

THE EARTHWORMS OF BURMA. I.

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INTRODUCTION.

In a previous paper (Gates, 1929) I have presented a detailed historical account of earlier work on the earthworms of this province. Since the publication of that paper, Stephenson (1929) has added *Drawida nepalensis*, *Pheretima andersoni choprai*, and *Pheretima anomala* forma *centralis*, and reduced *Pheretima insolita* to the status of a variety of *P. anomala*.

The Oligochaetes with which this paper is concerned were collected in sundry localities in Burma, during 1928 and 1929, the cost of travel and collection being met mainly by grants from research funds of the University of Rangoon.

I take this opportunity to express my thanks to the authorities of the University for the financial assistance provided; to Mr. J. L. Lewis, Mr. J. H. Telford, and Mr. K. N. Sharma for the collection of specimens, and to Maung Kyaw Zan for assistance with illustrations.

GEOGRAPHICAL AND SEASONAL CONSIDERATIONS.

The first collections were made during the last week of May, 1928 at Kalaw in the Southern Shan States. Earthworms were found only in low swampy areas that remain moist the year round. Yet there had been rain for two months. The provincial meteorological reports show a rainfall for the Southern Shan States during April, 1928, of 5.18 inches, and in May of the same year a precipitation of 5.45 inches; the total for the two months, 10.63 inches, was quite insufficient to bring to the surface the worms which cover the hillsides around Kalaw with vast arrays of tower-like castings. This may be contrasted with a previous observation made in Meiktila (Gates, 1926). In this latter locality, which has a yearly average of 33 inches of rain distributed over 52.8 rainy days, seven days of rain was adequate to bring to the surface large numbers of specimens of one or more species of *Eutyphoeus*.

The Chindwin valley fauna was rather superficially examined in the latter part of July, 1928. Three weeks only could be allotted to collecting in this region and owing to breaches in the railway line, the slowness of travel on the river and the infrequency of communications, all of the time available was consumed in going to Homalin, the present head of navigation, and returning by the same boat. Collecting was possible only in the rather short intervals when the small stern-wheeler stopped to take on cargo, fuel, or passengers; or just before dark when the boat tied up for the night. Unfortunately, nearly all of these stops were made at villages which were invariably located in alluvial, paddy-growing plains, and in such areas the majority of specimens secured belonged to widely distributed peregrine species. At only two places was there sufficient time to permit of collecting in what may be called "jungle" conditions. The first place, Monywa, lies within the so-called dry zone, and has a normal average precipitation of about 30 inches, but at the time visited was dry and dusty. The worms secured in and around the town belonged largely to the peregrine species, but ten to fifteen miles away from the town in various directions jungle growths were encountered from which larger numbers of endemic forms were obtained. The second place, Pantha, is in the Upper Chindwin District which has a normal rainfall of about 70 inches. At this stop two specimens of *Hastirogaster* and numbers of immature *Notoscolex* were secured. On the return trip the boat was tied up at Pantha for more than 24 hours but in spite of extensive digging by a gang of coolies during the whole day, no additional specimens of *Hastirogaster* nor any completely mature specimens of the *Notoscolex* could be found.

In the latter part of September Toungoo and Thandaung were visited. Both of these localities are in a zone with considerable rainfall. Yet there had been little rain for several weeks in Toungoo and the ground was dusty and worms, of course, difficult to find, with peregrine species comprising the majority of specimens obtained. In Thandaung there had been no cessation of the rain and heavy showers fell every day while there, but countless hordes of small land leeches effectively prevented entrance into jungle areas. In fields, compounds, and by the roadsides where the relative scarcity of leeches permitted digging, peregrine species were most common with usually little else. Four weeks later, after the rains had ended, a friend wrote that, "early every morning for several days earthworms were crawling about in large numbers on every road and open space." These worms belonged to an endemic species which had been laboriously and almost vainly sought after the month previous.

Tavoy and Mergui districts were visited in October and November, 1928. Here again climatic conditions were unfavourable and a large proportion of the specimens secured belonged to peregrine species.

In August, 1929, Mr. U. Devasar kindly collected and forwarded from Myitkyina a number of worms. In October of that year collections were made in various places in the Sandoway district. In the latter part of the month Mr. K. N. Sharma returned to Rangoon overland *viâ* the Taungup pass across the Arakan yomas and collected earthworms along the way wherever collecting was possible. These

collections were largely composed of peregrine forms, although a few specimens of several endemic species were secured. Mr. J. H. Telford collected in Burma and Siam in the early part of November, 1929, while *en route* to Kentung in the Federated Shan States from Rangoon *via* Tavoy, Bangkok and Chiangmai. Except for one specimen of *P. anomala*, only peregrine species were secured.

In spite of leeches, unfavourable climatic conditions when many of the collections were being made, and lack of time for thorough exploration and collection, a fair amount of important material has been secured. The difficulties encountered have been mentioned not so much with the idea of explaining paucity of specimens or species as to furnish data for a discussion of seasonal occurrence of the local fauna and to permit emphasis on the following statements. First, our knowledge of the earthworm fauna of practically all localities in this province outside of Rangoon must still be regarded as fragmentary in spite of the collecting that has been done. Furthermore, the unknown fraction, small or large, of the earthworm fauna of any particular locality comprises the rarer, harder-to-obtain species, and quite possibly in many places the majority of the endemic species. Finally it should be pointed out that practically all of the worms hitherto collected in this province have been obtained either in towns and villages or from the country side immediately surrounding these. A considerable percentage of specimens secured within village or town limits have always belonged to peregrine species. Possibly in Burma, as in many other parts of the world, the endemic fauna in settled areas is being replaced by hardier immigrants. Should this prove to be so the necessity for study of the more remote jungle fauna will become even more imperative. Yet in the summer months, when the collecting must be done, the omnipresent leeches make collecting difficult and the heavy showers, thickness of the vegetation and absence of roads make travel almost impossible.

An appendix to this paper contains a list of the more remote or less familiar places at which collections were made during 1928 and 1929.

In the alluvial plains as the rainfall decreases during the months of September and October the superficial layer of earth rapidly dries out. With the cessation of the rains the ground becomes increasingly harder and more brittle, and after some weeks of rainless weather cracks begin to appear on the surface and gradually grow deeper. These conditions of increasing dryness are, of course, detrimental and sooner or later the worms abandon their burrows in the surface layers, presumably penetrating deep into the ground until they reach conditions favourable for aestivation during the dry, hot months. The preceding statements apply primarily to the low areas either under cultivation or close to towns and villages. Similar conditions prevail, however, in such jungles or hilly areas as have been visited. In these places worms can be found during October and subsequent months only in depressions and at bottoms of valleys. The hillsides, although frequently dotted with castings, are entirely devoid of worms.

It is not possible to indicate at present when the downward migration begins ; probably it will not prove to be at exactly the same time

every year, but the Tavoy-Mergui collections show that the surface layer of soil may become too dry for the continued existence of these animals some time before the actual close of the rainy season. Tavoy had had from the first of January to the thirtieth of September 204.14 inches of precipitation, almost all of which doubtless fell during the last five months of that period. Digging in the very first days of October showed that even in September with its 26 rainy days and a total precipitation of 25.52 inches the ground had become unfavourably dry for the worms. October, with only 7 rainy days and a total fall for the month of 5.33 inches, must have been even more unfavourable. Mergui has less rainfall than Tavoy. In 1928 it had had by the end of September 161.12 inches, but during October there were 14 rainy days and a precipitation of 10.92 inches. Conditions in this district were apparently the same, however, as in Tavoy.

The reason why a rainfall of five to ten inches in a month is insufficient to maintain a soil-moisture adequate for the worms lies probably in the large amount of precipitation in single rainfalls and the increasingly greater intervals of dryness between showers. In Tavoy, for example, 2.02 inches of the 5.33 inches for October fell at one time. If this should prove to be true the seasonal occurrence of the worms will be limited not so much by the amount of actual rainfall as by the number and sequence of bright sunny days that dry out the surface between storms.

All the worms do not however begin their downward migration simultaneously. Generally speaking the endemic species are the first to disappear. In exceptionally moist spots an isolated specimen or two of these more interesting species may linger on for several weeks after their confreres of the same species have gone. If collecting must be done towards the end of the rainy season, the only hope of securing endemic forms lies in finding such exceptional spots. Certain peregrine species may still be obtained in large numbers for some time after the majority of species have withdrawn. Eventually the soil becomes too dry for even them and they too disappear.

But even after the soil in general has become too dry for worms there may be found in almost every locality small areas which remain moist during the dry season, such as ground around wells, the banks of canals, rivers, lakes, ditches, drains, etc. In these restricted spots certain species are able to maintain themselves during the whole of the dry weather, providing, of course, that the particular spot remains well watered during the period of drought. The worms found in such spots are usually and in largest numbers peregrine forms; mainly *Pheretima posthuma*, *P. excavatus*, *Megascolex mauritii*, and to a lesser extent *P. elongata* and *Glyphidrilus papillatus*. *Perionyx excavatus*, the *Eisenia foetida* of Burma, is usually not found with other worms but in localities richer in decaying organic matter. *Megascolex mauritii* seems to have the greatest power of adapting itself to the conditions in such areas. In the dry zone this species is found in large numbers in the rainy season and in the dry weather is almost the only form to be secured. *Drawida longatria* and to a much less extent certain other species of *Drawida* are able to maintain themselves in favoured localities

during the winter months. These species are not usually found together with other forms but rather by themselves and when so encountered may be secured in fairly large numbers.

MORTAL WANDERINGS.

Several times during the last six years earthworms have been observed crawling about on the surface of the ground. On every one of these occasions the worms had come out from their burrows during the night and were found just before sunrise or shortly thereafter. The wanderings appeared to be quite aimless and either brought the worms on to roads or open clearings where they were either crushed by passing traffic or, surviving that, were eventually dried up by the heat of the sun.

European observers have noted similar wanderings or dead worms and have offered divergent explanations such as parasitism, especially by fly larvae, drowning, or lack of oxygen in the soil. In Burma these mortal migrations have been observed only after the rains have ceased or during the latter part of the rainy season but only after an interval of some days or several weeks without rain.

These wanderings were first noted at Kawkareik in October where for several mornings large numbers of *Pheretima feae* were found on the roads leading out from the town. No actual counts were made but every five or six feet of road length for several miles contained one or more individuals. *Desmogaster doriae* was found under similar circumstances by Mr. Lewis at Thandaung in November. *Eutyphoeus longiseta* was found along Sandoway roadsides but in smaller numbers in October. *Pheretima andersoni*, also in smaller numbers, was found along the Maungmagaun-Tavoy road on several mornings in the early part of October. On Kala island in the latter part of October a number of worms belonging to several species of *Pheretima* were found in advanced stages of desiccation on the hot, dry sand just above the high tide mark to which place the worms had struggled down from the dried out jungle higher up.

The Rev. J. H. Cope of Tiddim has on several occasions witnessed at the close of the rainy season in the Chin Hills District, what he calls "migrations" of earthworms. The worms in "tremendous numbers" were all migrating *downhill*.

All wandering individuals observed by the writer have been sexually mature.

ZOOGEOGRAPHICAL CONSIDERATIONS.

The new species described in this paper belong to the genera *Desmogaster*, *Hastirogaster*, n. g., *Drawida*, *Notoscolex*, *Pheretima*, and *Eutyphoeus*. The number of species of *Drawida*, *Notoscolex*, *Octochaetus*, and *Eutyphoeus* that are now recorded from this province indicate a much closer relationship between the Oligochaete fauna of this region and that of India in its north-eastern borders than has hitherto been suspected. Very little if anything seems to be known of the earthworm fauna of the Malay Peninsula immediately south of Burma or of Siam.

In view of this gap in our knowledge and the incompleteness even yet of our information concerning the fauna of Burma and of the districts of North-eastern India, it seems undesirable at present to venture into any detailed consideration of the zoogeographical relationships of the areas mentioned. Preliminary discussions of what may be called the tendencies or trends of recent investigations will be found in connection with the various genera concerned.

It may be stated quite definitely, however, that the much discussed *Pheretima* domain is not as extensive as has been thought previously. This *Pheretima* region certainly needs much additional study and re-definition of its boundaries.

SYSTEMATIC CONSIDERATIONS.¹

The *MONILIGASTRINAE*.

Male pores one or two pairs in 10/11, or 11/12, or 11/12 and 12/13. Gizzards two to ten, behind the reproductive segments, at the beginning of the intestine. The ectal end of each vas deferens enters a "prostate".

The definition above is a modification of that given by Stephenson in the Fauna volume, the emendation necessitated by certain considerations to be discussed in subsequent pages of this paper.

Genus *Desmogaster* Rosa.

One or two pairs of spermathecal pores in 7/8 or 8/9 or 7/8 and 8/9 or on vii and viii; male pores two pairs, in 11/12 and 12/13; female pores anteriorly on xiv. Spermathecae without atrial dilatation or stalked glands at the ectal end. Two pairs of testes and funnels, enclosed in sacs, on septa 10/11 and 11/12. Ovaries in xiii; ovisacs extending posteriorly from septum 13/14.

The genus was founded by Rosa for a Burmese species, *D. doriae*. Stephenson's definition of the genus in the Fauna volume contained two statements, "Gizzards, 7-10" and "Two pairs of much elongated prostates" which require modification since the finding of *D. buttikoferi* and *D. albalabia*, n. sp. with divergent conditions of these two structures. The genus now comprises six species as follows:—

- D. doriae* Rosa, 1890. One pair of spermathecal pores in 7/8. Ten gizzards in segments xx-xxix. Burma.
- D. horsti* Beddard, 1895. Eight gizzards in segments xvii-xxv. Sumatra. (No information available in regard to the spermatheca.)
- D. schildi* Rosa, 1897. One pair of spermathecal pores in 8/9. Nine gizzards in segments xxiii-xxxi. Sumatra.
- D. giardi* Horst, 1899. Two pairs of spermathecal pores. Seven gizzards (segments not stated). Borneo.

¹ 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.

D. buttikoferi Michaelsen, 1922. Two pairs of spermathecal pores. Three gizzards in segments xv-xvii. Dutch Central Borneo.

D. albalabia, n. sp. Two pairs of spermathecal pores. Three to five gizzards in segments xiv-xix. Prostates small, not enlongate.

***Desmogaster albalabia*, n. sp.**

Description of the Type-specimen. External characteristics. Length 98 mm. Diameter in the thickest portion 5 mm. Number of segments 236.

The first segment (?) is nearly twice as long (antero-posteriorly) as ii; iii is slightly longer than ii; iv than iii; the greatest length reached with segment viii. All of the intersegmental furrows are deep and clear cut. The first secondary furrow is slight and on the posterior portion of vi. There is also a slight secondary furrow on vii, like that on vi posterior to the setae. On viii there is a slight furrow anterior to the setae and a deeper furrow just posterior to the setae, with a slighter furrow on the posterior third of the segment. On each of segments ix-xii there are two fairly deep secondary furrows and in addition on the posterior third of each segment a tertiary furrow. Segments xiii and those behind have two slight secondary furrows only.

The prostomium is prolobous but instead of being an anterior projection from the mid-dorsal region of the first segment, in this species the prostomium passes into the buccal cavity and is attached to the roof of the buccal cavity in segment ii just behind intersegmental furrow 1/2. The transverse groove which marks the prostomium as prolobous is not merely a slight furrow but a deep cleft which passes into the buccal cavity as far as 1/2. On the ventral face of the protruding portion of the prostomium is an antero-posterior cleft which gives to the prostomium a sucker-like appearance.

The worm is unpigmented except on the clitellum which is a pretty rose colour.

The setae are minute, very closely paired, and begin on (iii?) iv; *ab* and *cd* are equal, $aa=3-4 \times bc$, and *dd* is greater than one half of the circumference.

The clitellar colouration extends from the setae of x to the setae of xviii and is the only external indication of a clitellum.

The spermathecal pores are minute round apertures very slightly internal to *c* on small papillae extending from the posterior margins of vii and viii over the contiguous intersegmental furrows. The papillae extend from external to *d* to internal to *c*.

The male pores are minute round apertures slightly internal to *c* in 11/12 and 12/13.

The female pores are smaller than the male and on the anterior margin of xiv in line with *b*.

The only genital markings, aside from the tiny papillae bearing the spermathecal pores, are rather conspicuous, whitish sucker-like structures around the male pores. These extend from external to *d* to internal to *c* and occupy the posterior and anterior annuli of the segments involved, and consist of a slight thickening of the parietes sharply marked

off from the rest of the surface by a groove. A transversely placed slit-like concavity in line with the intersegmental furrow almost divides the structure into an anterior and a posterior lip, but the slit is less well marked at its ends and does not quite reach to the intersegmental furrow. The male pores lie at the bottom of the slit-like concavity.

Internal anatomy.—Septa 5/6-9/10 are present and thickened; 12/13 and 13/14 are fused except where separated by masses of ovarian material.

The last pair of hearts is in xi.

The spermathecal ampullae are flattened against the posterior faces of septa 7/8 and 8/9, and consist of two lobes, with the lobulation indicated ventrally only. The spermathecal duct arises between these two ventral lobes.

The testis-sacs are small masses protruding from the posterior faces of 10/11 and 11/12 into xi and xii. The vasa deferentia run down nearly to the parietes on the anterior faces of 10/11 and 11/12, pass through the septa and are loosely coiled in xi and xii before passing into the prostates.



TEXT-FIG. 1.—*Desmogaster albalabia*. A club-shaped body from the prostate; \times ca. 45.

Paired ovisacs, large, protrude from the posterior face of 13/14 and fill the upper half of the coelomic cavity in xiv.

The three gizzards are in xv, xvi, and xvii. There is a rudimentary gizzard in xiv.

Distribution and occurrence.—Thandaung, September, nine specimens.

Remarks.—The length of other specimens varies from 86-115 mm., and the greatest diameter from 4-5 mm. The secondary annulation is much the same in all the specimens. The first segment is usually slightly shorter than the second.

The prostomium is withdrawn into the buccal cavity in all except two specimens. The antero-posterior cleft is present on the ventral surface of the prostomium in each individual.

The clitellar colouration may extend over all of x and all of xviii or over a part of both of those segments or a part of one alone.

The setae are visible only from segment iv posteriorly, although on several worms a single black spot was noted on iii that may be the tip of a seta. Interval *aa* is always larger than *bc* throughout the whole length of the worm and varies from 2-4½ times *bc*.

The spermathecal pores are in line with or slightly internal to *cd*.

The male pores are in line with *c*, *d*, or just internal to *c*.

The female pores are usually on tiny whitish areas on the anterior margin of xiv, in line with *a* or *b*, or just external to *b*.

The whitish flattened lips around the male apertures are well developed on all specimens even on those which lack the clitellum, and on

mature individuals are quite conspicuous against the rose colour of the clitellum.

The brain is in segment iii on the anterior face of the large pharyngeal bulb. The circumpharyngeal commissures are short and the diameter of the circle inside the commissures unusually small.

There are large paired commissures connecting the dorsal and ventral blood vessels in segments v to x. The commissures of xi are small in all except the type and bound down to the alimentary canal. The subneural trunk bifurcates in the region of xiv into two branches each of which pass out from under the nerve cord and then anteriorly as a ventro-lateral trunk. In the anterior part of xi each of these trunks receives a commissure from the dorsal vessel of the same size as the posterior commissure which passes to the ventral vessel. The ventro-lateral trunks run forward alongside the ventral vessel underneath the alimentary canal into v. In this segment the ventral vessel decreases in size until it can be traced no further, while the ventro-lateral trunks break up into several small branches. A commissure in the shape of an inverted U on the anterior faces of septa 5/6-10/11 connect the ventro-laterals with each other in segments vi-x. In vi there is a small branch vessel from the commissure to the ventro-lateral trunk of its side. A branch from the sub-neural on each side in the region of xviii collects parietal vessels of some size and then passes into the ventro-lateral trunk in xii or xiii.

The spermathecal ampullae are flattened, heart-shaped, or bilobed structures high up on the posterior faces of 7/8 and 8/9. The duct issues from the cleft in the base of the ampulla, is looped several times and then passes into the tissue of the septum, emerging therefrom just before reaching the ventral parietes with another small loop in the coelom before passing into the body wall.

The testis sacs are ovoid structures high up on the posterior faces of 10/11 and 11/12. The male funnel in the posterior part of the sac has a red-orange-yellow iridescence. The vasa deferentia are sometimes on the anterior faces of the septa concerned, with loops projecting freely into the coelomic cavity of the anterior segment in one specimen, or within the tissue of the septum. In either case the deferent ducts eventually pass into xi or xii and drop to the floor of the segment where after several loose loopings they finally pass into the parietes but not deeply as their course still is visible. In xi and xii are flattened or rounded berry-like bodies, consisting of a mass of club-shaped whitish structures attached to a small, rounded, hollow dome over the male pore. Into the anterior face of this body, which must be regarded as a prostate, the vas deferens passes after emerging from the body wall.

The ovisacs may be restricted to xiv or extend through segments xv-xvii.

The gizzards are three to five as follows :—

3 gizzards in segments xv-xvii	1 specimen.
3 " " " " , rudimentary gizzard in xiv	1 "
4 " " " xiv-xvii	1 "
4 " " " xv-xviii	4 "
4 " " " xv-xviii, rudimentary gizzard in xiv	1 "
5 " " " xv-xix, rudimentary gizzard in xiv	1 "

Desmogaster doriae Rosa, 1890.

This species, the type of the genus, was founded for worms collected by Leonardo Fea at the "Villaggio di Meteleo fra i Carin Cheba o Biapo a 1000-1400 m. sul livello del mare" in 1888. The name Meteleo does not appear on maps of Burma, and no further indication of the locality of the village is given in the paper apart from a reference to collecting in the Karen Mts. (nei Monti Carin) which is not a definite place name. In volume ix of the Annals of the Genoa Museum there is an account of Fea's travels in Burma, from which it appears that "Dopo pochi giorni di soggiorno in Leito, ove trovansi la sede della Prefettura Apostolica della Birmania Orientale, posto nel distretto dei Carin Cheba o Biapo, egli si recava nei villaggi di popoli, Meteleo e Cobapo trattenendosi vario tempo in ciascuna di essi." Leiktho (Leito) is the headquarters of a circle in Toungoo district, about 22 miles from Yedashe on the Rangoon-Mandalay railway line above Toungoo. Father B. Peano of the R. C. Mission in Toungoo in a letter explains Meteleo as Metelin-daung, a village in the Leiktho circle; Carin Cheba as White Karens, one of the tribes living in the Toungoo hills.

In a footnote to a paper published in 1897 (p. 340) Rosa corrected a previous misstatement about the relative values of the setal intervals:—"l'intervallo ventrale e doppio dei laterali e non viceversa come fu stampato per isboglio nella descrizione di detta species." Aside from this brief statement no further reports of collection or study of this worm appear in the literature.

The worms to be described were all secured at Thandaung which is, according to Father Peano, about 18 miles due southeast over the hills from Leiktho. Five immature specimens were collected by Mr. Lewis in August, two specimens, of which one is mature, were secured by the writer in September, and four additional worms without clitella were picked up by Mr. Lewis in October. Mr. Lewis further reports that on several mornings in November, several weeks after the rains had ceased, very large numbers of this species were crawling around on roads, trails, and other open spaces where they were eventually killed or else died in the heat of the midday.

External characteristics.—None of the specimens are complete; some were broken off apparently when dug out of the ground, others were regenerating new tails. Rosa estimated the length of a complete mature worm to be at least 500 mm. The diameter varies from 8-12 mm. The colour is dark brown dorsally, greyish or yellowish-brown ventrally.

Dorsal pores are lacking.

Annular furrows are of two sorts; deep, clear-cut, intersegmental furrows and much slighter secondary grooves usually not complete circumferentially. The antero-posterior length of the first annulus is equal to or slightly smaller than that of the second, the second slightly smaller than that of the third, the third than the fourth, etc., until the greatest length is reached with segment ix.

A large bulbous prostomium is attached to the roof of the buccal cavity just behind $1/2$, the cleft marking off the prolobous prostomium penetrates into the buccal cavity to $1/2$. In one worm in which the

prostomium is unusually protuberant there is a ventral antero-posterior cleft. Pressure on the posterior segments of the worm forces the coelomic fluid into the prostomial lobe which becomes swollen and spherical with obliteration of the indentation. Relaxation of the pressure allows the bulb to collapse into the semblance of a sucker very similar to that previously described for *D. albalabia*.

On the single fully mature specimen the clitellum is indicated by a dark crimson colour extending from the posterior portion of x to 18/19. Rosa stated that a clitellum was lacking which may be taken to indicate that all of his specimens were immature.

The setae are small, very closely paired, and first visible on vi or vii; *dd* is much greater than one half of the circumference, and *aa* is $1\frac{1}{2}$ -4 times *bc*.

The spermathecal pore is a minute aperture at the tip of a tiny, antero-posteriorly flattened, triangular flap of tissue in line with *cd*, in intersegmental furrow 7/8 against the anterior face of the groove in such a way that the papilla seems to belong more to vii than to viii.

The male pores are in 11/12 and 12/13 in line with *c*, *cd*, or *d*. These pores are surrounded by whitish areas somewhat similar to those on *D. albalabia*, but smaller, less sharply marked off, and not elevated above the general surface of the epidermis.

The female pores are on the anterior border of xiv, in line with or very slightly external to *b*, each pore at the bottom of a slight transverse cervice.

The nephridiopores when visible are on the anterior portion of the segment close to the intersegmental furrow in line with or slightly external to *b*.

Beginning in the region of the body which contains the gizzards or just behind the gizzard metameres, each segment throughout the rest of the length of the animal has two lateral thickenings, one on each side of the body, about equally distant from the mid-dorsal and mid-ventral lines. These areas are roughly circular in appearance and extend nearly to the intersegmental furrows both anteriorly and posteriorly. These areas are not sharply defined and in some specimens give the impression of being due to poor preservation. Sections show, however, that the circular muscle under these patches layer is thickened and in contrast with the rest of the same layer markedly whitish. The thickened whitish portion of the layer is divided into strata by fine, dark, concentric lines.

Internal anatomy.—Determination of the septal relationships has proved to be a matter of some difficulty. In opening and pinning out a worm from either the dorsal or ventral sides the dorsal or ventral portions of the septa are destroyed. Mid-lateral dissections have not proved satisfactory. Furthermore the intersegmental furrows are not clearly visible in such pinned out specimens especially when the parietal walls are thick as in the present species. This lack of visibility becomes a serious obstacle when the septum has a variant attachment dorsally and ventrally. Septal determinations made from median incisions have been divergent. The last two determinations were made after bisecting a worm by a median, vertical, antero-posterior cut through

the digestive tract. In a single half of a worm bisected in this fashion the attachment of the septa to the alimentary canal and to the parietes both dorsally and ventrally, as well as the position of the external intersegmental furrows both dorsally and ventrally are simultaneously visible. Disregarding the previous divergent results the septal determinations made twice in this fashion have been adopted.

Although this mode of study solves what may be called the mechanical problems of dissection there still remain difficulties of enumeration due to the absence of certain septa, the abnormal position of others, and the presence of septa-like sheets of tissue that obviously cannot be septa. In these circumstances it becomes necessary to adopt arbitrarily a segment containing a structure with a constant relation to some external annulus as a starting point. It so happens that in the Moniligastrinae the spermathecae are attached to the posterior face of the septum corresponding to the intersegmental furrow in which the spermathecal pores are situated. In *D. doriae*, which has the spermathecal pores in 7/8, the spermathecae should be found in segment viii and the septa bounding the spermathecal segment should therefore be 7/8 and 8/9. The septa bounding the spermathecal segment do actually lie just under the intersegmental furrows 7/8 and 8/9 so that the spermathecal segment corresponds exactly to the externally marked off segment viii. With this as a starting point the septal relations appear as follows:—In the region of the first five segments there are four or five transverse sheets of tissue attached to the alimentary tract and to the parietes in a manner similar to the septa. These pseudo-septa are very delicate, more so than the thin septa, but are strengthened by flat, radial bands of muscular tissue. All of these sheets have a similar appearance but since all of them cannot be septa they are disregarded. The first septum recognizable as such is 3/4 (?) which is attached to the middle region of vi ventrally, and to the dorsal parietes with 4/5 and 5/6; it is noticeably thicker than the two succeeding septa. Septum 4/5 is not attached to the parietes at all but to the anterior face of 5/6 at a slight distance from the parietes circumferentially. This sheet of tissue is so abnormal in its attachment that it was not at first counted as a septum, but within the space formed by its attachment to 5/6 there is a pair of large nephridia, and since these organs are attached to the posterior faces of the septa it seems necessary to regard the sheet of tissue on which these nephridia are located as a septum. Septum 5/6 is thin, attached to the parietes both dorsally and ventrally in the posterior portion of vi very close to 6/7. Septum 6/7, the first of four greatly thickened sheets, is attached to the body wall in the anterior portion of vii, the position varies from about the first third to the middle of the segment. Septa 7/8 and 8/9 are attached normally; 9/10, the last thickened septum, is attached to the parietes in the anterior part of x, varying from about the first third to the middle of the segment both dorsally and ventrally. Septum 10/11 is similarly attached in the anterior portion of xi; 11/12 is attached ventrally on the anterior part of xii and dorsally to the posterior part of xii. Septum 12/13 varies from a middle to a posterior position on xiii both dorsally and ventrally. Septum 13/14 is attached dorsally to

the anterior region of xiv or under 13/14, ventrally over the furrow 13/14, while 14/15, normal in its ventral attachment, may be normal dorsally or placed just behind 14/15.

The preceding account of the parietal locations of the septa does not agree in most of its details with that given by Rosa nor, as has been previously admitted, with the determinations made after median incisions. As no further specimens are available for examination and in view of the divergent results just mentioned it does not seem wise to attempt an explanation of the discrepancies in the two accounts. It may be pointed out, however, that there are inconsistencies in the data given by Rosa. Thus "The ovaries are said to be in segm. xiii; but the funnels to be on the anterior faces of 14/15, *i.e.*, in segment xiv. The spermathecae are first stated to be in viii, but further on to be on the posterior face of 6/7, *i.e.*, in vii. This would seem to indicate that the estimation of the segments was not easy, and that the author himself came to different results at different times" (Stephenson, 1922, p. 139). To enable comparison with the preceding account a summarised statement of Rosa's description is given herewith:—Septa 2/3-8/9 are inserted on the parietes normally, 9/10 is attached to the middle of x, 10/11 is inserted on the middle of xi ventrally and under 11/12 dorsally, 11/12 is attached ventrally to the middle of xii and dorsally to 12/13, 12/13 is attached ventrally to the middle of xiii and dorsally under 13/14, 13/14 is located ventrally at 13/14 and dorsally towards the end of xiv, 14/15 and succeeding septa are similarly attached.

Large paired commissural vessels connect the dorsal and ventral blood vessels in segments vii-xi (v-xi Rosa). The commissural hearts of vi pass from the dorsal vessel to the ventro-lateral trunks. There does not seem to be any vessel passing from the heart of this segment to the ventral trunk but if small and empty may have been overlooked. The ventral trunk constantly diminishes in size as it passes anteriorly, and in segment iv just over the sub-pharyngeal ganglion divides into two small branches which pass up along the pharynx on the inner side of the circum-pharyngeal nervous commissures. The dorsal vessel continues forward onto the pharynx as a large, well filled vessel, dividing into two or three branches anteriorly which are coiled up into a spherical mass of loops.

Throughout the greater portion of this worm no definite sub-neural vessel is visible although in the parietes under the nerve cord there is a fine wavy greyish line which, beginning at about 65 mm., from the anterior end, gradually becomes larger, and more anteriorly recognizable as a definite blood-filled vessel although still within the tissue of the ventral body wall. In the region of segments xviii-xvi a small branch is given off to the left side which receives other vessels from the parietes until it reaches segment xi where it rises from the floor of the segment and continues anteriorly suspended in the coelom as a ventro-lateral trunk. The sub-neural vessel continues anteriorly into xiv or xiii where it passes out from under the nerve cord to the right side and after collecting several small vessels from the parietes is continued forward suspended in the coelom as the right ventro-lateral trunk.

After receiving the commissures of vi the ventro-lateral trunks pass anteriorly in divergent fashions in different specimens. In one worm both trunks bend in towards the nerve cord in v (as indicated by the external annulation) and are there joined to each other by a very short, fat commissure, after which each vessel continues into the anterior segments independently. In another specimen the right ventro-lateral trunk gives rise to several branches in v, one of which passes into the left ventro-lateral trunk, the others passing to the parietes. In a third specimen the right ventro-lateral trunk also divides in v into several branches but none can be traced into the left ventro-lateral trunk. One of the branches passes dorsally and then anteriorly. In this same worm the left ventro-lateral trunk passes under the nerve cord where it bifurcates, the two branches separating and emerging from under the nerve cord, one to the right, the other to the left side. Both branches then pass anteriorly to the region underneath the subpharyngeal ganglion where they turn upwards to pass dorsally along the outer side of the circumpharyngeal nervous commissures, giving off branches to the walls of the alimentary tract and dorsally to the parietes in segments i, ii, and iii, as well as to the prostomium.

As Rosa pointed out the commissures of x and xi are double, the "heart" on each side shortly after passing out from the dorsal vessel divides into two vessels, an outer, larger free "heart", and an inner, smaller vessel usually bound to the digestive canal. Shortly after its origin the inner commissure divides into two branches, an inner one which passes transversely across the top of the oesophagus to join a similar vessel from the inner commissure of the other side, and the more conspicuous branch which passes into the ventro-lateral trunk.

The meganephridia are large, the first pair in v, present in all succeeding segments except xiv. In segments xi and xii the nephridia are modified and connected with the deferent male apparatus.

The gizzards are ten in segments xx-xxix.

The spermathecal ampulla is flattened into a heart-shaped or bilobed disc. The ampulla is attached to the posterior face of 7/8 by a mesentery. The ampullae of the two spermathecae are connected to each other by a strong, thick cord of tissue which arises from the region between the ventral lobes internal to the origin of the spermathecal duct. The duct of the spermatheca is 15 mm., or more in length, is coiled into several loops on the posterior face of the septum underneath the ampulla and then passes into the septum and in a direct line to the external aperture. In the smallest specimen the ampulla is a minute spherical enlargement of the ental end of the duct.

The testis-sacs are suspended in septa 10/11 and 11/12, the wall of the sac being several times the thickness of the septum and much tougher. When the sac is opened the contents may be lifted out as one single mass.

The prostates are conspicuous structures in xi and xii, 8-14 mm. in length, circular in cross section, the lumen of the prostatic canal very small relative to the thickness of the glandular wall. At the inner end the prostates narrow abruptly to the vas deferens which passes downwards along the side of the prostate to the body wall, passing

into the parietes through a small excavation therein and underneath a considerable mass of integumentary tissue directly towards the nerve cord. After a short interval deep in the parietes the vas deferens emerges and passes up on to or into the septum. The ectal half of the duct is rather tough and easily traced, that portion of the body wall which lies dorsal to the deferent tube is easily dissected off, but from here on the duct seems to be more fragile and breaks easily. No satisfactory determination of the remainder of its course has been made in spite of the fact that all of the specimens have been carefully dissected. Associated in one way or another with the vas deferens are two other structures, the first a more or less modified nephridium, and the second a tube very similar to the deferent duct. Rosa interprets the latter as a blood vessel, but in the Thandaung specimens it has very little resemblance to the rest of the blood vessels and never seems to be filled with blood as are other vessels in that part of the body. In the single mature specimen, the vas deferens after emerging from the parietes appears to divide, one branch passing up along the septum to form one limb of the modified nephridium, the other branch passing up also along the septum where it becomes involved in a confused tangle with the tube interpreted by Rosa as a blood vessel.

The ovarian funnels are large, flattened out on the body wall anterior to 13/14 with very definite pore visible at the centre. Ovisacs may be absent, when present may extend through one to four segments.

Behind the gizzards, in each segment, on each side of the dorsal vessel for about 150 segments there is a large rounded dark brown mass. * Each of these masses is composed of small columns attached ventrally to the dorsal face of the intestine by a very fine thread. Each of the brown columns has a minute greyish lumen at the centre. Passing posteriorly these masses gradually decrease in size and after about 120 segments are represented only by tiny, brown, warty projections from the intestinal surface.

Numbering of the segments in Desmogaster. Stephenson (1922) believes that the accepted numbering of the segments in this genus is incorrect and should be diminished by one, but does not himself carry this belief into practice. The absence of the setae in the first few segments as well as the absence of anterior septa are responsible for the difficulties of enumeration. In both Burmese species of the genus the primary and secondary annulation are clearly distinct from each other so that in well preserved specimens no question of confusion of the two types of furrows arises. Since there are no secondary furrows on the first few segments and since the furrow separating the first two annuli has exactly the same appearance as an intersegmental furrow, it should be regarded as such in absence of definite evidence to the contrary. Furthermore the combined antero-posterior length of the first two annuli is greater than that of the third, while the length of the first few segments increases slightly but regularly up to a maximum at segment viii or ix. The cerebral ganglia are in segment iii in both species as "in the earthworms, almost without exception" (Beddard, 1895, p. 19). Finally the prostomium in both Burmese species is attached to the roof of the buccal cavity near 1/2 as in the Burmese

species of *Drawida*, and if that portion of the head of *Desmogaster* anterior to the attachment of the prostomium is not to be regarded as a segment, there would seem to be equally valid reasons for not regarding the same portion of the head of *Drawida* species as a segment. The segmental numbering of *Drawida* would thus remain one less than that of *Desmogaster*. Yet it is to avoid this very difference in segmental enumeration, for purposes of phylogenetic derivation, that leads Stephenson to his belief.

Genus **Eupolygaster** Mich.

In 1887 Horst described under the name *Moniligaster houtenii* a worm from Sumatra having, among others, the following characteristics:—spermathecal pores in 8/9, male pores in 11/12, female pores anteriorly on xiv, prostates and testis sacs in xi, segment xiii reduced to an ovarian chamber. In a later paper (1892) Horst reaffirms certain statements made in the earlier paper in the following words:—“In my description of the gigantic *M. houtenii* I stated the male pores to be situated between segments xi and xii; as it is now settled that in all other *Moniligaster*-species those pores lie between segments x and xi, I reexamined these specimens, for it might be possible that I made the error of one segment in my enumeration, as was done by Beddard in his first description of *M. barwelli*, I however believe my statement to be correct, though it is very difficult to number the segment accurately” (p. 46). (Also Horst, 1894, p. 144). In the same paper the author doubts “whether the large Sumatra species really does belong to the genus *Moniligaster*” (1892, p. 47). Later (1894, p. 137) he makes a similar statement that *M. houtenii* “probably will prove to belong to another genus.”

The 1894 paper contains a description of *M. coeruleus* with spermathecal pores in 7/8, male pores in 10/11, and female pores anteriorly on xiii. In a short note published some months later Horst (1895) suggested the generic name *Polygaster* for *M. coeruleus*, but made no reference in that note either to *M. houtenii* or to the inclusion of any other species in the new genus.

Michaelsen (1900) replaced *Polygaster*—preoccupied by a Dipteran genus—by *Eupolygaster* and included in the generic definition: spermathecal pores in 7/8, male pores in 10/11, female pores anteriorly on xiii. Three species, *M. modiglianii* Rosa 1896, *Polygaster coeruleus* Horst 1895, and *M. houtenii* Horst 1887, were included in the genus. The original descriptions of the first two species agree in so far as the characters above mentioned are concerned with the generic definition, but the description of *M. houtenii*, as has already been pointed out, does not. No explanation for the inclusion of the latter species in the genus was given in the Tierreich volume and none has been found in the literature available locally, nor is there further reference to the segmental determination made by Horst in later literature on the phylogeny of the Moniligastrinae. No other species of Moniligastrid was known in 1900 to have the characteristics of *M. houtenii* and possibly Michaelsen concluded that Horst miscounted the segments

on this worm and accordingly reduced the segmental enumeration by one to justify the inclusion of the species in *Eupolygaster*.

In view of Horst's reaffirmation of his segmental enumeration and pending re-examination of his specimen or the acquisition of further data, we are as much justified in accepting the segmental determination made by Horst for this species as the enumeration made for his other species *E. coerulea*. The acceptance of Horst's numbering necessitates the removal of his species from Michaelsen's genus and the erection of a new genus, for which the name *Hastirogaster* is proposed.

In 1907 a fourth species, *E. browni*, was erected by Michaelsen for a single worm collected in Lashio, Burma. Later Michaelsen (1909, p. 139) pointed out that the "First segment (is) apparently divided into two annuli by a furrow which exactly resembles an intersegmental furrow." In spite of this apparent annulation, in order to bring the numbering of the segments into agreement with that characteristic for the genus *Eupolygaster*, the first two annuli were regarded as composing one segment only.

This peculiar annulation is similar to that which occurs in the two Burmese species of *Desmogaster* and presumably in other species of the genus. Since both annuli are regarded as segments in *Desmogaster* it is necessary to adopt the same enumeration for *E. browni*. Accepting the revised enumeration "Then it would be justifiable to create a separate genus for it." (Michaelsen, 1909, p. 141). *E. browni* with augmented segmental number, however, has its sexual apertures located as in *Hastirogaster houteni* and must therefore belong to the same genus. *Eupolygaster*¹ is thus left with but two species :—

E. modiglianii (Rosa) 1896. Seven gizzards in xvi-xxxii. Sumatra.

E. coerulea (Horst) 1894. Gizzards in xv-xviii or xix. West Borneo.

The genus has been derived, according to Stephenson, from *Desmogaster* by the disappearance of the anterior spermathecae and the posterior male organs.

Genus *Hastirogaster*, n. g.

Moniligastrinae with spermathecal pores in 8/9, male pores in 11/12, female pores anteriorly on xiv. Spermathecae in ix, one pair testis sacs on 10/11, one pair prostates in xi, ovaries in xiii.

The genus is to be derived from *Desmogaster* by the disappearance of the anterior spermathecae and the male organs of xii. The genus comprises three species, as follows :—

H. houteni (Horst) 1887. Length 1500 mm., diameter 18 mm.

Four gizzards. Septa 6/7-9/10 thickened. Tapanœli, Sumatra.

H. browni (Michaelsen) 1907. Length 150 mm., diameter 4-8 mm.

Seven gizzards in xviii-xxiv, the first rudimentary. Septa

¹ Stephenson (1923) gives the following definition of the genus :—Clitellum xii-xv (4). Male pores in 10/11; female pores on the anterior part of xiii; spermathecal pores in 7/8. Gizzards 4-7. Last heart in x. One pair of testis and funnels, enclosed in testis sacs on septum 9/10. Prostates long, sausage-shaped. Ovaries in xii; ovisacs extending backwards from 12/13. Spermathecae without atrial dilatation or stalked glands at ectal end.

5/6-9/10 thickened. Clitellum lacking on the single specimen which is probably immature. Lashio, Burma.

In the original description Michaelsen stated that the male pores were in 10/11, in his 1909 paper that they were in 11/12. Presumably the latter is to be regarded as a typographical error. The ovarian chamber was not described.

H. livida, n. sp. Seven gizzards in segments xxiii-xxx. Pantha, Chindwin valley, Burma.

Hastirogaster livida, n. sp.

External characteristics.—Two anterior fragments, length 98 mm., and 144 mm., diameter 10 mm., and 8 mm. Colour greyish or brownish-grey. The larger worm, when alive, had a distinct "golden brownish" appearance on the anterior end, according to notes made when the worm was found.

A large collapsed prostomial lobe protrudes from the buccal cavity to the dorsal wall of which it is attached behind 1/2, the transverse groove, which separates the prostomium from the first segment, is a deep cleft which passes into the buccal cavity as far as 1/2.

Segments i and ii are about the same length, and together are longer than iii. The antero-posterior length of the segments increases slightly with each segment behind ii until the greatest length is attained by segment ix in the smaller worm, and segment x in the larger worm. Beginning with segment v on the larger worm and segment vi on the smaller worm there is a single well-marked secondary furrow on each segment located on the anterior portion of the segment, anterior to the setae on segments on which the setae are visible. On the larger fragment, on xvi and several succeeding segments there is a secondary furrow on the posterior portion of the segments concerned, but not so well marked as the anterior secondary furrow.

Dorsal pores are lacking.

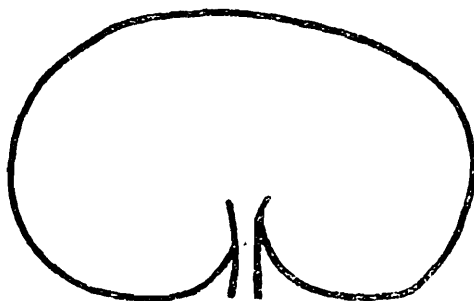
There is no trace of a clitellum on the smaller specimen. The larger fragment has an indistinct blackish-blue appearance on segments x-xx which may be regarded as indicating clitellar colouration, the epidermis in this region is damaged so that no distinct boundaries to the colouration can be given. The segments anterior to x have a greyish-blue appearance quite different from the brownish-grey colouration behind xxx but much lighter than the blue of the clitellar segments.

The setae are small, very closely paired, *aa* is 2-2½ times *bc*, *ab* and *cd* are approximately equal, *dd* is much greater than one half the circumference. The setae are first visible on segment x in the smaller specimen and on xxiii in the larger, although slight glandular swellings of the body wall in line with the setal rows can be seen anterior to xxiii.

The nephridiopores are on the anterior borders of the segments close to the intersegmental furrows and very slightly external to *b*.

The spermathecal apertures are minute pores at the tips of rounded papillae in line with *cd* in 8/9. These small protuberances, like those bearing the spermathecal pores of *Desmogaster*, lie in the depression of the intersegmental groove in such a fashion as to give the impression

of belonging to segment viii. The porophores are more nearly columnar and more protuberant than the spermathecal papillae of *D. doriae* or *D. albalabia*.



TEXT-FIG. 2.—*Hastirogaster livida*. A spermatheca.

The male pores are in 11/12 in line with *cd*. In the larger specimen the parietes around the pore within the groove between the segments is whitened.

The female pores are on the anterior margin of xiv close to 13/14, just external to *b*, at the bottom of deep transverse slits.

Internal anatomy.—Septum 4/5 is present but attached circumferentially to the anterior face of 5/6, forming a small space in which is enclosed a pair of large nephridia. Septa 5/6-9/10 are greatly thickened, 5/6-8/9 attached to the parietes normally under the appropriate intersegmental furrows, 9/10 appears to be attached to *x* just behind the groove 9/10 both dorsally and ventrally, but is so close to 9/10 that it might almost be said to be normal in its attachment. There is no trace of a septum to be found in the region of 10/11, the next visible septum which must be 10/11 is attached to the middle of *xi* ventrally and to the posterior portion of *xi* very close to 11/12 dorsally; 11/12 is inserted ventrally on the middle of *xii* and dorsally just anterior to 12/13, 12/13 is incomplete but inserted ventrally just anterior to 13/14, while 13/14 is attached to the parietes close to the groove 13/14 ventrally, but dorsally slightly more posteriorly.

The cerebral ganglia are in the anterior portion of segment iii as indicated by external annulation.

There is a pair of large nephridia in each of segments v-ix, xii, xv, and succeeding segments.

There are paired commissural "hearts" in segments v-xi.

The spermathecae are in ix, the ampulla is flattened and bilobed ventrally, the duct arising from the ventral side between the lobes. The duct is looped several times in the coelom and then passes into the septum 8/9. The ducts of the smaller fragment are about 13 mm. in length, of which 3 mm. is within the septum. The ducts of the larger fragment are 11-12 mm. in length up to the point where they pass into the septum. The intra-septal portion of the duct runs in a straight line to the parietes.

The testis sacs are large, suspended from 10/11. The wall of the testis sac is much thicker and stronger than the septum from which it is suspended. The entire contents can be removed in one mass after slitting open the sac. The male funnel is small, and in the larger frag-

ment is on a slight projection into the testis sac, produced by an external circumferential indentation of the sac by the septum.

The vas deferens passes down to the ventral body wall, where it is coiled into a mass of loops, but eventually passes deeply into the parietes. In these specimens the musculature dorsal to the buried deferent tube cannot be dissected off, as in the two species of *Desmogaster*, so that the course of the duct after penetration into the body wall has not been determined. Associated with the vas deferens is a tubular structure similar to the anomalous ducts or blood vessels (?) of *D. doriae*.

The prostates are paired tubular structures in xi, nearly circular in cross section. In the larger worm they are 13-14 mm. long and 1 mm. in diameter, in the smaller worm, 7-8 mm. long and less than a mm. in diameter. The prostates are bent into a slight spiral and the ental ends are rounded off and perfectly smooth, without any trace of an ental continuation as a deferent duct, apparently ending quite blindly. The internal preservation of these worms is excellent which makes it difficult to explain this appearance except by assuming that the vas deferens passes into the wall of the prostates in its basal portion within the parietes, a characteristic not hitherto reported from any species of this genus. The surface of the prostates has a mottled appearance due to the presence of many spots of black or dark brown pigment.

Septum 12/13 is attached ventrally to the parietes just in front of 13/14. Laterally its attachment to the parietes can be traced half way up the side of the body wall to a point about mid-way between the mid-dorsal and mid-ventral lines. At this locality the septum bends posteriorly and fuses with 13/14 in such a way that the two septa cannot be separated from each other. Just internal to the ovarian funnels and just dorsal to the nerve cord, 12/13 again fuses with the anterior face of 13/14 in such a way as to form two lateral ovarian chambers, connected by a tunnel-shaped passage on the ventral parietes underneath the oesophagus.

The oviduct funnels are large and at the inner angle of the ovarian chambers. In the larger fragment the ovisacs extend into xviii, fusing anteriorly on the posterior face of 13/14 to form a transversely placed mass over the oesophagus. The ovisacs are filled with a black pasty mess.

The gizzards are seven, in segments xxiii-xxix in the smaller specimen, in the larger specimen in xxiv-xxx with slight pinkish thickenings of the oesophagus in xxii and xxiii.

Distribution and occurrence.—Pantha, July, in jungle near the I. B. P. plant.

Remarks.—In spite of careful supervision and long-continued digging by a gang of coolies over a considerable area only the two fragments of this species could be secured.

The smaller fragment was bisected vertically, the larger dissected out from the dorsal side.

The species resembles very closely in its external and internal conformations *D. doriae*. The worm probably resembles very closely *H. browni* also, from which it differs in the number and position of the gizzards. Like *D. doriae* the present species also has paired, round

masses of brown filaments attached to the dorsal face of the intestine, one on each side of the dorsal blood vessel.

Genus **Drawida** Mich.

Moniligastrinae with spermathecal pores in 7/8, male pores in 10/11, female pores in 11/12. Spermathecae in viii, testis sacs on 9/10, prostates in x, ovaries in xi. Last hearts in ix.

Drawida, from the standpoint of number of individuals as well as number of species and their extent and distribution, must be considered one of the most important components of the terrestrial Oligochaete fauna of the province. The genus has been found practically everywhere that collections have been made, from Myitkyina in the north to Mergui in the south, from Sandoway in the west to Yaungwhe in the east; it has been collected in the lowlying plains country, in the hills of the Arakan yomas as well as on the Shan plateau. The genus is not, as has been supposed, confined to regions of considerable rainfall, not at least so far as Burmese species of the genus are concerned. Several species exist, apparently in considerable numbers, in the dry, arid zone of central Burma. Furthermore several species at least are able to maintain themselves in fairly large numbers at the surface in moist localities during the long dry season after the majority of endemic forms have withdrawn deep into the ground. At present, including the new forms described in this paper, 16 species are on record as occurring in Burma. Of these 14 are, to the best of our present knowledge, endemic.

Drawida caerulea Gates.

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

Thongwa, July, numerous specimens.

Mingin, July, one specimen.

Masein, July, several specimens.

Monywa, July and August, several specimens.

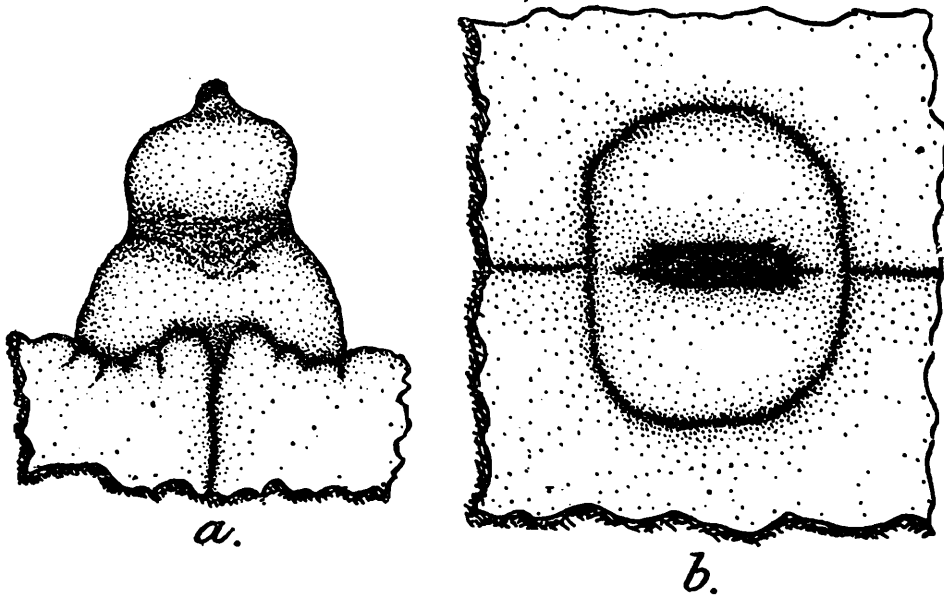
Mandalay, August, numerous specimens.

The Thongwa specimens are like the worms previously described from Nyaunglebin and Thonze. Specimens from these three places differ from each other, so far as external appearances are concerned, only in the amount of bending of the male porophores towards each other and the presence or absence of a tiny, teat-like projection from the tip of the male porophore. This uniformity of external appearance of specimens from three widely separated localities is quite unlike the extreme variability of external appearance of other Burmese species of the genus *Drawida*. The uniformity only characterizes the specimens from the alluvial plains of lower Burma. The specimens from Upper Burma are more variable in external appearance although even here the variability is restricted to the male porophores (external copulatory apparatus) for none of the specimens show any trace of additional genital markings.

Each genital papilla of the Lower Burma worms consists of an ovoid thickening of the ventral parietes of x and xi on which is seated a

columnar male porophore. The basal body protrudes from the ventral side and projects only very slightly into the coelom, the floor of which in x and xi gives little if any indication of the presence of the ovoid thickening. The columnar porophore is hollow with the tiny male pore on the middle of its ventral face, sometimes located at the tip of a tiny teat-like projection from the free end of the porophore.

At first only the basal parietal portion, the ovoid thickening, appears to be present in the Upper Burma worms. The basal body may protrude from the ventral side as in the earlier specimens, it may be at the bottom of a depression in the body wall, or it may be only slightly protuberant on the exterior but projecting into the coelom. In all of these specimens there is a conspicuous transverse slit on the ventral face of the ovoid body where the intersegmental furrow would be located were it continued across this body. This slit is not a male pore, for it merely opens into a cavity in the basal body which contains a hollow structure similar to the protruding hollow porophore of the southern worms. In some few individuals this male porophore protrudes slightly through the slit on one or both sides of the body. The differences in appearance between the worms of the two groups, northern and southern, may be explained by assuming that the columnar porophore is retractile and has been withdrawn into the ovoid body in one group, and also that the basal body may similarly be more or less retracted into the



TEXT-FIG. 3.—*Drawida caerulea*. a. Male porophore, extruded, lateral view. b. Male porophore, retracted, ventral view.

interior of the body. Structures as protuberant as in the southern worms would be an impediment to locomotion as well as liable to damage by friction. In absence of evidence to the contrary it may be assumed that the copulatory apparatus of the southern worms is retractile in a manner similar to that indicated by the northern worms. But at the same time it should be noted that none of the northern worms have completely protruded porophores, nor does a single specimen of the larger number of southern specimens examined have retracted porophores. Since both groups of worms were killed and fixed by the same technique it is not quite clear why there should be these differences.

In the southern worms and the majority of the northern worms the vas deferens is thrown into a small number of coils, which are compacted into a mass small in size relative to the size of the testis sac and contained within a transparent connective tissue sac that appears to be formed by the splitting of 9/10 into two lamellae. In bisected specimens that are properly preserved this double condition of the septum appears to be continued dorsally above the testis sac. The vas deferens has a pinkish iridescence. The spermathecal duct passes into 7/8 just before reaching the parietes. Its ectal end may be slightly thickened into a conical structure entirely within the parietes or extending from the parietes into 7/8 or into vii but leaning against 7/8. This conical enlargement of the duct varies slightly in size from one individual to another but in all specimens is a small structure. The portion that is buried within the parietes is hollow and the interior surface of the dorsal wall is ridged. Behind the gizzards for some distance there are paired brownish masses attached, one to each side of the dorsal blood vessel, just behind each septum. The masses consist of spherical or elongate lobes. Brownish material with a similar appearance is attached along the sides of the dorsal blood vessel but is not present dorsally or ventrally on this vessel.

About one fourth of the northern specimens differ from all other individuals of the species in certain respects. The vas deferens is very much longer, the loops or coils much more numerous and compacted into a mass that is about the same size as, or even larger than, the testis sac, but with the loops still contained within a transparent connective tissue sac. The testis sac and a portion of the vas deferens of one side, usually the left, penetrate through the periesophageal annulus of xi so that these male organs lie alongside the alimentary canal in some or all of segments xii, xiii, and xiv. The ovoid thickening of the parietes of x and xi projects conspicuously into the coelom, much less conspicuously externally; in several individuals without trace of external projection. The ovisacs extend posteriorly into xviii or xix. Nearly filling the coelom in vii is a pair of large, thick-walled, nearly spherical bodies. In 7/8 in region *cd* on each side is a conspicuous slit in the body wall, the ectal face of the spherical body bearing at its centre a small pore which must be regarded as the true spermathecal pore, pressed against the body wall in this region and visible through the slit. The spermathecal duct passes into 7/8 just before reaching the parietes of viii ventrally, through the septum and into the posterior wall of the atrium. The dorsal wall or roof of the atrium is thicker than the other walls and from it there protrude into the cavity ceiling ridges arranged into geometrical patterns, the ridges in the form of V's with two V's at the centre in contact in such a way as to form an X.

The important differences between the two groups of Upper Burma forms are practically confined to differences in size or length of organs. For this reason individuals with more highly developed organs have been regarded as fully mature, others as partially mature only. It should be noted, however, that in this species no worms have been found with either atrium or vas deferens in transitional stages between the two extremes characteristic of the worms designated as mature

and partially mature. Furthermore the clitellar colouration and spermathecal ampullae are fully developed in both groups. If the interpretation adopted is correct the hypertrophy of the atrium and the vas deferens must take place with considerable rapidity after other structures are already fully developed.

Drawida constricta Gates.

Drawida constricta, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 8, fig. 2-3 (1929).

Pakokku, July, 41 specimens.

Kalewa, July, a number of specimens.

Laungbyin, July, several specimens.

Homalin, July, several specimens.

Kalewa, August, several specimens.

Monywa, August, several specimens.

Mandalay, August, 7 specimens.

Mandalay, August, a number of specimens.

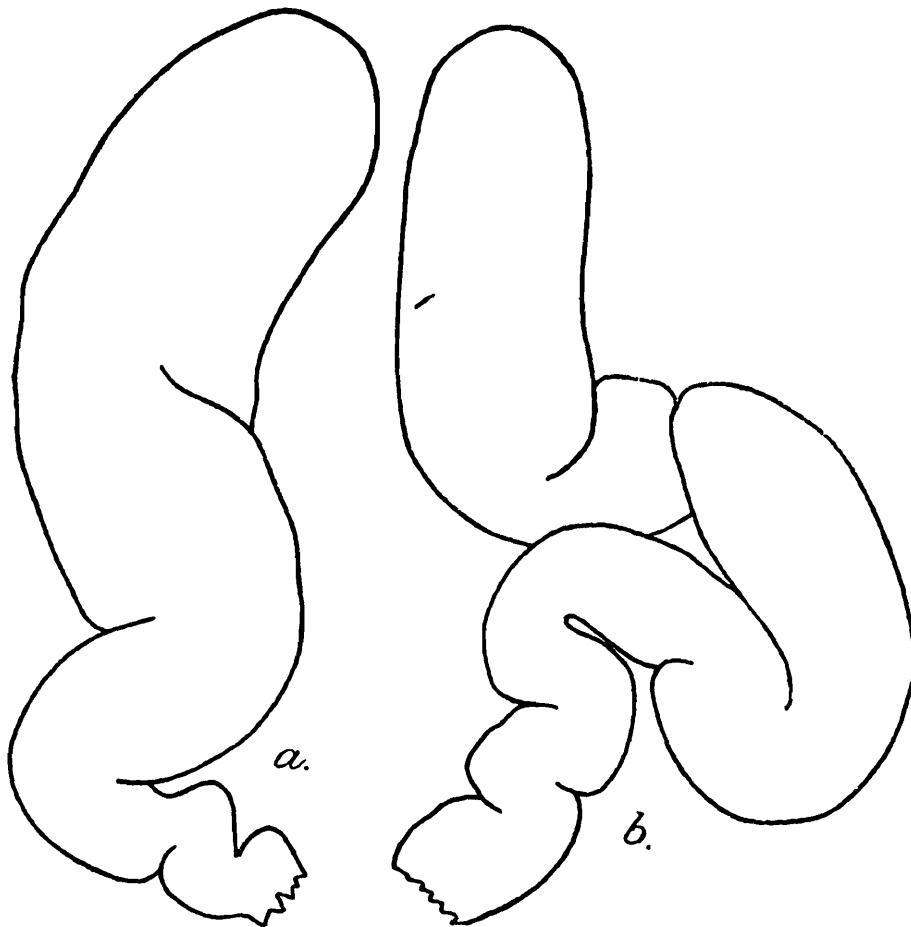
Mingin, July, several specimens.

The length and diameter varies considerably: in the first batch of Mandalay specimens from 40-50 and 3-3½ mm., in the second batch of Mandalay specimens 100-190 and 4-6 mm., in the second batch of Kalewa specimens 130-150 and 6-7 mm. Only one of the second lot of Mandalay specimens has any clitellar colouration. In the second group of Kalewa specimens the clitellar colouration extends anteriorly onto ix and posteriorly onto xiv.

Conical male porophores similar to those of the type-specimen are present in all except the second lot of Mandalay worms and the second lot of Kalewa worms. In these two batches of specimens the porophore is not conical but is flattened out into a basal plate on the centre of which is a nipple-like elevation bearing at its tip the male pore. The basal plate is however constricted off from the parieties by a circumferential furrow as is the conical porophore of the type and other specimens.

The genital markings are either unpaired or paired. In the former case they may extend across the ventral side from *c* to *c*, or from mid *bc* to mid *bc*; antero-posteriorly they may occupy the posterior half, posterior two thirds, or the whole length of the segment. Paired markings are laterally and posteriorly placed with the outer edge in line with the outer edge of an unpaired marking, if the latter be present, and extend internally towards the midventral line in varying degrees, either nearly reaching mid *aa*, or just internal to *a*, or just to *b*. One specimen has three pairs of lateral markings on ix, x, and xi; the laterals on xi nearly meet in *aa*, those on x extend slightly internal to *a*, those on ix do not quite reach line *b*. Whether unpaired or paired the markings are smooth-surfaced, glistening, whitish areas without any trace of the pink or red colour otherwise characteristic of the clitellar segments. The parietes are only slightly if at all thickened by the development of these markings, with no protrusions into the coelom in any of the specimens. Concavities may or may not be present, in fully mature specimens they are only found on the paired laterals. Fully developed unpaired markings cannot be properly described as oval, the ends are

bluntly rounded so that the markings are almost rectangular. Of the largest specimens (Mandalay and Kalewa) about ninety per cent. have only unpaired markings, and in most of the remainder the lateral markings nearly meet in *aa*. In only one of these specimens are the laterals widely separated (on segment ix). Genital markings may occur on any



TEXT-FIG. 4.—*Drawida constricta*. *a*. Spermathecal atrium, \times ca. 33. *b*. Spermathecal atrium of a mature individual, \times ca. 48.

of segments (vii) ix, x, xi, and xii; most frequently on x and xi, more rarely on xii, and more rarely still on ix. The large majority of worms have markings on both x and xi. Two specimens have an unpaired marking on vii, two others have paired laterals on vii.

Septum 4/5 is thin and attached circumferentially to 5/6, 5/6-8/9 are thickened and attached normally both dorsally and ventrally, 9/10 is attached to the middle of x dorsally and to 9/10 ventrally, 10/11 and 11/12 are fused to each other along the lateral and dorsal parietes but are separated from each other internally and ventrally. The ovarian chamber is in the shape of a U inverted over the oesophagus.

The gizzards are two in xv and xvi, xvi and xvii, xvii and xviii, or three in xv-xviii (Kalewa specimens).

Brownish material similar to that in *D. caerulea* is attached to the dorsal blood vessel along its sides in the segments behind the gizzards but there are no paired masses just behind the septa as in *D. caerulea*.

The testis sacs may or may not be considerably restricted by 9/10. The prostate has a granular surface in all specimens; it may be dome-shaped, or erect and columnar, or bent slightly into a kidney-shape

with the concavity of the bend directed towards the oesophagus. The vas deferens is twisted into several loops under the testis sac and passes into the inner face of the prostate near its ental end or into the end.

There may be no trace of an atrium in vii (spermathecal duct slightly thickened as it passes into 7/8 or the parietes—Pakokku specimens), or the atrium may be a slight tubular structure 1-2 mm. long (first lots of Kalewa and Mandalay worms), or tubular, bent or looped in various ways, most frequently looped into a zigzag with the loops all in one plane and limbs of the loops in contact (second batches of Mandalay and Kalewa worms). The ental end of the atrium may or may not be slightly enlarged and ovoid in shape. The smaller atria (1-2 mm. long) are enclosed in a transparent connective tissue sac, but no such sac is visible in specimens with the larger atria.

The original description makes no mention of an atrium. The type-specimen has been re-examined but no trace of an atrial projection into vii is visible. An undissected cotype-specimen is also available but this likewise has no atria. Yet both type and cotype-specimens have the clitellar colouration and fully developed spermathecal ampullae.

On first working over this material there seemed to be at least two distinct varieties, if not distinct species, but more careful examination and dissection of all of the specimens have furnished such a complete series of transitions from specimens with paired lateral genital markings only to those with unpaired markings only, and from specimens without atria to specimens with fully developed atria, that the conditions described may be more properly regarded as different stages in sexual development. Fully mature specimens always have atria, but may lack the medial development and fusion of the paired lateral markings on one or two segments but never on the last segment bearing such markings. The male porophores in all specimens are characteristic, the difference between these structures in the mature and immature specimens are due to a flattening out process in the larger forms.

Drawida lacertosa, n. sp.

Ngapoli, October, a single specimen.

External characteristics.—Length 92 mm. Diameter 5-5½ mm. Colour unpigmented, very light greyish.

The prostomium is prolobous, the furrow separating the prostomium from segment i passes into the buccal cavity as far as 1/2.

Dorsal pores are lacking.

On segment vi there is a single secondary furrow, just behind the setae. Segments behind vi have two secondary furrows, one anterior to and one posterior to the setae of the segment.

The setae begin on ii, are closely paired, *ab* equal to *cd*, *aa* slightly less than *bc* throughout the entire length of the worm.

Segments x-xiii have a deep red clitellar colouration.

The spermathecal pores are in 7/8, about in line with *c*, each pore surrounded by a tumid lip.

The male pores are rather large, at the end of conspicuous, white, conical swellings just external to *b* on 10/11. The base of the swelling is surrounded by a ring-shaped, white, circumferential lip.

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

There are whitish, glandular areas on x and xi anterior to and posterior to and in line with the male porophores. In *aa* on xii there is a protuberant, flat, whitish, genital marking extending from 11/12 to just posterior to the transverse setal line.

Internal anatomy.—Septa 5/6-8/9 are present and thickened. The gizzards are four in xvii-xx. The last pair of hearts is in viii.

The testis sacs are minute ovoid bodies on the posterior face of 9/10. The vas deferens is long and coiled into a closely compacted mass of loops several times the size of the testis sac. A prostate of the usual *Drawida* type is lacking, but in its place there is an elongate, dome-shaped gland about 3 mm. long projecting into the coelom about 1½ mm. from the floor of segments x and xi (as indicated by external annulation), with the long axis of the gland parallel to the long axis of the worm and internally in contact with the nerve cord. The vas deferens passes into the centre of the dorsal face of this gland.

The ovarian chamber is almost empty and collapsed so that it is difficult to make out its structure. It is apparently of the usual inverted U shape. The ovisacs are small and project into xiii, the portion of the sacs in xii practically empty.

The spermathecal ampullae are ovoid bodies on the posterior face of 7/8. The ental portion of the spermathecal duct is slightly thicker than usual and coiled into a number of loops just under the spermathecal ampulla. Emerging from this mass of loops the duct enlarges very gradually, simultaneously acquiring a reddish hue, which I assume indicates strong muscular development. The ectal-most portion of the duct is erect in vii against the posterior face of 7/8, bending internally to pass into the coil of loops. The ectal portion of the duct as it rises from the parietes, gradually tapering to its narrower diameter, strangely suggests the appearance of a *Megascolex* or *Pheretima* prostatic duct. The reddish portion of the duct is about 5 mm. in length, of which 3 mm. are considerably thickened. The atria are stout, thick-walled, reddish cylindrical structures erect in vii immediately in front of 7/8. The inner wall of the atrium has four vertical ridges so placed that the outline of the lumen in transverse section suggests a four-leaf clover.

Remarks.—In order to preserve this worm in the best possible condition for future reference the elucidation of several points of interests has been omitted. The description does, however, deal adequately with the points of major systematic importance. The atrium and spermathecal duct are characteristic and differentiate this form from all other known species of *Drawida*. The dome-shaped body, into which the vas deferens opens, resembles somewhat a corresponding structure in *D. caerulea*, but in *lacertosa* there is no external evidence for its presence.

***Drawida longatria* Gates.**

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

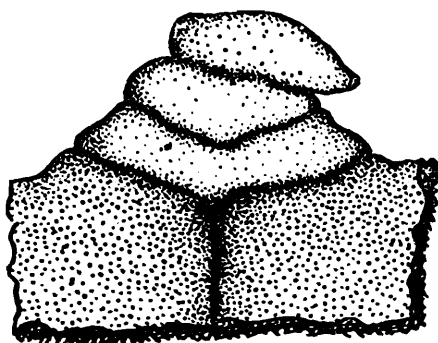
The furrow separating the prostomium from the first segment is continued into the buccal cavity as far as 1/2, so that the prostomium is attached to the roof of the buccal cavity behind 1/2.

The supra-pharyngeal ganglia are in iii as indicated by the external annulation.

Septa 5/6-8/9 are thickened and attached normally at the intersegmental furrows to the parietes; 4/5 is present but is attached circumferentially to the anterior face of 5/6; a sheet of tissue, possibly representing 3/4, is attached to the parietes in the anterior portion of v; anteriorly there are four or five transverse, thin sheets of tissue superficially resembling septa; 9/10 is displaced posteriorly and attached to the parietes in the hinder part of x both dorsally and ventrally, but with the dorsal attachment usually slightly posterior to the ventral attachment; 10/11 and 11/12 are fused dorsally but attached separately to the ventral parietes in the region of 11/12.

In the region of segments xiv or xiii the subneural blood vessel passes out from under the nerve cord, usually to the left side, and then anteriorly as a ventro-lateral trunk. In x a conspicuous branch passes upwards into the dorsal blood vessel after giving off a short branch which passes across the dorsal surface of the oesophagus to open into the corresponding vessel of the other side. The heart of ix and the branch from the ventro-lateral trunk are separated from each other dorsally by the septum 9/10, and in this region are always empty, so that the exact relationships between these two vessels and between these vessels and the dorsal trunk have not been determined.

On the opposite side of the worm the ventro-lateral trunk can ordinarily be traced posteriorly only into xii or xiii, where it breaks up into several large parietal vessels, but in a few favorable specimens the ventro-lateral trunk of this side can be traced as a conspicuous, blood-filled vessel into the region of xiii-xv, where it passes into the subneural trunk. In viii a small pair of commissural vessels from the ventro-lateral trunks open into the dorsal blood vessel immediately posterior to the origin of the "hearts" of viii.



TEXT-FIG. 5.—*Drawida longatria typica*. Male porophore, lateral view.

The parietal glands are characteristic, occurring in only one other Burmese species of the genus.

Variety *typica*.

Thongwa, July, numerous specimens.

Pakokku, July, numerous specimens.

Homalin, July, numerous specimens.

Monywa, August, several specimens.

Mandalay, August, several specimens.
 Toungoo, September, 18 specimens.
 Sandoway, October, several specimens.
 Andrew Bay, October, several specimens.
 Ngapoli, October, several specimens.
 Nyaungbinkwin, October, several specimens.

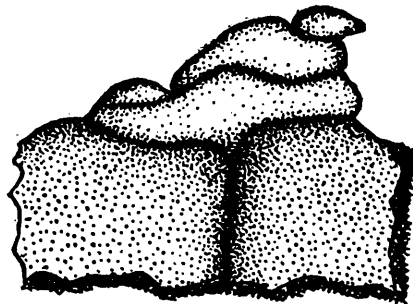
This variety may be distinguished from the two succeeding varieties by its large, ovoid, male porophore.

Variety **deminuta**, n. var.

Pyinmana, August, 20 specimens, found wandering on the surface after a heavy rain.

Specimens of this variety have a distinctly projecting ridge in the interval *bc* on each side of the body, extending anteriorly to the setae of *x* or to 9/10, and posteriorly to the setae of *xi* or to 11/12. Usually the ridge is not so distinctly protuberant anterior to the setae of *x* or posterior to the setae of *xi*. On the ridge, in the region of 10/11, is a roughly conical swelling which bears the male porophore, a tiny, smooth-surfaced, ovoid body with the male pore at the smaller, posteriorly directed end. The small size of the porophore is not due to immaturity for these specimens are 150-160 mm. long. Specimens of *typica* from Sandoway, which are 90-120 mm. in length, have porophores two to four times as large. On several worms a transverse slit in line with 10/11, with wrinkled lips in apposition to each other, opens into a cavity in the ridge. Into this cavity the porophore has been retracted. Two specimens show partial retraction of the porophores into these cavities. Retraction of the male porophores has not hitherto been observed in this species. On the ridge anterior to the porophore there may be one or two round papillae. The intersegmental furrow 10/11 is not continued across the ridge but comes to an end at the base.

The remaining genital markings may be said to consist of a triad on *xii*, a quartette arrangement on *x* and *xi* of two pairs, a triad on *ix*,



TEXT-FIG. 6.—*Drawida longatria deminuta*. Male porophore, lateral view.

and a sextette of two triads on *viii*. This combination of genital markings is only theoretical and represents the sum total of all the groupings observed; no single worm has all of these markings, a varying number of papillae being absent on each worm. The papillae of the quartette are located just anterior to *ab* and extend from the setae of *x* or *xi* to

or nearly to 9/10 or 10/11. They may be placed exactly anterior to the setae *ab* or slightly internal to *b*. Their inner margins may be in contact in the mid-ventral line or there may be a more or less wide space between their inner margins. The markings are circular, transversely or longitudinally oval, and consist of an outer, opaque, whitish rim surrounding a greyish, circular, central area, usually slightly depressed below the level of the rim. Each of these markings is the external face of a characteristic *longatria* parietal gland. Sixteen of the twenty worms have all four of these markings, two specimens lack the papilla on the right side of x, one lacks the marking on the right side of xi, and one worm lacks both right and left papillae of xi.

The triad of papillae of xii is on the anterior third of the segment, one papilla median in *aa*, and two lateral in line with *ab*. These papillae are usually larger than the quartette papillae. The lateral markings may include on their outer edge setae *a* and *b*. Only a few specimens have all three of these markings.

The triad of ix is on the posterior third of the segment, one papilla in *aa*, and a lateral papilla on each side in line with the ridge across x and xi. The lateral papillae are thus external to the quartette papillae. Two of the specimens have all three markings, nine have the laterals only, and the remainder have only one lateral each.

The sextette of viii consists of two triads, one triad on the posterior third of the segment in line with the triad of ix, and a second triad on the anterior third of the segment in line with the posterior triad of the same segment. Nearly all specimens have the anterior triad, most of the specimens have one or two papillae of the posterior triad.

Setal intervals *aa* is less than *bc* throughout the whole length of the animal. The clitellar colouration is very slight or entirely lacking.

The testis sacs are ovoid bodies on the posterior face of 9/10. The vas deferens is perhaps slightly thicker than in *typica*, is coiled into a closely compacted mass of loops two to three times the size of the testis sac and opens into the extreme end of the prostate. The gizzards are three in xvi-xviii or xvii-xix.

Variety *ordinata*, n. var.

Toungoo, September, 30 specimens.

The length of these worms varies from 175-200 mm., and the diameter from 8-9 mm. The red clitellar colouration begins behind the setae of ix and extends nearly to the setae of xiv, the colour a deeper shade of red than in *typica* from the same locality.

On each side of the body in mid *bc* there is a roughly conical projection from the anterior third of xi and the posterior third of x. The free end of this projection is directed posteriorly and bears at the tip the male pore. The demarcation of the posteriorly directed nethermost portion of the swelling into an ovoid body is less evident than in *typica*. Nor are the circumferential furrows on the basal portion quite as clearly marked as in *typica*.

More characteristic of this variety is the appearance and arrangement of the copulatory markings. In *typica* there are often median papillae on segments x, xi, and xii, such median papillae extending

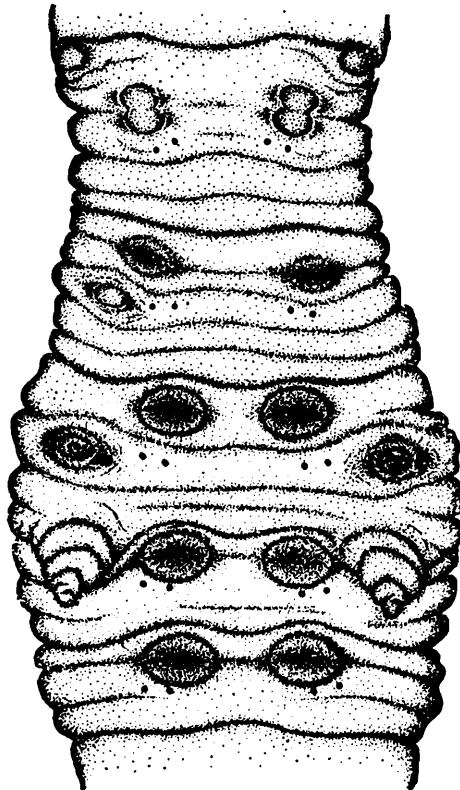
usually on each side to *a* or to *b*, while lateral papillae extend from the median papilla into the middle of *bc*.

Such median papillae are lacking in *ordinata*, in their place are three pairs of characteristic more or less median papillae. These markings are so located that there is a pair on the anterior margins of each of segments x, xi, and xii. Each papilla extends antero-posteriorly from the setae of the segment to or nearly to the anterior intersegmental furrow, and laterally from the mid-ventral line or slightly external to the mid-ventral line nearly to *b*. All thirty specimens have the pair on x, one specimen lacks one of the papillae of xi, two other specimens lack a papilla on xii.

All thirty worms have a further pair of lateral papillae on x, each papilla on the middle third of the segment in line with the male porophore and hence slightly posteriorly and external to the first pair of papillae of x.

The wide whitish rim of the genital markings of *typica* is here represented on these eight papillae only by a thin whitish line, nearly all of the marking greyish like the central concavity of the markings of *typica*. The greyish centre is frequently depressed in the form of a transverse slit.

Additional less sharply outlined copulatory markings occur on segments viii and ix. There may be as many as six of these markings on each of the two segments or as few as two. The markings are paired and lateral, on the anterior, middle, or posterior thirds of the segments,



TEXT-FIG. 7.—*Drawida longatria ordinata*. Ventral view of segments with genital markings.

just external to *b*, in mid *bc*, or just internal to *c*. Three specimens have in addition to these paired laterals an unpaired median papilla on ix.

The internal anatomy is very similar to that of *typica*. The gizzards are four in xvi-xix. The vas deferens consists of two parts; a narrow portion coiled very closely into a linear mass attached vertically to the posterior face of 9/10, and a thicker portion twisted into a spherical mass.

The spermathecal diverticulum of one of the largest worms was straightened out as much as possible without breaking the kinks and in this condition measured 56 mm.

The parietal glands are about twice the size of similar structures in *typica*. In an immature individual no glands projected into the coelomic cavity although external copulatory markings were present. After removing the longitudinal muscle fibre bundles the inner faces of the glands were visible. These parietal glands therefore appear to develop as local thickenings of the epidermis which, as they become hypertrophied, push their way through the muscular layers to project more or less conspicuously into the coelom cavity. If one of these glands be seized by the forceps, it can easily be extracted from the body wall leaving an aperture with clean-cut edges. Variety *ordinata* may be said to be rather well supplied with these glands.

Although *D. longatria* has been collected rather widely in the province no forms resembling these new varieties have hitherto been obtained. It is interesting to note that *typica* occurs alongside of *ordinata* in Toungoo. Whether *typica* occurs also in Pyinmana cannot be stated at present, the collection of worms from that locality consisting solely of *deminuta* which were found wandering aimlessly about after a heavy rain.

Drawida nepalensis Mich. 1907.

Mandalay, August, four specimens.

The identification rests upon the similarity of the spermathecal atrium with that described by Stephenson for the species. No specimens of the species have been available for comparison. Stephenson has already recorded this species from Burma:—Myitkyina district.

The male porophores are nearly conical in appearance but slightly flattened antero-posteriorly, and located in the intersegmental furrow 10/11. The posterior margin of x and the anterior margin of xi in contact with the porophore is swollen slightly in such a way as to produce the appearance of a small anterior and posterior lip at the base of the porophore. The gizzards are four in xv-xviii. The testis sacs are kidney-shaped, half in ix and half in x. The vas deferens is long and twisted into a mass of closely packed coils of about the same size as the testis sac. The male duct passes onto the prostate near the ectal end, from this point to the ental end of the prostate the vas deferens lies in a deep groove in the wall of the prostate from which it may be easily lifted out.

The atria vary considerably in size and appearance but all have the interior wall of both stalk and sac strongly ridged in an annular fashion. Specimen 1: atria small, ental end a very slight enlargement of stalk. Specimen 2: atria small, ental end sac-like, not flattened or invaginated but with external annular furrows. Specimen 3: atria

larger, ental end not flattened or invaginated but in shape of a very baggy, sac-like enlargement. Specimen 4: atria stalked, ental portion enlarged, flattened and free end invaginated as figured by Stephenson (1923, p. 146, fig. 53).

Drawida peguana Gates.

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

Drawida peguana, Gates, *Rec. Ind. Mus.* XXVIII, p. 146, fig. 1 (1926).

Mergui, October, 11 specimens.

Ngapoli, October, several specimens.

Several localities in the Arakan yomas, October.

Drawida rangoonensis Gates.

Drawida rangoonensis, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 320 (1925).

Drawida rangoonensis, Gates, *Rec. Ind. Mus.* XXVIII, p. 146, fig. 2 (1926).

Sandoway, October, 20 specimens.

Ngapoli, October, several specimens.

Several localities in the Arakan yomas, October.

Drawida rara Gates.

Drawida rara, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 321 (1925).

Drawida rara, Gates, *Rec. Ind. Mus.* XXVIII, p. 147 (1926).

Arakan yomas, October, three specimens, exact localities not recorded.

Drawida spissata, n. sp.

Tanyagyi, Patle, Tsalu, October, 12 specimens.

Description of the type-specimen, external characteristics.—Length 115 mm. Diameter 5-6 mm. Number of segments 159. Colour unpigmented, light greyish except segments x-xiv which are yellowish.

The prostomium is withdrawn into the buccal cavity.

There are no dorsal pores.

On vi there are two secondary annulations dividing the segment into three equal parts, the middle portion containing the setae. Segments behind vi have two similar secondary furrows, in the posterior half of the worm these furrows are much less conspicuous than anteriorly.

The setae begin on ii, are closely paired, *cd* appears to be a trifle smaller than *ab*; behind the clitellar segments *aa* is equal to *bc*, but in the posterior half of the animal *aa* is slightly smaller than *bc*.

The nephridiopores are in line with setae *d*.

The spermathecal apertures are in 7/8 in line with *c*. The epidermis in the region around the pore is wrinkled, whitish, and slightly protuberant.

The male pores are on the tips of conical porophores situated on the anterior margin of xi close to 10/11, the porophores directed anteriorly over the intersegmental furrow. Around the base of the porophore is a circular lip, sharply marked off from the porophore by a deep groove,

less sharply marked off from the parietes externally. The porophore and circumferential lip are both just posterior to 10/11 and slightly external to *b*.

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

The anterior two-thirds of viii is darkened mid-ventrally and the epidermal surface roughened but no definite papillae or genital markings can be distinguished. A pair of poorly defined, circular genital markings on *x* extend from the line of the outer edge of the male porophores to internal to *a* (including setae *a* and *b*) and antero-posteriorly from the first secondary furrow of *x* to 10/11.

Internal anatomy.—Septa 5/6-8/9 are present and thickened. There are four gizzards in xvii-xx. The annuli between the gizzards are long and in the posterior half of the segments behind the gizzards. The last pair of hearts is in ix.

The testis sacs are quite small relative to the size of the worm, nearly spherical, attached by their anterior ends to the posterior face of 9/10. The vas deferens is very long and coiled into a compact mass of long loops about three times the size of the testis sac, and passes into the prostate almost, but not quite exactly, at the ental end. The prostates are unusually long, coiled or looped and push through the perioesophageal annulus of segment xi into xii on the left side and xiii on the right side. The surface is characterized by a very fine granulation. The vas deferens of the left side passes through the perioesophageal annulus and into the ental end of the prostate in segment xii.

Segment xi is reduced to a characteristic, inverted U-shaped chamber with large, club-shaped ovisacs projecting into xii. From the posterior end of each of these sacs is a narrow finger-like projection. The spermathecal ampulla is rather small. The duct is coiled into a small mass just underneath the ampulla. Emerging from this mass of coils the duct is suddenly thickened to more than five times its previous diameter, and coiled into a large mass of loose loops which covers over the ampulla and the narrower portion of the duct. There are no atria in vii.

Remarks.—These worms are not in first class condition. Although the internal preservation is good the cuticle is fragmented and the epidermal surface roughened so that the characteristics of the genital markings cannot be satisfactorily determined, nor are the anterior setae clearly visible. This may perhaps be due to poor packing and the result of shaking and friction in the course of transportation over the hills. Possibly the indistinctness of the genital markings is due to a seasonal regression.

The length varies from 90-130 mm. The diameter ranges from 5-7 mm. All specimens have the yellowish colouration on some or all of segments x-xiii.

The prostomium is a small, ovoid body on the dorsal wall of the buccal cavity. It has on the centre of its ventral surface a deep antero-posterior slit or pit which gives to the prostomium a distinctly sucker-like appearance.

The spermathecal pore may be merely a transverse slit in 7/8 or may be located at the end of a distinctly projecting, tubular porophore.

Ten of the twelve specimens have a more or less definitely outlined genital marking in the mid-ventral region of viii. This genital marking extends from $7/8$ over the anterior two-thirds of the segmental length or more rarely as far as $8/9$, and may consist of an irregular but conspicuously projecting, narrow ridge, or of 1, 2 or 3 round swellings of the parietes in a row. In the latter case the markings may be only slightly or decidedly protuberant, and are located on one or more parts of the area occupied by the protruding ridge in other specimens. All the worms have the characteristic male porophores as well as smooth, white, glistening areas on x as in the type-specimen. In one worm the external borders of these markings extend beyond the line of the outer edge of the male porophores. The posterior secondary furrow may be continued across the markings of x or may end abruptly at their outer edges.

The gizzards are four in xvii-xx (7 worms) or five in xvii-xxi (1 worm).

The small size of the testis sac seems to be characteristic of the species.

The prostates are 15-25 mm. long, 1 mm. or slightly more in diameter. They may penetrate as far back as segment xiv. The prostates of this species resemble those of *D. doriae* more than those of any other species of *Drawida* hitherto found in Burma and are larger than in any other Burmese species of the genus *Drawida*.

The spermathecal ampullae are small. The ental-most portion of the spermathecal duct is slightly thicker than is customary in other species of *Drawida*. The narrower portion of the duct is 10-20 mm. in length and coiled into a close mass of loops under the spermathecal ampulla. The thicker ectal portion varies from 35-50 mm. in length and is thrown into a mass of loose loops which is attached by a thin sheet of transparent connective tissue to the posterior face of $7/8$ and which covers over the ampulla. The two masses of loops may be confined to their respective sides or they may meet mid-dorsally over the oesophagus.

There are no glands projecting into the body cavity over the genital markings.

***Drawida tecta* Gates.**

Drawida tecta, Gates, *Rec. Ind. Mus.* XXVIII, p. 148 (1926).

Taungyi, F. S. S., April, several specimens.

The tubular male porophore is practically a penis.

The gizzards are in xv-xviii.

The testis sacs have narrowed anterior and posterior projections referred to as "tails" The posterior tail may be very long and almost filamentous. The vas deferens is long and coiled into a nearly spherical mass of closely compacted loops, it passes into the prostate almost but not quite at the ental end.

The spermathecal duct is 6-7 mm. long and after several wide loops under the ampulla passes into the septum $7/8$ perhaps slightly dorsal to its point of entrance in other species. Within the base of the septum and the parietes the spermathecal duct is somewhat thickened.

Drawida tumida Gates.

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

Variety typica.

Tavoy District, October, 30 specimens.

On segment xx the setal interval *aa* varies from $\frac{2}{3}$ to $\frac{3}{4}$ of *bc*, posteriorly *aa* diminishes slightly relative to *bc*.

The spermathecal pores are in $\frac{7}{8}$ just internal to *c*.

In all of these specimens the ventral body wall is provided with two conspicuously projecting ridges, one on each side of the worm in *bc*, which bear the male porophores and an extra papilla as described for the type-specimen. The anterior papilla is placed usually at a slight angle, slanting towards the mid-ventral region. On only one worm are the papillae of vii as well developed as in the type-specimen. In other specimens there are only slight indications of glandularity on vii or none at all. In several specimens there are similar papillae on the anterior region of viii at about the same distance from the mid-ventral line as those on vii. Aside from these markings 26 of the present batch of specimens have no other genital papillae. Four worms have additional markings on ix as follows:—

27. Two papillae in *aa*, one papilla from $\frac{8}{9}$ to the transverse setal line; the second on the posterior half of the segment from the transverse setal line to $\frac{9}{10}$.

28. One papilla in *aa* on the anterior half of the segment.

29 and 30. One papilla in *aa* on the posterior half of the segment.

The copulatory markings are similar to the papillae of *D. longatria* and like them are the external faces of parietal glands that project into the coelom and which can be easily dissected out from the body wall.

The gizzards are usually four in xvii-xx as in the type (6 worms), or in xviii-xxi (1 worm), or in xix-xxii (2 worms), or five in xvi-xx (1 worm).

The testis sacs are deeply constricted by $\frac{9}{10}$, the anterior portion in ix about one-half the size of the posterior portion in x. The prostates are erect, conical, club-shaped, or slightly bent at the ental end. The vas deferens is long and coiled into a closely compacted, elongate mass of short loops on the posterior face of $\frac{9}{10}$ under the testis sac, and passes into the inner face of the prostate one-quarter to one-half of its length from the ental end. The compacted mass of loops is about one-fourth the size of the testis sac.

The ovisacs are large and may extend as far back as xvi or xvii. The spermathecal ampullae are large and ovoid. The atrium is 2-3 mm. long. In many of the worms it is compressed in such a way as to produce a wrinkled surface, or it may be erect and without wrinkles, or it may be bent in the middle nearly at right angles.

In the type and cotype specimens the atrium seemed to be attached to the dorsal surface of the parietal gland in vii and in some cases to actually pass into that gland. The specimens were too soft to permit exact determination of the relationships. In the present specimens the atrium passes into the septum just behind the parietal gland and hence

its ectal portion lies between the gland and the septum. The parietal gland is lacking on one or both sides of nearly all of the present worms.

It may be suspected that worms of this species are in reality but immature specimens of *D. longatria* in which the spermathecal atria have not been completely developed. The deep red colouration of the clitellar segments, the large size of the spermathecal ampullae, the large size and considerable posterior extent of the ovisacs indicate, however, complete sexual maturity, and taken together with the difference in point of entrance of the vas deferens into the prostate, and in absence of definite evidence to the contrary, may be regarded as sufficient justification for the maintenance of a distinct species. *D. tumida* must, however, be more closely related to *D. longatria* than to any other Burmese species of the genus known at present. To derive *D. longatria* from *D. tumida* practically all that is necessary is to increase by varying amounts the lengths of the prostates, vasa deferentia and spermathecal atria.

Variety **deleta**, n. var.

Tavoy District, October, 24 specimens.

Setal interval *aa* on segment *xx* is more nearly equal to *bc* than in *typica*, but posteriorly diminishes until *aa* is $\frac{1}{2}$ - $\frac{2}{3}$ of *bc*.

This variety is characterized by the absence of any trace of the pair of papillae always present in *typica* on *x* anterior to the male porophores. Correlatively the ridged appearance of segments *x* and *xi* is almost entirely or entirely lacking. The male porophores are small, conical projections across 10/11 in mid *bc*. There is no ovoid porophore, the male pore located on the ventral face of the conical swelling or in a few specimens on the posterior face. Each specimen has several circular papillae (and parietal glands) of the *longatria* type variously located as follows :—

- Single, median, small, in *aa*, on the anterior half of *ix*.
- Single, median, small, in *aa*, on the posterior half of *ix*.
- Paired, median, small, in *aa*, on the posterior half of *x*.
- Paired, median, small, in *aa*, on the anterior half of *xi*.
- Paired, median, small, in *aa*, on the posterior half of *xi*.
- Single, median, large, in *aa*, on the anterior half of *xii*.
- Single, median, small, in *aa*, on the anterior half of *xiii*.
- Single, median, large, in *aa*, on the anterior half of *xiii*.

A smaller, transversely placed, oval, glandular area may be present on one or both sides of *vii* on the posterior margin of the segment immediately anterior to the spermathecal pore.

The gizzards are in *xvii-xx* (6 worms), *xviii-xx* (2 worms), *xviii-xxi* (2 worms).

The testis sacs may be oval and confined to *x* or present in both *ix* and *x* and constricted by 9/10. The vas deferens is long and twisted into short loops which are compacted into a dorso-ventral linear mass on the posterior face of 10/11. The vas deferens passes into the oesophageal face of the prostate about half way between the ental and ectal ends. In shape and granular appearance of the surface the prostate is similar to that of *typica*.

The ovisacs are large and may extend posteriorly into xvii. As in *typica* the spermathecal atria are tubular with wide lumen and thin wall. External conformation of atria as in *typica*.

Parietal glands are present in vii as in the type-specimen of *typica*.

The writing on the labels of the two batches of worms has become illegible so that the exact locality from which the present specimens of the two varieties were secured is not definitely known. The specimens of one variety were secured in the near vicinity of Tavoy town, those of the other variety from Myittha.

Drawida vulgaris, n. sp.

Kalewa, July, 61 specimens.

Masein, July, 1 specimen.

Description of the type-specimen, external characteristics.—Length 45 mm. Diameter 3 mm. Number of segments about 134, the segments in anal region closely crowded as if being regenerated. Colour: unpigmented, light greyish, except clitellar segments which are deep red.

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

Functional dorsal pores are absent. A thin, grey, longitudinal line indicates unusual thinness of the parietes in the mid-dorsal line, the grey line slightly enlarged in the intersegmental furrows in such a way as to simulate the presence of dorsal pores.

The setae begin on ii, are small, and closely paired; *ab* is equal to *cd*, just behind the clitellum *aa* is less than *bc*, but posteriorly *aa* and *bc* are nearly equal.

The clitellar colouration extends from the posterior half of ix onto the anterior margin of xiv.

The spermathecal pores are in $7/8$ in line with *cd*.

The male pores are presumably located on the flaps protruding from the posterior margin of x but have not been seen in this specimen.

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

A pair of small, flap-like protrusions from the posterior margin of x in *bc* project ventrally and posteriorly. The copulatory markings are transversely elongate, whitish, very slight swellings of the parietes on the anterior half of xiii (2), and the anterior half of ix (1). The single swelling of ix lies in mid *aa* and has at its centre a single grey spot. The markings on xiii meet internally in *aa*, extend externally to just beyond *b*, each has a pair of grey spots at the centre.

Internal anatomy.—Septa $5/6-8/9$ are present and thickened. There are three gizzards in xiii-xv. The last pair of hearts is in ix.

The testis sacs extend into both x and xi and are constricted by $10/11$. The vas deferens is short and passes after a very few zig-zag loops into the ental end of the prostate. The prostates are slightly flattened, bent into a crescent shape with the opening of the crescent facing the alimentary tract, the surface coarsely granular. The prostate narrows to a fragile stalk as it enters the body wall.

The ovarian chamber is closed dorsally over the oesophagus and is in the form of an inverted U. The ovisacs are thick in xii. The sper-

mathecal ampullae are large, ovoid sacs, the ducts slightly looped. Small, tubular but flattened, strap-like atria in vii.

Remarks.—The length varies from 30-48 mm. Behind the clitellum *aa* and *bc* may be equal or *aa* may be greater than *bc*, posteriorly *aa* and *bc* may be equal or *aa* may be smaller than *bc*.

The spermathecal pores are in line with *cd* or slightly internal to *c*.

The marginal flap of *x* is present in all specimens but varies slightly in size and degree of projection. In some worms a distinct pore, presumably the male pore is visible at the tip. The flap may not be sharply marked off anteriorly from *x*, or a slight furrow, which passes posteriorly into 10/11, may demarcate the flap anteriorly and laterally.

The copulatory markings are transversely placed, very slight swellings of the parietes, more or less oval in shape, usually with a single grey spot at the centre, rarely a pair of grey spots at the centre, located on the anterior half or middle third of segments vii-xiv. The copulatory markings on 21 specimens picked at random are as follows :—

- Single, median, in *aa*, on viii, 5 worms.
- Single, median, in *aa*, on ix, 12 worms.
- Paired, median, in *bb*, on xiii, 17 worms.
- Paired, median, in *bb*, on xiv, 1 worm.
- Paired, lateral, in *bc*, on vii, 17 worms.
- Paired, lateral, in *bc*, on viii, 7 worms.
- Paired, lateral, in *bc*, on ix, 13 worms.
- Paired, lateral, in *bc*, on *x*, 21 worms.

The papillae on *x* are just anterior to the marginal flaps.

The gizzards vary in number from 2-4 and in segmental location from xii-xvi: in xii-xiii-xiv 4 worms, in xii-xiii-xiv-xv 2 worms, in xiii-xiv-xv 8 worms, in xiii-xiv-xv-xvi 1 worm, in xiv-xv 1 worm, in xiv-xv-xvi 2 worms.

The subneural blood vessel emerges from under the nerve cord in the region of xii and divides into two branches, one of which continues anteriorly as the ventro-lateral trunk of the right side, the other passes dorsally and either into the heart of ix just after it emerges from the dorsal blood vessel, or into the dorsal blood vessel just behind the heart of ix. The ventro-lateral trunk of the left side is similarly connected with the dorsal blood vessel but being empty has not been traced posterior to xii. Probably it passes into the subneural vessel posteriorly as in other species of this genus.

The testis sacs are always constricted by 10/11, sometimes so much so that they appear as two distinct lobes connected by a narrow stalk. The vas deferens is short and passes into the prostate very near to the ental end on the side facing the oesophagus.

The ovisacs are usually confined to xii but extend in several specimens into xiii. The atria have thick walls, the diameter of the lumen about equal to the thickness of the atrial wall. The atrium is flattened and strap-like with rounded ental end, may or may not have several annular constrictions, passes into the anterior face of 7/8 and in the septum into the parietes. The spermathecal duct passes into the septum and into the atrium just before reaching the ventral parietes. The

atrium may or may not be slightly narrowed before it passes into the septum.

The single specimen from Masein is 34 mm. long, 2 mm. in diameter. Colour : dark, greenish-grey. There are three gizzards in xiii-xv.

Drawida species ?

Mergui, October, 4 specimens, all softened.

Length 23-27 mm. Diameter 2 mm. Colour greyish, tinged with a bluish shade.

The setae begin on ii, are very closely paired, *ab* is equal to *cd*, *aa* varies from $\frac{1}{2}$ to $\frac{2}{3}$ *bc*.

On the posterior part of x in *bc* but nearer *ab* than *cd* there is on each side an indistinctly outlined glandular area extending from the transverse setal line to 10/11. Another pair of similar areas extend from the transverse setal line of xi anteriorly to 10/11. In 10/11 between the outer ends of these two slight glandular areas a smooth-surfaced, teat-like structure projects anteriorly and towards the mid-ventral line. This is probably a male porophore, the free end is narrow and thread-like. There are no other copulatory markings.

The gizzards are four in xii-xv.

The testis-sacs are small ovoid bodies on the posterior face of 9/10 concealed from view in dorsal dissection by the oesophagus. The vas deferens is long and loosely coiled into a mass of loops about equal in size to the testis sac. The prostate is a small berry-shaped body with a fine duct and a granular surface. The vas deferens passes into the inner lower face of the prostate.

Segment xi does not appear to be closed off dorsally, or else was opened in pinning out the worm after mid-dorsal incision. Paired ovisacs in xii. The spermathecal ampulla is minute, relative to size of duct unusually small. The spermathecal duct is nearly straight, except for a single loop, as it passes into the parietes on the posterior face of 7/8 it is abruptly enlarged. The enlarged portion is short with diameter three to four times that of the rest of the duct. There is no atrial prolongation into vii.

These worms are, most probably, immature. They cannot, however, belong to any of the species of *Drawida* recorded from Mergui district in the preceding part of this paper. The specimens are too soft to permit satisfactory study or description. The preceding data are given because of their interest in adding a further species of an important genus to the records of the fauna of a district that is at present only partly known.

Family MEGASCOLECIDAE.

Sub-family MEGASCOLECINAE.

This sub-family is represented in the Burmese fauna by endemic species of *Woodwardiella*,¹ *Notoscolex*, *Perionyx*, and *Pheretima*. Of these

¹ Replacing *Woodwardia* which was preoccupied.

four only the second and the last seem to be of importance at the present as *Woodwardiella* and *Perionyx* are represented in the province by a single endemic species each. Neither of these two forms have been collected recently and both are known only from the original descriptions of worms from single localities.

Genus *Notoscolex* Fletcher.

This genus is an important constituent of the earthworm fauna of the province and wherever it is found apparently occurs in large numbers. Unfortunately it seems to be very difficult to obtain complete fully mature specimens. On three separate occasions, at the beginning, in the middle and at the end of the rainy season, attempts to secure complete adult *N. birmanicus* have been unsuccessful. Clitellate individuals of the shorter species are more easily found.

The new *Notoscolex* localities are Toungoo district in its hill portion, Kalaw, and the Chindwin Valley. Stephenson has recently (1929) described a form from the Indawgyi Lake region in Myitkyina district.

In spite of numerous and long continued efforts to obtain fully mature specimens all of the worms of this genus in the present collections are immature. A gang of coolies dug one whole day at one locality and while large numbers of specimens were secured none had any indication of clitellar development.

One of the Chindwin valley forms and the Toungoo worms have characteristic markings and in the latter case slightly developed clitella which enable a rather tentative identification. The remaining worms from the Chindwin region cannot be definitely placed in any of the present species of the genus. One, however, has such distinctively characteristic seminal grooves that it may be treated definitely as a new species although it cannot, of course, be described at length at the present.

? *Notoscolex depressus* Gates.

Notoscolex depressus, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 14 (1929).

Thandaung, September, a number of specimens, not quite mature, clitella only faintly indicated.

The length of the present specimens ranges up to 275 mm., with the longest specimen incomplete posteriorly. The diameter at the anterior end is 6-7 mm. The clitellum is a light reddish colour. The first dorsal pore is in 9/10.

The setal intervals vary from worm to worm as the following from several individuals picked at random will show:— $ab : cd : bc : aa : \frac{1}{4} : \frac{1}{2} : 1 : 1\frac{1}{8}$, or $\frac{1}{3} : \frac{2}{3} : 1\frac{1}{2} : 1\frac{1}{2}$, or $\frac{1}{3} : \frac{1}{2} : 1 : 1$, or $\frac{1}{3} : \frac{3}{4} : 1 : 1\frac{1}{4}$, or $\frac{1}{3} : \frac{3}{4} : 1 : 1$. Posteriorly a and b are more widely separated than anteriorly.

? *Notoscolex lunatus* Gates.

Homalin, August, four specimens, all immature.

On these specimens there are a pair of diagonally placed, oval protuberances similar to those of *N. lunatus*, extending across segments

xvii and xviii and bearing the seminal grooves. Unlike the type and cotype specimens of this species these oval swellings of the parietes are not contracted into a mid-ventral depression but project from an otherwise smooth body wall.

Setal intervals *ab* and *cd* are about equal, and *bc* is about equal to one-half of *aa*. The setae begin on segment ii.

The spermathecal pores are closely paired in the mid-ventral line in 6/7 and 7/8.

The prostates and prostatic ducts are similar to those in *N. lunatus*. Likewise the spermathecae resemble those of *N. lunatus* except that the diverticulum is slightly shorter in each spermatheca.

None of the specimens have any indication of clitella.

THE CHINDWIN VALLEY FORMS.

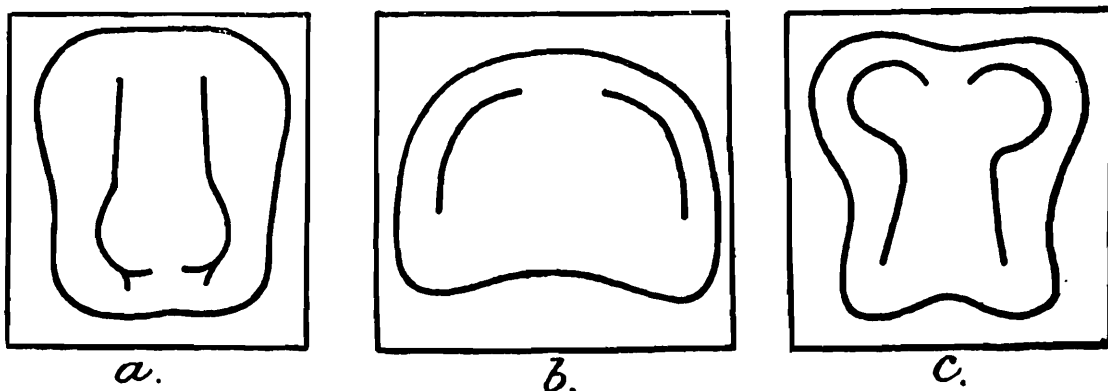
Pantha, Paungbyin, Mawleik, July, a number of specimens of varying lengths from each locality, none mature.

Specimens were easily secured by digging in the vicinity of the large characteristic castings. In the first two or three inches of surface soil there were short individuals about 5 inches long (alive). Three to six inches deeper longer individuals about 10-12 inches in length (alive) were found. The longest individuals were deeper still. All of the species represented evidently attain a considerable length. The longest complete specimen (Form C) was between three and four feet in length when alive and preserved (and of course strongly contracted) is 533 mm. in length and 9 mm. in diameter. A number of specimens complete or incomplete nearly as long were obtained. When a worm reaches such unusual lengths the difficulties of getting complete specimens by digging are greatly increased, especially when one must rely on coolies of the usual degree of intelligence.

The setae are paired and begin on ii; $ab < cd < bc < aa$.

The spermathecal pores are paired in 6/7 and 7/8.

Septa 5/6-12/13 are thickened. There is an elongate gizzard in vi. The calciferous glands are four pairs in ix-xii. The last hearts are in xii. There is no subneural blood vessel, but in many of the specimens, at least in the anterior ends, there are two fairly large longitudinal trunks



TEXT-FIG. 8.—Diagram of ventral parietal swelling and seminal furrows of three forms of *Notoscolex* from the Chindwin Valley region.

on the ventral parietes, each a short distance from the nerve cord. There is a large mass of nephridia on each side of segment vi.

The male funnels in x and xi are larger than the female funnels and slightly more dorsal in position. There are paired seminal vesicles in xi and xii. The prostates are elongate, flattened, and strap-shaped, the outer edges slightly lobed or incised, the inner margins smooth.

Each spermatheca has a finger-shaped diverticulum arising from the anterior face of the duct. The ovaries and funnels are in xii in the usual positions.

Though the worms are immature it is possible to sort them all into three groups by comparison of their genital markings (*vide* fig. 8). On the ventral body wall of every worm is a protuberant swelling extending across two segments and containing thereon the seminal furrows or grooves. In *B* and *C* the swelling extends across segments xvii and xviii; in *A* the swelling extends across segments xvi and xvii. In *B* and *C* the male pores are located on xvii in the anterior end of the seminal grooves, which extend posteriorly onto xviii in different modes in the two forms. In *A* the male pores are located on xvii in the posterior ends of seminal grooves, which extend anteriorly onto xvi as figured.

The first dorsal pore is in 10/11 in *a* and *b*, in 11/12 in *c*.

The prostatic ducts of *a* and *c* pass from the inner edge of the prostate straight towards the nerve cord in a direction transverse to the long axis of the animals. The prostatic ducts of *b* pass from the inner margin of the prostate anteriorly in a line parallel to the nerve cord.

Either or both of forms *b* and *c* may belong to *N birmanicus* although this is rather doubtful. Form *a* is quite unlike any other species of the genus hitherto found in Burma and can be readily recognized by its inverted seminal grooves. Inasmuch as this form can be readily recognized it may as well, for the sake of future convenience of reference, be named :—⁴

Notoscolex conversus, n. sp.

First dorsal pore in 10/11. Seminal grooves located on an oval protuberant swelling of the parietes extending across the greater portion of the antero-posterior lengths of segments xvi and xvii. Male pores on xvii in the posterior ends of the seminal grooves which continue anteriorly onto xvi. Other characteristics as previously described.

Notoscolex species ?

Kalaw, May, immature specimens.

These are about 62 mm. in length and about 3 mm. thick. The first dorsal pore is in 12/13. These specimens were found along with *B. parvus* in black soil in swampy localities near the bazaar.

Genus **Megascolex** Templeton.

Megascolex mauritii (Kinb.), 1867

Pakokku, July, a large number of specimens.

Monywa, July, a large number of specimens.

Mingin, July, a number of specimens.

Kalewa, July, a number of specimens.

Kindat, July, a number of specimens.

Tavoy, October, several specimens from each of a number of localities in the vicinity of the town.

Mergui, October, several specimens.

Ngapoli, October, several specimens.

Sinbyudaing, November, several specimens.

Banks of the Tennaserim river on Tavoy-Siam Road, November, several specimens.

Bawti and Not Theinko, Siam, November, several specimens.

This species, judged by number of specimens in the present collections, is the commonest form at Pakokku and Monywa, and one of the commonest forms at Mingin, Kalewa, and Kindat. Now Monywa, Pakokku, and certain other places such as Thazi, Meiktila, Myingyan, etc., at which this worm has been previously found in large numbers, are all in the dry zone. Furthermore the species is one of a few that are able to maintain themselves in considerable numbers in moist spots throughout the long dry period of the year. *M. mauritii* must therefore be peculiarly adapted to a mode of life under such circumstances. Correlatively, it forms a much less important constituent of the earthworm population in areas of greater rainfall.

Genus *Pheretima* Kinberg.

Stephenson (1923) writing of *Pheretima* states that "The genus is one of the commonest throughout India, but this is in virtue of its peregrine species, such as *P. posthuma*, *hawayana*, *heterochaeta* and *houletti*; the only parts where *Pheretima* is endemic are Burma, the Andamans, Lower Bengal (one or two species), and possibly the Nilgiris and the extreme south (perhaps two or three species)"

The two or three species from the Nilgiris and the extreme south are *P. burliarensis*, *P. travancorensis* and *P. trivandranæ*. The first of these, *P. burliarensis*, was described in a very sketchy manner by Bourne and has not since been found. Michaelsen thinks it may be identical with *P. rodericensis*. The second species, *P. travancorensis*, was described by Fedarb and, like the previous form, has not since been found. It has been merged by different authors with different species according to their interpretation of the description and figures of the spermathecae and seminal vesicles. *P. trivandranæ*, founded for a single immature specimen, has likewise not been collected since its first description and is, as has already been pointed out by Stephenson, very similar to *P. houletti*, to which it probably belongs. Aiyer, who himself collected and studied the Oligochaetes of Trivandrum and Travancore, makes no mention of finding either of the two latter species.

It is obviously impossible to attach any zoogeographical significance to these records of incompletely described or immature forms so far removed from the true *Pheretima* domain. All three most probably are peregrine forms.

Lower Bengal is much nearer the true *Pheretima* domain. Its one or two possibly endemic species are *P. anomala* and *P. alexandri*. The first of these two species was collected in the Botanical Gardens near

Calcutta some time previous to 1907 and has not since been found anywhere in India proper. Quite possibly it was accidentally imported into the Gardens in soil around plants. But whether this is so or not the species has an extensive distribution, being widely distributed in Burma and also occurring in Siam and does not therefore have the same zoogeographical value as more restricted forms. The second of these two species is based upon a single, probably immature worm imported into Kew Gardens from the neighbourhood of Calcutta. Michaelsen (1910, p. 11) thought that it might possibly be identical with *P. heterochaeta*. Stephenson (1923, p. 291) considered this possibility but decided that the form of the spermatheca and its diverticulum distinguished the species from *P. heterochaeta*. The worm is probably an immature specimen of *P. lignicola*; evidence for this is presented elsewhere in this paper (see p. 314).

Since the publication of the Fauna volume two additional species of the genus have been recorded from India proper. *P. himalayana* from Darjeeling is another single-specimen species. *P. planata* was later reported from South Cachar in Assam. This latter species is widely distributed in Burma from Mergui to Myitkyina and if not actually peregrine will probably prove to be, like *P. anomala*, of limited zoogeographical significance.

The Andaman Islands may be omitted from the present discussion, their Oligochaete fauna, so far as it is known, is quite different from any other part of the Indian empire.

There has been more justification for regarding Burma as part of a "*Pheretima* domain" There had been listed from this province previous to 1923 ten valid species that were probably endemic and of this number five belonged to the genus *Pheretima*. Michaelsen (1909) concluded that "Indeed, we can hardly look for more frequent relics in this region, for it is the proper dominion of the vigorous, phyletically youngest Megascolepine genus *Pheretima*; which certainly has extirpated nearly all the phyletically older and feebler genera with which it has come into contact" Stephenson (1923) also maintains that "Burma is well within the *Pheretima* region."

The endemic species added to the Burmese fauna in the last few years have been almost entirely Moniligastrine or Octochaetine. It can no longer be maintained that *Pheretima* is the dominant genus in Burma or even that it forms a very important part of the endemic Oligochaete fauna of the major portion of the province. If a line be drawn on the map from just south of the Indawgyi Lake, Myitkyina District, in northern Burma through Bhamo and then along the edge of the Shan plateau to Moulmein the province will be divided practically longitudinally into two unequal parts. The larger western part, in which collecting has been the more extensive, entirely lacks endemic species of *Pheretima*, the only species of this genus therefrom that can have any zoogeographical significance being *P. anomala* and *P. planata*. The dominance in this section of the province, so far as domination can be ascertained from present records of distribution, clearly lies with *Eutyphoeus* and *Drawida* and perhaps, to a lesser extent in the north central part, with *Notoscolex*.

In the smaller western portion of the province are the habitats of the five species of *Pheretima* from which Michaelsen derived his ideas of *Pheretima* dominance, as well as of the two recently described species (Gates, 1929). But even in this region *Drawida* and *Notoscolex* form a more important part of the fauna than does *Pheretima*. Furthermore, other genera, perhaps equally important, such as *Hastirogaster*, *Desmogaster* and *Ramiella* are present here.

Having stated these facts, perhaps somewhat emphatically, it may be admitted that *Pheretima* with its (formerly) 7 endemic species does form a rather important part of the endemic Oligochaete fauna of a small, western, hilly section of the province; although even here the genus is nowhere near as important as was once thought.

The present collections contain several specimens each of two new species, and single specimens each, in some cases fragmentary, of three further new species of *Pheretima*. Generally speaking, it is not desirable to erect new species for single earthworms, especially when these individuals are obviously incomplete posteriorly. Earthworms are variable animals and abnormalities and variations are frequently found. The posterior portion may have certain definite specific characters lacking anteriorly. Then too the spermathecae, which are particularly important for specific definition, vary considerably in appearance from one season to another, from one individual to another and specially from immature to mature individuals. It is, therefore, quite possible that a single individual may be highly aberrant or variant and that the specific definition based on structures ordinarily somewhat variable or perhaps definitely aberrant may be misleading. There are at present altogether too many single-specimen earthworm species which have never again been seen. It has been the practice in this laboratory to lay aside undescribed all single specimens of new species until such time as additional specimens are secured. But in order to indicate as fully as possible what importance *Pheretima* does have in Burma this rule has been discarded so far as this paper is concerned and provided only that the single specimens involved are mature. There still remain several immature specimens belonging to one or more species which may also be new.

We thus have, if all are valid, 12 endemic species of *Pheretima*, all of which are from the smaller western portion. It should, however, be pointed out that of these species, two of Rosa's 1890 forms have not since been collected, and that very few of the others have been collected in any considerable numbers. The paucity of specimens is partly due to collection at unfavourable seasons of the year, but more fundamentally to definite rarity. To secure the very few specimens of endemic *Pheretima* that the writer has collected in the last five years many thousands of worms have been dug. The importance of this statement may be best illustrated by a single quotation from the journal of a recent collecting trip. "At Labaw Mr. Sutton of Tavoy kindly arranged with the Karen teacher in charge of the school for the collection of earthworms by the school boys. As a result of the first effort considerably over a thousand specimens were obtained. In this large collection two species, *P. defecta* and *E. peguanus*, were represented only by single individuals. No further specimens could be found anywhere,"

The collection just referred to contained large numbers of the common peregrine species of *Pheretima*. The high percentage of these forms is without doubt partly due to their greater resistance to unfavourable climatic conditions. At the same time it may be possible that the endemic species of *Pheretima* are being replaced by peregrine species of the same genus. There certainly is no evidence for a belief in the annihilation or extermination of non-*Pheretima* forms by *Pheretima*.

In spite of considerable collecting in various parts of the province during the last eight years we are still entirely ignorant of a more or less considerable fraction of the Oligochaete fauna of Burma. Similarly much remains to be done in working out the fauna of the neighbouring regions of India. A portion of this unknown fauna may consist of still further *Pheretima* species. Should this prove to be true they are to be expected first of all from the Shan Plateau, secondly from the north-east portion of the province above Myitkyina and Bhamo, and lastly perhaps from eastern Assam.

To summarize briefly :—So far as our present records of distribution are concerned, no part of India belongs to a *Pheretima* dominated region ; on the extreme western border of the Indian empire, into a small hilly section of the province of Burma there have penetrated a number of species of *Pheretima* which have been only rarely found and when discovered are usually present only in small numbers relative to other species.

***Pheretima andersoni* Mich., 1907.**

Maungmagaun, October, 3 anterior fragments, found on the Maungmagaun-Tavoy road, western hill section, in the early morning.

The longest fragment had lost its posterior portion some time previously and the wound had healed over. The shorter pieces had been cut off in some way from their tails so recently that no healing had as yet taken place. Although coolies dug in the neighbouring jungle on both sides of the road for some time no further specimens were obtained.

The only previous account of this worm is by Michaelsen who had two specimens collected at Amherst about 150 miles north of Tavoy, which were softened and stretched but supposedly mature. The greatest diameter was smaller by 4 mm. than the thickness of the present specimens, and the number of segments was smaller than that indicated as characteristic for the species by the longest of the present three fragments.

External characteristics.—Length of longest fragment 204 mm. Diameter just behind the clitellum 10 mm. Number of segments in the longest portion, 124. Colour of preserved specimens dark blue or brown, clitellum dark red.

The prostomium is retracted into the buccal cavity in all the specimens. The first dorsal pore is in 12/13, the second is in 16/17.

The clitellum extends from 13/14 to 16/17. Setal circles are clearly visible on clitellar segments in two specimens, doubtfully in the third.

The male pores are tiny apertures located at the centre of round or transversely oval, smooth-surfaced areas. These areas are delimited by a more or less deeply marked circumferential furrow and may be at the outer ends of conical swellings in the setal circle or may be withdrawn into a crater-like excavation within each swelling. Between the swollen protuberances there are 25-30 setae.

The female pore is single, in the setal circle of xiv, at the centre of a transversely oval, creamy white, smooth-surfaced, glistening area.

The spermathecal pores are four pairs in 5/6, 6/7, 7/8, and 8/9. On segments vi and vii between the lines of the spermathecal pores there are 27-30 setae.

There are only three copulatory cushions on each of the present worms, on furrows 20/21, 21/22, and 22/23. These cushions consist of a hard, outer thickening of the epidermis and a looser, much softer, glandular mass of tissue projecting into the body cavity.

Internal anatomy.—Michaelsen's description of the anterior male organs may be confusing to some as he has called the testis sacs seminal vesicles and the seminal vesicles sperm sacs. There are no seminal vesicles in x. The four testis sacs are large and all approximately of the same size. The anterior pair are against the anterior face of 10/11, which is bent forward in such a way as to cover them over. The posterior pair extend from 10/11 to 11/12. The seminal vesicles of xi are small relative to the size of the worm. The seminal vesicles of xii are large, filling segments xii and xiii and pushing 13/14 and the subsequent septa back into contact with 17/18 at the anterior edge of the prostate.

The prostate extends through segments xviii, xix, and xx; the duct is looped and reaches into xix with the concavity of the loop directed anteriorly. The two vasa deferentia of a side do not meet until in the neighbourhood of the prostates, the fused vasa deferentia opening into the prostatic duct about 1 mm. from the edge of the prostate.

The spermathecal duct is much longer than figured by Michaelsen and the ampulla is more nearly ovoid in shape. The length of duct is approximately equal to the length of the ampulla. The diverticulum is much longer than the combined lengths of duct and ampulla and may reach a length more than twice as great. There is no appreciable enlargement of the ental end. The diverticulum may be nearly straight or variously coiled, looped or twisted. In one specimen the diverticulum of the right spermatheca of segment vii passes under the nerve cord into the left side, turns back to the right side dorsal to the nerve cord, again passes under the nerve cord into the left side where it is spirally twisted.

There are large nephridial masses on the anterior faces of septa 5/6 and 6/7. On the posterior face of 4/5, on each side of the oesophagus, is an elongate yellowish mass composed of a large number of small round glands.

The intestinal caeca are long enough to stretch into xviii but are doubled back underneath themselves in xxiii. Just behind the gizzard the oesophagus has a conspicuous glandular collar dorsally and laterally. This collar consists of four large lobes, each lobe composed of a large

number of spherical or ovoid bodies, each of which is provided with a cluster of dark granules at the centre.

In the anterior portion of the combined gizzard chamber the dorsal blood vessel gives off a conspicuous pair of vessels to the anterior portion of the gizzard. Posteriorly another pair of vessels are given off, the one on the left side passes onto the anterior face of 10/11, the one on the right side, which is larger, passes ventrally and into the ventral blood vessel. The last pair of hearts is in xiii and not xii as stated by Michaelsen. The commissures in segments x-xiii all pass into the ventral blood vessel. The commissures of xiii give off a branch to the supra-oesophageal blood vessel, but a similar branch could not be found in xii, although it may have been present but unobserved due to lack of blood content. The commissures of x and xi are swollen and as large as those of xii and xiii. The commissures of segments x and xi are similar to those of *P. lignicola*, *P. anomala*, etc., (Gates 1925) rather than to the condition described by Bahl as typical for the genus. The supra-oesophageal vessel is small and inconspicuous until joined by the commissural branches from the hearts of xiii. The lateral oesophageals are side by side on the ventral wall of the oesophagus, conspicuous trunks in segments viii-xiv.

***Pheretima anomala* Mich., 1907.**

Namsamkyin Island, Pantha, Kalewa, Mawleik, July, several specimens from each locality.

Myitkyina, August, a large number of specimens.

Toungoo, September, a number of specimens.

Maungmagaun, Labaw, Ngapoli, Taungup, October, several specimens from each locality.

Chiengrai, Siam, November, a single specimen.

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

Toungoo, September, four specimens.

Myitkyina, August, four specimens.

This species has hitherto been recorded only from Bhamo, Lashio and Maymyo, and is either rare and hard to find or not widely distributed.

***Pheretima campanulata* (Rosa), 1890.**

Mawleik, July, a number of specimens.

Pantha, July, several specimens.

Myitkyina, August, a number of specimens.

Toungoo, September, a number of specimens.

Maungmagaun, October, a number of specimens.

Tavoy, October, a number of specimens.

Mindat, October, several specimens.

Wuzinok, October, several specimens.

Kanyindaung, October, several specimens.

Myittha, October, a number of specimens.

Labaw, October, a very large number of specimens.

Mergui, October, several specimens.

Kala Island, October, three specimens found dead and dried at high water mark on sandy beach.

Nyaungbinkwin, October, several specimens.

Ngapoli, Andrew Bay, Sandoway, Taungup, October, a considerable number of specimens from each locality.

Yebawgyi, October, several specimens.

Myaya, October, several specimens.

***Pheretima defecta*, n. sp.**

Labaw, October, the anterior portion of a single worm, posterior end healed over but without regeneration.

External characteristics.—Length of fragment 78 mm. Greatest diameter 6 mm. Number of segments 49. Colour: dorsally brownish, ventrally greyish, clitellum bluish-grey.

The prostomium is epilobous, about one-half; there is no posterior demarcation of the tongue on segment i.

The first dorsal pore is in 11/12.

The setae begin on ii, are small, do not project noticeably beyond the cuticle. Setal circles are closed both dorsally and ventrally. Number of setae on xvii about 80.

The clitellum is ring-shaped and extends from 13/14 to 16/17; intersegmental furrows and dorsal pores are lacking.

There are no spermathecal pores.

The female pore is single, at the centre of a round, whitish area on the midventral portion of segment xiv.

There are two flat-surfaced, smooth, glistening, oval areas on segment xviii with the long axis parallel to the longitudinal axis of the worm, extending across the whole length of the segment. The intersegmental furrows are not visible in front of and behind these markings. Each of these areas is raised slightly above the level of the rest of the body and is surrounded by a single circumferential furrow external to which there are shorter furrows. At the centre of each of these genital areas, in line with the setae of the segment is a small round aperture through which projects very slightly a papilla bearing the male pore. There are 14 setae between the genital markings.

There are no other genital markings.

Internal anatomy.—Septa 3/4-7/8 present, 8/9 is absent, 9/10 is present but very thin.

The gizzard is in viii. The intestine is sacculated in xv-xx. Intestinal caeca arise in xxvii and extend in xxvi on the left side and xxv on the right side; from each caecum a number of whitish, nearly solid, ventral, finger-like projections; the dorsal margin slightly lobed. The lumen of the caecum is reduced, the walls thickened and whitish.

Large masses of nephridia on the anterior faces of 5/6 and 6/7. Masses of acinous bodies (blood glands?) in vi on the anterior face of 6/7, the posterior face of 5/6 and on the muscular cords passing through

these septa. The last pair of hearts is in xiii. The right commissure of ix is atrophied.

The testis sacs are large, in x and xi. The seminal vesicles are very small paired bodies on the posterior faces of 10/11 and 11/12. There are no prostates. A characteristic *Pheretima* type of prostatic duct emerges from the parietes, passes forwards, bends outward and then loops under itself to pass forward again decreasing very gradually in thickness to run anteriorly toward the testis sacs as a characteristic small vas deferens.

Remarks.—*P. defecta* may of course be an abnormal individual but some of its possible abnormalities, such as the absence of spermathecae and prostate, may characterise normal individuals of other species. *P. elongata* rarely has spermathecae in Burma. *P. anomala* has no spermathecae, *P. houlleti rugosa* (which is probably not a variety of *P. houlleti*) has no spermathecae. *P. insolita* has no prostates, while *P. h. rugosa* may or may not have prostates. It will be of considerable interest to learn how these animals are able to breed without the spermathecae, structures which are almost universally present in earthworms.

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

Mawleik, July, 3 specimens.

Toungoo, September, 1 specimen.

Ngapoli, October, 23 specimens.

Sandoway, October, 22 specimens.

Nyaungyo, October, several specimens.

Bangkok, Chiengmai-Siam, November, several specimens from each locality.

The male porophores on xviii may be completely everted, partially everted, or completely withdrawn into parietal cavities.

Thirty-four of the 45 specimens from Sandoway and Ngapoli and all except one of the specimens from other localities have no spermathecae although sexually mature. The spermathecal pores are located as follows :—

- a. 1 on the right side in 6/7.
- b. 1 on the left side in 6/7 and 2 on the right side in 6/7.
- c. 3 on each side in 5/6.
- d. 3 on the left side in 6/7.
- e. 2 on the left side, one in 5/6 and one in 6/7, two on the right side in 5/6.
- f. 3 on the right side in 5/6, one on the left side in 5/6 ; one on the right side in 6/7 in line with the middle pore in 5/6.
- g. 2 on the left side in 5/6.
- h. 2 on the left side in 5/6.
- i. 3 on the right side in 5/6.
- j. 3 on the left side in 5/6.
- k. 2 on the right side, one in 5/6 and one in 6/7 ; one on the left side in 6/7.
- l. 2 on the left side in 5/6. (This specimen from Siam).

All of the worms have been dissected and have well developed spermathecae, one for each pore indicated externally.

The length varies from 250-300 mm.

***Pheretima exigua*, nom. nov.**

Pheretima minuta, Gates, Proc. U. S. Nat. Mus. LXXV, p. 18 (1929).

Nyaungbinkwin, October, 23 specimens.

Prof. J. Stephenson has kindly called my attention to the fact that *minuta* was preoccupied in 1901 by a species described by Beddard.

The length of the present specimens varies from 36-42 mm., and the diameter from 2-2½ mm. The first dorsal pore is in 12/13 in all of these worms.

The genital papillae of the present specimens differ slightly in number and position but are otherwise similar to those of the original specimens. On 17 of the present specimens there are only two papillae, on xix, closer to the mid-ventral line than previously. There are only 5 or 6 setae between the centres of these papillae on most of the worms, 7 on two worms, instead of about 13. Furthermore these genital markings are not so closely restricted to the anterior margin of the segment but extend anteriorly nearly to the setae of xviii; intersegmental furrow 18/19 not visible in the vicinity of these papillae. The number of setae between the male pores is also smaller, 8 on 19 worms, 9 on 2 worms, 10 on 2 worms, instead of 10-12. Five specimens have one or two papillae on the anterior margin of segment ix. Three of the five have two with 4 or 5 setae between longitudinal lines through the centres of the papillae, two worms have a single marking on the left side only.

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

Thandaung, September, several specimens.

The length varies from 90-106 mm. The greatest diameter of all the worms is 5 mm. The first dorsal pore is in 11/12 in one specimen, in 12/13 in the others. In this respect these specimens agree with worms secured from farther north in the Shan plateau rather than those described by previous authors in which the first dorsal pore is in 10/11.

The setal numbers are:—about 25 on v, about 42 on xii, about 46 on xx, about 48 on lxxvi. Between the male pores there are 12, 13, or 14 setae.

The male pores are minute apertures at the centres of transversely placed, oval papillae located at the top of slight conical swellings in the setal circle of xviii. On the anterior and posterior sides of the swellings are crescentic furrows facing the male pores. A narrow but deep furrow surrounds the porophore which may be retracted into a slight concavity within the outer ends of the conical swellings.

Copulatory papillae are present in all of the specimens. These are small and consist of a slightly elevated, ring-shaped lip surrounding a

small greyish concavity. The papillae are always paired and symmetrically placed on the segment. All of the worms have papillae on the posterior portions of vi, vii, and viii; not quite touching the intersegmental furrow and very slightly internal to the lines of the spermathecae. Most of the specimens have an additional pair on vii and viii each, just anterior to the setae and in line with *c* or *d*.

A pair of vessels passes from the dorsal trunk to the gizzard in viii. In ix there is a commissure connecting the dorsal and ventral trunks on the right side only, the corresponding vessel of the left side passing onto the posterior portion of the gizzard. No commissures were found in segment x. The hearts of xi, xii, and xiii all pass into the ventral blood vessel.

The seminal vesicles are small sacs on the posterior faces of 10/11 and 11/12. There are no prostates. From the ental end of the prostate duct thin shreds of transparent tissue pass to the parietes. The vas deferens passes into the side of the prostate duct as if a prostate gland were present and not into the ental end.

There are masses of nephridia in v and vi. In iv and v there are large masses of whitish glands with numerous large lobes.

This species, unlike other peregrine *Pheretimas*, does not seem to have been able to establish itself in the plains and has been found hitherto only in the Shan plateau.

***Pheretima houletti* (E. Perr.), 1872.**

Variety *typica*.

This species has been secured in fairly large numbers at all of the following localities; Kalaw, May; Thongwa, Anidaung, Laungbyin, Masein, Paungbyin, Homalin, Mawleik, July; Mandalay, Sagaing, Myitkyina, August; Toungoo, September; Maungmagaun, Tavoy, Wuzinok, Mindat, Labaw, Kanyindaung, Myittha, Mergui, Kala Island, Nyaungbinkwin, Andrew Bay, Ngapoli, Sandoway, Taungup, Yebawgyi, Myaya, Sinbyudaing, Bawti, Not Theinko, Bangkok, November.

The worms from Yebawgyi appear to be fully mature but are only 40-45 mm. long and 3-4 mm. in diameter.

Variety *rugosa*.

Anidaung, Masein, Mawleik, Paungbyin, Homalin, Kalewa,
July, several specimens from each locality.

Toungoo, September, several specimens.

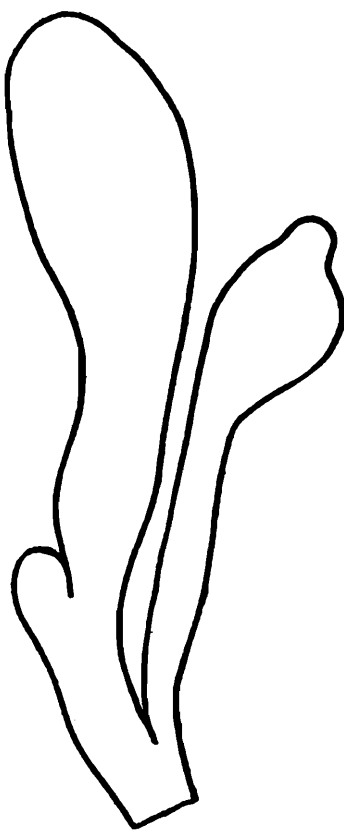
Labaw, October, several specimens.

Mergui, October, several specimens.

Arakan yomas, several specimens from each of several localities,
October.

One worm from Labaw had a single spermathecal pore in 6/7 on the left side. The spermatheca has a rudimentary diverticulum and attached to the lower end of the duct a stalked gland (fig. 9). Another worm from one of the localities in the Arakan yomas has a somewhat

similar spermatheca in viii with the spermathecal pore in 7/8 on the left side.



TEXT-FIG. 9.—*Pheretima houletti rugosa*. Spermatheca from the left side of vii, \times ca. 20.

***Pheretima insolita* Gates.**

Pheretima insolita, Gates *Ann. Mag. Nat. Hist.* (9) XVI, p. 568 (1925).

Namsamkyin, Pantha, Mawleik, Kalewa, July, several specimens from each locality.

Myitkyina, August, a number of specimens.

Tavoy, October, 1 specimen.

Labaw, October, 6 specimens.

Ngapoli, October, 8 specimens.

The original description states that "There are no visible male apertures; but from internal dissection they are usually on xx, sometimes perhaps on xix or xxi." The sentence just quoted is too briefly stated and should have been worded in some such fashion as this:—Male pores are not visible externally but the vasa deferentia pass into the body wall usually in xx, sometimes in xix or xxi; the male pores presumably located on the segments under the place where the vas deferens passes into the parietes.

In specimens from Tavoy and Mergui districts the vasa deferentia are very frequently continued, undiminished in diameter, into segments xxiii, xxv, xxvi, or xxix, apparently in a vain "search" for non-existent prostates.

***Pheretima insulanus*, n. sp.**

Kala Island, October, one specimen, found wandering about on a sandy beach just above the high tide mark, at ten o'clock

in the morning. The beach at this point was shaded so that the worm had not yet been killed by the heat of the sun.

External characteristics.—Length 79 mm. Greatest diameter 5 mm. Number of segments 67, the posterior portion of the worm had been lost some time previous to collection and the wound had healed over without trace of regeneration. Colour dorsally, anterior to the clitellum, bluish-grey, posterior to the clitellum reddish-brown; ventrally greyish. Clitellum dark blue.

The prostomium is epilobous, about $\frac{1}{2}$, but lacks the posterior demarcating groove of the prostomial tongue on i.

There is a single secondary furrow on vii just posterior to the setae, on each of segments viii to xiii there are two secondary furrows, one anterior to, one posterior to the setae of the segment.

The first dorsal pore is in 12/13.

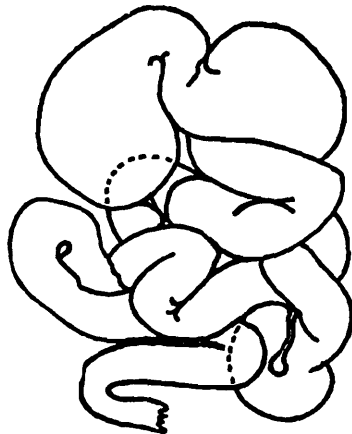
The setae begin on ii, are small; setal circles without conspicuous dorsal or ventral break. There are 55 setae on segment xix, 60-65 setae on segments posterior to xx. The setae are slightly closer together ventrally.

The clitellum is ring-shaped and extends from 13/14 to 16/17. Dorsal pores, intersegmental furrows and setae are lacking.

The spermathecal pores are in 7/8 and 8-9 at the edge of the dorsal pigmented area, slightly more than one-half of the circumference apart. There are 32 setae on segment viii between the lines of the pores.

A single female pore on xiv at the centre of a transversely placed, oval, whitish area.

The male pores are on xviii internal to the lines of the spermathecal pores, at the bottom of small depressions in the setal circle, about in line with setae j. There are sixteen setae between the depressions on xviii.



TEXT-FIG. 10.—*Pheretima insulana*. Spermathecal diverticulum, \times ca. 40.

There are no copulatory papillae.

Internal anatomy.—The intestine begins in xv. The intestinal caeca arise in xxvii and pass forward into xxiv, the dorsal margins slightly incised. The last hearts are in xiii. The left commissure of ix is atrophied. Posterior to xxvii there is a pair of conspicuous, elongate, finger or strap-shaped, lymph glands attached to the dorsal blood vessel in each segment just anterior to each septum. Nephridial masses present in v and vi.

The ovaries and oviduct funnels in xiii in usual positions.

Paired testis sacs in x and xi. Medium-sized seminal vesicles in xi and xii. The prostates extend through segments xv-xx on the right side, xvi-xxi on the left side. The prostatic duct of one side is looped, of the other curled into a figure like the letter G. The ectal end of the duct passes into the top of an erect, columnar, copulatory chamber. On the anterior face of this chamber 3 or 4 masses of glandular tissue.

The spermathecae are in segments vii and viii. The duct is shorter than the irregularly ovoid ampulla. The diverticulum is longer than twice the combined length of duct and ampulla and is twisted into a coiled mass somewhat after the fashion in *P. houletti*. The ental end of the diverticulum is enlarged. A single, poorly preserved, stalked gland passes into the base of the duct of the spermatheca.

Remarks.—Careful search along the shore for a considerable distance, and digging in several moist places on the island failed to turn up further specimens.

In several ways the present species so closely resembles *P. houletti* or *P. campanulata* as to suggest that the present specimen may be an abnormal individual in which the spermathecae of vi failed to develop. The size of the worm, the larger number of setae, their smaller size, the absence of breaks in the setal circles, the larger number of setae between the male apertures and the posterior position of the first dorsal pore differentiate the present species from *P. houletti*. The species is distinguished from *P. campanulata* by the absence of penial setae. One other Burmese species, *P. ordinata*, has spermathecal pores in 7/8 and 8/9 and from this *P. insulanus* may be distinguished by the larger size of the prostates and the much greater length of the spermathecal diverticulum.

***Pheretima lignicola* Steph., 1914.**

? *Amyntas alexandri*, Beddard, *Proc. Zool. Soc. London*, 1900, p. 998, figs. 1-3.

Pheretima lignicola, Stephenson, *Rec. Ind. Mus.* VIII, p. 399, pl. xxvii, fig. 17 (1914).

Mawkadaw, Mingin, Kalewa, Masein, Mawleik, Homalin, July, numerous specimens from each locality.

Sagaing, Mandalay, August, several specimens from each locality.

Toungoo, September, a number of specimens.

Tavoy, Myittha, San Hlan, Maungmagaun, Labaw, Mergui, October, a number of specimens from each locality.

Bangkok, Chiengmai, Chiengrai-Siam, November, a number of specimens from each locality.

P. alexandri has been thought to represent an endemic outpost of the genus *Pheretima* in Bengal. The status of the species is a matter therefore of some importance. The description of the species by Beddard is based upon the study of a single specimen imported from the neighbourhood of Calcutta into the Kew Gardens from whence, still alive, it came into the possession of Beddard. No further individuals of the species have been recognized. A careful study of Beddard's

figures and descriptions of *P. alexandri*, as well as of local worms previously identified as *P. lignicola*, have led to the conclusion that the two forms are identical.

Beddard's description is, however, much too brief, and although his figures are excellent, even they may be misleading. Identifications based on incomplete descriptions are to be avoided if at all possible. *P. campanulata*, for instance, was placed as a synonym for *P. houletti* and long regarded as such, apparently as a result of reliance on such descriptions. It is probable that this would not have happened if the actual type-specimens of both species had been studied by the person responsible for the identification. Since the types of neither of the two species involved nor identified specimens of *P. lignicola* are available at the present writing, it is preferable to allow the latter species to stand for the present and merely present some of the arguments for the identification. Beddard states that he carefully preserved his specimen of *P. alexandri*. It should, therefore, be possible to trace this specimen and perhaps settle the matter more definitely.

	From Beddard's descrip- tion of <i>P. alexandri</i> .	From Stephenson's descrip- tion of <i>P. lignicola</i> .
Length	145 mm.	105-165 mm.
Number of segments	133.	90-130.
Male, genital region	There are 13 setae lying between the male pores. There are depressions of a groove-like character which may perform the function of adhesive papillae. One of these lies in front of each male pore; the other, the longer, lies behind it. They are surrounded by tumid walls.	The male apertures are distant from each other about $\frac{2}{7}$ of the circumference. They are situated in large, conspicuous, circular depressions; these are surrounded anteriorly, posteriorly, and especially externally by a prominent semicircular lip or ridge, which is absent on the inner side. Twelve setae intervene.
Spermathecal apertures	The spermathecal pores were not visible externally, but the point of their opening would seem to correspond to that of the male pores. The spermathecae are four pairs and lie in segments vi-ix. (The spermathecal pores would therefore be in $\frac{5}{6}$ - $\frac{8}{9}$).	Spermathecal apertures scarcely visible; internal examination shows that they are four pairs in $\frac{5}{6}$ - $\frac{8}{9}$. Those of the same pair are separated by an interval equal to $\frac{2}{7}$ the circumference.
Spermathecae	The duct of the pouch is longer than the pouch and broadens towards the external orifice. The diverticulum is longer than the spermatheca; it is plainly composed of a duct and a distal moniliform sperm receptacle. The two parts are about equi-sized.	The ampulla is oval, duct of about equal length, shining, very stout and muscular, rather broader in its distal two-thirds than near the ampulla. The diverticulum is long, narrow, sometimes rather twisted, its distal portion is shining and muscular like the duct, in the greater part of its extent, its walls are thin and marked by numerous and close-set small sacculi.

The absence or invisibility of the spermathecal pores and the presence of dorsal pores on the clitellum indicate that *P. alexandri* was not fully mature. This may account for the relatively small size of the spermathecal ampulla in that species. In immature specimens of the Rangoon form the ampulla varies considerably in size and appearance and very frequently is strikingly similar to the condition figured by Beddard.

The spermathecal duct of both forms is spoken of as broad.

The diverticula of the two worms differ chiefly, so far as the respective figures can be relied upon, mainly in the relative length of the "muscular duct-like portion" connecting with the spermathecal duct. The external conformation of the diverticulum in the Rangoon specimens varies considerably. It may appear like either of Stephenson's or like Beddard's figure. Stephenson has himself figured in a recent paper (1929) a spermatheca in which the "diverticulum is longer and more simply tubular than originally described" In view of these variations the differences relative to this structure in the two accounts do not seem important. The diverticulum of mature specimens from Rangoon is usually longer than the combined length of the ampulla and duct.

The differences in the descriptions of the copulatory structures around the male pores are easily reconciled. The body wall around the male pore of immature or not quite mature specimens from Rangoon presents a picture very similar to that figured by Beddard. It is only necessary to continue Beddard's anterior groove externally around the male pore, until it becomes continuous with the posterior groove, and then retract this region within the tumid wall obliquely, to produce the circular depression of Stephenson surrounded on three sides by a semi-circular lip or ridge.

The prostatic duct is frequently referred to in systematic descriptions. In *P. lignicola* the duct has "many windings, becomes thicker and more muscular as it proceeds, stout, smooth, and shining at its termination" Beddard does not describe in detail the prostatic duct of his species but his figure has been interpreted by Stephenson (1923) as indicating that the duct is "of equal diameter throughout" In the Rangoon specimens very frequently the thicker, more muscular portion of the duct may be looped in a fashion very similar to that figured by Beddard with the narrower less muscular portion entirely concealed from dorsal view.

An additional minor point of some interest is that the number of setae between the male pores is almost exactly the same, 12 in one worm, 13 in the other.

***Pheretima papilio*, n. sp.**

San Hlan, October, 5 specimens, from jungle on hills immediately above the seashore.

Description of the type-specimen. External characteristics.—Length nearly 90 mm. Greatest diameter 6 mm. Number of segments 87. Colour dorsally: anterior to the clitellum bluish, posterior to the clitel-

lum brownish, pigment most strongly concentrated in the region of the mid-dorsal line. The clitellum is dark red.

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

There are no well defined secondary annulations.

The first dorsal pore is in 5/6.

The setae begin on ii, are small, do not project conspicuously, crowded more closely together ventrally; setal circles without appreciable dorsal or ventral break.

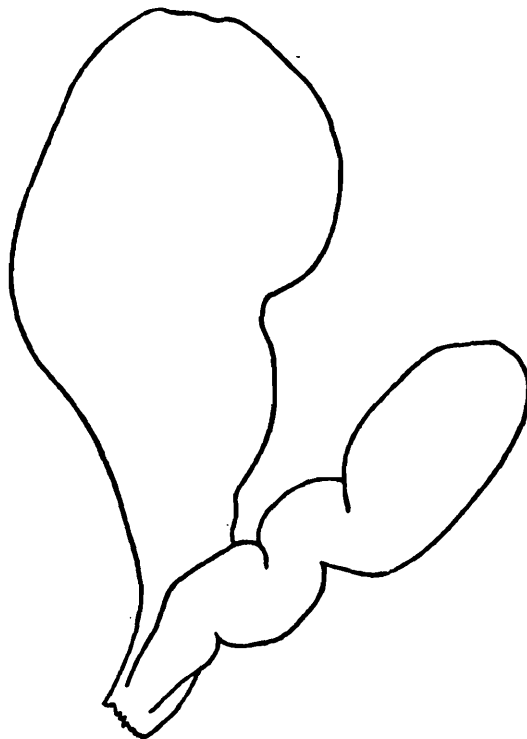
The clitellum is ring-shaped and extends from 13/14 to 16/17; intersegmental furrows and dorsal pores lacking; no setae visible.

The spermathecal pores are in 5/6, about one-half of the circumference apart at the margin of the pigmented area.

The female pore is a single opening at the centre of a white, transversely placed, oval area in the mid-ventral region on xiv.

The male pores are minute apertures in line with the setae of xviii, each bordered by a tiny anterior and posterior lip.

The genital markings are a pair of smooth-surfaced, glistening, hard areas extending from the setae of xvii to the setae of xix. Each area is depressed slightly below the level of the body wall, elongate, with the long axis nearly parallel to the long axis of the body, ends bluntly rounded, inner edge nearly straight, outer margin indented slightly just anterior to the setal circle of xviii. The male pore lies on this glandular area, slightly nearer to the outer margin than to the inner. There are five setae in the unmodified epidermis between the two genital markings. There are no other genital markings.



TEXT-FIG. 11.—*Pheretima papilio*. Spermatheca, \times ca. 20.

Internal anatomy.—Septa present from 4/5 on, except 8/9 and 9/10, which are lacking. None especially thickened.

Gizzard in the combined segments, with a posterior flange. The intestine begins in xv. The caecum of the right side extends from xxvii into xxiv, 7 finger-shaped processes projecting from the dorsal surface.

The last pair of hearts is in xiii, the left commissure of segment ix atrophied. Blood glands on the posterior face of 4/5.

Large masses of nephridia in v and vi.

The ovaries are compact, rounded bodies, in xiii. The oviduct funnels are small. The spermathecal duct is short; the ampulla irregularly sac-like, with greatest diameter at the ental end, much longer than the duct. Diverticulum about as long as the duct and ampulla together, with much thickened ental end, ectal portion with four or five short, closely pressed loops.

The testis sacs are in x and xi. Medium sized seminal vesicles in xi and xii, the left vesicle of xi projecting through 10/11 into the combined gizzard segments. The prostates are large, the right gland in xvii-xxi, the left in xviii-xx. The prostatic duct bent into a long, almost U-shape with the concavity directed posteriorly. The vas deferens passes into the prostatic duct about 1 mm. from the edge of the gland.

Remarks.—All specimens are probably anterior fragments as the last segment has a circle of conspicuous setae and a posterior opening not characteristically anal but resembling the result of autotomy followed by healing without regeneration.

The first dorsal pore is in 5/6 in all five specimens.

There are 61-65 setae on segment xx, 67-71 setae on segment li. On xviii there are 6-8 setae between the copulatory markings. Between the lines of the spermathecal pores on v there are 27-30 setae. Setae much more closely crowded ventrally than dorsally.

Finger-shaped diverticula may be present on the intestinal caeca both dorsally and ventrally. There is no typhlosole in the specimens dissected.

The commissures of ix-xiii all pass into the ventral blood vessel.

The species can be readily recognized for it is the only *Pheretima* from the Indian Empire with one pair of spermathecal apertures in 5/6. The genital markings are also characteristic.

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

Mingin, July, several specimens.

Mandalay, August, several specimens.

Sagaing, August, several specimens.

Toungoo, September, a number of specimens.

Maungmagaun, October, a number of specimens.

Tavoy, October, several specimens.

Labaw, October, a large number of specimens.

Mergui, October, several specimens.

Nyaungbinkwin, October, several specimens.

Kala Island, October. A number of specimens were found on a sandy beach at high tide mark in a dried condition.

Ngapoli, October, 1 specimen.

Taungup, October, several specimens.

Kywegale, October, several specimens.

Bangkok, Chiengmai, Chiengrai-Siam, November, several specimens from each locality.

Rangoon, March, 5 specimens.

On one previous occasion (Bhamo, March) this species was collected in the dry season, but at that time only a single specimen could be found.

***Pheretima pinguis*, n. sp.**

Toungoo district, September, one anterior fragment. Exact locality from which this specimen was secured cannot be stated as the label has become illegible but the worm was probably collected at or near Thandaung.

External characteristics.—Length 72 mm., the posterior portion broken off in digging and not secured. Diameter 6 mm. Colour: brownish dorsally, greyish ventrally, clitellum reddish.

The prostomium is epilobous, about $\frac{2}{3}$, the transverse furrow demarcating the posterior portion of the tongue on i lacking.

The first dorsal pore is in 12/13.

The clitellum is ring-shaped and extends from 13/14 to 16/17, without dorsal pores or intersegmental furrows, setae present.

The setae begin on ii, are small, closely crowded; setal circles without marked ventral break. The ventral setae are perhaps slightly larger than the dorsal, but the dorsal and dorso-lateral setae are retracted within the parietes so far that this cannot be stated positively nor can any statement be made as to a dorsal break. There are about 66 setae visible on segment xii and about the same number on lxxiii.

The spermathecal pores are in 6/7, 7/8, and 8/9, less than one-half of the circumference apart. There are 21 setae between the lines of the spermathecal pores on viii.

The female pore is minute, single, just anterior to the setae in the midventral line of xiv.

The male pores are minute, on the centre of small, transversely placed, ovoid papillae in the setal circle. Around the bases of these protuberant papillae are shallow, greyish, circumferential depressions, each depression reaching anteriorly nearly to 17/18, and posteriorly to 18/19. There are 12 setae between these male papillae on xviii and 19 setae between the lines of the male pores on xvii. There are no other genital markings of any sort.

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

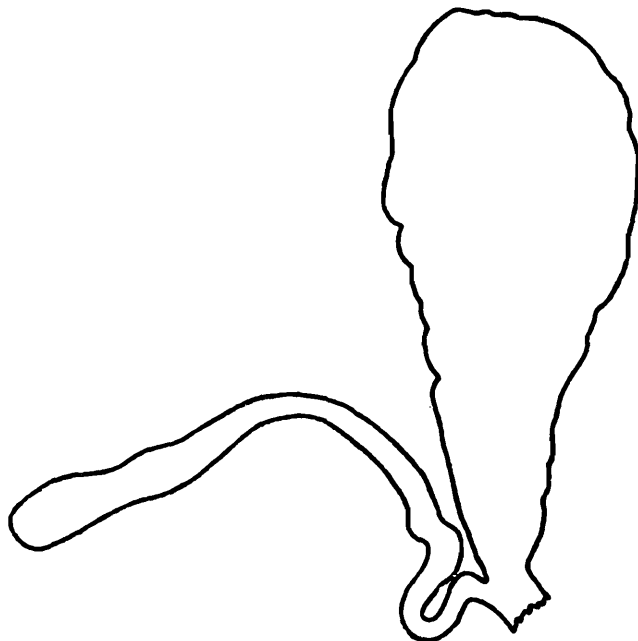
The intestine begins in xv. The typhlosole is small. The intestinal caecum of the left side is simple, finger-shaped, and extends from xxvii into xxii where it is bent backwards under itself, but is long enough to reach into xviii.

Small nephridial masses in v and vi.

The last pair of hearts is in xiii. There are masses of acinous blood glands in v.

A large pair of seminal vesicles in contact dorsally fill segment xi. These vesicles seem to be attached in some way to the testis sacs of

their respective sides in xi, for on removing one of the seminal vesicles from this segment the contents of the testis sac were also removed



TEXT-FIG. 12.—*Pheretima pinguis*. Spermatheca, \times ca. 20.

leaving the male funnel bare. The seminal vesicles of xii are large, extending through xii and xiii, in contact dorsally and pushing 13/14 and two succeeding septa back into contact with 16/17. The vas deferens is large and clearly visible on the ventral parietes, it passes into the prostatic duct just as the latter emerges from the prostate gland. The prostates are large, extending from xvii into xxii on the left side and from xvii into xix on the right side. The prostate duct is thick, bent into a U-shape with the opening of the U facing externally on the left side and anteriorly on the right side.

The ovaries and female funnels are in the usual positions in xiii. The spermathecae are in segments vi, vii, and viii. The flattened ampulla is not sharply marked off from the duct of which it seems to be a very gradual enlargement. It is in fact difficult to determine where the one ends and the other begins. The diverticulum is longer than the combined lengths of the duct and ampulla, is tubular, transparent, and hardly enlarged at the free ental end. It arises from the duct in or very close to the parietes, and may be slightly looped or spirally coiled close to the duct, but the longer ental portion is comparatively straight.

Remarks.—This species does not seem to have any very striking specific characteristics but the spermathecal conformation and the male porophores are characteristic so far as Burmese or Indian species of the genus are concerned.

***Pheretima planata* Gates.**

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

Mawleik, July, several specimens.

Masein, July, several specimens.

Toungoo, September, several specimens.

Myitkyina, August, a number of specimens.

Maungmagaun, October, several specimens.

Ngapoli, October, three specimens.

Arakan yomas, October, several localities, several specimens each.

On segment xviii there may be a transverse slit, in the setal circle on each side ventrally, opening into a cavity in the body wall, or the surrounding wall of the cavity may be everted as a thick, flat-ended column. Minute round papillae are located on the walls of the cavity or on the flat end of the everted chamber.

The species is widely distributed in Burma and Stephenson has had specimens from South Cachar, Assam. But in spite of its wide distribution the species is rather rare and only once (Myitkyina) have more than half a dozen specimens been found at any one locality.

Pheretima posthuma (L. Vaill.), 1868.

Pakokku, July, several specimens.

Ingyindaung, Powindaung, Anidaung, Okma, Laungbyin, Mingin, Masein, Homalin, Kalewa, July, several specimens from each locality.

Toungoo, September, a number of specimens.

Mergui, October, several specimens.

Ngapoli, October, three specimens.

Taungup, October, three specimens.

Sanbôt, Nyaungyi, Okshitbin, October, several specimens from each locality.

Bangkok, Chiangmai, November, several specimens from each locality.

At Okma and Pantha the sandy soil near the steamer landings was covered with pyramidal piles of small round or ovoid, pellet-like castings. The only worm that could be found in the soil at both of those places was *P. posthuma*. All other Burmese species of earthworms that deposit their intestinal ejecta on the surface of the ground form castings in the shape of "towers"

Pheretima velata, n. sp.

Thandaung, September, 1 specimen.

Thandaung, October, 4 specimens, found wandering about in the morning by Mr. Lewis.

Description of the type-specimen. External characteristics.—Length 187 mm. Diameter in the widest part 10 mm. Number of segments 121. Colour dorsally: anterior to the clitellum bluish-brown, posterior to the clitellum reddish-brown; ventrally greyish. The clitellum is reddish. There are white unpigmented bands in the region of the intersegmental furrows dorsally and dorso-laterally, the intersegmental furrows in the middle of these bands.

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

Completely circumferential secondary furrows are lacking.

The first dorsal pore is in 12/13.

The clitellum is ring-shaped and extends from 13/14 to 16/17, setae and dorsal pores are present, intersegmental furrows are faintly indicated laterally.

The setae begin on ii, are small, more closely crowded ventrally, farther apart and more deeply withdrawn into the parietes dorso-laterally and laterally. Due to the retraction of the dorsal setae into the parietes the counting is difficult but there are approximately 90 setae on segment iv and about 90 on xix.

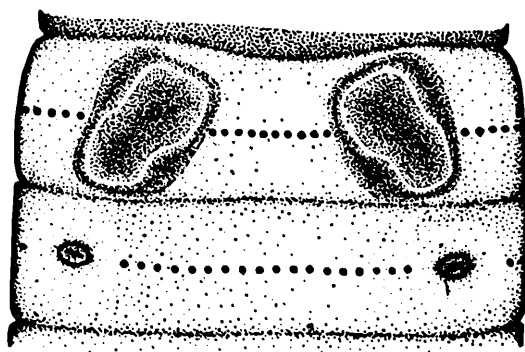
The spermathecal pores are minute, transversely placed slits on vi, vii, viii, and ix on the anterior borders of the segments very close to but not actually in the intersegmental furrows. There are 32 setae on vi and vii between the lines of the spermathecal pores.

The female pore is single, on xiv just anterior to the setae.

The male pores are minute, transversely placed slits at the centre of oval, smooth-surfaced areas in the setal circle of xviii with 16 setae intervening ventrally. The oval areas are surrounded by deep but narrow furrows and are transversely placed, at the top of slight swellings in the setal circle, the swelling extending antero-posteriorly to 18/19 and almost to 17/18.

The copulatory markings are paired on xvii, extending probably from the region of 17/18 to 18/19 although the intersegmental furrows are not clearly visible here. Each genital marking is nearly oval with a slight indentation of the inner margin of the posterior half, bluish in colour with a whitish edge surrounded by a greyish rim, and placed slightly diagonally with the anterior end nearer the mid-ventral line. Between these markings there are 9 setae. The setal circle of xvii broken by the markings.

Internal anatomy.—Septum 4/5 is present, thin; 5/6-7/8 present and thickened; 8/9 absent; 9/10 present apparently as a ventral fragment only.



TEXT-FIG. 13.—*Pheretima velata*. Genital markings on xvii and xviii.

The gizzard is elongate and tubular and extends from 7/8 nearly to 10/11. There is a glandular collar on the oesophagus dorsally and laterally just behind the gizzard. The intestine begins in xv. The caecum of the right side is simple, finger-shaped and extends from xxvii into xxv, bent under the intestine in the latter segment, but long enough to extend into xx into contact with the prostate.

There are nephridial masses in v and vi on the anterior faces of 5/6 and 6/7.

The last pair of hearts is in xiii. The right commissure of ix is atrophied.

The testis sacs are large, in x and xi. Segment x appears to be present only as a ventral chamber beneath the alimentary canal containing the testis sacs. The seminal vesicles of xi are large, in contact dorsally and filling all the coelomic space. The vesicles of xii are nearly twice as large as those of xi and push 12/13 and 13/14 posteriorly into contact with 14/15. The prostates extend through xvii-xxi on the left side and xvii-xx on the right side. The prostate duct is U-shaped with the opening facing externally.

The ovaries and female funnels are in the usual positions, in xiii. The spermathecal duct is short and stout, not sharply marked off from the ampulla which is roughly oval in outline. The ampulla is nearly three times the length of the duct. The diverticulum is tubular, stoutish, enclosed within a sac that binds the loops closely together. This sac appears to be continuous with a layer of tissue on the outside of the duct and ampulla. The ental end of the diverticulum is very slightly enlarged.

Remarks.—The length varies from 180-220 mm., the diameter from 9-10 mm., the number of segments from 120-140. The first dorsal pore is in 12/13 in all cases, but in one worm there is a weak spot in 11/12. The clitellum of the cotype-specimens begins slightly anterior to 13/14 and does not extend quite to 16/17; dorsal pores and intersegmental furrows are lacking but setae are present.

A ventral break in the setal circle when present is very slight, dorsally there seems to be a large break in a space where there should be some 6-8 setae, but this may be due to retraction of the setae within the parietes so that they are no longer visible. Towards the anal end the dorsal break becomes smaller and the ventral break disappears. On one specimen 105 setae were counted on v. There are 32-36 setae between the spermathecal lines on segment vi. There are 23-24 setae between the lines of the male pores on segment xix, and 7-10 setae between the copulatory areas on xvii.

The genital markings do not extend as far as the intersegmental furrows either anteriorly or posteriorly in the cotypes, although the furrows are not actually indicated ventrally.

The left commissures of ix are atrophied in the cotypes. The commissures of x pass from the dorsal blood vessel to the ventral blood vessel. The commissures of xi, xii, and xiii all pass into the ventral blood vessel, dorsally each of these "hearts" divides sending a branch to both the dorsal blood vessel and to the supra-oesophageal vessel.

The ovarian funnels are unusually elongate, on the floor of xiii just over the vasa deferentia.

Internal to each genital marking is a large, elongately dome-shaped gland with a very thick, tough wall and softish centre, extending from the level of 15/16 to the setae of xviii. This gland when firmly grasped with forceps and carefully manipulated can be extracted from the parietes with the copulatory marking, including the greyish rim on its

external face, leaving a clear cut aperture in the parietes still covered over by cuticle. The vas deferens passes up onto and continues posteriorly along the dorsal face of this gland.

P. velata may be readily distinguished from all other Indian *Pheretima* by its genital markings and associated glands.

Genus **Perionyx** E. Perr.

Perionyx excavatus E. Perr., 1872.

Kalaw, May, 21 specimens 40-55 mm. long, from black soil with
B. parva.

Toungoo, September, a number of specimens.

Thandaung, September, a number of specimens.

Maungmagaun, October, a number of specimens.

Mergui, October, a number of specimens.

Masein, July, several specimens.

Paungbyin, July, several specimens.

Ngapoli, October, one immature specimen.

Perionyx species ?

Yebawgyi, October, two anterior fragments, immature.

Both fragments have marked yellowish or whitish, circumferential bands without pigment in the region of the intersegmental furrows. The dorsal surface between these bands has a deep red pigment. Laterally the pigmented region gradually diminishes both anteriorly and posteriorly on each segment, coming to an end with a sharp point in the setal circle at a point about half-way between the mid-dorsal and mid-ventral lines. The first positively functional dorsal pore is in 7/8, although there is a pore-like depression in 4/5. The gizzard of these worms is more strongly developed than in *P. excavatus*.

Sub-family **OCTOCHAETINAE**.

This subfamily is represented in the Burmese fauna by three genera *Octochaetus*, *Ramiella* and *Eutyphoeus*. *Ramiella parva* was described by Stephenson who had two specimens from Yaungwhe, in the Shan plateau. This worm is small, 30-35 mm. in length and has not been recently collected, due perchance to its insignificant size. *Octochaetus* has two species endemic in the province which are rather widely distributed but in distinctly separate areas. *Eutyphoeus* with a large number of endemic species is one of the most important constituents of the Burmese Oligochaete fauna, and, perhaps, taking into consideration the size of the individuals, and their large numbers, as well as the number of species and wide area of distribution, the most important generic constituent.

Genus **Octochaetus** Beddard.

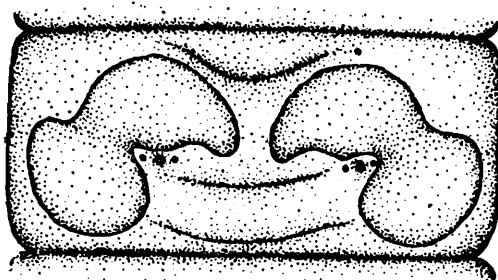
The provincial distribution of this genus is curiously unlike any other genus with species endemic in this province. If a line be drawn across the map from Toungoo to Sandoway the province will be divided

thereby into a southern and a northern portion. *O. birmanicus* has only been collected from this southern part while the other species, *O. lunatus*, has been collected only in the northern part.

***Octochaetus birmanicus* Gates.**

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

Thongwa, July, several specimens, all immature.
Toungoo, September, a number of specimens.
Labaw, October, a large number of specimens.
Tavoy, October, a number of specimens.



TEXT-FIG. 14.—*Octochaetus birmanicus*. Genital markings on viii.

This species of *Octochaetus* is apparently confined to the southern part of the province of Burma, as Toungoo is the most northern record. In Upper Burma it is replaced by *O. lunatus*.

***Octochaetus lunatus* Gates.**

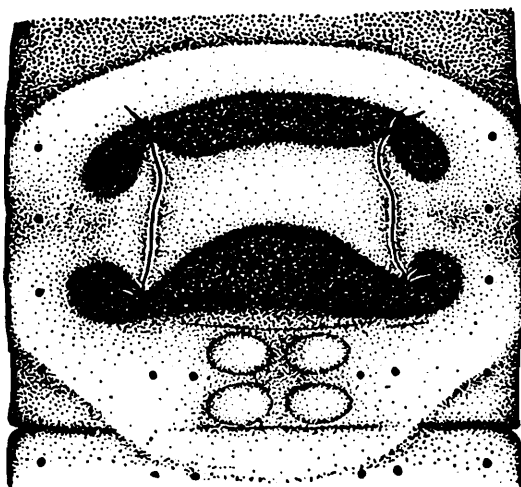
Octochaetus lunatus, Gates, *Proc. U. S. Nat. Mus.* (LXXV), p. 24, fig. 12 (1929).

Ingyindaung, July, several specimens.
Powindaung, July, two specimens.
Monywa, July, four specimens.
Mingin, July, two specimens.
Chaukma, July, one specimen.
Kalewa, Kindat, July, numerous specimens from each locality.
Thindaw, Kalewa, Masein, Paungbyin, Mawleik, Anidaung, July, several specimens from each locality.
Pakokku, July, numerous specimens.
Myitkyina, August, 13 specimens.
Sagaing, August, 7 specimens.
Mandalay, August, a large number of specimens.
Ngapoli, October, 1 specimen.
Patle, October, 1 specimen.

The clitellum extends from 12/13 to 17/18, onto xviii, or to 18/19 dorsally, to 17/18 ventrally. The clitellar colouration is lacking between the seminal furrows on xvii.

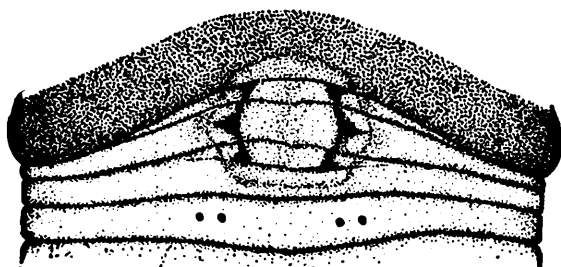
The male pores are in the seminal grooves on xviii internal to *a*. The prostatic pores are at the ends of the seminal furrows on xvii and xix internal to *a*.

Septum 8/9 is attached to the parietes in the middle of ix, 9/10 to the middle of x, 10/11 just posterior to the intersegmental furrows 10/11,



TEXT-FIG. 15.—*Octochaetus birmanicus*. Post-clitellar genital markings.

11/12 in the region of intersegmental furrow 11/12 at least ventrally and laterally, 10/11 and 11/12 are bound to each other peripherally by very delicate connective tissue fibres which break readily if one attempts to pull the septa apart.



TEXT-FIG. 16.—*Octochaetus lunatus*. Genital markings.

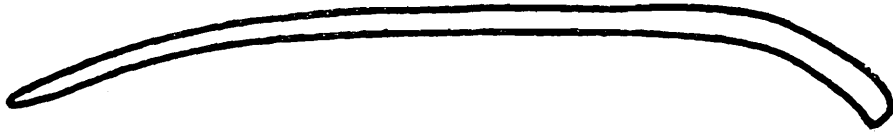
The supra-pharyngeal ganglia are in iii.

The male funnels in x are approximately the same size as those in xi but the margins are not so crinkled and they lack the iridescence characteristic of the funnels of xi. No testes are visible in x in any of the specimens. Nor are there any seminal vesicles in ix. The vesicles of xii are small, finger-shaped with the unattached end projecting dorsally, on the posterior face of 11/12 just beside the oesophagus.

The ovaries, masses of long strings of eggs, extend from 12/13 to 13/14 on the ventral parietes. On the posterior face of 13/14 at about the same height above the floor of the segment as the seminal vesicles is a pair of ovisacs. The number of eggs in any one sac is small and the ova have a vacuolated appearance, distinctly different from the ova in the ovarian egg strings of xiii.

Setae *a* and *b* are not visible externally as a rule on segments xvii, xviii and xix. A pair of setae that may be called penial can be pulled out from the parietes with the prostatic duct of xvii and xix. These setae are 500-560 micra long and about 15-20 micra in diameter through the thickest portion. The major part of the shaft is practically straight, but each end is bent slightly, the basal end more than the ental, both

bends on the same side of the shaft. Ornamentation consists of a few sparse teeth near the tip.



TEXT-FIG. 17.—*Octochaetus lunatus*. Penial seta, \times ca. 160.

In these specimens the prostomium is not prolobous but combined pro-and epilobous, the furrows forming the epilobic tongue very close together and extending only half way towards $1/2$.

Setae *a* and *b* on viii and ix are slightly modified.

This species occurs only in Upper Burma where *O. birmanicus* has not been found.

Genus *Eutyphoeus* Mich.

This genus is confined entirely to India (including Burma). It was formerly thought that Burma had "scarcely been. .invaded by



TEXT-FIG. 18.—*Octochaetus lunatus*. *a.* Copulatory seta, \times ca. 40. *b.* Tip of penial seta, \times ca. 700.

Eutyphoeus from the Indo-Gangetic Plain", but it has since been shown that this genus constitutes an important, probably one of the most

important parts of the earthworm fauna of the province. It is widely distributed, *E. peguanus*, for instance, has been found in widely separated localities from Mergui district in the south to Myitkyina in the north, from the Arakan coast on the west to Kawkareik in the east. Hitherto the genus has not been found in the Shan plateau in the eastern part of the province but *E. sejunctus* may possibly occur at Thandaung on the western edge of the plateau although the illegibility of the label prevents a more definite statement at present.

There has been some confusion in the past in the terminology of the posterior openings of the male reproductive organs. In this paper the term male pore will refer only to the external aperture of the male deferent duct, which is small, and visible only with good optical conditions after careful search. Vestibular pore will be used to refer to the much larger opening into a parietal excavation; the excavation within the body wall, either paired or median will be called a vestibulum. Within the vestibulum (when present) or protruding from the general external surface there may be a tubular porophore more or less equivalent to a penis, the pore at the end of the penis, or if no penis is present in the wall of the vestibulum or on the ventral surface, which is the common external aperture of the penial sac and the prostatic duct will be referred to as the peni-setal prostate pore.

The species of this genus may be either holandric or metandric. *E. hastatus* and *E. hamatus* are both holandric but in both worms the male funnels in segment x are smaller than those in xi and the vesiculae seminalis in ix are much smaller than those in xii. The vasa deferentia of the first worm do not unite until segment xvii although they come into contact in segment xii. The vasa deferentia of the second species have not been traced due to poor preservation. In both of these species the first dorsal pore is in 10/11. There are paired female pores, and the dorsal blood vessel continues anteriorly through 5/6 with a pair of vascular commissures in vi.

In *E. constrictus* there is a median testicular chamber or testis sac and a small pair of male funnels on the anterior face of 10/11, but no seminal vesicles in ix. The vasa deferentia come into contact in xiii and run posteriorly side by side into xvii without fusing. There are paired vascular commissures in vi, paired female pores, and the first dorsal pore is still in 10/11 in most of the specimens.

In *E. peguanus* there is a median testicular chamber, the dorsal blood vessel may end with the commissures of vi or may be continued anteriorly onto the posterior face of 5/6. There are recognizable male funnels in some specimens in x, while in other specimens there are present structures which may represent rudiments of the male funnels, while in still other specimens of the same species there is no trace of any rudiment of a male funnel in x. The first dorsal pore in this species is in 11/12. There are paired female pores.

In *E. sejunctus* there are still paired commissures in vi and paired female pores on xiv but no trace of male funnels in x. Like the preceding species this worm is unpigmented but has the first dorsal pore in 11/12, and has a pair of vestibular excavations containing penial tubes.

The remaining Burmese species of the genus all have the first dorsal

pore in 11/12 or more posteriorly as in *E. bifovis*, a single female pore on the left side only, a characteristic velvety brown colour, and usually a single median or paired lateral vestibula with more or less well-developed penial projections from the epidermis.

Eutyphoeus bifovis Gates.

Eutyphoeus bifovis, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 25, fig. 13-14 (1929).

Mandalay, August, 38 specimens.

All of the specimens have median genital markings on 15/16 and 18/19 as in the type-specimen. Two specimens have an additional genital marking similar to that of 18/19 on 19/20. Another specimen has an additional genital marking on 17/18.

The dorsal blood vessel ends with the commissures of segment vii.

Eutyphoeus foveatus (Rosa), 1890.

Mandalay, August, 1 specimen.

Toungoo, September, 1 specimen.

Nyaungyi, Okshitbin, Pegyin, Padaung, October, several specimens from each locality.

The specimens from the Arakan yomas are much smaller than usual but are quite evidently *foveatus*. In spite of the small size of the worms the penial setae are 4-5 mm. in length.

Eutyphoeus excavatus Gates.

Eutyphoeus excavatus, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 30, fig. 17-18 (1929).

Sagaing, August, 16 specimens.

All of the specimens have median genital markings on 14/15 and 15/16 as in the type-specimen. The present specimens have a very short rudimentary penis on each side at the bottom of the median, transversely elongate vestibulum.

Eutyphoeus hamatus, n. sp.

Kalewa, July, 9 specimens, of which 6 are immature.

Description of the type-specimen. External characteristics.—Length 89 mm. Diameter 3-4 mm. Number of segments 188. Unpigmented, light greyish with pinkish tinge.

The prostomium is not sharply demarcated from segment i; two slight furrows deeper than the "wrinkles" on this segment extend practically to 1/2; the prostomium might be called combined pro-and tanylobous. On the ventral surface of the prostomium is an antero-posterior cleft-like depression which gives to this organ a distinctly sucker-like appearance.

On each of segments iv-xiii there is a deep secondary furrow behind the setae, on segments vii-xiii inclusive there is an additional secondary furrow anterior to the setae. Less well-marked tertiary furrows are present on segments ix-xiii.

The first dorsal pore is in 10/11.

The setae are eight per segment, four pairs, beginning on ii, *ab* more closely paired than *cd* throughout. Just behind the clitellum $ab < cd < bc < aa$, *dd* is greater than one-half of the circumference. Posteriorly *cd* and *bc* become about equal. Anterior to the clitellum *cd* is larger than *cd* posterior to the clitellum but remains smaller than *bc*.

The clitellum extends from the setae of xiii to the setae of xvii and is brownish-red in colour.

The male apertures (external openings of the vasa deferentia) are not visible, but the large pore through which the penial setae project is in line with *b* at the top of a slightly protruding thick porophore.

The female pores are paired on xiv, anterior and just internal to *a*.

The spermathecal pores are in 7/8 in line with *b*.

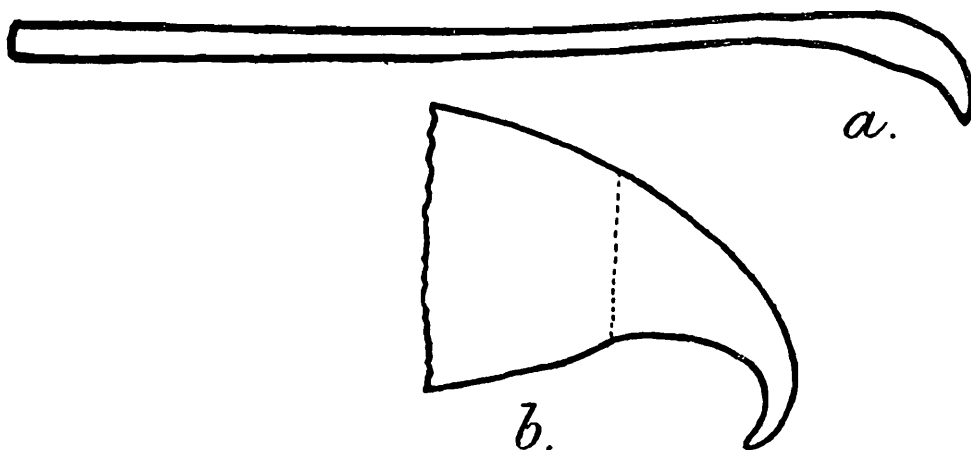
The genital markings are a single pair of cup-shaped depressions on segment xx, extending from just internal to *a* to mid *bc*. The wall of the depression pushes 19/20 and 20/21 anteriorly or posteriorly.

Internal anatomy.—Septa 4/5 and 5/6 are present and thickened, the latter much more than the former; 6/7 and 7/8 are absent; 8/9, 9/10 and 10/11 are thickened and displaced posteriorly, 10/11 and 11/12 very close together. Remaining septa thin and attached normally.

The gizzard is large and occupies practically all of the space between 5/6 and 8/9. There are calciferous glands of the usual type in segment xii. The intestine begins in xv just behind 14/15.

There are two pairs of hearts just under 8/9 and one pair just anterior to the gizzard; the dorsal blood vessel continues through 5/6, v, and 4/5 anteriorly.

The male funnels are paired, in x and xi. The anterior seminal vesicles in ix are smaller than the posterior vesicles, which lie alongside the intestine in the region of annulations xv and xvi but without passing through 12/13 which, with the succeeding septa, is pushed backwards. The prostates extend through xvi-xxi. The ental free end of the prostate is in xix and passes backwards in a nearly straight line parallel to the nerve cord into xxi, turning there and passing anteriorly as a



TEXT-FIG. 19.—*Eutyphoeus hamatus*. *a*. Penial seta, $\times ca.$ 50. *b*. Tip of penial seta, $\times ca.$ 1100.

fairly regular series of hairpin loops on the floor of the coelom, pressed into contact with each other. The prostatic duct is small, 2-3 μ m.

long and loosely looped thrice. There is a battery of reserve penial setae on each side.

The ovaries and oviduct funnels are in the usual positions in xiii. The spermathecal ampulla is large, sac-like; the duct short and stoutish; the diverticula two, small, attached one to each side of the duct and bent at an angle to the duct.

Remarks.—The length of other specimens ranges from 68-90 mm., the diameter from 3-5 mm. The first dorsal pore is in 10/11 in all specimens.

The clitellum begins with the setae of xiii and extends either to the setae of xvii or to 17/18. Dorsal pores are indicated on the clitella of all specimens, none of which are consequently quite fully mature.

The setal distances just behind the clitellum are usually closely similar to this formula $ab : cd : bc : aa :: \frac{1}{4} : \frac{1}{2} : \frac{3}{8} : 1-1\frac{1}{8}$. Posteriorly cd and bc become nearly equal or in some cases on the last few segments cd may become larger than bc .

The spermathecal pores are either in line with b or in bc just external to b . The penial setal pores are in line with b or just external to b . The male porophores on the two largest specimens are located on a faintly outlined, dumb-bell-shaped area. The penial setal pore may be surrounded by a distinctly outlined circular lip.

All of the specimens, even the smallest in which there is no trace of a clitellum, have the genital markings on xx. In the more immature specimens these markings are merely glandular slightly elevated areas on which setae a and b are still visible. These setae cannot be seen in the more mature specimens.

Septum 8/9 is attached to the middle or posterior portion of ix, 9/10 to the middle or posterior portion of x, and 10/11 and 11/12 together in the region of xii.

The supra-pharyngeal ganglia are in segment iii.

There are eight or ten pairs of supra-intestinal glands in four or five successive segments about 43-45 mm. from the anterior end of the worm. From about segment xxx there are ventral intestinal caeca for a few segments. The typhlosole is small.

The prostates extend through segments xvi-xxii, the looping of the gland described for the type-specimen appears to be characteristic of the species, as all other specimens dissected show a similar condition. Such strictly regular looping has not been previously observed in Burmese species of the genus.

There are glandular thickenings of the parietes projecting into the coelom in xx over the genital markings.

The penial setae are about 2 mm. in length, practically straight except for the enlarged reddish end which is bent into a hook-like conformation. At the extreme tip is a greenish-hued spine. Thickness near base 45-55 micra, through enlargement 55-65 micra. Ornamentation: (1) a fur of very fine spines on the enlargement, (2) 15-20 circumferential rows of spines just behind the enlargement, rows not completely circumferential, interrupted more frequently basally until there are only short rows of a very few spines.

Eutyphoeus hastatus Gates.

Eutyphoeus hastatus, Gates, *Proc. U. S. Nat. Mus.* LXXV, p. 32, fig. 19 (1929).

Anidaung, July, one mature and several immature specimens.

Thindaw, July, several specimens.

Okma, July, several specimens.

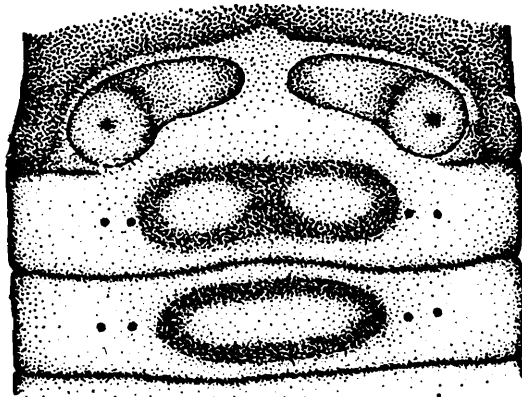
Laungbyin, July, several specimens.

Mingin, July, one specimen.

Kalewa, July, several specimens.

Masein, July, several specimens.

The genital marking on xviii when single is an oval papilla placed transversely across the long axis of the animal in *aa*, slightly nearer to 17/18 than to 18/19, the papilla surrounded by a circumferential, groove-like depression. One specimen has an additional papilla similarly placed on xix. In some specimens the anterior and posterior edges of the papilla may be slightly indented in the mid-ventral line, in other specimens the indentations are continued across the papilla dividing it into two equal halves. Several specimens have two, small, oval papillae in *aa* on xviii, each completely surrounded by a circumferential groove-like depression.



TEXT-FIG. 20.—*Eutyphoeus hastatus*. Genital markings.

The large, prolobous prostomium is a protrusion from the anterior dorsal margin of i, the groove marking off the prostomium from segment i very slight or sometimes apparently lacking.

The supra-pharyngeal ganglia are in segment iii.

There are ventral caeca on the intestine similar to those of other species of the genus *Eutyphoeus*.

The seminal vesicles of ix are always much smaller than those of xii, rarely even half as large as the posterior vesiculae seminalis.

Eutyphoeus longiseta, n. sp.

Variety **typicus**.

Sandoway, October, 26 specimens.

Description of the type-specimen. External characteristics.—Length 210 mm. Greatest diameter through the clitellum 11 mm., anteriorly 10 mm., through the anal region 8 mm. Number of segments 163. Colour, deep rich brown.

The prostomium is combined pro-and epilobous, the tongue furrows reaching nearly to $1/2$.

On each of segments iv, v, and vi there is a single secondary furrow posterior to the setae of the segment; on segments vi-ix there are secondary furrows both anterior to and posterior to the setae; on segments viii and ix there are three slighter tertiary furrows, one on each of the annuli produced by the secondary furrows; segment x has five furrows all of the same depth, while segments xi-xiii have four such furrows. Posterior to the clitellum there are usually two secondary furrows per segment and occasionally slighter furrows on the annuli marked off by the secondary furrows.

The first dorsal pore is in $11/12$: there is also a pore in $12/13$ and a non-functional pore-like depression in $13/14$.

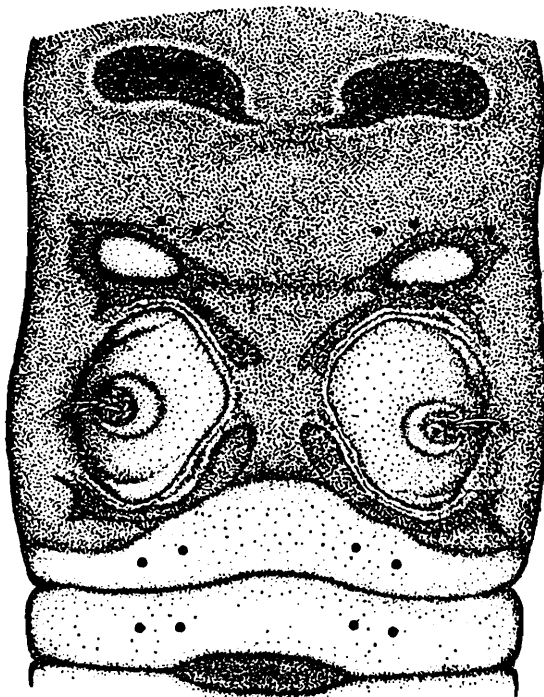
The setae are eight per segment, not closely paired, and begin on ii. Posterior to the clitellum $ab : cd : bc : aa :: \frac{2}{3} : \frac{3}{4} : 1 : 1\frac{1}{2}-2$. Anterior to the clitellum aa is smaller than bc and ab and cd are more nearly equal. The dorsal distance is much greater than one-half of the circumference.

The clitellum begins behind the setae of xiii ventrally, slightly more anteriorly dorsally and extends nearly to $17/18$, setae present, inter-segmental furrows lacking.

The spermathecal pores are in $7/8$ in bc .

The female pore is on the left side anterior and slightly internal to a .

The external aperture of the deferent male duct is not visible but the penisetal-prostate pores are on xvij in line with b .



TEXT-FIG. 21.—*Eutyphoeus longiseta*. Genital markings.

The genital markings are (1) median, concave, oval depressions in aa on the posterior half of segments ix and x; (2) median, more slit-like depressions in aa on $19/20$, $20/21$, and $21/22$; (3) paired, lateral, diagonally placed, oval depressions on the posterior margin of xv, from

internal to *a* to mid *bc*, with the anterior end external to the posterior end; (4) paired oval protuberances on xvii surrounded, except on the most lateral portion, by a slightly raised lip; (5) anterior and posterior to the lip just mentioned on each side of the body a slight crescentic depression; (6) on the centre of each oval papilla a whitish projecting porophore with two penial setae protruding from the opening.

Internal anatomy.—Septa 4/5 and 5/6 are present and greatly thickened; 6/7 and 7/8 are absent; 8/9, 9/10 and 10/11 are thickened and displaced backwards together; 11/12 is probably represented only by the thin connective tissue which forms the postero-dorsal wall of the median testicular chamber.

The gizzard is short but stout. There are calciferous glands of the usual sort in the wall of the alimentary canal in segment xii. The intestine begins in xv.

Large tufted masses of nephridia adhere to the parietes in iii.

The last pair of hearts is in xiii; the hearts of xii are in the anterior portion of the annulus and bound down to the oesophagus. There are two pairs of hearts under 8/9. The dorsal vessel terminates with the commissures belonging to segment vii.

Under the alimentary canal in xii is a median testicular chamber or testis sac. The seminal vesicles are large; lobed, and extend from 10/11 to 12/13, but push 12/13 and 13/14 back into contact with 14/15. The tubular prostates extend through segments xvii-xx.

The ovaries and oviduct funnels are in the usual positions in xiii. The spermathecal ampulla is antero-posteriorly elongated and sausage-shaped. The duct is short and stout. On the right and left sides of the duct just below the ampulla are the stalked diverticula, each diverticulum with 3-9 seminal chambers at the ental end.

Remarks.—The length of other specimens varies from 175-290 mm., and the diameter from 7-11 mm.

The first dorsal pore is in 11/12 in 25 specimens; on one worm there is a pore-like depression in 11/12 which does not seem to be functional, the first functional pore in 12/13.

The antero-posterior limits of the clitellum are not sharply defined, but the clitellar thickening of the epidermis begins on xiii, usually posterior to the setae, and extends to 17/18, the setae of xviii, or 18/19.

The spermathecal pores are always in *bc* and usually nearer to *b* than to *c*.

Only the left female pore is present, this may, be anterior to *a*, in line with *a*, or in the region *ab*.

The genital markings vary in position and number, but though several types of such markings are present they are quite characteristic for certain segments or segmental locations. Similar to the type-specimens these markings may be classified as follows:—

1. Concave oval depressions with smoothly rounded ends. These may be unpaired and median or paired and lateral. The median markings are in *aa* on the anterior half of segments vii, viii, ix, and x, and the posterior half of segments ix and x. The paired lateral markings are in *cd* or *bc* on the posterior half of segments vii and viii or the anterior half of viii.

2. Longer, narrower depressions with pointed ends less regularly concave. These are unpaired and always median in *aa*. They occur on 11/12, 12/13, 18/19, 19/20, 20/21, and 21/22.

3. Paired papillaceous markings with smooth, white, rounded surface, surrounded by a fairly deep, more or less regular furrow, elongately oval, slightly diagonal in position so that the outer end in *bc* is slightly anterior to the inner end; the inner end may extend nearly to mid *aa*, the outer end to mid *bc*. Occasionally the parietes between the inner ends of these markings is sunk so that they appear to be confluent. These markings occur on the posterior border of *xv* in every specimen, and may or may not be present on the posterior border of *xvi*. The markings on *xvi* are present on only half of the specimens and in more than half of these worms are smaller than the markings on *xv*.

4. Paired, longitudinally elongate, ovoid, whitish protuberances on *xvii*, not quite meeting in *aa* and extending laterally to mid *bc*, sometimes slightly flattened, often wrinkled, surrounded except on the outer side by a ridge or lip with a slight groove.

5. On the centre of each of these areas is a whitish projecting porophore or penis, from the end of which protrude two penial setae. The penis consists of a tubular basal portion and distally an anterior and a posterior lip. The pore is large, slit-like and transverse to the long axis of the animal.

6. Anterior and posterior to the ridge surrounding the oval protuberance there may be a slight but definitely marked, crescent-shaped depression.

Setae *a* and *b* of a varying number of segments behind the clitellum are unusually long, straighter than usual, especially on *xix* and *xx*, and ornamented on the outer tip with short ridges of closely-set teeth.

The protruding penial setae are 6-8 mm. long. The shaft with a slight suggestion of spiral twisting so that when the seta is placed on a slide the glass is in contact with the seta at two points, tip and curve near the base, or base and curve near the tip. The ornamentation consists of numerous, short, crowded, transverse ridges of close-set denticular tips not softened or broken have a characteristic single row. A battery of 6-8 reserve penial setae is always present on each side.

There are 12 pairs of ventrally directed, lateral intestinal caeca in *xxviii*. There are 12 pairs of dorsal glands on the intestine about 120 mm. from the anterior end.

The seminal vesicles of all specimens dissected have the antero-posteriorly elongated, sausage-shaped ampulla with the stalked diverticulae. The number of seminal chambers at the enlarged free end of the diverticulum varies from 3-11. The shape of the diverticulum varies with the number of seminal chambers.

The bilobed median testis sac resembles superficially the paired testis sacs of *Pheretima* but there does not seem to be any internal division corresponding to the two lobes. Each seminal vesicle is attached to the posterior end of a lobe. The male funnels are large and irregularly reticulated. The deferent duct is covered over with parietal

tissue shortly after emerging from the testis sac and is rather difficult to dissect out. The ectal end of the duct is slightly enlarged in xvii but remains covered over with tissue and passes into the posterior wall of the penial tube out of sight. The prostatic duct is 22-24 mm. long and passes into the anterior wall of the penial tube.

The lateral-oesophageals (or more aptly ventro-laterals) are attached to each other just behind the gizzard but separate and pass posteriorly, independently of each other, into the calciferous glands. Anteriorly each vessel gives off two large branches to the anterior face of the gizzard before passing into 5/6. The two trunks are again attached to each other in 5/6 but emerge separately into v where the right trunk divides into two equi-sized branches, one of which passes directly to the nephridial mass of iii, while the other passes up dorsally and then anteriorly in a mid-dorsal line over the pharyngeal bulb. The left trunk passes directly to the nephridial mass of iii unbranched. The ventral vessel diminishes until it becomes too small to trace just over the subpharyngeal ganglia.

There are whitish (glandular?) masses in the body wall over the oval concavities which may or may not project into the coelom. These concavities have a distinct sucker-like appearance in section through the parietes. Similar masses have not been observed over the genital markings on xv or xvi or the posterior median inter-segmental markings.

Variety **postremus**, n. var.

Taungup, Kyauktaga, Tanywagyi, October, seven specimens.

The specimens of this variety have penial setae, spermathecal diverticula, and certain genital markings such as the anteclitellar concavities both paired and median, the post clitellar genital markings, and certain other characteristics either very similar to or exactly alike those in *typicus*. The variety may be characterized as follows:—

1. The protuberant oval areas bearing the penial tubules are lacking, replaced by a deep but narrow vestibular excavation in the parietes which is almost entirely filled by the penis. The posterior lip of the penial tube is larger than the anterior and projects more conspicuously from the vestibular pore, in two specimens filling the aperture.
2. The markings on the posterior half of xv are entirely lacking. A well developed pair of transverse or diagonal markings on xvi.

Eutyphoeus peguanus Gates.

Eutyphoeus peguanus, Gates, *Ann. Mag. Nat. Hist.* (9) XV, p. 323 (1925)

The finding of worms at Toungoo with characteristics hitherto supposed to be peculiar to *E. peguanus* or to *E. similis* necessitated a re-examination of the status of the two forms. As the result of the dissection and study of numerous individuals it seems advisable to reduce *E. similis* to the status of a variety and to regard the different forms previously included indiscriminately in *E. peguanus*, as well as the Toungoo forms, as distinct varieties. Since the type-specimen of

the species has paired genital markings on xvii and xix, worms with these markings will be designated as variety *typicus*.

Variety **typicus**.

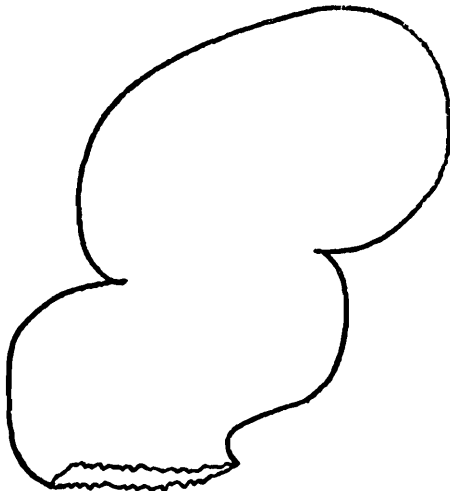
53 specimens available for examination.

The first dorsal pore in all of these specimens is in 11/12, but in 11 worms there is a marked pore-like depression in 10/11 which does not however penetrate through all the layers of the body wall. In addition 12 other specimens have a minute greyish spot in 10/11.

The spermathecal pores are either in line with *c* or in *bc* close to *c*. The vestibular pores are on the posterior third of the clitellar genital markings and in *bc* just external to the line *b*. The vestibular pore is a narrow, transverse slit, the vestibulum is a narrow tubular excavation in the parietes.

The clitellar genital markings are large, more or less rounded, glandular areas on xvii pushing 16/17 anteriorly and 17/18 posteriorly. These markings are very slightly elevated above the general surface of the body but are not sharply marked off otherwise. They extend from internal to *a* into *bc*, sometimes nearly to *c*. The post clitellar markings are similar in appearance to the clitellar markings and may be of the same size or smaller or larger. The genital markings dislocate the bounding furrows of xxi so that the antero-posterior length of the segment in the region of these papillae may be as much as $2\frac{1}{2}$ -3 times the dorsal length. They extend from just internal to *a* into mid *bc*, sometimes reaching nearly to *c*.

Attached to the parietes behind the male funnels of segment xi is a sheet of tissue, in many specimens thicker than septum 12/13, firmly attached to the oesophagus just behind the hearts of xi, laterally and dorsally apposed to 10/11 so that it does not come into contact with the parietes independently except midventrally. Fibres of delicate connective tissue bind this sheet to the posterior face of 10/11 so that as a general rule there appears to be only one very thick septum passing to the parietes in this region. The space between this posterior sheet



TEXT-FIG. 22.—*Eutyphoeus peguanus typicus*. Spermathecal diverticulum.

and 10/11 is occupied by the commissures of xi, the large male funnels, and whitish masses of testicular material which vary considerably in

their total amount. If the amount of this material is small, segment xi appears, when the worm is opened in dorsal dissection, as an inverted U-shaped mass bulging out from the posterior face of 10/11. If the mass of testicular material is much larger as in a few specimens the posterior sheet of tissue may be so separated from 10/11 that segment xi is opened in pinning out the worm. In this case the posterior sheet of tissue has the appearance of an ordinary septum except for lateral attachment and doubtless is a modified septum 11/12.

In segment x a strong muscular cord passes from the posterior face of 9/10 into the parietes at the base of 10/11 on each side of the nerve cord. Directly dorsal to this cord, on the anterior face of septum 10/11, and projecting freely into x there is on each side a short stalk bearing at its free end a funnel-like structure. These funnels are rarely as large as those of xi but are readily visible in dissected specimens, and have crenelated edges and a pore or pore-like depression at the centre. Nine specimens were examined, in eight of which these funnels are present. Another unusually large worm fully mature had large and extensively crenellated funnels in this segment, while two other worms, small and immature, had small funnels in x. The ninth specimen of the lot previously mentioned had no trace of funnels in x.

The prostatic duct varies in length from 5.5 mm. to 8 mm., the average length in six specimens 6.7 mm. The penial setae are straight or with a bend at the tip as previously figured for this species but the tips of all examined are more or less deformed and softened. The softening may possibly be responsible for the ball-like tips of the previous figures. In one specimen a functional penial seta has its tip bent as previously figured for *E. similis*. There is a battery of four to eight reserve penial setae on each side.

The spermathecal diverticula vary in their external conformation. They may be straight as figured for *E. similis*, or they may be bent at right angles as figured for *E. peguanus*, or more rarely may be bent twice (fig. 22). Usually both straight and right-angled conformations are present in the same worm. One worm has all four diverticula bent. In several specimens all three types of conformations are present.

After giving off the commissures belonging to segment vi the dorsal blood vessel is continued forward onto the posterior face of 5/6 as a minute blood-filled vessel. In one specimen this vessel is continued into v and onto 4/5 from whence it could be traced no further, giving off a very small yet commissure-like pair of vessels in v. In none of the other worms examined is there a dorsal vessel in v.

The lateral intestinal caeca of xxviii are small, usually merely round bulgings of the intestinal wall. In one specimen the caeca are dorsally directed, short, and with bluntly rounded ends. Ventro-median intestinal caeca present, usually more than 20.

The vas deferens is not extensively covered over and is readily visible on the ventral parietes as a clearly double tube until it reaches segment xvii.

The body wall in the region of the post-clitellar genital markings is thickened, the parietal thickening may project slightly into the coelom as a flat-surfaced mass.

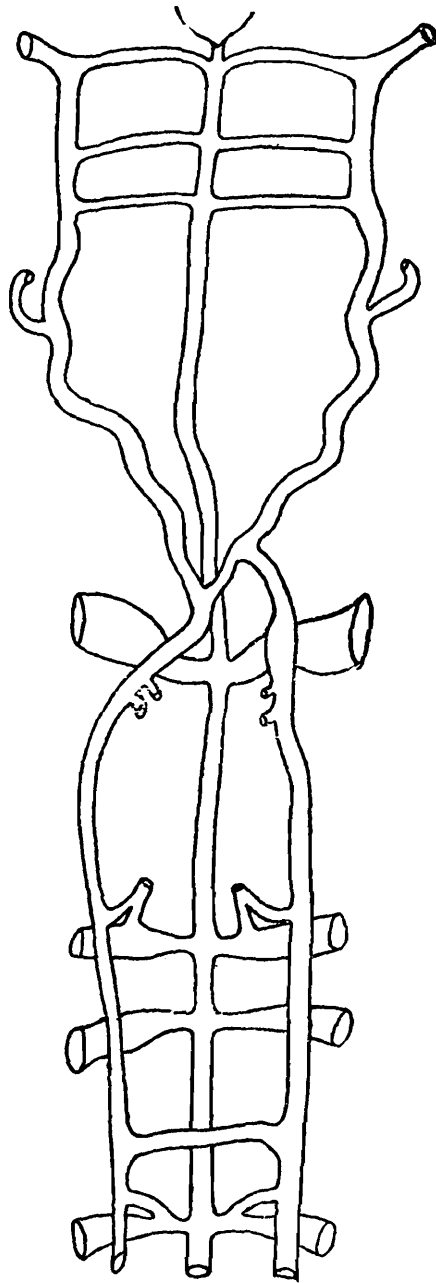
The specimens in this collection were secured in the month of August at Myitkyina and Rangoon.

Variety **promotus**, n. var.

Rangoon, August, 51 specimens.

Myitkyina, August, 3 specimens.

The first dorsal pore is in 11/12 in all specimens. There are no rudimentary dorsal pores, or traces thereof, in 10/11 in any of the specimens. The spermathecal pores, vestibular pores, and clitellar markings are as in *typicus*. The post-clitellar markings are as in *typicus* but are located on segment xix instead of xxi. In immature worms of this variety, the vestibular pore is minute, about the size of the female



TEXT-FIG. 23.—*Eutyphoeus peguanus promotus*. Diagram of ventral and ventro-lateral trunks in anterior segments.

pore of a fully mature worm, exactly in line with *b*. Through this pore project two penial setae, even though the specimens are quite small.

Segment xi varies in size and appearance much as in the preceding variety. The male funnels in x are definitely smaller than in the preceding variety and the margins are less crenellated. One specimen only lacks these funnels.

The prostatic duct is 4-6 mm. in length, with an average length of 4.8 mm. in six specimens in which the ducts were measured. The penial setae are similar to those of *typicus*, straight or with a single bend, disappointingly softened at the free end. In several specimens there are functional penial setae with the tip bent as figured for *E. similis*. The vas deferens is covered over with connective tissue and more difficult to trace than in *typicus* but is double into xvii.

The spermathecal diverticula are small round knobs, or elongate and with one or more of the conformations described for the preceding variety. One diverticulum has a bifid end.

The dorsal blood vessel may pass beyond the commissures of vi as a tiny vessel to the posterior face of 5/6 or may end with the commissures of vi.

The lateral intestinal caeca in xxviii are more definitely marked off from the intestine in this variety, with a bluntly rounded end. Ventro-median caeca have been observed in as many as 17-27 segments.

The body wall in the region of the genital markings on xix is thickened as in *typicus*.

Two worms of this variety are abnormal. In the first, the marking on the left side of xix is lacking, but there is an extra similar marking on the right side of xx. In the second, in addition to the usual markings on xix, there is an extra marking on the left side of xviii, similar to those on xix. In the first specimen, the vasa deferentia of a side are widely separated and do not come into contact with each other until segment xvii.

Variety **simplex**, n. var.

Rangoon, July to September, 6 specimens.

Mandalay, August, 6 specimens.

Myitkyina, August, 5 specimens.

Labaw, October, 1 specimen.

Nyaungyo, October, 1 specimen.

Chaukma, July, 1 specimen.

Post clitellar markings are entirely lacking. This is not due to immaturity for all of the specimens have fully developed clitella, while quite young specimens of *typicus* and *promotus* without any trace of clitella have oval or round glistening glandular thickenings of the parietes where the characteristic post-clitellar genital markings are to develop. The spermathecal pores, vestibular pores, clitellar markings, penial setae, spermathecal diverticula, segment xi, and the dorsal blood vessel are as in the two preceding varieties.

The vas deferens is double and more or less covered with connective tissue. The male funnels in x are small and more like those of *promotus* than *typicus*, except in one specimen in which they are large and extensively crenellated. In two worms in place of a funnel there is merely

a sausage-shaped enlargement of the end of the vas deferens. The lateral intestinal caeca are similar to those of *typicus*.

Variety **tumidus**, n. var.

Toungoo, September, 15 specimens.

The flattish, round genital markings on xvii in all of the preceding varieties are lacking here. In place of them there is on each side a protuberant conical porophore which extends from *a* or mid *ab* to just external to *b*. In the mid-ventral region of xvii between the two porophores is a faintly defined, elongate, glistening area. The pore at the end of the porophore is a peni-setal-prostate pore. On the posterior lip of this pore is a tiny, slightly projecting lobe of whitish tissue which bears a small pore. This is the true male pore or external aperture of the male deferent duct. There are paired post-clitellar markings on xix similar to those of *promotus*. The clitellar and post-clitellar markings are exactly the same in all of the specimens.

The first dorsal pore is in 11/12 in all specimens but in twelve worms there is a non-functional pore-like depression in 10/11. The spermathecal pores are in line with seta *b* or in *bc* close to *b*. The peni-setal-prostate pores are in line with *b*.

The male funnels of x are large and of approximately the same size as in *typicus*, and always with distinct crenellation of the funnel margin. The vas deferens is not covered, is double, the outer duct may be readily traced to the funnel of x. The prostatic duct is 2.5—5 mm. in length, the average length 3.5 mm. The penial setae are less softened in this variety. The tips may be either straight, bent slightly or as in *similis*. This latter condition occurs in practically all of the worms examined. There are 4-8 reserve penial setae in a battery.

The intestinal caeca in xxviii are larger than in the preceding varieties, with bluntly rounded, free, ventral end.

The spermathecal diverticula are either bent once and more or less at right angles, or bent twice, or rarely three times. The diverticula appear to be slightly larger than in the preceding varieties.

The vessels in the anterior region of these worms are distended with blood, but in certain places are bound together by masses of connective tissue, in such a way as to make it difficult to determine whether the vessels are definitely connected with each other or merely bound into contact. Attempts to dissect off this connective tissue have not been successful, and only those connections have been figured which have been definitely traced in favourable specimens.

The dorsal trunk after giving off the large heart-commissures in segments xiii-vi may be continued onto the posterior face of 5/6 or may end with the hearts of vi. The ventral vessel is first visible as a ventral trunk just over the sub-pharyngeal ganglia, where it receives a pair of tiny vessels that pass down along the inner side of the circum-pharyngeal commissures. As it passes posteriorly it receives on each side the commissures from the dorsal trunk.

The ventro-lateral trunks are first noticeable as blood-filled vessels on the inner face of the nephridial masses on each side of iii, from whence they pass onto a longitudinal sheet of tissue immediately dorsal to the

nerve cord. Here they turn posteriorly and receive three commissures from the ventral trunk. Posterior to these and just anterior to 4/5 on each side these trunks receive a vessel from the dorsal side. These vessels from the lateral oesophageals pass up onto the pharyngeal bulb, where they fuse in the mid-dorsal line and pass forward as a definitely recognizable vessel as far as the brain. At the base of 4/5 each ventro-lateral trunk passes up from the longitudinal sheet of tissue and is henceforth suspended in the coelom ventro-laterally to the alimentary tract. Just behind 5/6 a commissure connects the two trunks. There is a similar commissure just anterior to 8/9. In ix each trunk receives a small vessel from the "heart" of its side in ix. In the posterior part of x or in xi each trunk passes up onto and into the wall of the alimentary canal to run along the vertical partition dividing off the calciferous gland from the lumen of the oesophagus. A small branch passes posteriorly in the outer wall of the calciferous gland. Each ventro-lateral trunk gives off in vi a conspicuous vessel to the posterior face of 5/6 and in v a vessel to the anterior face of 5/6 and another to the posterior face of 4/5. Posterior to the commissures of vi each trunk gives off two vessels to the anterior face of the gizzard, and just anterior to the hearts of vii a single vessel to the posterior face of the gizzard. The vessel to the gizzard also receives a branch from the heart of vii.

Just in front of the vessels passing to the anterior face of the gizzard the ventro-lateral trunk is bound to the heart of vi. In ix a small vessel from the lateral trunk passes into the heart of ix just before the latter enters the ventral vessel.

The ventral trunk gives off on each side a large vessel to the spermatheca and the ventral parietes.

There is no trace of a subneural trunk either on the ventral side of the nerve cord or on the parietes under the nerve cord in any of the specimens examined.

Variety **similis**.

Eutyphocus similis, Gates, *Proc. U. S. Nat. Museum* LXXV, p. 37 (1929).

The type-specimen of the species is the only specimen available for examination.

Genital markings paired on xvi and xvii. The markings on xvi extend from close to the mid-ventral line to mid *bc*, are larger than those on xvii and resemble the markings on xix or xxi in other varieties, except that there the marking is surrounded by a slight but distinct groove-like depression in the clitellum. The markings on xvii extend from near to *a* into *bc*. At the centre of the markings on xvii is the transverse slit-shaped vestibular pore with centre of pore in line with *b*. The vestibulum is small. On the posterior edges of the vestibular pore is a small funnel-like lobe with a pore at the centre which is probably the external aperture of the male deferent apparatus. The spermathecal pores are in line with *b*.

Male funnels were not noticed in first studying this and the other specimens from Kyundo and Kawkareik. On re-examining the specimen two minute knobs were found on the anterior face of 10/11 immediately dorsal to the muscular cords and hence in the position that

should be occupied by the male funnels. Doubtless these structures are rudiments of male funnels. The vasa deferentia of the right side have a longitudinal grey line into xv indicating perhaps that the duct is double to that extent.

***Eutyphoeus quinquepertitus*, n. sp.**

Sanbot, Nyaungyo, Nyaungyi, October, eight mature specimens collected by K. N. Sharma.

Description of the type-specimen. External characteristics.—Length 156 mm. Diameter 7 mm. posteriorly, 9 mm. in the clitellar region. Number of segments 120. The colour is brownish.

The prostomium is combined pro- and epilobous with the tongue furrows not quite reaching to 1/2.

On segments iv and v there is a single secondary furrow posterior to the setae of the segment; on vi and vii there are two secondary furrows, one anterior to and one posterior to the setae; on segment viii the secondary furrows run into each other in a spiral fashion similar to that of the primary furrows called by Morgan spiral metamerism; on ix-xii there are four furrows each, all of about the same depth. On xii there are two furrows anterior to the setae.

The first dorsal pore is in 12/13.

The setae begin on ii, four pairs per segment, but not closely paired; posterior to the clitellum $ab : cd : bc : aa :: \frac{3}{8} : \frac{5}{8} : 1\frac{1}{4} : 1\frac{1}{2}$; anterior to the clitellum aa is smaller than bc on some of the segments. The dorsal distance is greater than one-half of the circumference.

The clitellum extends from just behind the setae of xiii to 17/18, setae are present but intersegmental furrows and dorsal pores are lacking. The clitellar limits are not sharply marked.

The spermathecal pores are in 7/8 about in line with b . The female aperture is single, on the left side, anterior and slightly internal to a . The male apertures are not visible. A very narrow slit-like vestibular pore can only be seen by separating the edges of the genital markings.

The genital markings consist of a five-fold arrangement of oval glandular areas. Four of these markings, of approximately the same size, are on xvii, two on the anterior half and two on the posterior half; they extend from near the mid-ventral line to mid bc and from the middle of the segment to the anterior or posterior boundary of xvii. The posterior oval lies across 18/19, extending from the setae of xviii to the setae of xix and laterally to b . This marking is surrounded by a slight lip like that on the lateral markings of *E. rarus*.

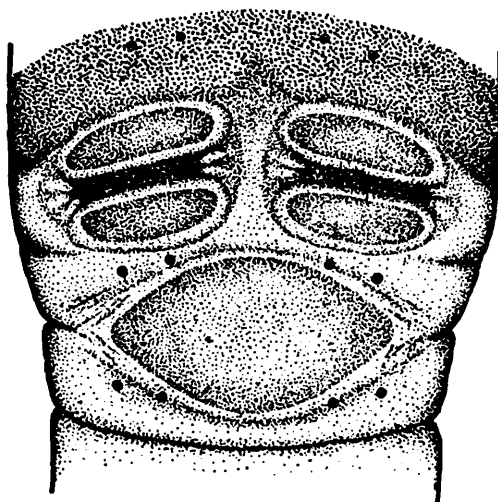
Internal anatomy.—Septa 4/5 and 5/6 are present and thickened; 6/7 and 7/8 are absent; 8/9, 9/10, and 10/11 are thickened and displaced posteriorly closely together.

The gizzard is short and stout. There is a pair of characteristic calciferous glands in xii. The intestine begins in xv. There is a pair of ventrally directed, lateral intestinal caeca in xxviii.

Large masses of nephridia adhere to the parietes in iii.

There are two pairs of vascular commissures under septum 8/9. The last pair of hearts is in xiii.

The seminal vesicles are in contact with 10/11 anteriorly, and posteriorly push 12/13 and 13/14 back into contact with 14/15. The testicular chamber is median, its edges just visible below the oesophagus. The male funnels are large and crenellated. The tubular prostates extend through segments xvii-xxii, the duct about 15 mm. long.



TEXT-FIG. 24.—*Eutyphoeus quinquepertitus*. Genital markings.

The ovaries and oviduct funnels are in the usual positions in xiii. The spermathecal ampulla is elongated antero-posteriorly and is sausage-shaped; the duct is short and stout. There are diverticula on the right and left sides of the duct just below the ampulla, each diverticulum with a stalk and an enlarged and slightly flattened end with a varying number of seminal chambers.

The vas deferens lies on the surface of the parietes, it passes around the outer side of the prostatic duct, bends inward towards the nerve cord, slightly enlarged just as it passes into the parietes. There are no penial setae.

Remarks.—The length varies up to 190 mm. but probably none of the specimens are complete. The greatest diameter observed is 9 mm. The colour of these worms is brownish but not so rich as in *E. longiseta* and other large species of Burmese *Eutyphoeus*, more resembling that of *E. raris*. The setal distances just behind the clitellum vary and on five of the worms are as follows:— $ab : cd : bc : aa :: 3/8 : 2/3 : 1\frac{1}{4} : 1\frac{3}{4}$, or $\frac{1}{2} : \frac{2}{3} : 1\frac{1}{4} : 2$, or $\frac{1}{2} : \frac{2}{3} : 1\frac{1}{4} : 1\frac{1}{2}$, or $\frac{3}{8} : \frac{3}{4} : 1\frac{1}{4} : 1\frac{1}{2}$, or $\frac{1}{2} : \frac{4}{5} : 1\frac{1}{4} : 1\frac{1}{2}$. Setae *a* and *b* on the clitellum are about 1 mm. in length, straight, ornamented with short ridges of small teeth.

The clitellum is sharply marked in the cotypes and extends from the setae of xiii to the setae of xvii or to 17/18.

The first dorsal pore is in 11/12 in all except the type-specimen.

The spermathecal pores are in 7/8 in *bc* close to *b* or in line with *b*. The slit-like vestibular pores extend from *a* to slightly external to *b* or to mid *bc*.

The genital markings are the same in all specimens.

The prostate duct is 12-15 mm. long and opens into the vestibule through a very small conical porophore. The vas deferens opens into the vestibule directly through a small pore. There are glandular thick-

enings of the parietes over the genital markings which may or may not project into the coelom.

There are 8-12 pairs of dorsal glands on the intestinal wall in the middle region of the body.

The present specimens of this species have no penial setae nor does there seem to be any trace of a peni-setal sac. Since all other Burmese species of *Eutyphoeus* have penial setae, as only eight specimens have been available for examination, and since these were collected at the close of the rainy (reproductive?) season, a rather unfavourable time, it may be possible that penial setae are present normally or at other seasons of the year. But even when functional penial setae drop out there is always on each side of the worm a battery of reserve penial setae of various lengths. I cannot recall ever having found before any specimen of *Eutyphoeus* lacking this battery, much less a number of successive specimens with this characteristic. Absence of penial setae appears then, somewhat doubtfully, to be a characteristic of this species. The arrangement of the genital markings is characteristic and in contrast to the variability of similar markings in other species is strikingly uniform. The spermathecal conformations are similar to those of *E. longiseta* or *E. rarus*.

***Eutyphoeus rarus* Gates.**

Eutyphoeus rarus, Gates, *Ann. Mag. Nat. Hist.* (9) XVI, p. 59 (1925).

Eutyphoeus rarus, Gates, *Rec. Ind. Mus.* XXVIII, p. 164, fig. 4 (1926).

The original description was based on a study of eight specimens collected during three years previous to 1925 in Rangoon. The worm is rather rare and was not obtained again in the type-locality for several years. In the meantime several specimens had been collected in other localities, Thonze, Prome, and Bassein, which made possible the addition of further information in regard to the penial setae. During the rainy season of 1929 a specially trained mahli spent several weeks hunting for this worm in Rangoon and obtained over a hundred specimens. The genital markings are one of the most important characteristics for specific distinction, but since these are somewhat variable, it is desirable that as large a number of specimens as possible be examined to obviate erection of unnecessary species.

The genital markings are of various types as follows:—

1. "Crescents". These are greyish, crescent-shaped areas just anterior to or posterior to the vestibular pores with the limbs of the crescent directed around the anterior or posterior margin of the pore. These markings are not, as a rule, as sharply defined as the other markings and may be lacking on either or both margins of the vestibular pore. Occasionally part of the anterior crescent is occupied by one of the more conspicuous lateral markings.
2. Post-clitellar "laterals". These are transversely located areas across the intersegmental furrows, usually about in the region *ab* although they may extend from *a* to mid *bc* or more rarely even to *c*, and may or may not nearly reach to the setae of the segments concerned. The marking is

composed of a flattened, oval area slightly depressed, the surface roughened as if finely granular, and a slightly tumid, lip-like swelling of the parietes. The ends of these laterals may be rounded or, less frequently, pointed, at one or both ends.

3. Intra-clitellar "laterals". These are transversely placed oval areas on the clitellum where the clitellar pigment is lacking. There is a definite circumferential groove sunk in the epidermis but the region within this groove is not flattened as in the post-clitellar laterals but is rounded in a convex fashion. These vary in size and position but usually are in the region *ab*, *bc*, or from internal to *a* to mid *bc* or even to *c*.
4. Intra-clitellar "medians". These are transversely placed, usually unpaired markings similar in appearance to the intra-clitellar laterals and are either just on the mid-ventral line, or in region *aa*, or in *bb*.
5. Pre-clitellar medians or laterals. These are concave depressions in the parietes with rounded ends, in the mid-ventral region, laterally, anteriorly or posteriorly placed on the segments. These markings are very similar to the pre-clitellar markings of *E. longiseta*.

The vestibular pores may be rounded and widely open or narrowed to a transverse slit with the edges apposed. The vestibulum contains a penis in which are the two functional penial setae. As in the type-specimens the outer end of this tube usually has an anterior and a posterior lip, each consisting of two rounded lobes, the two anterior lobes smaller than the posterior lobes. The penis may be concealed within the vestibulum or the posterior lips may project to the exterior through the vestibular pore.

The setal distances vary from one individual to another but may all be covered by the general formula $ab \angle cd \angle bc \angle aa$, with dd greater than one-half of the circumference. The first dorsal pore is practically always in 11/12. The spermathecal pores are in *bc* but as a rule nearer to *b* than to *c*.

The number of seminal chambers in the spermathecal diverticula varies considerably; there may be only two or three seminal chambers, or ten to twelve, or more numerous still. The free end of the diverticulum may be very slightly enlarged, or much enlarged and berry-like. All four diverticula of one worm may resemble each other closely or each may have a different appearance and a different number of seminal chambers.

The penial setae has the characteristic spine previously figured and vary in length from 4-5 mm. The ornamentation and curvature of the setal shaft also varies. The ornamentation may consist of short, closely placed, irregular rows of fine teeth, or the teeth may be larger in rows of three to five, or the teeth may be single and isolated. There are 6-8 reserve penial setae in each battery.

Glandular masses of tissue project into the coelom over the post-clitellar and intra-clitellar medians and the intra-clitellar laterals.

There is a pair of ventrally-directed, lateral, intestinal caeca in xxviii. There are 8-12 pairs of dorsal glands on the intestine in the middle of the body.

The length varies up to 205 mm., and the diameter up to 7 mm.

The penial setae of this species are similar to those of *E. longiseta*.

The genital markings are somewhat similar to the markings of *E. longiseta* as well as of *E. quinquepertitus*. The spermathecae of *E. rarus*, *longiseta*, and *quinquepertitus* all have similar variations of the spermathecal diverticula. The three species are apparently quite closely related. *E. l. postremus* may be intermediate between *E. longiseta typicus* and *E. rarus*.

Variety **typicus.**

Rangoon, July, August, 101 specimens.

Sandoway, October, 19 specimens.

Taungup, and other localities, on both sides of the Arakan yomas, along the Taungup-Prome telegraph line, a number of specimens. (The collector did not keep exact records of localities.)

E. rarus with paired post-clitellar laterals. Of the 101 specimens from Rangoon eighty have one pair of intra-clitellar laterals on the posterior half of xvi or across 16/17; 11 have two pairs of intra-clitellar laterals on the anterior and the posterior halves of xvi, the anterior pair larger than the posterior pair and extending from *a* nearly to *c*; 10 worms have in addition to paired intra-clitellar laterals on posterior xvi, intra-clitellar medians in different localities as shown by the table.

1. 14/15, 15/16, anterior xiv, posterior xvi, anterior xvii.
2. 14/15, 15/16, posterior xvi.
3. Posterior xv, anterior xvi.
4. 15/16.
5. Anterior xvi.
6. Posterior xvi.
7. Posterior xv.
8. Posterior xv, posterior xvi, anterior xvi.
9. Posterior xiv, posterior xv. (In addition paired laterals on 15/16.)
10. Posterior xv.

In seven specimens one of a pair of post-clitellar laterals has failed to develop.

Variety **deminutus**, n. var.

Rangoon, July, August, 10 specimens.

Sandoway, October, 14 specimens.

E. rarus with no post-clitellar genital markings but with paired intra-clitellar laterals, single medians, and paired medians. These worms are fully mature and fully as large as variety *typicus*. The absence of the post-clitellar markings cannot therefore be due to immaturity.

Variety **simplex**, n. var.

Rangoon, August, 2 specimens.

Sandoway, October, 14 specimens.

E. rarus lacking all trace of genital markings except the crescents around the vestibular pores. Like the specimens of the preceding variety these worms are large and apparently fully mature.

Variety **duplex**, n. var.

Sandoway, October, 20 specimens.

E. rarus with pre-clitellar laterals or medians in addition to other markings posteriorly. The following table shows the locations of the genital markings on these specimens :—

	Paired pre-clitellar laterals.	Pre-clitellar medians.	Posterior medians.	Posterior laterals.
1	<i>ab</i> post. vii <i>bc</i> post. viii.	..	14/15, 15/16, 18/19.	
2	<i>bc</i> ant. viii	..	post. xv.	
3	..	post. vii	ant. xvi.	
4	..	post. viii	15/16	post. xvi.
5	<i>bc</i> ant. viii	..	18/19.	
6	<i>bc</i> post. vii	..	....	post. xiv, xv, xvi.
7	<i>ab</i> post. vii	..	post. xiv, xv, 18/19, 19/20.	
8	....	post. viii	ant. xvi	post. xvi.
9	<i>a l</i> post. vii <i>hc</i> ant. viii.	..	14/15, 15/16, 16/17, 17/18.	
10	....	ant. vii	post. xv.	
11	<i>b c</i> ant. viii	..	post. xvi.	
12	....	post. viii	15/16	post. xvi.
13	<i>bc</i> ant. viii	..	14/15, 15/16, 18/19.	
14	....	post. viii	18/19.	
15	....	post. viii	ant. xvi	post. xvi.
16	<i>ab</i> ant. viii	..	....	15/16.
17	<i>ab</i> post. vii. <i>ab</i> post. viii	..	15/16, 18/19	15/16.
18	<i>bc</i> post. vii	..	post. xv.	
19	<i>bc</i> post. viii	..	18/19.	
20	<i>bc</i> ant. viii.	..	..

Etyphoeus sejunctus, n. sp.

Toungoo District, September, a number of specimens. The label is nearly illegible, but is probably Thandaung.

Description of the type-specimen. External characteristics.—Length 144 mm. Diameter 2-4 mm. Number of segments 178. The worm is unpigmented and a very light greyish, except the clitellum, which is reddish.

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

On segments vi there is a single secondary furrow posterior to the setae of the segment; on vii-xi there are two secondary furrows per segment, one anterior to and one posterior to the setae; segments x and xi have in addition slighter tertiary furrows which do not however form completely circumferential rings. On segment xii and the anterior half of xiii there are numerous very slight furrows, eight can be counted in the region between the dorsal pores of 11/12 and 12/13, while on the ventral face of segment xi there are three slight furrows anterior to the setae and three posterior to the setae.

The first dorsal pore is in 11/12.

The setae begin on ii, eight per segment, just behind the clitellum $ab : cd : bc : aa :: \frac{1}{3} : \frac{1}{2} : \frac{2}{3} : 1$, dd greater than one-half of the circumference. Passing posteriorly seta d becomes more and more widely separated from c and more dorsal in position until on the last few segments dd is smaller than cd . On the last few segments the setal distances are $ab : cd : bc : aa :: 1 : 1\frac{1}{4} : 1\frac{1}{4} : 1$, $dd : cd :: 1 : 1\frac{1}{4}$. Posteriorly the setae project more conspicuously than anteriorly.

The clitellum begins just behind the setae of xiii and extends to mid xvii. There are no intersegmental furrows present but setae are present and the dorsal pore in 12/13 is functional.

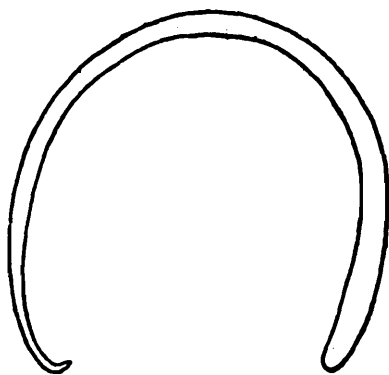
The spermathecal apertures are fairly large, in 7/8 just external to b . The female pores are minute transverse slits on xiv just anterior to a . The vestibular pores are rounded apertures about in line with b .

The genital markings are a single pair of greyish, bluntly rounded, oval areas slightly depressed in a concave fashion, on the posterior half of xi in the region ab but extending internally slightly beyond a and externally just beyond b , and pushing 11/12 slightly backwards out of its normal position. Around each oval area is a very slight rim-like elevation of the parietes and at the bottom of the rim circumscribing the oval marking a very slight but distinct groove. There is no distinctly marked off rim around the vestibular pores. The penial tubes project very slightly from the vestibular pores. The reddish clitellar colouration is lacking in a very slight longitudinal line extending from 16/17 to the setae of xiv. This whitish region has the appearance of a very slightly depressed but definite groove. The clitellar colouration is also lacking between the vestibular pores and extending as far forwards as 16/17.

Internal anatomy.—Septa 4/5 and 5/6 are present; the former thin, the latter thicker; 6/7 and 7/8 are absent; 8/9, 9/10, and 10/11 are displaced posteriorly together.

The gizzard is short and stout, the oesophagus drawn into the posterior end of the gizzard producing a distinctly flanged appearance. There are calciferous glands of the usual structure in xii. The intestine begins in xv. There is a pair of ventrally directed lateral intestinal caeca in xxvi but the caeca take their origin from the intestine in xxvii.

The dorsal blood vessel gives off two pairs of commissures behind the gizzard, belonging to segments vii and viii and anterior to the gizzard a pair of commissures belonging to vi and then passes through 5/6 from whence it can be traced to the region of the supra-pharyngeal ganglia. There are no commissures in v. The last pair of hearts is in xiii.



TEXT-FIG. 25.—*Eutyphoeus sejunctus*. Penial seta, $\times ca.$ 35.

The testicular chamber or testis sac is median, underneath the oesophagus. The seminal vesicles are large, extending from 10/11 to 12/13 but pushing 12/13 and 13/14 back into contact with 14/15. The coiled tubular prostates extend through segments xvii-xix. The duct is short.

The ovaries and oviduct funnels are in the usual locations. The spermathecal ampullae are flattened out underneath the gizzard. The duct is short and fairly stout, a knob-like diverticulum on each side just beneath the ampulla.

There are dome-shaped masses of glandular tissue in the ventral parietes over the genital markings.

Remarks.—The length of other specimens varies from 64-146 mm., and the diameter from 3-4 mm. The first dorsal pore is in 11/12 in all specimens. Posteriorly the setal intervals vary from worm to worm as the following shows:— $ab : cd : bc : aa :: 1 : 1\frac{1}{4} : 1\frac{1}{2} : 1$; or $\frac{1}{2} : \frac{3}{4} : \frac{3}{4} : \frac{3}{4}$; or $\frac{3}{4} : 1\frac{1}{4} : 1 : 1$; or $\frac{2}{3} : 1\frac{1}{4} : 1 : \frac{7}{8}$; or $\frac{1}{2} : 1 : 1 : 1$. The relations of the two dorsal intervals on the same worms are as follows:— $dd : cd :: 1 : 1\frac{1}{4}$; or $1\frac{1}{2} : \frac{3}{4}$; or $1\frac{1}{2} : 1\frac{1}{4}$; or $1\frac{1}{2} : 1\frac{1}{4}$; or $2\frac{1}{2} : 1$. In all specimens seta *d* is distinctly dorsal in position. The posterior-most setae are ornamented with sparse ridges of few teeth.

The spermathecal pores are usually in line with *b*.

The pre-clitellar genital markings are exactly the same in all of the specimens. The whitish mid-ventral line is visible in all specimens, in some so conspicuously as to suggest the presence of a distinct groove, but no groove is visible in sections through the parietes. The vestibulum is small and nearly filled by the penial tube. The latter is distinctly conical and has at its tip an antero-posterior, narrow slit.

The intestinal caeca are in xxvi but arise from the intestine in xxvii. All specimens of this species examined also have unpaired ventro-median caeca projecting anteriorly from the floor of the intestine, about $\frac{1}{2}$ - $\frac{3}{4}$ mm. long, diminishing in size towards the anterior end. The number of these varies from 6-8 and they are located one in a segment in xxxiv-xl. These caeca are small and are confined to the segment in which they originate. A small pore in the floor of the intestine communicates with the lumen of the caeca. The larger caeca contain fine particles of dirt. There were numerous white granular particles in the lateral caeca of one specimen. These granules effervesced in acetic acid but may possibly have been calcareous granules taken up with the soil.

There are four or six pairs of dorsal glands on the intestine wall in 2 or 3 segments approximately in the middle of the body.

The prostatic duct is 4-5 mm. long. External to the nerve cord and projecting upwards into the coelom is a solid column of tissue. On the external face of this column, enclosed in a very thin sheath of connective tissue, are the penial setae, two functional and one or two reserve setae. The peni-setal sac is pressed against the column by the prostatic duct. This column and the prostatic duct can be traced in the parietes to the conical porophore into which presumably the duct opens. The vas deferens is readily visible throughout its course, is enlarged to a bulbus ejaculatorius which passes into the parietes just behind the column. The penial setae are rather short, spirally coiled, when flattened out by the cover glass on a slide have the form of a shortened U. The ends of all penial setae examined are softened. The ornamentation consists of rows of teeth placed very close together, especially near the tip.

If these specimens were secured at Thandaung, this constitutes the first record of a *Eutyphoeus* from the Shan plateau, the genus having been found hitherto only in that portion of the province to the west of this plateau.

Subfamily *DIPLOCARDIINAE*.

Genus *Dichogaster* Beddard.

This genus has not been hitherto reported from this province. Specimens belonging to one or more species of the genus have been secured from numerous localities and will be reported upon by Dr. Stephenson at some later time.

Family *GLOSSOSCOLECIDAE*.

Subfamily *GLOSSOSCOLECINAE*.

Genus *Pontoscolex* Schmarda.

Pontoscolex corethrurus (Fr. Müll.), 1890.

Paungbyin, July, a number of specimens.

Sagaing, Mandalay, August, a number of specimens from each locality.

Toungoo, Thandaung, September, a number of specimens from each locality.

Maungmagaun, Tavoy, Mindat, Labaw, Wuzinok, Kanyindaung, Myittha, San Hlan, Mergui, Kala Island, Nyaungbinkwin, Taungup, Kyauktaga, Tanyagyi, Patlé, October, a number of specimens from each locality.

This species was, at the time of collection, by far the commonest form in Maungmagaun, Tavoy, Mergui, and Wuzinok.

Cocoons of this worm with living embryos were found at Tanyagyi, Thandaung, Mergui, Myittha and Tavoy, from September to the end of October. Cocoons have been found in Rangoon from December till the end of March. At Thandaung and Tanyagyi large numbers of cocoons were obtained from piles of cow dung. At other places the cocoons have been obtained from rather dryish soil in which there are no worms at all aside from *P. corethrurus*. Worms brought into the laboratory in December have continued to deposit cocoons throughout December and January. The collector who finds these cocoons cannot but be impressed by the dryness of the soil in which they are found, soil that is very much too dry for other species of Burmese worms. Possibly this ability to breed in a season when most other worms are aestivating may partially explain the extensive distribution of a species which is said to be the "most widely distributed earthworm known".

Subfamily *MICROCHAETINAE*.

Genus *Glyphidrilus* Horst.

Glyphidrilus papillatus (Rosa), 1890.

Okma, Monywa, Anidaung, Ingyindaung, Powindaung, Laungbyin, July, a number of specimens from each locality.

Family *LUMBRICIDAE*.

Genus *Bimastus* Moore.

Bimastus parvus (Eisen), 1874.

Kalaw, May, 33 specimens from black soil in low, swampy part of the town near the bazaar.

Length 25-35 mm. Diameter 3 mm. Unpigmented, clitellum yellow. The first dorsal pore is in 5/6. The dorsal setae are more closely paired than the ventral setae. The clitellum is saddle-shaped on xxiv-xxx (7). Very slight ridges (tubercula pubertatis?) extend across xxv-xxix. The male pores are on xv external to *b* and are surrounded by glandular areas. Female pores on xiv just external to *b*.

The species is peregrine and has been found elsewhere in the United States, Mexico, Guatemala, Africa, China, Japan, and India (Kashmir, Peshawar, Punjab, Western Himalayas and South Rajputana). Lumbricid worms have not been previously recorded from the province of

Burma. Kalaw is a hot season resort and many foreign plants are grown around the bungalows. The worm may possibly have been introduced into Burma in the dirt around the roots of such plants. If the species occurs elsewhere in this region where collections have been made, it has been missed out because of its small size.

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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 the earthworms mentioned in the preceding portion of the paper were collected, together with some indication as to location, direction, and (when known) altitude.

The Chindwin Valley.

All of the worms from this region are from localities near to the river. Only at Monywa could collections be made at distances greater than two or three miles from the river banks.

Monywa, about 76 miles from Pakokku, left bank.

Ingyindaung, 15-20 miles from the right bank opposite Monywa.

Powindaung, 15-20 miles from the right bank opposite Monywa.

Anidaung, right bank.

Thindaw, right bank, 152 miles.

Laungbyin, left bank.

Mawkadaw, left bank, 165 miles.

Mingin, right bank, 183 miles.

Chaukma, right bank.

Kalewa, right bank, 228 miles.

Masein, left bank, 246 miles.

Mawlaik, right bank, 269 miles.

Kindat, left bank, 276 miles.

Pantha, left bank, 288 miles.

Paungbyin, left bank.

Namsamkyin, an inland north of Paungbyin.

Homalin, left bank, 442 miles.

Mileage quoted from Irrawaddy Flotilla Co. tables.

Sagaing District.

Sagaing, right bank of the Irrawaddy, below Mandalay.

Pakokku District.

Pakokku, right bank of the Irrawaddy, 105 miles below Mandalay.

Southern Shan States.

Kalaw, 63 miles from Thazi by rail, or 369 miles from Rangoon by rail, altitude 4,300 feet.

Toungoo District.

Toungoo, 166 miles from Rangoon by rail.

Thandaung, about 29 miles by road, east of Toungoo, altitude 4,300 feet.

Sandoway District.

Andrew Bay, port for Sandoway, about 11 miles distant.

Ngapoli, coastal village, about 6½ miles from Andrew Bay or four miles from Sandoway.

Taungup, about 65 miles from Sandoway by boat.

Kyauktaga, 11 miles from Taungup, altitude 800 feet.

Tanyagyi, 20 miles, altitude 1,600 feet.

Patlé, 26 miles, altitude 2,000 feet.
 Tsalu, 30 miles, altitude 2,500 feet.
 Yebawgyi, 41 miles, altitude 3,400 feet.
 Myaya, 48 miles, altitude 4,000 feet.
 Kywegalay, 62 miles, altitude 3,800 feet.

Prome District.

Nyaungyo, 39 miles from Prome, altitude 3,500 feet.
 Sanbôt, 35 miles, altitude 2,500 feet.
 Nyaungchidauk, 24 miles, altitude 1,000 feet.
 Okchitbin, 20 miles, altitude 500 feet.
 Pegyin, on the plains.
 Padaung, right bank of the Irrawaddy near Prome.
 Taungup to Padaung are on the Burma-Arakan telegraph line and road.

Tavoy District.

Myittha, 35 miles, from Tavoy on the Tavoy-Siam road.
 Sinbyudaing, further along on the same road.
 Banks of the Tenasserim river, along same road.
 Maungmagaun, fishing village on the coast about 10 miles west of
 Tavoy.
 San Hlan, on the coast, about 12 miles south of Maungmagaun.
 Mindat, 38 miles from Tavoy, on Tavoy-Mergui road.
 Kanyindaung, 52 miles from Tavoy.

Mergui District.

Labaw, 63 miles from Tavoy on Tavoy-Mergui road.
 Wuzinok, 77 miles, same road.
 Kala Island, opposite Mergui.
 Nyaungbinkwin, on the Thaget creek, about 63 miles from Mergui.

Siam.

Bawti,
 Not Theinko, between Tenasserim and Me Klong rivers.
 Chiengmai, rail head from Bangkok.
 Chiengrai, near Burmese border, on motor road from Chiengmai.

B. EARTHWORMS OF SIAM.

Practically nothing is known about the earthworms of Siam. Only one record can be found in the literature available locally and that is of a peregrine species, *P. peguana*, reported by Rosa from Chantaboon in 1898. The species secured by Mr. Telford :—

Megascolex mauritii
Pheretima anomala (1 specimen only)
 „ *elongata*
 „ *houletii*
 „ *lignicola*
 „ *peguana*
 „ *posthuma*

are, with the single possible exception of *P. anomala*, peregrine. Mr. Telford reports that it was "very difficult to get worms as the season was late" Possibly the drought begins in Siam at about the same time of the year as in Burma. However that may be, the Siamese worms, so far as species are concerned, might have been procured at the same time from almost any plains locality in Burma.

It would be unwise to attach too much importance to these collections but they seem to indicate that in Siam as in Burma endemic species retreat deep into the ground towards the end of the rainy weather, while the peregrine species are able to maintain themselves in restricted spots that remain moist during the dry season.