11/12 | vii-viii. | 0 | |
| 21 | 13 | 8 | 11 | 12 | 11/12 | vii-viii. | 0 | |

| Number of specimen. | Number of seta between the male pores. | Number of setae between the lines of the spermathecal pores on VI. | On VII. | On VIII. | First dorsal pore. | Pre-clitellar genital markings. | | Locality. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Pre-setal markings. | Post-setal markings. | |
| 22 | 12 | 9 | 10 | 12 | ?11/12 | vii-viii. | vi-vii-viii. | |
| 23 | 15 | 9 | 11 | 12 | ?11/12 | vii-viii. | vi-vii-viii. | |
| 24 | 15 | 8 | 10 | 13 | 11/12 | vii-viii. | Rvii-viii. | |
| 25 | 12 | 8 | 10 | 11 | ?11/12 | vii-viii. | O | |
| 26 | 13 | 8 | 12 | 13 | 11/12 | vii-viii-ix. | O | |
| 27 | 14 | 8 | 10 | 13 | ?11/12 | vii-viii. | R vi-vii-viii. | |
| 28 | 14 | 8 | 11 | 13 | 11/12 | vii-viii. | O | |
| 29 | 12 | 8 | 12 | 13 | 11/12 | vii-viii. | O | |
| 30 | 12 | 9 | 10 | 11 | 11/12 | vii-viii. | vii-viii. | |
| 31 | 13 | 8 | 10 | 13 | 11/12 | viii-ix. | O | |
| 32 | 14 | 6 | 11 | 13 | 11/12 | vii-viii. | O | |
| 33 | 12 | 8 | 10 | 10 | ?11/12 | viii. | O | |
| 34 | 13 | 8 | 11 | 13 | 11/12 | vii-viii. | O | |
| 35 | 13 | 9 | 11 | 13 | 11/12 | vii-viii. | vi-vii-viii. | |
| 36 | 12 | 8 | 10 | 11 | 11/12 | vii-viii. | O | |
| 37 | 15 | 8 | 11 | 11 | ?11/12 | vii-viii. | vii-viii. | |
| 38 | 12 | 8 | 10 | 13 | 11/12 | vii-viii. | vi-vii-viii. | |
| 39 | 14 | 8 | 10 | 11 | ?11/12 | vii-viii. | vii-viii. | |
| 40 | 14 | 8 | 10 | 11 | 11/12 | vii-viii. | vi-vii-viii. | |
| 41 | 12 | 8 | 10 | 11 | 11/12 | vii-viii. | O | |
| 42 | 14 | 8 | 10 | 12 | 11/12 | vii-viii. | O | |
| 43 | 12 | 8 | 11 | 13 | 11/12 | vii-viii-ix. | O | |
| 44 | 14 | 8 | 12 | 13 | 11/12 | vii-viii. | vii R viii. | |
| 45 | 15 | 9 | 11 | 13 | 11/12 | vii-viii. | O | |
| 46 | 14 | 8 | 11 | 12 | 11/12 | vii-viii. | O | |
| 47 | 12 | 8 | 9 | 12 | 11/12 | vii-viii. | O | |
| 48 | 14 | 8 | 10 | 11 | 11/12 | vii-viii. | R vi-vii-viii. | |
| 49 | 13 | 10 | 13 | 16 | ?11/12 | O | R vii. | |
| 50 | 14 | 10 | 12 | 13 | 11/12 | vii-viii. | R vi-vii-viii. | |
| 51 | 13 | 7 | 10 | 12 | 11/12 | vii-viii. | O | |
| 52 | 14 | 9 | 11 | 13 | ?11/12 | R vi R vii R viii. | O | |
| 53† | 12 | 8 | 11 | 12 | ?11/12 | vii-viii. | vi-vii-viii. | |
| 54† | 14 | 8 | 9 | 12 | 11/12 | R viii. | R vi-vii-viii. | |
| 55* | 12 | 8 | 11 | 11 | 11/12 | vii-viii. | vi-vii-viii. | |
| 56* | 14 | 9 | 9 | 11 | 11/12 | vii-viii. | vi-vii-viii. | |
| 57* | 15 | 8 | 11 | 12 | 11/12 | R viii. | L vii-viii. | |
| 58 | 12 | 9 | 12 | A | ?11/12 | vii-viii-ix. | O | |
| 59 | 13 | 9 | 12 | A | 11/12 | L vii-viii. | O | |
| 60 | | | | | | With spiral abnormalities. | | |
| 61 | 12 | 8 | 10 | 11 | 11/12 | viii. | O. | China. |

| Number of specimen. | Number of setae between the male pores. | Number of setae between the lines of the spermathecal pores on VI. | On VII. | On VIII. | First dorsal pore. | PRE-CLITELLAR GENITAL MARKINGS. | | Locality. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Pre-setal markings. | Post-setal markings. | |
| 62 | 9 | 9 | 9 | 10 | 11/12 | viii. | O | |
| 63 | 9 | 8 | 11 | 12 | 11/12 | O | O | |
| 64 | | 8 | 11 | 12 | 11/12 | + | + | North India. |
| 65 | | 8 | 10 | 11 | 11/12 | + | + | |
| 66 | | 8 | 11 | 12 | 11/12 | + | + | |
| 67 | | 9 | 11 | 13 | 11/12 | + | + | |
| 68 | | 8 | 11 | 11 | 11/12 | + | + | |
| 69 | | 8 | 12 | 12 | 11/12 | + | + | |
| 70 | | 8 | 10 | 13 | 11/12 | + | + | |
| 71 | | 7 | 10 | 13 | 11/12 | + | + | |
| 72 | | 7 | 9 | 11 | 11/12 | + | + | |
| 73 | | 8 | 11 | 12 | 11/12 | + | + | |
| 74 | | 8 | 10 | 12 | 11/12 | + | + | |
| 75 | | 7 | 11 | 13 | 11/12 | + | + | |
| 76 | | 8 | 10 | 13 | 11/12 | + | + | |
| 77 | | 8 | 10 | 12 | 11/12 | + | + | |
| 78 | | 8 | 11 | 13 | 11/12 | + | + | |
| 79 | | 7 | 9 | 12 | 11/12 | + | O | Burma. |
| 80 | | 8 | 10 | 12 | 11/12 | + | O | |
| 81 | | 8 | 10 | 12 | 11/12 | + | O | |
| 82 | | 7 | 10 | 11 | 11/12 | + | O | |
| 83 | | 7 | 9 | 11 | 11/12 | + | O | |

EXPLANATION OF THE TABLE.

? indicates that there is a well developed pore-like structure in 10/11 but when pressure was brought to bear upon that region of the worm no fluid could be observed exuding out through the body wall where the pore-like structure is located.

R indicates that a genital marking is located on the right side only.

L indicates that a genital marking is located on the left side only.

O indicates absence of genital markings.

A roman numeral without the prefix R or L indicates the presence of a pair of genital markings on that particular segment. R vii-viii indicates the presence of genital markings on the right side of segment vi and the right and left sides of segment viii.

A indicates that the posterior pair of spermathecae are lacking.

† indicates that the specimen is immature but that the clitellum has begun to develop.

* indicates that the specimen is immature and that there is no trace of clitellar development visible.

+ indicates that the genital markings are present but that the segments on which the markings are located were not noted.

The worms from South India were collected at Kodaikanal in the Palni Hills, those from North India at Kalimpong near Darjiling in the Himalayas, those from Burma at Namkham in the Northern Shan States, those from China at Suifu, Szechuan.

Four of the Kalimpong specimens have non-functional pore-like depressions in intersegmental furrow 10/11.

The setae between the male pores of the Kalimpong and Burma worms vary from 11-14 in number.

None of the specimens have post-clitellar genital markings.

Before the clitellum begins to develop the future positions of the male and spermathecal pores are indicated by greyish spots in the parietes. It is therefore possible to determine the number of setae between the spermathecal pore lines and between the male apertures before these pores are actually formed. The numbers of the setae between the spermathecal pore lines and between the male apertures of such specimens do not vary

significantly from those of more nearly matured or fully matured specimens. Accumulation of enough information of this nature may eventually enable identification of immature specimens.

The South Indian specimens were divided into two groups according to the presence or absence of the post-setal genital markings, and the two groups thus obtained were carefully compared with regard to both their external and internal characteristics, but no further consistent differences between worms of the two groups were found.

The ventral setae on segment x of the Kodaikanal worms appear to be much the same as on the preceding and succeeding segments and not smaller and more closely crowded as in the North Indian and Burmese specimens.

Several times during the course of studies of Burmese species of the genus *Pheretima* the question has arisen as to the variability of certain characteristics of internal organs that are employed in systematic descriptions. As this question may have been suggested to other workers by their studies a few notes with regard to some of the internal structures may be of interest. These notes are based on the dissection of twenty-five of the specimens included in the previous tabulation.

The intestinal caeca are simple. The margins may be without any trace whatever of incisions, or the caeca may be slightly constricted by the septa through which the caeca pass, or the ventral margins may have a number of very slight incisions or more rarely both dorsal and ventral margins may have a number of slight incisions. The intestine begins in segment xvi in every one of the specimens.

The hearts are three pairs in segments xi, xii and xiii in all of the twenty-five specimens. No hearts or dorso-ventral commissures belonging to segment x have been found. The three pairs of hearts as well as the asymmetrical commissure belonging to segment ix open into the ventral trunk. The whitish structures attached to the dorsal blood vessel and commonly referred to as " lymph glands " vary considerably as regards size and lobulation.

The anterior testis sacs are oval in shape and somewhat diagonal in position with their posterior ends closer to each other than the anterior ends. Between the two sacs there may be a narrow tubular passage, or the passage may be larger and wider. Occassionally the passage between the two sacs is shortened so that the appearance is of a single median sac but with a very conspicuously bilobed anterior margin. There is a single median testis sac in xi with a conspicuously bilobed anterior margin. When the sac is first revealed by a dorsal dissection it has a transversely rectangular appearance. This is due to a longitudinal sheet of tissue that extends along the top of the sac from 11/12 to 10/11. This sheet can be cut off from 10/11 without opening the sac. The two anterior lobes of the sac are connected each to the posterior face of 10/11 by a short whitish cord.

The size and conformation of the seminal vesicles varies considerably. The vesicles may be small, medium-sized or fairly large. There is usually a rounded lobe projecting dorsally from each vesicle, but the lobe may be small, scarcely recognizable, sunk into the dorsal face of the vesicle, slightly protuberant or conspicuously protuberant. Sometimes there are two dorsal lobes. Occasionally the vesicle is a strap-shaped structure with a single lobe projecting posteriorly from the middle part of the posterior face.

The prostatic duct is bent into the form of a U with the aperture facing posteriorly. Prostates may be present or absent. When present

with considerable variation as to size and development. The gland may be large, extending through segments xvii-xxi and deeply lobulated; it may be much smaller and also lobulated or without lobulations; or the gland may be represented only by a few shreds of tissue that bind down the ental end of the prostatic duct to the parietes. Both prostates may be absent, both may be present and well developed or only one may be lacking, or the two prostates may be quite differently developed. Stalked glands are always present in xviii but are usually buried in the musculature.

In segments xiii and xiv, each on the posterior faces of septa 12/13 and 13/14 just at the sides of the oesophagus, there is always a pair of structures of doubtful function. These bodies may be mere cords of whitish tissue bent into the shape of a crescent with the hollow of the crescent facing towards the alimentary canal or the dorsal end of the cord may be enlarged. In the latter case the shape of the enlargement is oval, round, or bi- or tri-lobate.

The spermathecae are characteristic throughout except that a number of these structures have a doubling of the enlargement of the ental end of the diverticulum.

As a result of this study it is suggested that there be incorporated in the definition of this species the following :—

Length 45-170 mm. Diameter 3-6 mm. Segments 90-113. First dorsal pore (10/11) 11/12. Spermathecal pores minute, on tiny rounded tubercles, four pairs, in 5/6-8/9. Male pores small, on transversely oval markings. Setae on segment xx 42-52; between the male pores 9-15; between the spermathecal pore lines on vi 7-11, on vii 8-13, on viii 10-16. Genital markings small, paired, round, slightly protuberant tubercles on pre-clitellar segments, pre-setal slightly median to the spermathecal pore lines, post-setal in line with the spermathecal pores. Hearts three pairs in xi-xiii, opening into the ventral trunk.

**Perionyx sansibaricus** Mich. 1891.

Kodaikanal, 67 specimens.

**Eisenia foetida** (Sav.) 1826.

Kodaikanal, 252 specimens.

**Bimastus parvus** (Eisen) 1874.

Kodaikanal, 7 specimens.