

# INDIAN EARTHWORMS.

## VII. CONTRIBUTION TO A REVISION OF THE GENUS *EUDICHOGASTER*.

*By G. E. GATES, Judson College, Rangoon, Burma.*

### CONTENTS.

	PAGE.
Introduction .. .. .	151
Terminology .. .. .	153
Acknowledgments .. .. .	154
Systematics .. .. .	154
<i>Barogaster</i> , gen. nov. .. .. .	154
<i>Barogaster barodensis</i> (Stephenson) .. .. .	156
<i>Eudichogaster</i> Michaelsen .. .. .	160
<i>Eudichogaster ashworthi</i> Michaelsen .. .. .	162
<i>Eudichogaster ashworthi</i> ? .. .. .	163
<i>Eudichogaster indicus</i> (Beddard) .. .. .	170
<i>Eudichogaster kinneari</i> Stephenson .. .. .	171
<i>Eudichogaster kinneari</i> ? .. .. .	172
<i>Eudichogaster mullani</i> Stephenson .. .. .	173
<i>Eudichogaster poonensis</i> (Fedarb) .. .. .	176
<i>Eudichogaster</i> sp. .. .. .	177
<i>Lennogaster</i> , gen. nov. .. .. .	183
I. Acanthodriline section .. .. .	184
<i>Lennogaster falcifer</i> (Stephenson) .. .. .	184
<i>Lennogaster trichochaetus</i> (Stephenson) .. .. .	185
<i>Lennogaster yeicus</i> (Stephenson) .. .. .	186
II. Microscoleine section .. .. .	191
<i>Lennogaster barkudensis</i> (Stephenson) .. .. .	191
<i>Lennogaster chittagongensis</i> (Stephenson) .. .. .	192
<i>Lennogaster</i> (?) <i>parvus</i> (Fedarb) .. .. .	198
<i>Lennogaster pusillus</i> (Stephenson) .. .. .	199
<i>Pellogaster</i> , gen. nov. .. .. .	200
<i>Pellogaster bengalensis</i> (Michaelsen) .. .. .	201
Forma <i>orissanus</i> , nov. .. .. .	205
Forma <i>jubbulporensis</i> , nov. .. .. .	206
<i>Rillogaster</i> , gen. nov. .. .. .	207
<i>Rillogaster matheranensis</i> (Stephenson) .. .. .	208
Notes on the Excretory organs, Gizzard and Phylogenetic Relationships of <i>Ramiella</i> .. .. .	212
Notes on the Nephridia of <i>Eutyphoeus</i> and <i>Octochaetoides</i> .. .. .	213
Notes on an Indian species of <i>Diplocardia</i> .. .. .	213
<i>Diplocardia</i> (?) <i>indica</i> Stephenson .. .. .	214
References .. .. .	217

### INTRODUCTION.

*Eudichogaster*, according to Michaelsen (1921) and Stephenson (1923 and 1930), is the direct ancestor of *Eutyphoeus*. In a previous paper in this series (Gates 1938) certain objections have been advanced against the derivation just mentioned, but the discussion of the phyletic relationships was handicapped by the inadequacy of our knowledge of important

systems and organs in the supposedly parental genus. In another paper in this same series (Gates 1937) it was shown that structures testifying for a close relationship to *Eutyphoeus* had been overlooked in a species previously assigned to the Megascolecine genus *Megascolides*. Similar structures indicating a somewhat similar relationship to *Eutyphoeus* might also have been overlooked in *Eudichogaster*. To discover if this was actually the case, a specimen was examined and well developed supra-intestinal glands, hitherto known in the Octochaetinae only from *Eutyphoeus* were found. These glands indicate a closer relationship of *Eudichogaster* to *Eutyphoeus* than had been thought possible in 1938 but the structure of the glands and certain other peculiarities were such as to suggest further objections to a direct ancestral relationship. Information obtained from examination of the single specimen indicated that a more extended investigation of the genus might provide at least some of the evidence necessary for a revision of the Indian Megascolecidae and accordingly arrangements were made for the study of further material.

As a result it became evident that *Eudichogaster* was a complex of at least five, possibly six or even seven groups of species, each with characteristic structural peculiarities of such importance as to require some taxonomic recognition. Subgeneric status for these groups, at least within one and the same genus, is probably impossible. Hence, in absence of any present possibility of inclusion in other Octochaetine genera, the groups must be given generic status.

Expression of the differences between these groups in generic definitions results in a considerable widening of generic concept, not in greater inclusiveness so far as number of species is concerned but by way of recognition of the fact that earthworms are something more than oligochaetes with perichaetine or lumbricine setae, meganephric or micro-nephric excretory organs, tubular or racemose prostates, acanthodriline, microscolecine, balantine or megascolecine male organs.

Once again, as in previous attempts to present satisfactory revisions of certain Indian genera, the work has been seriously handicapped by insufficient material, its poor state of preservation and the juvenile condition of many of the specimens. Of the 16 species hitherto recognized, types of four (including the genotype) have been lost. Topotypes are unobtainable while types of one other species are inaccessible. Ten species are known only from types, type-series, or material on hand at the time the species was first described. (With the exception of two Burmese species no new material appears to have been collected since 1924.) Of the material which has been studied types or supposed types of three species are juvenile, seven species having been erected on acelitellate or juvenile specimens. In addition to the lost or unobtainable types of five species, types (or other material) of four further species have not been examined though available, either because the material is not sexual or is poorly preserved or of such importance as to forbid drastic dissection. However each of these four species can be identified generically with some degree of certainty although the generic relationships of one of the doubtful species (no material of which is available) remain doubtful. In *Eudichogaster* itself

(as now delimited) not one single species can be adequately defined. Fortunately, however, many characteristics of generic importance are recognizable even in quite young juveniles so that a more satisfactory generic definition is possible. One species in each of the four or five other main groups has been studied in clitellate material but with limitations due to condition of specimens, paucity of material or restriction on dissection. Here perhaps fairly satisfactory (though still incomplete) generic diagnoses have been obtained but there still remains to be determined the extent of intra-specific variation in characteristics that now appear to be of diagnostic value. In view of all these circumstances the revision presented herewith can only be considered as a tentative contribution towards a more adequate treatment of the groups involved.

A brief statement as to some of the corrections now made and yet to be made will serve to indicate the necessity for greater care in examination, dissection and description in the future: spermathecal pores correctly located for the first time in several species (in other species still to be correctly or accurately located), genital markings hitherto overlooked—perhaps as a result of failure to remove the cuticle—now recorded from several species, segment of intestinal origin corrected in one species (still to be corrected in others?), penial setae described from two supposedly apenisetal species, spermathecal diverticula recognized in two species in which they were supposed to be lacking, boundary between the spermathecal duct and ampulla determined for the first time in several species, recognition of “hearts” in xiii as anterior portions of lateroparietal trunks (similar mistakes have been made as to presence of “hearts” in xiii or xiv in other genera), and recognition of paired structures in x as testis sacs—not conjoined seminal vesicles and testis sacs.

#### TERMINOLOGY.

A few words of explanation are necessary with regard to certain terms, some of which are used for the first time.

A heart connecting ventral and dorsal blood vessels was termed lateral by Perrier many years ago while a heart connecting the ventral and supra-intestinal trunks was designated intestinal. Bourne followed Perrier's usage but added to the list “latero-intestinal” for a heart which opens beneath into the ventral trunk and above into supra-intestinal and dorsal trunks. These terms are less cumbersome than those used by Stephenson, but are inaccurate in part since the vessels concerned are not in an intestinal region at all but anterior to it and associated with the oesophagus. With the substitution of oesophageal for intestinal the Perrier-Bourne usage will be followed in this paper. Thus hearts are lateral, oesophageal, or latero-oesophageal according as to whether they open above into the dorsal or supra-oesophageal trunks alone, or into both.

Supra-oesophageal for the reason just mentioned is substituted for supra-intestinal. Extra-oesophageal is used for any ventrolateral trunk in the oesophageal region more or less intimately associated with the gut, especially in the region of x-xiii, regardless of presence or absence

of a subneural with which it may be associated. A longitudinal vessel on the parietes on each side, lateral and parallel to the nerve cord, in the region of xii-xviii, and with an anterior portion passing onto the gut is termed a lateroparietal trunk. This trunk usually cannot be traced behind the prostatic (or last prostatic) segment. In favourable specimens a vessel that may be a posterior continuation of the lateroparietal is recognizable throughout a longer or shorter portion of the region behind the prostates.

Micronephric or micronephridial and meganephric or meganephridial are no longer useful descriptive terms. Micronephridia may be large as in *Ramiella bishambari* (Stephenson 1914), while meganephridia may be smaller than the so-called micronephridia of the same worm. Meganephridium is however still used by some oligochaetologists but without reference to size and is understood to refer to a nephridium opening externally by an integumentary pore and provided internally with a preseptal funnel. The term is used by Bahl for enteronephric excretory tubules (*i.e.*, opening into gut lumen rather than through an integumentary aperture) that are much smaller than "true meganephridia" (as for instance in *Lumbricus*, *Perionyx* and *Drawida*) though of course slightly larger than the "true micronephridia" in the same segments. In the interests of accuracy and to avoid further confusion use of terms micronephridia and meganephridia should be qualified so as to indicate whether they are open or closed (*i.e.*, with or without a funnel), exonephric or enteronephric (opening directly to the exterior or indirectly through the gut), and integumentary (parietal) or séptal. Mention of the location of funnels is important especially in worms in which funnels are not preseptal. Unfortunately preservation often will be such that important characteristics of excretory tubules cannot be determined with certainty.

The phrase "setal circle" provides a useful line of reference in locating external structures such as spermathecal pores or genital markings in perichaetine species. A similarly concise phrase is needed for similar purposes in lumbricine species and "setal arc" is suggested. This is defined as the ventral segment of an imaginary equatorial circle passing across the apertures of all eight setal follicles of a metamere.

#### ACKNOWLEDGMENTS.

The authors thanks are once more extended to Dr. B. Prashad, Director, Zoological Survey of India, for the loan of the material on which most of this contribution is based, to L. W. Trueblood for assistance with matters geographical, and to the University of Rangoon for a generous grant from its research funds.

#### SYSTEMATICS.

##### **Barogaster**, gen. nov.

*Diagnosis*.—Biprostatic; male deferent and prostatic ducts as well as penisetal follicles opening to exterior by one pair of apertures on xviii. Bithecal; spermathecal pores on or near 7/8. Female pore median. Reproductive apertures minute and superficial. Setae lumbricine;

ventral setae of xviii penial, in paired follicles on each side. Clitellum annular; on development of clitellar glandularity intersegmental furrows disappear and dorsal pores are occluded but setae are retained. Unpigmented (?). Septa present from 5/6; 5/6-11/12 muscular. Gizzards in v-vi. Calciferous glands paired in xi-xii, opening directly into gut lumen dorsolaterally by upper poles or very short stalks and pendent below level of ventral face of oesophagus. Intestine begins in xv. Typhlosole begins in xxiv-xxv and terminates with the "grid"; folded, anteriorly at least, in a regularly zigzag fashion with ventral margins of folds united alternately as in *Eutyphoeus*. A longitudinally placed, grid-like thickening of the roof of gut at posterior end of typhlosole. Hearts latero-oesophageal, in x-xii. Extra-oesophageal trunks pass into calciferous glands of xii after giving off branches to anterior glands. Lateroparietal trunks pass in xiii to dorsal face of gut.<sup>1</sup> Excretory organs: closed (?), exonephric (?), parietal micronephridia, closely crowded into wide, paired, vertically placed bands in iii, in transverse rows of 12-16 on each side anteriorly, in about seven longitudinal ranks on each side posteriorly; in the last 40 segments the median nephridium on each side enlarged and with preseptal funnel. Prostates tubular.

*Genotype.*—*Eudichogaster barodensis* Stephenson 1914.

*Distribution.*—Known only from the type locality of the type species, Baroda, Western India north of Bombay.

*Remarks.*—In the definitions of the Megascolecoid subfamilies Megascolecinae and Octochaetinae in Stephenson's monograph (1930, pp. 828 and 841) only one pair of characteristics actually serves to distinguish the two families from each other, and that pair of characteristics is one which has been denied even generic or subgeneric value in each of the subfamilies under discussion. "Male pores on xviii. each prostatic duct uniting with the vas deferens of the same side and opening in common with it" (Megascolēcinae). "Sexual apparatus from pure acanthodriline to pure microscolecine", or in other words, prostatic duct *not* united with vas deferens of same side to open to the exterior by a common aperture on xviii (Octochaetinae). By definition then *Barogaster* must be Megascolecine (or Megascolecinae, Michaelsen 1921) though its affinities presumably are with certain genera of the Octochaetinae. The same problem is presented even more clearly by *Scolioscolides* as the latter is distinguished from the Octochaetine *Eutyphoeus*, aside from the junction of deferent and prostatic ducts and the segmental location of the male pores, only by relatively unimportant characteristics. Further difficulties of a similar sort in distinguishing between the Octochaetinae and Megascolecinae (as now defined) exist and although this is not recognized in definitions of the subfamilies, must have been in mind, to some extent at least, in the construction of Stephenson's key to the Megascolecoid subfamilies in 1923 (p. 163). In this key the two subfamilies are distinguished as follows: "Vasa deferentia opening into the prostates" . "Vasa deferentia opening separately from the prostates, at most close besides them, or into the

<sup>1</sup> In accordance with previous practice, omission of reference to the subneural trunk indicates that such a vessel is lacking in the genus. A supra-oesophageal trunk apparently is also lacking but this requires confirmation.

prostatic duct at its termination" This does not solve the problem (of discriminating between the Megascolecinae and Octochaetinae) and even renders the solution more difficult, for according to this criterion the Megascolecine *Diplostrema*, as well as certain Indian species of *Plutellus* also Megascolecine, would be Octochaetine.

*Barogaster* thus serves to emphasize once again not only the necessity for radical revision in the classification of the Megascolecidae but also of the fundamental concept on which classification in that family has been based. (*Vide* Gates 1937, p. 306 and 1938, pp. 46, 47.)

Direct derivation of *Barogaster* from any other portion of the old *Eudichogaster* complex is improbable and impossible unless ventral chaetae of xvii and xix once modified to penial setae can revert to a normal sigmoid condition and ventral setae of xviii once lost (or reduced in size ?) can be restored and then converted to penial chaetae.

### **Barogaster barodensis** (Stephenson).

1914. *Eudichogaster barodensis*, Stephenson, *Rec. Ind. Mus.* X, p. 358. (Type locality, Baroda. Types in the Indian Museum.)

1923. *Eudichogaster barodensis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 409.

*Material examined*.—From the Indian Museum: 9 clitellate and 3 partially clitellate specimens (3 dissected) labelled, "*Eudichogaster barodensis* Stephenson. Types. Baroda. 2. viii. 1912. B. Das. W 27/1".

*External characteristics*.—Setae begin on ii, ventral setae of xvii and xix sigmoid, ornamented (as are those of xx) near tip by short, transverse rows of fine spines. First dorsal pore on 12/13 (5). Clitellum reddish or reddish brown, annular, extending from 12/13 (4) or from a posterior portion of xii (1) to 17/18 or slightly onto xviii; intersegmental furrows and dorsal pores lacking, setae present.

Spermathecal pores are minute and superficial, on or immediately lateral to *b*. On one clitellate specimen each pore is on a shortly spindle shaped, transversely placed area of slight epidermal thickening, the centre of the area about on *b*, the median margin of the area lateral to *a*. Intersegmental furrow 7/8 is lacking on these areas but is present midventrally between them, the areas symmetrically placed with relation to the furrow. On other worms 7/8 is lacking midventrally and both spermathecal pores are located on a single, transversely placed area of elliptical outline, lateral margins slightly indented by 7/8, the pores in line with, anterior or posterior to the indentation.

There is a single female pore (8).

On xviii, approximately at the site of seta *b* is a single minute aperture which represents the combined openings of penisetal follicles and prostatic duct.

Genital markings are tiny, circular to shortly elliptical and transversely placed areas of greyish translucence located on raised regions of slight but definite epidermal thickening. On an anterior portion of the unpaired area that bears the spermathecal pores there is usually a transverse row of 5-11 markings (noted on nine specimens). On

the posterior part of the same area, an anterior portion of viii, or on the setal annulus of viii, there is another row of two or more markings (eight on one specimen). Posterior areas of epidermal thickening are postsetal (the segmental restriction quite obvious on partially clitellate as well as some clitellate specimens), lateral portions pointed, not quite reaching to *b*, on xvi-xviii (3), xvii-xviii (6), xvii-xix (3). Markings on these areas are in transverse rows, the number per row varying from three to eight. In addition there is on xviii at the approximate site of seta *a* and at the centre of a circular area of epidermal thickening, a further marking. The area bearing this marking may be fairly sharply marked off peripherally or may be continuous laterally with a slight, rather conical tumescence that bears the male pore.

*Internal anatomy.*—Septa 5/6-10/11 are thickly muscular, 11/12 muscular, 12/13 strengthened but translucent.

Gizzards are in v and vi (4), just in front of 5/6 and 6/7, the portion of the gut between the two gizzards not especially short. Calciferous glands, paired in xi and xii (4), are shortly ovoidal, attached to the gut dorsolaterally by pointed upper pole or with a dorsal portion narrowed to a very short stalk, bound by connective tissue to the gut on which the glands may at first appear to be sessile but actually clearly constricted off and hanging down below the level of the ventral face of the oesophagus. Lamellae are vertical, the lumen small. The inner wall of the oesophagus in xi and xii is provided with low, longitudinally placed ridges, the circular apertures of the glands opening directly into gut lumen and not partitioned off as in certain species old of the *Eudichogaster* complex. The intestine begins in xv (4), the valve anteriorly in xv and posteriorly in xiv. The typhlosole is a lamelliform ridge about  $\frac{3}{4}$  mm. high, in part folded regularly in a zigzag fashion with margins of folds united as in *Eutyphoeus*, beginning in xxiv-xxv (4) and terminating with the "grid" The roof of the gut in lxx-lxxxi (1), lxxviii-lxxxvii (1), or lxxix-lxxxix (1) is modified into an area of longitudinally rectangular outline with a grid-like or honeycomb appearance, about 1 mm. thick. In one worm the somewhat irregular longitudinally ridges are much more noticeable than the transverse connections between those ridges. A median ridge, slightly higher than the others, might be regarded as a continuation of the typhlosole. On the coelomic face of the gut little evidence as to the presence of the grid is visible except for an increased size of the dorso-intestinal vessels but the region can be recognized by a toughness lacking in other portions of the intestinal wall.

The dorsal blood vessel (single) and the ventral vessel are continued anteriorly into the region of the cerebral ganglia. A definite supra-oesophageal vessel is lacking or unrecognizable in all specimens examined. Extra-oesophageal trunks are first visible just behind the subpharyngeal ganglia as small vessels parallel to the ventral trunk, on or in the subpharyngeal mesentery. Just anterior to  $\frac{3}{4}$  each trunk receives a larger vessel that can be traced dorsally and anteriorly on the parietes. In iv the trunks pass upwards and from v posteriorly are free in the coelomic cavity. Each trunk gives off a large branch in xi which passes into the median face of the anterior calciferous gland and then in xii

passes into the posterior calciferous gland, a transverse commissure between the two trunks close to 11/12. A lateroparietal trunk is present on the body wall lateral to the prostatic duct on each side, just anterior to 13/14 rising abruptly to pass onto the dorsal face of the gut, then turning anteriorly. After giving off several rather thick but short branches to the gut wall, the vessel disappears from sight just behind 12/13, or turns mesially (2) to unite with the other trunks. (The vertical portion of this trunk was mistaken for a heart by Stephenson.) In l-xc, in bc on the ventral parietes of each side, a fairly large, blood-filled, longitudinal vessel may be readily visible. Possibly this is a posterior continuation of the lateroparietal trunk. No subneural. The last pair of hearts is in xii (4). Hearts of x-xii bifurcate dorsally, one branch of each heart passing into the dorsal trunk. The other bifurcation of the hearts of xi and xii divides into two branches, one of which shortly disappears from sight on the dorsal face of the oesophagus while the remaining branch passes into the dorsal face of the calciferous gland. The oesophageal branch of the hearts of x passes mesially and apparently unites with the similar vessel from the other side to form a short supra-oesophageal vessel that is continued anteriorly to 9/10, but the vessels are colourless in all of the dissected specimens and relationships are not certain. The hearts of ix have been traced to the dorsal trunk only.

Nephridia are in transverse rows. In a middle region of the body there are seven on each side. Anteriorly the number is larger, 12 on each side in xiv, 16 on each side in vi-ix, in xv-xvii (possibly more than 16), the tubules more closely crowded mesially. In the last 40 segments the medianmost nephridium of each side is enlarged and often, perhaps always, with a preseptal funnel close to the ventral parietes median to a. In iii on each side there is a vertically placed band of closely crowded nephridial tubules similar to that of *Eutyphoeus*.

A horseshoe-shaped to annular mass of testicular coagulum fills the coelomic cavities of x and xi, male funnels iridescent. Seminal vesicles are anteroposteriorly flattened, vertically placed bodies on the anterior face of 9/10 and the posterior face of 11/12, the vesicles of a pair in contact above the dorsal blood vessel. A pair of rudimentary or small vesicles is present on the anterior face of 10/11 (4), ovoidal—with or without a stalk, or more irregular. The prostates are in xviii-xix. The prostatic duct is  $1\frac{1}{2}$ -2 mm. long and with a muscular sheen. Deferent ducts have not been traced throughout but are clearly visible in xviii where they pass into the anterior face of the prostatic duct just at or within the parietes, the two deferent ducts of a side passing separately into the prostatic duct one just above the other. Just median to each prostatic duct are two penisetal follicles, one passing into the parietes on the median face of the prostatic duct and separated from the median follicle by a distinct strand of longitudinal musculature. Within the parietes the lateral follicle at least passes into the prostatic duct. Penial setae are almost straight or very slightly curved. The tips usually appear to be softened or damaged. Ornamentation is recognizable with difficulty under high power and comprises 6-11 transverse rows or circles of fine spines.



*Measurements of the Penial setae (in millimetres).*

Length.	Greatest thickness.	Tip.
0.57	0.014	Bluntly rounded.
0.59	0.016	Bluntly rounded, the ectalmost portion of the shaft, 28 micra long, is noticeably narrower.
0.56	0.012	Bluntly rounded.
0.54	0.012	Bluntly rounded. Slightly bent.
0.50	0.011	With short, sharp terminal spine.
0.59	0.012	Eroded.
0.50	0.012	Bluntly rounded.
0.43	0.012	With spoon-shaped concavity (abnormality?).
0.10	0.013	Bluntly rounded <sup>1</sup> .

<sup>1</sup> Reserve seta.

Egg strings may be 3 mm. long.

The spermathecal ampulla is sharply marked off from the duct, the latter  $1\frac{1}{2}$  + mm. long, slender, with muscular sheen, slightly and gradually narrowed ectally, slightly curled, twisted or bent close to the parieties, circular in cross section. In at least a portion of the duct the lumen is crescentic in transverse section due to the presence of a fairly high, smooth and glistening longitudinal ridge which bears a single, deep longitudinal groove. On the median face of the duct entally is more or less cauliflower-like mass with spermatozoal iridescence in numerous small spots. This diverticulum usually appears to be sessile on and adherent to the duct but in a partially clitellate specimen the diverticulum is pendent and attached only to the entalmost portion of the duct. In spermathecae from clitellate specimens the single aperture into the diverticulum is close to the ampulla.

The longitudinal musculature is uninterrupted above the genital markings.

*Remarks.*—The medianmost nephridium of each side in the posterior 40 segments is a “meganephridium” having a preseptal funnel and opening to the exterior. It is however not large as in *Perionyx* or the Moniligastridae but quite small, only slightly larger than the micronephridia of the same segments though of about the same size as the two or three lateralmost micronephridia of segments shortly behind the clitellar region. In these circumstances “meganephridium” is quite inaccurate unless the term is defined as “open, exonephric with pre-septal funnel”

*Diagnosis.*—Male apertures on *b*, each on the tip of a very slight conical protrusion just lateral to or on the lateral portion of a transversely placed area of epidermal thickening that reaches slightly median to *a*. Spermathecal pores on or just lateral to *b*, almost in line with 7/8

within a transversely placed area of epidermal thickening on which the intersegmental furrow is lacking. Genital markings tiny areas of greyish translucence located in transverse rows of 2-11 on regions of epidermal thickening in *bb*, presetal on viii (or on setal annulus), postsetal on vii, xvi-xix. Clitellum from a postsetal portion of xii or 12/13 to 17/18 or a presetal portion of xviii. Setae;  $ab=cd < bc < aa, dd > \frac{1}{2}C$ . First dorsal pore on 12/13. Length 74-100 mm. Diameter 3-4 mm.

Supra-intestinal grid in lxx-lxxix : : lxxxi-lxxxix. Holandric; seminal vesicles in ix and xii, rudimentary in x. Penial setae 0.43-0.59 mm. long, maximum thickness 0.011-0.016 mm., shaft nearly straight, ornamented with 6-11 circles of fine spines. Spermathecal duct shorter than ampulla, lumen crescentic in transverse section; diverticulum an acinous mass of seminal chambers sessile on ental part of duct. Longitudinal musculature uninterrupted over sites of genital markings.

*Distribution.*—Known only from the type locality, Baroda (Elevation below 500 feet).

### **Eudichogaster** Michaelsen.

1903. *Eudichogaster* (part), Michaelsen, *Mitt. Mus. Hamburg* XIX, p. 13. (Genotype *Benhamia indica* Beddard 1896.) Excluding all species without supra-intestinal glands.
1910. *Eudichogaster* (part), Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), p. 92.
1921. *Eudichogaster* (part), Michaelsen, *Mitt. Mus. Hamburg* XXXVIII, p. 37.
1921. *Eudichogaster* (part), Stephenson, *Proc. Zool. Soc. London*, 1921 p. 103.
1923. *Eudichogaster* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*; p. 402.
1930. *Eudichogaster* (part), Stephenson, *Oligochaeta*, p. 846. (Excluding here as in each of the citations above, all forms without supra-intestinal glands.)

*Diagnosis.*—Quadriprostatic; prostatic pores on xvii and xix. Male pores on xviii. Quadrithecal; spermathecal pores on viii and ix. Female pore median. Reproductive apertures minute; spermathecal pores superficial, male and prostatic pores in seminal grooves. Setae lumbricine; ventral setae of xvii-xix lacking, on certain anterior segments modified, the modifications more pronounced on viii or viii and ix. Clitellum annular (inter-segmental furrows? dorsal pores? setae?). Unpigmented. Septa present from 4/5; 5/6-7/8 (at least) muscular. Gizzards in v-vi. Calciferous glands paired in xi-xii, ovoidal to retort-shaped, vertically placed, opening through dorsal poles or very short stalks from those poles into a slight lateral depression in the wall of the gut on each side in region of 11/12. Intestine begins in xv. Typhlosole begins in xv (?) and terminates with supra-intestinal glands; folded, in part, in a regularly zigzag fashion with ventral margins of folds united alternately as in *Eutyphoeus*. Supra-intestinal glands separated by segmental transverse clefts passing to dorsal face of gut, slightly incised by septa, the preseptal portion larger. Hearts latero-oesophageal, in x-xii. Extra-oesophageal trunks pass into floor of gut in x? Supra-oesophageal trunk in ix-xii. Lateroparietal trunks pass in xiii into the supra-oesophageal trunk? Excretory organs; closed (?), exonephric (?), parietal micronephridia, closely crowded into paired, vertically placed bands in iii (in transverse rows [of ?] on each side anteriorly?), in 6-10 longitudinal ranks on each side posteriorly;

the median nephridium on each side in the posteriormost segments with a preseptal funnel. Holandric (?), seminal vesicles in xii at least. Prostates tubular. Spermathecal diverticulum opens into duct entally.

*Distribution.*—Western India from Poona north just into Rajputana, Central India and Central Provinces east to Nagpur and Jubbulpore. Elevations at which worms of this genus were secured are usually unknown.

With two exceptions (*prashadi* from Surat and *mullani* from Bombay) all *Eudichogaster* localities are at elevations of 1,000 to 2,500 feet. Possibly the Surat and Bombay worms were secured from nearby hills. The soil of the northern portion of the Deccan where the genus has been most frequently found is said to be black to dark brown and formed by the weathering of volcanic lavas in a fairly dry climate.

*Remarks.*—The genotype (designation by Michaelsen in 1902) is *Benhamia indica* Beddard 1896. The original account of this species is very unsatisfactory, with many failures to mention important characteristics of taxonomic significance, and was never supplemented or amended. The whole of the type series is lost. Efforts to secure topotypes have been futile. Michaelsen's generic name has been retained for species with supra-intestinal glands as these species alone of the old *Eudichogaster* complex are characterized by an association of two pairs of calciferous glands located in xi-xii with the acanthodriline condition of the male sex organs and absence of ventral setae on xvii-xix, a combination of characteristics also found in *indica*.

Although a fair amount of material of this genus has been studied very little of it has been sexual. Michaelsen had one doubtfully clitellate specimen and Stephenson had several clitellate individuals but it is questionable if any of Beddard's or Fedarb's worms were clitellate. A loan of Michaelsen's material could not be arranged and Stephenson's clitellate specimens have been lost as well as those worms studied by Beddard and Fedarb. All of the material available for the author in the present investigation is certainly aclitellate and probably, in large part if not entirely, juvenile; repeated efforts to secure sexual worms having been wholly unsuccessful.

Previous accounts of species of this genus are inadequate for present purposes and are under suspicion of inaccuracy in connection with important characteristics. Even if complete and accurate accounts of the very few clitellate worms hitherto collected were available there still would be need for information as to constancy of certain characteristics that may be useful in specific definition.

In these circumstances and especially in view of the lack of sexually mature specimens any attempt at specific definition is likely to be of little value. Nevertheless, on a portion of the material even though juvenile, differences in structures or characteristics that may be of taxonomic importance have been observed. Employing these few small and perhaps trivial differences as criteria of specific distinctness, an attempt has been made to arrange the material, so far as age will permit, into groups of specific rank<sup>1</sup>. Unfortunately it is impossible

<sup>1</sup> The following may be useful in defining species: location of spermathecal pores, seminal grooves, genital markings, modifications of ventral setae,—especially on viii-ix, location of supra-intestinal glands, seminal vesicles.

at present, with any certainty, to indicate which of the several available specific names any of these groups should bear.

There is some reason to suspect that modifications of the ventral setae on an anterior region of the body and/or specially on the spermathecal segments may provide useful criteria for specific definition. The taxonomic value of these modifications can only be determined from adult material, since we are ignorant as to changes that may take place during growth. Accordingly only a few rather casual observations on the ventral setae have been recorded, and no mention of these setae is made in the diagnoses.

Although none of the species can be adequately defined generic characteristics, with a few exceptions, are fairly obvious. In Rangoon, during the monsoon season, recognition of finer details of structure in dissections is impossible without brilliant artificial illumination. During the period in which the work on *Eudichogaster* was carried on, the B. & L. lamp usually employed was out of commission and a Monla lamp which gives an inferior illumination had to be substituted. It is possible therefore that failure to discover certain characteristics (as for instance in connection with the extra-oesophageal and lateroparietal trunks) is not to be blamed wholly on the condition of the spemens studied.

### ***Eudichogaster ashworthi* Michaelsen.**

1903. *Eudichogaster Ashworthi*, Michaelsen, *Mitt. Mus. Hamburg* XIX, p. 14. (Type locality Nagpur, Central Provinces. Types in the Hamburg Museum.)  
 1903. *Eudichogaster Ashworthi*, Michaelsen, *Geogr. Verbr. Berlin*, p. 109.  
 1909. *Eudichogaster ashworthi*, Michaelsen, *Mem. Ind. Mus.* I, p. 112.  
 1910. *Eudichogaster Ashworthi*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), p. 13.  
 1923. *Eudichogaster ashworthi* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 405. (Excluding all except *ashworthi* Michaelsen 1902 and 1910.)

*Diagnosis.*—"Prostata-Poren. .auf winzigen Papillen in. .*b*. durch stark geschweifte, E-förmige Samenrinnen verbunden; die Konvexität der Samenrinnen-Schweifung ist lateral hingekehrt" Spermathecal pores in *ab*, presetal<sup>1</sup>. Genital markings "konstant grosse, rundliche, stark erhabene Pubertätspapillen. .2 Paar am 16. und 20. Segment oberhalb der Borstenlinien *b*; dazu kommen meist noch 2 Paar weniger deutliche, flachere, .am 17. und 19. Segment dicht medial von den Papillen der Prostata-Poren. .ein Paar hinten am 9. Segment oberhalb der Borstenlinien *b* oder eine unpaarige ventral-median hinten am 8. Segment." Clitellum  $\frac{1}{2}$  xiii-xvi. First dorsal pore on 12/13. Prostomium prolobous. Length 190 mm. Diameter 7 mm.

Intestine begins in xiv (?). Supra-intestinal glands? Anterior male funnel smaller than posterior. Seminal vesicles in ix and xii. Spermathecal duct narrow, very short; diverticulum multichambered, opening by a short stalk into ectal (?)<sup>2</sup> end of duct.

<sup>1</sup> Location originally given as on 7/8-8/9 (on *b* ?), but corrected in 1910 (p. 93). Pores are now said to be on presetal porophores in *ab* formerly regarded as genital markings, but exact location is still unknown, *i.e.*, whether on setal or presetal annuli and whether similarly placed on both viii and ix.

<sup>2</sup> Stephenson (1920, p. 246) points out that Michaelsen means ectal by the term distal and suggests that use of distal here is a "slip" for proximal or preferably ental

*Distribution.*—Nagpur, Central Provinces.

*Remarks.*—Of the eight specimens studied by Michaelsen one was said to be clitellate but it should be noted that the clitellar glandularity is more weakly developed ventrally and that setae and intersegmental furrows remained visible on the ventrum. Quite possibly then Michaelsen's clitellate worm was not mature. (Other possible alternatives: the worm was in a postsexual stage of clitellar regression, or the clitellum in this species, is less well developed ventrally.)

The original account of the species is inadequate for present purposes, and erroneous in part. One mistake was corrected later (Michaelsen 1910, p. 93), another possible mistake was pointed out by Stephenson (1920, p. 246) and there may be still others (seminal vesicles?). If Michaelsen failed to remove the cuticle, recognition of certain genital markings may have been impossible, as for instance an apparently important transverse row of postsetal markings on xvi in *bb*.

The "stark geschweifte, E-förmige" seminal grooves may be like the wide depressions described hereinafter which are not certainly known to be seminal grooves.

Michaelsen's worms apparently are distinguished from other specimens of the same batch to be discussed below by the absence of a postsetal transverse row of genital markings on xvi in *bb* and of the seminal vesicles in *x*, and by the constant presence of genital markings on xvi and xx lateral to *b* as well as the ectal attachment to the duct of the spermathecal diverticulum.

If the original batch of material, from which the Indian and Hamburg Museum series were obtained, comprised two distinct species, it is surprising that the two forms were so completely separated as now seems to be possible.

The "meganephridia" originally overlooked were later mentioned (Michaelsen 1910) when it was suggested that funnels might also be present on the lateral tubules.

The segment of intestinal origin requires confirmation or correction.

### ***Eudichogaster ashworthi* ?**

1920. *Eudichogaster ashworthi* (part), Stephenson, *Mem. Ind. Mus.* VII, p. 246. (Excluding all except Nagpur specimens.)

1923. *Eudichogaster ashworthi* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 405. (Excluding all except Nagpur worms.)

*Material examined.*—From the Indian Museum: 1 dissected and 3 undissected juveniles labelled "*Eudichogaster ashworthi* Michaelsen. Nagpur, C. P. Dr. J. H. Ashworth. ZEV 4943/7 and W 340/1".

*External characteristics.*—Length 160-210 mm., diameter  $4\frac{1}{2}$ -5 mm., all specimens relaxed. Unpigmented (pigment bleached out by alcohol?).

Setae begin on ii. On xx,  $ab < cd < bc < aa$ . Ventral setae (*a* and *b*) are invisible on xvii-xix, and could not be found in a dissected specimen even after separation of fibres of the longitudinal musculature. From viii to xxxiv at least, the ventral setae are ornamented with short transversely placed ridges or rows of very fine, thorn-like teeth. Ectal to each of these rows there is a light spot with an appearance of a slight depression as if a bit of the shaft had been gouged out in such a way

as to leave a jagged ental margin. At margins of the shaft a slight incision may be visible just in front of each row of teeth. Ornamentation on "copulatory" setae of viii and ix is more easily recognizable, the gouges deeper and more obvious, especially at the margins. Length



TEXT-FIG. 1.—*Eudichogaster ashworthi*? Seta *a* of segment xi;  $\times$  ca. 410.

is shown in table below. Both *a* and *b* setae of xiii and xiv are thickened, more so than those of viii and ix. The tips are bluntly rounded. Ental ends or tips may be softened or cracked, occasionally a tip is lacking, more rarely the shaft terminates ectally in a brush-like bundle of fibres.

*Ventral Setae.*

Segment.	Seta.	Length in mm.	Ornamentation.	Remarks.
viii	a	0.45	9 (e)	
	a	0.40	..	Reserve.
	a	0.42	9 (e)	Right side.
	a	0.34	..	Tip crumpled. Reserve.
	b	0.47	..	Right side (f).
	b	0.39	..	Reserve.
ix	a	0.25	7	
	b	0.26	9	
	a	0.25	..	Right side.
x	a	0.32	8	
	b	0.26	11	
xi	a	0.20	4	Shaft wide and flat.
	b	..	..	Fragments only obtained.
xii	a	0.34	7	Along with one reserve ca. 0.055.
	b	0.33	6	

(e) Ornamentation in two longitudinal ranks.

(f) Ornamentation in three longitudinal ranks.

*Ventral State*—contd.

Segment.	Seta.	Length in mm.	Ornamentation.	Remarks.
xiii	a	0.37	9	Along with one reserve 0.28. ( <i>g</i> )
	b	0.34	5	Along with one reserve 0.29. ( <i>g</i> )
xiv	a	0.39	7	Along with one reserve 0.25. ( <i>g</i> )
	b	0.395	6	
xv	a	..	..	Tip lacking.
	b	..	..	No seta in follicle.
xvi	a	0.415	9	
	b	0.37	..	
xx	a	0.40	3	
	b	0.375	7	
xxi	a	0.36	7	Along with one reserve 0.055.
	b	0.36	6	Along with one reserve 0.055.
xxii	a	..	..	Broken. Along with one reserve 0.10.
	b	0.30	7	Along with one reserve 0.20.
xxxiv	a	0.315	7	Along with one reserve 0.10.
	b	0.30	..	

(*g*) Ornamentation present.

Unless otherwise noted setae are from the left side. Each follicle of viii contains a reserve seta nearly as large as the functional seta.

Figures in the ornamentation column indicate the number of rows on the surface on which ornamentation is best visible, the rows in two, occasionally three, longitudinal ranks.

The first dorsal pore on 12/13 (1).

Spermathecal pores are minute and superficial, not easily recognizable. On viii the pores are in *ab*, actually on the setal arc or only slightly anterior to it, and hence on the middle (setal) annulus (4). On ix the pores are also in *ab* but are on the presetal annulus, and slightly nearer to 8/9 than to the setal arc (4). (Segments viii and ix each have

a presetal and a postsetal secondary furrow marking off three equisized secondary annuli, location of the pores confirmed by dissecting out the spermathecal ducts from the parietes.)

The single female pore is median, just in front of the setal arc (1). On other specimens female pores are unrecognizable but an oviduct traced through the parietes and then pulled out left a median aperture in the epidermis.

Prostatic pores are minute and superficial, each pore about on *b*, on the ventral end of a tiny, whitish, rather conical protuberance, the prostatic porophores at the median ends of the seminal grooves.

The minute male pores are visible only on one specimen, in the seminal grooves and about on the setal arc of xviii (confirmed by dissecting out the vas deferens from the parietes after removal of the longitudinal musculature).

The seminal grooves are slight but definite, bracket-shaped, just lateral to *b*.<sup>1</sup>

Genital markings are indistinctly demarcated areas of slight epidermal tumescence bearing tiny, circular, slightly depressed, greyish translucent spots. Markings are located as follows:—(First specimen). A transversely placed postsetal area on xvi, in *bb*, with four spots, the two median slightly anterior to the lateral spots; a transversely placed postsetal area on xviii between the seminal grooves, with four spots; a pair of circular areas, presetal on xx, each immediately lateral to *b* and with three spots; a pair of postsetal areas on viii, in *aa*, each with one spot; a postsetal area on ix, the centre about on *c*, with three spots.

(2) A transverse postsetal area on xvi with a somewhat irregular transverse row of eight spots, with two or possibly three further spots just in front or behind; a transverse presetal row on xix between the seminal grooves, with five spots; a postsetal median area on ix, with three spots; a postsetal area on ix, right side, in *ab*, with two spots; a postsetal area on ix, in *bc*, left side, with two spots; a presetal area, on *ab*, on ix, each side, each with two spots; a presetal area, on *ab*, of viii, left side; a postsetal area, on *ab*, of viii, right side. In addition there are several areas containing only one spot, the rest of the area peripheral to the spot like a rather wide rim, the whole much like a very small *D. longatria* genital marking in appearance: a pair of markings on xviii, middle annulus, between the seminal grooves; a postsetal row of four markings on xvii, between the seminal grooves; a single, presetal marking on xx, right side, just lateral to *b*.

(3) A postsetal area on xvi with four spots; one postsetal area in *bc*, on ix, each side, with one or two spots; a median postsetal area on ix with one spot; a presetal area in *ab*, on ix, on each side, each with three spots which surround the spermathecal pore. In addition there appear to be markings on the male region which are very difficult to make out, possibly a transverse row of four postsetal spots or markings on xvii, of two spots or markings on the middle annulus of xviii, of

---

<sup>1</sup> As characteristics of seminal grooves may be of specific importance it is regretted that more careful notes were not made on these structures even though material was immature.



four spots or markings on xix, in the latter case possibly extending over the two anterior annuli, including the setal, all markings median to the seminal grooves.

*Internal anatomy.*—The gizzards are in v and vi (4). From ix to the anterior portion of xiv there are present on the inner wall of the oesophagus, longitudinally placed, red or white ridges. Calciferous glands are two pairs in xi and xii (4), the posterior glands slightly larger. Each gland is rather ovoidal, attached to the oesophagus midlaterally, just in front of or just behind septum 11/12, by the more pointed dorsal apex, a stalk almost unrecognizable or very short. On each side of the oesophagus, on the inner wall in the region of the septal attachment, there is a slight but definite depression into which the calciferous glands open, the apertures of the glands just anterior and just posterior to the septal attachment. The gland lumen is eccentric, anterolateral in xi and posterolateral in xii, lamellae horizontal except for a few small and vertical ridges ventrally. The intestine begins in xv (3), the oesophageal valve just reaching into xv. Lateral and ventral intestinal caeca are lacking. The typhlosole begins (?) as a low ridge in the first intestinal segment, and may at first have a rounded ventral margin or be lamelliform, nearly straight or zigzagged, very gradually increasing in height passing posteriorly. In the region of xxvii-xxix the typhlosole reaches or nearly reaches its greatest height. From there to the region of xxxv-xxxvii the typhlosole may be practically straight (2), from thence posteriorly for some distance folded in a zigzag fashion and with the ventral margins of the folds united alternately as in *Eutyphoeus* or the *Eutyphoeus* condition may begin in the region of xxv-xxvii (1). Posteriorly the typhlosole loses much if not all of its folding and becomes nearly straight, triangular in section, thickened dorsally, where slight vertical grooves are present, more or less regularly alternating from one side to the other. In the supra-intestinal gland segments the typhlosole is thickened and with a spongy texture like that of the glands, terminating in the last gland segment. Supra-intestinal glands are transversely placed bodies, grooved mesially to contain the dorsal blood vessel, the glands separated from each other by deep, segmental, transverse clefts which pass ventrally to the thin intestinal wall, the glands continuous with each other only through the typhlosole. At the septal attachment the lateral margin of each gland is slightly cleft so as to mark off two portions, the preseptal part much larger. In one worm the supra-intestinal glands are in lxxxvii-xciv. In other specimens the locations could not be determined accurately, but in one of them glands are approximately in lxxx-lxxxvii or perhaps slightly posteriorly. On each side of the typhlosolar ridge (1 specimen) and slightly dorsal to the ventral margin is a longitudinally placed row of minute apertures into the supra-intestinal glands, about nine openings in each row.

The last pair of hearts is in xii (4). Hearts of x-xii bifurcate dorsally, an anterior branch passing to a supra-oesophageal vessel, the posterior bifurcation passing to the dorsal blood vessel. The somewhat slenderer commissures of ix pass to the dorsal blood vessel only. All hearts as well as the smaller commissures of vii-ix pass into the

ventral blood vessel. A supra-oesophageal trunk is recognizable in ix-xii, bifurcating anteriorly in xii, each branch passing to 12/13 slightly lateral to the gut and in xiv ventrally to the body wall (and posteriorly as a lateroparietal trunk?). An extra-oesophageal trunk on each side has been traced from 6/7 nearly to the nephridia of iii, with commissures to the other trunk just behind 4/5 and 5/6 and possibly with connectives to the ventral trunk anterior to 4/5. Posterior to 6/7 the ventrolateral trunks cannot be traced. Midsegmentally on each lateral face of the gut in x there is a vertically placed whitish band of tissue that may be a blood vessel. A longitudinal vessel on the floor of the gut mesially and behind the supra-intestinal gland segments, as in *Eutyphoeus*, has not been found. In a middle region of the body a fairly large longitudinal vessel is present on the parietes, on each side, in *bc* (1). Anteriorly this vessel is unrecognizable but may be continuous with a lateroparietal trunk.

In the postprostatic segments as well as the region of the supra-intestinal glands excretory organs are in longitudinal rows, probably six on each side, of which three are lateral to *d*, all nephridia of approximately the same size. In the posteriormost segments the median tubule on each side is much thickened but the loops are no longer than those of lateral tubules. From each thickened nephridium a slender thread passes to and through the anterior septum terminating, in a rather spheroidal swelling to which coelomic coagulum is often adherent. This bulbous termination, located just above the ventral parietes is probably a funnel but preservation is too poor to permit recognition of histological structure. In iii on the parietes, each side, there is a vertical band of closely crowded tubules (4).

Testes are paired, fan-shaped, apparently undischarged, in x and xi. Male funnels of both segments are fairly large, frilled, of approximately the same size, without spermatozoal iridescence. Seminal vesicles are three pairs, on the posterior face of 11/12, and the anterior faces of 9/10 and 10/11 (4). Posterior vesicles are vertically placed, each with a more or less ovoidal dorsal portion not very clearly marked off from the ventral part which alone is attached to the septum. Each vesicle of ix and x also consists of two portions. The dorsal is tough, reniform, firmly attached to anterior face of the septum, fairly high up in the coelomic cavity. Beneath the reniform portion and reaching to the ventral parietes or even anteriorly to the septum next in front is a thin walled, almost membranous, translucent sac containing a flocculent coagulum and attached to the hilus on the lateral margin of the dorsal portion by a short but definite, fairly tough though translucent stalk. Prostates are restricted to xvii and xix, the duct about 2 mm. long, nearly straight, with marked muscular sheen, slightly thicker than the gland. Vasa deferentia could not be traced though the anterior portions just behind 10/11 and 11/12 were found. After removal of the longitudinal musculature from segments xvii-xix ectal ends of the deferent ducts were found and traced through the parietes to the supposed male pores. No setae, fragments of setae, or setal follicles were found on either side at sites of *a* and *b* of xvii-xix, or in association with the ectal ends of vasa deferentia or prostatic ducts.

Spermathecae are anteroposteriorly flattened, the ampullae slightly less so than the rest of the organ, duct and diverticulum in a vertical sheet of tissue. The duct is slightly shorter than, to nearly as long as, the ampulla, gradually narrowed passing ectally, the wall thick and lumen narrow. The diverticulum is flattened, along the median side of the duct entally, with a very short stalk from the dorsal portion. Within the diverticulum the lumen is arborescent, each branch apparently terminating in a small, rather ellipsoidal seminal chamber which is not protuberant beyond the margin of the diverticulum.

*Remarks.*—Stephenson examined two specimens, loaned by Dr. Ashworth, from "the same batch which furnished the types of the species described by Michaelsen" One of the worms was dissected. Eventually these worms, along with two others presumably from the same original series came into possession of the Indian Museum.

In spite of the size of these specimens, seminal vesicles, prostates, and oviducal funnels appear to be juvenile. The testes appear to be undischarged. There is no trace of spermatozoal iridescence on the male funnels or within the seminal chambers of the spermathecal diverticula, nor is there any testicular coagulum within the coelomic cavities of x and xi. The spermathecae are further developed than in most of the specimens of *Eulichogaster* that have been available for examination but still appear to be juvenile (though anteroposteriorly flattened the ampulla is sac-like with a thin wall and obvious though empty cavity). In clitellate specimens of *kinneari* prostates are much thicker than the prostatic ducts, and pass beyond the limits of xvii and xix, crowding the intestine so that the gut is narrowed, the large seminal vesicles of xii bulge 12/13 posteriorly, the spermathecal ampullae are ovoidal rather than flattened, and the diverticulum is probably also rounded rather than flattened. If reproductive organs of the Nagpur species, at a sexually mature stage, are like those of *kinneari*, then the Nagpur specimens must be juvenile or quite immature.

As noted on a previous page worms from the Indian Museum just described above are distinguished from the types of *ashworthi* (as known from Michaelsen's descriptions) as well as from other forms just studied by characteristics which may be of specific value. In view of the uncertainties with regard to Michaelsen's worms erection of a new species is inadvisable. The diagnosis below, based on the Indian Museum specimens, is for comparison with that of *ashworthi*.

*Diagnosis.*—Prostatic pores on *b*, on ventral ends of tiny conical porophores at anteromedian and posteromedian ends of bracket-shaped seminal grooves with a double convexity laterally. Spermathecal pores in *ab*; on setal annulus of viii and on or just in front of setal arc, on presetal annulus of ix. Genital markings tiny, circular, greyish translucent areas in a transverse row of 4-8 on a postsetal area of epidermal thickening in *bb*, on xvi. In addition similar rows or single markings with wide marginal rims on some of the following locations: postsetal on xvii in *bb*, postsetal on xviii in *bb*, presetal on xix in *bb*, postsetal on ix in *aa*, presetal and postsetal on viii in *ab*, presetal on ix in *ab*, postsetal on ix in *ab* or *bc*, presetal on xx in median part of *bc*; single markings, postsetal and paired on viii in *aa*, postsetal and unpaired

in ix on *aa*, on setal annulus and paired on xviii in *bb*, presetal on xx in median half of *bc*. Clitellum? First dorsal pore on 12/13. Length 210 mm. (+?). Diameter 5 mm. (+?).

Supra-intestinal glands in lxxxvii-xciv. Male funnels all of same size. Seminal vesicles in ix, x and xii. Spermathecal duct about as long as ampulla (?), widened entally, with thick wall and narrow lumen; diverticulum acinous, opening through a very short dorsal stalk into median face of duct entally. Longitudinal musculature uninterrupted over genital markings.

*Distribution*.—Nagpur, Central Provinces. (Also Palia in Gwalior, Central India?).

### **Eudichogaster indicus** (Beddard).

1896. *Benhamia indica*, Beddard, *Proc. Zool. Soc., London*, 1896, p. 209. (Type locality elevations of 1,500 and 2,500 feet, Thana, near Bombay! No types.)

1900. *Trigaster indica*, Michaelsen, *Das Tierreich* X, p. 333.

1903. *Eudichogaster indica*, Michaelsen, *Mitt. Mus. Hamburg* XIX, p. 13.

1903. *Eudichogaster indica*, Michaelsen, *Geogr. Verbr. Berlin*, p. 109.

1909. *Eudichogaster indica*, Michaelsen, *Mem. Ind. Mus.* I, p. 112.

1910. *Eudichogaster indica*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX (5), p. 13.

1923. *Eudichogaster indicus*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 414.

*Diagnosis*.—Prostatic pores? Seminal grooves? Spermathecal pores? Genital markings tiny circular areas in a transverse row on areas of epidermal thickening in *aa* on 9/10 and 10/11? and paired markings on ix (=spermathecal porophores?) containing the setae. Clitellum on xiii-xvi? Female pore? First dorsal pore? Prostomium probolous? Length 75-100 mm. Diameter 6 mm.<sup>1</sup>?

Intestine begins in xvi? Supra-intestinal glands? Metandric (?) but with small male funnels in x; seminal vesicles in xii. Spermathecal diverticulum trilobed or quadrilobed, on ectal end of duct? Genital marking glands?

*Distribution*.—Elevations of 1,500 and 2,500 feet near Thana, Bombay Presidency. As the town of Thana is in the lowlands the type—locality can scarcely be regarded as adequately designated.

*Remarks*.—Known only from the type—series which cannot be traced (presumably lost). Beddard evidently thought that some of his specimens at least were clitellate as the location of the clitellum is given but he suggested that the absence of a second pair of seminal vesicles might have been due to immaturity! The figure of an entire worm shows no clitellum.

Although the male area is included in the figure nothing of diagnostic value can be deduced therefrom. It appears to show two transverse grooves between which (and presumably on xviii) there is a transversely placed, shortly elliptical area that may represent a genital marking, or merely a depression.

Tips of copulatory setae are “ornamented with elegantly disposed semicircular ridges”!

<sup>1</sup> Diameter estimated from figure which is said to be of “natural size”.

**Eudichogaster kinneari** Stephenson.

1920. *Eudichogaster kinneari*, Stephenson, *Mem. Ind. Mus.* VII, p. 255. (Typ-  
locality Nasik, 100 miles northeast of Bombay. No types.)
1923. *Eudichogaster ashworthi* var. *kinneari*, Stephenson, *Oligochaeta*, in *F. B. I.*  
*Series*, p. 407.

*Diagnosis.*—Prostatic pores on papillae in corners of an H-shaped depression, porophores connected by laterally biconvex seminal grooves (?). Spermathecal pores presetal, on *a*, at centres<sup>1</sup> of low, square papillae that extend across whole length of the segments. Genital markings paired, transversely placed papillae in *ac*, postsetal on xvi, and on xx (whole length of segment), and in addition circular papillae on some of the following locations; median on xvi and xx, median and presetal on x-xii, one or two in lateral portion of *bd* on viii and ix. Clitellum on xiii-xvi. Female pore? First dorsal pore on 12/13. Prostomium prolobous (?). Length 80 mm. Diameter 5 mm.

Supra-intestinal glands? Seminal vesicles in ix and xii. Spermathecal duct shorter than ampulla, widened entally; diverticulum acinous, opening by short thick stalk into ental end of duct. Genital marking glands?

*Distribution.*—Nasik, ca. 80 miles northeast of Bombay. (Jubbulpore?)

*Remarks.*—The type-series contained “a number of specimens”, including (probably) the only fully sexual and clitellate specimens of the genus *Eudichogaster* that have ever been available for study. Inquiries to English and Indian Museums have failed to provide any information as to the whereabouts of the types which presumably have been lost.

Although the clitellum is markedly protuberant dorsal pores appear not to have been occluded, traces of intersegmental furrows visible but setae invisible.

Spermathecal pores are “on the anterior part of the second annulus” As ix is triannular the pores of that segment are on the setal annulus, but viii is quadriannular and hence the pores of this segment may be on a setal or presetal annulus according to the location of the extra secondary furrow. If the second annulus on each segment is the setal annulus as seems likely<sup>2</sup> the location of the pores might serve in part to distinguish specifically from “*ashworthi*?”

Characterization of the seminal grooves is doubtful. Stephenson notes that the grooves “are not always distinguishable among the numerous fissures” on the male region, and none are recognizable in the figure (pl. xi, fig. 58).

The species appears to be small though dimensions are given of only one specimen which is said to be “fair-sized”.

<sup>1</sup> And hence on setal annuli?

<sup>2</sup> A tertiary furrow, when present on viii and ix, is on the third or last secondary annulus, in specimens which I have examined.

**Eudichogaster kinneari ?**

1920. *Eudichogaster ashworthi* (part), Stephenson, *Mem. Ind. Mus.* VII, p. 247. (Excluding all except specimen from Teor.)

1923. *Eudichogaster ashworthi* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 405. (Excluding all except Teor specimen mentioned above.)

*Material examined.*—From the Indian Museum: 1 dissected juvenile labelled “*Eudichogaster ashworthi* Michaelsen. Teor, 8 miles from Jubbulpore, C. P. 22. vi. 18. Dr. B. Prashad. W 338/1 ”

*External characteristics.*—Length about 75 mm. Diameter about 5 mm. On vii-ix the postsetal secondary annulus is subdivided by a tertiary furrow.

Ventral setae appear to be lacking on xvii-xix but are also invisible on xvi and xx.

Spermathecal pores are minute and superficial, each pore of both viii and ix, in *ab*, practically on or just in front of the setal arc. Three of the four pores are nearer to *a* than to *b*.

Prostatic pores are minute and superficial, each pore at or near the centre of a porophore which is slightly wider than *ab*, with a short and transversely elliptical outline, a smooth and regularly convex surface, reaching slightly median to *a* and slightly lateral to *b*, the prostatic pores on or just median to *b*. The prostatic porophores are at the anterior and posterior ends of the lateral limbs of a longitudinally placed H-shaped depression. Across this depression and on the setal arc of xviii is a clear-cut transverse groove. Each seminal groove is bilaterally convex like two similar curved marks of a parenthesis placed in a longitudinal series, one extending from the lateral margin of the prostatic porophore of xvii to the transverse groove on xviii, the other extending from that groove to the lateral margin of the prostatic porophore of xix, the concave sides of the curves facing mesially. The anterior and posterior ends of the grooves do not reach the prostatic pores but end at the margins of the porophores. Seminal grooves are well marked but not as deep or as wide as on specimens of other species.

Genital markings are two pairs, the anterior pair on the posterior two-thirds of xvi, the posterior on the anterior two-thirds of xx, the markings represented only by slightly protuberant, whitish swellings of the epidermis, indistinctly demarcated but apparently extending from or slightly median to *b* well towards *c*. In the region of *ab*, on each side of viii and ix, there is an area of epidermal tumescence, on viii reaching onto the pre- and postsetal annuli, on ix reaching still further posteriorly. On ix on one side the region around *c* is also swollen. If all of these tumescences on ix were united the area thus formed might be similar to that on the same segment of the type of *mullani*. Circular, greyish translucent spots are lacking on the male field and elsewhere.

*Internal anatomy.*—The intestine begins in xv. Calciferous glands as usual. Intestinal caeca are lacking. The typhlosole is in part folded as in *Eutyphoeus*. Supra-intestinal glands are probably in lxxix-lxxxvi.

Hearts of x-xii are latero-oesophageal.

In a middle region of the body the nephridia are in fairly regular longitudinal ranks on each side, three lateral to *d*, possibly one in *cd*, another in *bc*, and a third in *ab*. From xcv posteriorly the median tubule

on each side is much thickened, with a very slender neck continued anteriorly to and through the septum in front and then enlarged into a funnel-like swelling just above the ventral parietes. In iii on each side and on the parietes is a vertically placed compact mass of nephridial tubules.

Male funnels of x and xi are of approximately the same size, frilled but without spermatozoal iridescence. Seminal vesicles of ix are small, probably juvenile, vesicles of xii larger but still probably not mature. No vesicles in x.

Though larger and apparently further developed than in many of Stephenson's specimens, the spermathecae still appear to be juvenile. The diverticulum is anteroposteriorly flattened and on the median side of the duct entally.

*Remarks.*—Though one of the largest of Stephenson's specimens, this worm cannot be considered to be sexual, there is no trace of a swollen clitellum and the reproductive organs all appear to be juvenile.

Identification is impossible at least for the present, nevertheless similarities between this worm and Stephenson's clitellate specimens of *kinneari* should be noted. The figure of the male genital field in the F. B. I. monograph does not show clearly certain characteristics of the male field, but in figure 58 on pl. xi of the 1920 memoir the prostatic porophores are more obvious and in nearly the same position as on the Teor worm. If the (apparently) circular prostatic porophores shown in this figure are widened to papillae of transversely elliptical outline and shifted to the ends of the lateral limbs of the H-shaped depression the condition would be as in the Teor specimen. The genital markings on xvi and xx of the Teor worm are in about the same location as those of Stephenson's figure but are too juvenile to be so sharply demarcated or to show a central dark area.

If these worms actually are conspecific with *kinneari*, the species can then (apparently) be distinguished from "*ashworthi*?" (and possibly also *ashworthi*) by the more posterior location of the spermathecal pores of ix, the absence of seminal vesicles in x and of postsetal markings on xvi in *aa*, as well as by presence of a pair of markings in *bc* on setal-postsetal annuli of xvi.

### ***Eudichogaster mullani* Stephenson.**

1922. *Eudichogaster mullani*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 438. (Type-locality Bombay. Type in the Indian Museum.)

1923. *Eudichogaster mullani*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 414.

*Material examined.*—From the Indian Museum: 1 juvenile specimen labelled, "*Eudichogaster mullani* Stephenson. Bombay. Prof. J. P. Mullan. Type W 705/1".

*External characteristics.*—Unpigmented (? alcoholic preservation). Setae begin on ii, on which segment all four couples are present,—earlier inability to recognize setae on ii-iv and posteriorly, probably due to failure to remove the cuticle;  $ab < cd < bc < aa$ . One of the ventral setae of viii is unusually protuberant beyond the epidermis and doubtless is enlarged and to be considered a copulatory seta. Other ventral setae of viii are invisible or lacking though minute pits, which probably

are the apertures of the setal follicles, can be seen. Ventral setae of segments anterior and posterior to viii are not protuberant and do not appear to be especially enlarged. Setae *a* and *b* of *x* are only slightly sigmoid, without nodular thickening, and apparently without ornamentation, the thickest portion of the shaft slightly behind the ectal end: length of *a* 0.34 mm., diameter (at thickest region) 0.05 mm.; length of *b* 0.32 mm., diameter 0.3 mm. No ventral setae are visible externally or internally on xvii-xix.

Clitellar glandularity is unrecognizable. The female pore has not been found.

The spermathecal pores have not been definitely identified. There is however no trace of anything resembling a spermathecal aperture in the region of *bc* where the pores were supposed to be located. On the contrary there is on *ix*, on each side, in *ab*, and on or just anterior to the setal arc, a minute whitish spot similar to that forming the margin of a minute and superficial spermathecal pore. On *viii*, on each side, and about in the region of *ab*, there are three minute apertures or depressions which presumably represent openings of setal follicles and a spermathecal duct. Quite possibly on this segment also the spermathecal pores are in *ab*.

The seminal grooves are crescentic, with concave faces mesially, extending from mid *xvii* to mid *xix*, located about in *ab*. Minute, grey spots in seminal grooves on *xviii*; on the setal arc, and in or near the ends of the grooves may represent sites of male and prostatic pores.

Genital markings are circular, median and unpaired, each marking with a well-defined opaque rim and a greyish translucent, circular, central area, postsetal on *xvii* and *xix*. In addition there are four areas not so sharply demarcated and, possibly as a result of immaturity, not yet clearly marked off into rim and central portion,—one presetal on *xvii* and another postsetal on *xix* on each side, just lateral to the seminal grooves. On *viii* there is a slightly raised and fairly sharply demarcated area resembling somewhat the raised regions of *O. birmanicus* that bear the copulatory setae and spermathecal apertures; the area bounded in front by the presetal secondary furrow and hence with a straight anterior margin. Posteriorly the area is not on the whole bounded by definite grooves though the demarcation is fairly sharp, the posterior boundary beginning lateral to *d* on each side at the first postsetal secondary furrow, sloping to the second postsetal secondary furrow at *c*, and then reaching 8/9 at *b*, from whence it passes anteromesially to the first postsetal secondary furrow just lateral to the midventral line. Secondary furrows are lacking on the area but posteriorly, in *bc* on each side there is a pair of tiny, rather spindle-shaped greyish translucent spots.

*Internal anatomy.*—Septa 5/6-11/12 are muscular or thickly muscular; 12/13 slightly muscular.

The gizzards are of approximately the same size. The inner wall of the oesophagus posteriorly is provided with a longitudinally placed series of rather irregular ridges. About at the region of the attachment of 11/12, there is on the lateral wall of the oesophagus on each side, a small depression with the longer axis longitudinally placed. Within each depression there are two openings leading into the calciferous glands,



a short, vertically placed ridge just dorsal to each aperture. The glands are rather reniform, vertical, sessile by the concave faces on the oesophagus. The lumen of the gland is eccentric, and filled with particles of soil. In the thicker posterior wall of the gland there is a vertical series of horizontal lamellae. An oesophageal valve of the usual type is present in the posterior part of xiv and the anterior part of xv. The intestine begins in xv. As the gut had been removed from xv to xlii no statement is possible with regard to intestinal caeca or the anterior portion of the typhlosole. From xlii the typhlosole is like that of *Eutyphoeus* and is continued through the supra-intestinal gland segments where it is especially well developed. The supra-intestinal glands are in xc-xcix.

Hearts of xi and xii are latero-oesophageal. Extra-oesophageal trunks are just lateral to the gut on each side in vii to x, posteriorly in x passing into the floor of the oesophagus (?). Anterior to vii the trunks cannot be traced but in front of 5/6 are again recognizable on each side, parallel and slightly lateral to the ventral trunk. No subneural.

In iii, on each side, there is a vertically elongated mass of nephridial tubules. In the postprostatic segments there are 8-10 nephridia in each segment on each side, of which 5 (in the first few postprostatic segments) or 4 are lateral to *d*, the others in *bd*.

Seminal vesicles of ix are small and located high up on the anterior face of 9/10. The posterior vesicles (of xii) are somewhat larger, lateromesially flattened, vertically placed, in contact above with the dorsal blood vessel (vesicles of x ?).

Setae have not been found in xvii-xix, but if small or buried within the parietes would have been unrecognizable without drastic dissection. The vasa deferentia likewise have not been found.

Spermathecae are anteroposteriorly flattened, the duct much shorter than the ampulla. The diverticulum is small, on the median face of the duct at the ental end and without spermatozoal iridescence.

Genital marking glands are unrecognizable internally, the longitudinal musculature apparently uninterrupted.

*Remarks.*—In view of the uniqueness of the specimen and the previous loss of important structures such as copulatory setae, one spermatheca and an important portion of the gut, no further removals excepting setae of x, have been made. For this reason it has been impossible to state definitely the location of the spermathecal pores.

Spermathecae, prostates and possibly also the seminal vesicles are juvenile.

The species apparently resembles "*kinneari*?" in location of the spermathecal pores but is distinguished (?) by the absence of ornamentation on the ventral setae anteriorly, by the absence of genital markings in *bc* on xvi and xx. Distinguished from "*ashworthi*?" by the more posterior location of the spermathecal pores of ix ?

*Diagnosis.*—Prostatic pores? Seminal grooves convex laterally, *ca.* in *ab* (?). Spermathecal pores in *ab* (?), on or just in front of setal arcs. Genital markings circular, with opaque rim and translucent centre, unpaired and median-postsetal on xvii, and xix, paired, just

lateral to the seminal grooves—presetal on xvii, postsetal on xix. Clitellum? Female pore? First dorsal pore on 12/13 (?). Prostomium probolous (?). Length 134 mm. Diameter 6 mm.

Supra-intestinal glands in xc-xcix. Seminal vesicles in ix and xii (x?). Spermathecal duct much shorter than the ampulla; diverticulum on median face of duct entally. Longitudinal musculature uninterrupted over sites of genital markings.

*Distribution*.—Bombay.

### **Eudichogaster poonensis** (Fedarb).

1898. *Benhamia poonensis*, Fedarb, *Journ. Bombay Nat. Hist. Soc.* XI, p. 434.  
(Type locality Poona. No types.)  
1900. *Trigaster poonensis*, Michaelsen, *Das Tierreich* X, p. 333.  
1903. *Eudichogaster poonensis*, Michaelsen, *Mitt. Mus. Hamburg* XIX, p. 13.  
1903. *Eudichogaster poonensis*, Michaelsen, *Geogr. Verbr. Berlin*, p. 109.  
1909. *Eudichogaster poonensis*, Michaelsen, *Mem. Ind. Mus.* I, p. 112.  
1910. *Eudichogaster poonensis*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), p. 13.  
1923. *Eudichogaster poonensis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 416.

*Diagnosis*.—Prostatic pores on tiny, conical porophores (?), in *ab*? Seminal grooves? Spermathecal pores? Genital markings small, paired, postsetal on xvii, presetal on xix, including *a* and *b* on xx. Clitellum? Female pore? First dorsal pore? Prostomium? Length 134 mm. Diameter 3 mm.

Intestine begins in xiv? Supra-intestinal glands? Metandric (?); seminal vesicles in xii (only?). Spermathecal duct as long as ampulla (?), thickened entally; diverticulum acinous, opening into duct entally. Genital marking glands?

*Distribution*.—Poona.

*Remarks*.—Known only from the holotype which cannot be traced and presumably is no longer extant.

A clitellum supposedly "very ill-marked" quite possibly was entirely lacking, at least no trace of parietal thickening is shown on figure 10 while other and similar figures in the same paper all show such clitellar development. Nevertheless the type may have been mature or nearly so, as the figure of a spermathecal diverticulum looks much like that of Stephenson's clitellate specimens of *kinneari*.

According to Stephenson (1923, p. 416) spermathecal pores are on 7/8-8/9, but this is probably an inference from fig. 10 which appears to show spermathecal ducts passing into the parietes just behind the septa. Even if the figure can be regarded as accurate in this respect the inference is still unwarranted (especially in view of the segmental location in all forms in which location is known) as septa are usually bulged posteriorly or displaced posteriorly and attached to the parietes behind the sites of their proper intersegmental furrows. A spermathecal duct thus might pass into the body wall just behind a septum even though the point of penetration is at or just in front of the level of the setal arc.

Seminal grooves are not shown in the figure of the male pore region nor are they mentioned in the description. As these grooves are clearly recognizable on juvenile specimens before most other characteristics

of the male field are developed they surely ought to have been visible on a specimen so mature as the condition of the spermathecal diverticulum seems to indicate. Possibly grooves were overlooked or if seen considered of no importance.

The segment of intestinal origin is probably incorrect (as in *indicus*), a very careful dissection is often necessary in order to reveal the correct relationships in xiv-xvi.

A figure of the copulatory setae is interpreted by Stephenson to indicate that the setae are provided with stout spines, but the figures can almost as well be suspected of showing, in an exaggerated fashion, the incisions visible at the lateral margins near the tip when ornamentation like that on the setae of *kinneari* or *prashadi* is present.

### **Eudichogaster** sp.

1920. *Eudichogaster ashworthi* (part), Stephenson, *Mem. Ind. Mus.* VII, p. 247. (Excluding all except specimens from Wahi.)

1923. *Eudichogaster ashworthi* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 405. (Excluding all except Wahi specimens.)

*Material examined.*—From the Indian Museum: 2 dissected and 4 undissected juveniles labelled, "*Eudichogaster ashworthi*, Michael- sen. Wahi, on the way to Mahabaleshwar, W. Ghats, 20 miles from Matheran. 4.vii.17. Dr. B. Prashad. W 336/1".

*External characteristics.*—Length of largest worm *ca.* 70 mm. On viii and ix the postsetal secondary annulus is subdivided by a tertiary furrow.

Spermathecal pores are minute and superficial (on each of the two worms with genital markings), in *ab* and close to if not actually on the setal arcs, of both viii and ix.

On segments xvii-xix there is on each side a crescent-shaped area of slight epidermal tumescence, rather indistinctly delimited but much more like the area figured by Stephenson for *prashadi* (1920, pl. xi, fig. 54) than anything seen on any of the specimens of *prashadi*, the median concavity smaller and the transverse thickness greater than shown by Stephenson. At each end of each crescent and extending from just lateral to *a* to just median to *b* there is a fairly definite prostatic porophore much like porophores on "*kinneari*?" but here slightly more



TEXT-FIG. 2.—*Eudichogaster* sp.  
Prostatic porophores and supposed seminal grooves of right side.

indefinite, probably because of earlier development. On each crescent is a seminal (?) groove, much deeper and very much wider than any groove seen on other specimens. In the groove and about on the setal

arc of xviii is a tiny conical protuberance which bears at its ventral tip a minute aperture, probably the male pore. On one specimen mesially on xvii there is a swollen area of exactly the same shape as that between the anterior ends of the lateral limbs of the H-shaped depression on the Teor specimen of "*kinneari*."

On the first specimen the genital markings are as follows:—three tiny, grey, circular spots, postsetal on xviii and just median to the lines of the prostatic pores, 1 on the left side and 2 on the right side; rudimentary markings on xvi, just lateral to *b* on each side, no grey spots; rudimentary markings on xx, presetal portion, just lateral to *b*; a median presetal marking in *aa* on x, with three transverse rows of grey spots; a marking extending slightly beyond *a* and *b*, on viii and ix is, each side, on the setal annulus, containing the spermathecal pores, grey spots unrecognizable; a small but rather conspicuously protuberant whitish area on each side of ix, setal annulus and with seta *c* at the centre, no grey spots visible. On the second specimen the markings are as follows: an area of whitish tumescence on the anterior two-thirds of xx, from *a* to mid *bc*, on each side, no grey spots visible; spermathecal pore markings and setal markings (*c*) of ix as before.

*Internal anatomy.*—The intestine begins in xv. Calciferous glands as usual. The typhlosole is folded in part as in *Eutyphoeus*. Supra-intestinal glands are in (approximately) lxxxi-lxxxviii.

Hearts of x-xii are latero-oesophageal.

In the middle of the body the excretory organs are in fairly regular longitudinal ranks, 3 on each side lateral to *d*, 1 about in *cd*, 1 at *a* and 1 at *b* or only 1 in *ab*. In the posterior segments the medianmost nephridium of each side is thickened and apparently provided with a preseptal funnel. In iii on each side and on the parietes is a vertical mass of closely compacted nephridial tubules.

The male funnels of x and xi are large and frilled, approximately of the same size but with no spermatozoal iridescence. There is a pair of seminal vesicles in ix. The vesicles of xii each have an enlarged and softened portion that is not attached to the septum. There are no vesicles in x. The prostate glands may be a trifle thicker than the ducts but still are probably juvenile.

Spermathecae are juvenile though fairly large, anteroposteriorly flattened, the duct shorter than the ampulla, slender, and slightly sinuous. The diverticulum is on the median side of the duct. The lumen of the diverticulum is arborescent.

*Remarks.*—The supposed seminal grooves of the two specimens with genital markings are so different from those of other specimens as to suggest a possibility that these worms are specifically distinct. With maturity it might be expected that these differences in width and depth of the grooves would be accentuated rather than diminished and even on the juvenile specimens the grooves are much larger than on any other forms.

However it may be possible that the depressed areas are not true seminal grooves at all, but beginnings of some sort of a depression like that of *kinneari* in which grooves of the usual size will later develop.

## II.

1920. *Eudichogaster prashadi*, Stephenson, *Mem. Ind. Mus.* VII, p. 250. (Type locality Palia, between Indore and Ujjain, Gwalior, Central India. Types in the Indian Museum.)
1923. *Eudichogaster prashadi*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 416.

*Material examined.*—From the Indian Museum: 2 dissected and 4 undissected juveniles labelled, "*Eudichogaster prashadi*, sp. nov. Palia, between Indore and Ujjain, Gwalior, C. I. 27.vi.17. Dr. B. Prashad. W 282/1. Types.", 1 juvenile labelled, "*Eudichogaster prashadi* Stephnsn. Mhow Cantonment in Indore State, C. I. 23.vi.17. Dr. B. Prashad. W 283/1", 7 undissected juveniles labelled, "*Eudichogaster prashadi* Stephnsn. Hilly tracts on banks of River Nerbudda, Bheraghat, Marble Rocks, 13 miles from Jubbulpore, C. P. 22.vi.17. Dr. B. Prashad. W 284/1", 1 dissected and 2 undissected juveniles labelled, "*Eudichogaster prashadi* Stephnsn. On the banks of the rivers Mula and Mutta, Poona, Bombay. 3.vii.1917. Dr. B. Prashad. W 285/1", 1 dissected and 6 undissected juveniles labelled, "*Eudichogaster prashadi* Stephnsn. Surat, Bombay. 8.vii.17. Dr. B. Prashad. W 286/1", 1 dissected and 6 undissected juveniles labelled, "*Eudichogaster prashadi* Stephnsn. By the edge of a pool, Teor, 8 miles from Jubbulpore, C. P. 22.vi.1917. Dr. B. Prashad. W 287/1", 8 undissected juveniles labelled, "*Eudichogaster prashadi* Stephnsn. Saugor, C. P. 20.vi.17. Dr. B. Prashad. W 288/1", 1 dissected and 7 undissected juveniles labelled, "*Eudichogaster prashadi* Stephnsn. Khandwa, Nimar Dist., C. P. 23.vi.17. Dr. B. Prashad. W 289/1", and 1 dissected juvenile labelled, "*Eudichogaster prashadi* Stephnsn. Indore, Central India. 23.vi.17. Dr. B. Prashad. W 392/1".

*External characteristics.*—Unpigmented (?), the yellowish brown appearance mentioned by Stephenson often characterizes earthworms preserved in alcohol.

Setae *a* and *b* of viii and ix are elongated and without nodulus, ornamented as described by Stephenson but with ental edges of excavations jagged like a row of very fine spines. The tips taper to a rounded rather than a sharply pointed end. Setae *a* and *b* of vii, x and succeeding segments are sigmoid, but may be ornamented with transversely placed, straight, irregular or curved rows of very fine teeth. Just anterior to a row of teeth there may be a slight, much lighter area as of a very small excavation. Measurements of several setae of a specimen from Bheraghat are shown below.

*Ventral Setae.*

Segment	Seta	Length	DIAMETER		REMARKS
			Midshaft (viii or ix) or through nodulus	Base	
viii	<i>a</i>	0.76	0.022	0.028	
	<i>b</i>	0.63	0.020	0.026	
	..	0.35	0.020	0.025	Replacing.
	..	0.10	..	0.022	Replacing.
	..	0.08	..	0.020	Replacing.

## Ventral Setae—contd.

Segment	Seta	Length	DIAMETER		REMARKS
			Midshaft (vii or ix) or through nodulus	Base	
ix	<i>a</i>	0.69	0.023	0.028	Tip lacking.
		0.33	0.022	0.028	Replacing.
	<i>b</i>	0.62	0.022	0.026	
x	<i>a</i>	0.31	0.045		Tip lacking.
	<i>b</i>	0.30	0.031	..	
	<i>b</i>	0.25	0.032	..	Other side.
		0.08	..		Replacing.
xi	<i>a</i>	0.27	0.030	..	
	<i>b</i>	0.29	0.038		Tip lacking.
xii	<i>a</i>	0.35	0.026		Tip lacking.
	<i>b</i>	0.26	0.029	..	Tip lacking.
xiii	<i>a</i>	0.33	0.031	..	Tip lacking.
	<i>b</i>	0.30	0.031	..	Tip lacking.
	..	0.17		0.030	Replacing.

Measurements in mm. by Miss M. Chapman.

The spermathecal pores are minute and superficial, in *ab*, on the setal arcs, on viii usually slightly nearer to *a*, on ix usually slightly nearer to *b* (Bheraghat specimens). (On at least one of the types, the pores of viii are on the setal arc while the pores of ix are on the presetal, secondary annulus).

Female pores have not been found.

Prostatic pores are minute and superficial, in *ab*, on xvii and xix, possibly (1 specimen) at the termini of seminal grooves. On each side of the body, extending across xvii-xix is a slightly raised whitish area without definite demarcation, only rarely approximating to the crescent-shape figured by Stephenson. Male pores have not been found on any of the specimens but prostatic pores probably are at the termini of seminal grooves.

Genital markings are lacking but an indistinctly demarcated area including setae *a*, *b* and the spermathecal pore on each side of viii and

ix may be very slightly tumescent and more whitish than the surrounding epidermis. One of the types appears to have a slight thickening of the epidermis in *aa* on the postsetal portion of xvi, that may represent the rudiment of a genital marking.

*Internal anatomy.*—The calciferous glands are rather ovoidal, the larger end ventrally, the more pointed end attached to the oesophagus midlaterally, just in front of or just behind 11/12. The stalk is scarcely recognizable and very short, the gland lumen very small and eccentric. The intestine begins in xv close to 14/15, the oesophageal valve almost restricted to xiv. Intestinal caeca are lacking. Supra-intestinal glands are transversely placed, with a fairly large groove on the dorsal face mesially in which the dorsal blood vessel lies, not continuous but discrete, a deep cleft passing between two successive glands to the intestinal wall. At the septal attachment each gland is cleft slightly at the lateral margin, the cleft marking off two unequal portions, the much larger portion anterior to the septum, the smaller part postseptal. The vertical cleft between two successive glands is accordingly slightly nearer to the anterior than the posterior septum. The glands are located as shown below. The typhlosole extends from the first intestinal segment through the last supra-intestinal gland segment. In the first ten or so segments the typhlosole is low, lamelliform, and zigzagged, in the region of xxvi-xxvii abruptly enlarged and for some distance posteriorly with ventral margins of the folds united as in *Eutyphoeus*. Posteriorly folds are again without union. In the supra-intestinal gland segments the typhlosole is thickened and with a spongy structure like that of the glands.

*Supra-intestinal glands.*

Segments	Number of specimens					
	Palia	Bheraghat	Poona	Teor	Saugor	Khandwa
77—85	..	1		..	..	..
78—86	..	..	..	1	..	..
79—86	..	..	1	..	..	1
79—87	1	..	..	..		..
79—88	1	..	..	..	..	..
80—87	1	..	..	..	..	..
80—89	..	1	..	..	..	..
81—87	..	1	..	..	1	..
81—89	..	1	..	..	..	..

The hearts of x-xii bifurcate dorsally, the posterior branch passing into the dorsal trunk, the anterior into a supra-oesophageal vessel. The

hearts of ix pass directly into the dorsal trunk. All hearts of ix-xii pass into the ventral blood vessel, as do the smaller commissures of vii-viii. In segments iv-vi on each side a portion of an extra-oesophageal trunk is recognizable but trunks cannot be traced anteriorly or posteriorly in any of the specimens dissected. A subneural is lacking.

Nephridia, when well preserved, certainly appear to be in five longitudinal ranks, one in *ab*, another in the lateral half of *bc*, a third in *cd*, and two lateral to *d*, or there may be three lateral to *d* and none in *cd*. Tubules of the lateral rows are stretched out transversely on the parietes and are much larger than the nephridia of *Eutyphoeus*. From segment cxxv (at least) posteriorly the median nephridium of each side is thickened and with a narrow neck and preseptal funnel. Three rows are still recognizable lateral to *d* on each side, median to *d* the arrangement not clear. In iii on each side and on the parietes is a vertical mass of closely compacted tubules.

There are paired male funnels in x and xi, without spermatozoal iridescence. The posterior seminal vesicles are small vertically placed bodies on the posterior face of 11/12. Smaller, rounded bodies on the anterior face of 9/10 probably are anterior vesicles (no reference to vesicles of x in laboratory notes). The prostatic duct is straight and with marked muscular sheen.

The spermathecal duct is about as long as the ampulla, slender, especially ectally. The single sessile diverticulum is vertically placed on the ental portion of the duct next to the ampulla.

*Remarks.*—Most of the specimens referred to *prashadi* by Stephenson are so immature as to require no further comment beyond the fact that they can be identified only generically. A few of the specimens from Palia and Bheraghat are slightly further developed but are still too juvenile to warrant more than a guess as to their specific identification. All the evidence available (location of the spermathecal pores and the possible presence of a postsetal genital marking in *aa* on xvi) tends to show that the specimens from Palia are to be referred to "*ashworthi*?" Specimens from Bheraghat appear to be referable to almost any other species except the one to which the Palia specimens belong.

Of the several series of worms studied by Stephenson, only that from Palia bears a type designation.

### III.

1920. *Eudichogaster ashworthi* (part), Stephenson, *Mem. Ind. Mus.* VII, p. 246. (Excluding specimens from Nagpur, Teor and Wahi.)

1923. *Eudichogaster ashworthi* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 405. (Excluding specimens from Nagpur, Teor and Wahi.)

*Material examined.*—From the Indian Museum: 10 undissected and 1 dissected juveniles labelled, "*Eudichogaster ashworthi*, Michaelsen. Bina, Saugor district, C. P. 9.vi.17. Dr. B. Prashad. W 332/1", 1 dissected and 4 undissected, very small juveniles labelled, "*Eudichogaster ashworthi*, Michaelsen. Choral between Khandwa and Indore, C. I. 23.vi.17. Dr. B. Prashad. W334/1", 1 dissected and 3 undissected juveniles labelled, "*Eudichogaster prashadi*, Michaelsen. Poona, W. India. 3.vii.17. Dr. B. Prashad. W 335/1", 1 dissected juvenile labelled, "*Eudichogaster ashworthi*, Michaelsen. Saugor, C. P. 20.vi.1917. Dr. B. Prashad. W 337/1", and 2 dissected juveniles labelled, "*Eudichogaster ashworthi*, Michaelsen. Partabgarh, S. Rajputana. ii.18. Col. J. Manners-Smith. W 339/1".



*Remarks.*—Rudiments of seminal grooves are visible on a very few of these specimens but genital markings and other structures of specific importance are either quite undeveloped or unrecognizable.

A specimen from Bina has spermathecal pores in *ab* and on the setal arc of ix while the pores of viii appears to be on the presetal annulus in *ab*. This worm has 9 supra-intestinal glands.

In a specimen from Choral the supra-intestinal glands are in lxxviii-lxxxvi (approximately). In a specimen from Poona the glands are in lxxviii-lxxxiii (approximately). In a specimen from Saugor the glands are in lxxix-lxxxvi (approximately).

Specific identification is impossible, at least for the present.

### **Lenogaster**, gen. nov.

*Diagnosis.*—Reproductive apertures minute and superficial, prostatic and male pores in seminal grooves (?). Female pores paired. Setae lumbricine; ventral setae of xvii penial, in paired follicles on each side. Clitellum annular, on xiii-xvii; with development of clitellar glandularity intersegmental furrows disappear and dorsal pores are occluded but setae are retained. Unpigmented. Septa present from 4/5 or 5/6. Gizzards in v and vi. Calciferous glands paired, in x-xii, vertically placed, attached by upper poles without stalks to the oesophagus dorso-laterally, opening into gut lumen indirectly on each side through a longitudinal groove in the lateral wall of the gut that is bounded mesially by a thick partition, the groove in communication with the gut lumen dorsally so that the oesophageal lumen is T-shaped. Intestine begins in xv. Typhlosole in xvi-xviii to lxxiii-lxxviii, enlarged or otherwise modified in the last few segments. Hearts latero-oesophageal in x-xii. Extra-oesophageal trunks, connected with each other by transverse commissures near 5/6 and 6/7, pass in x into the floor of the oesophagus (?). Supra-oesophageal trunk in x-xii. Lateroparietal trunks present. Excretory organs: closed (?) exonephric (?) parietal micronephridia, closely crowded into paired vertical bands in iii, in transverse rows of three to six on each side in iv-xvii, with additional tubules mesially in xiv-xvii, from xviii posteriorly in three to five longitudinal ranks on each side; in the last (20+) segments the median nephridium on each side enlarged and with preseptal funnel. Prostates tubular.

*Genotype.*—*Eudichogaster yeicus* Stephenson 1931.

*Distribution.*—India (from latitude of Bombay northwards to Dehra Dun) and Burma.

*Remarks.*—The seven species to be included in *Lenogaster* fall into two groups according to the acanthodriline or microscolecine condition of the male sex organs. Derivation of the microscolecine section from the acanthodriline section (as now known) is impossible unless ventral setae of xviii once lost (or reduced?) can be regained, and ventral setae of xix once penial can revert to a typical sigmoid condition. Although such evolutionary changes are implied in current phylogenetic schemes and a regression of penial setae to the original sigmoid condition has been definitely suggested by Pickford (1937, p. 183) a complete reversal of this sort seems at least rather improbable. A derivation of microscolecine and acanthodriline groups from a common ancestral

form with unmodified sigmoid setae at least on xviii-xix would appear to be more in accordance with evolutionary theory.

### Key to species of *Lenogaster*.

- |   |                          |
|---|--------------------------|
| 1. <i>a.</i> Quadrithecal and quadriprostatic .. ..                               | 2.                       |
| <i>b.</i> Bithecal and biprostatic .. ..  | 4.                       |
| 2. <i>a.</i> Holandric, seminal vesicles in ix and xii, no testis sacs ..         | 3.                       |
| <i>b.</i> Proandric, no seminal vesicles, testis sacs in x                        | <i>yeicus</i> .          |
| 3. <i>a.</i> Penial setae 2 mm. long, with bifid and webbed tips .. ..            | <i>trichochaetus</i> .   |
| <i>b.</i> Penial setae less than 1 mm. long, tips tapering and not bifid .. ..    | <i>falcifer</i> .        |
| 4. <i>a.</i> Copulatory setae present in viii .. ..                               | <i>chittagongensis</i> . |
| <i>b.</i> No copulatory setae in viii .. ..                                       | 5.                       |
| 5. <i>a.</i> Tips of penial setae bifid and webbed or spoon-shaped .. ..          | <i>barkudensis</i> .     |
| <i>b.</i> Tips of penial setae not bifid or spoon-shaped, spear-head-shaped .. .. | <i>pusillus</i> .        |

NOTE.—In view of the numerous gaps in our knowledge of these worms and the possibility of mistakes (similar to those noted in course of re-examination of types of other groups) in published descriptions, the above key must be used with considerable caution.

## I.

### *Acanthodriline Section.*

Quadriprostatic, pores on xvii and xix. Male pores on xviii. Quadrithecal; spermathecal pores on or posterior to 7/8 and 8/9. Ventral setae of xix penial, in paired follicles on each side; ventral setae of xviii lacking. Lateroparietal trunks pass in xiii to dorsal face of oesophagus (?). (Seminal vesicles, when present, in ix and xii?).

*Remarks.*—Two species are known at present only from the lowlands, one in Bombay and the other in southern Burma. The third species has been found only in the uplands of a northern portion of the Deccan. The distribution of this section appears to be discontinuous. Further discussion of distribution will be of little value as worms as small as the species assigned to the genus *Lenogaster* have been collected but rarely.

### ***Lenogaster falcifer* (Stephenson).**

1920. *Eudichogaster falcifer*, Stephenson, *Mem. Ind. Mus.* VII, p. 252. (Type-locality Jubbulpore, C. P. Type and paratypes from Bheraghat, and Saugor, in the Indian Museum.)

1923. *Eudichogaster falcifer*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 412.

*Diagnosis.*—Spermathecal pores? Prostatic pores at *a*, at termini of seminal grooves? Male pores? Seminal grooves crescentic, convex laterally, almost restricted to *ab*, ending at *a*. Female pores? Clitellum? First dorsal pore on 12/13. Unpigmented? Length 40 mm. Diameter 2 mm.

Gizzards? Typhlosole? Holandric; seminal vesicles in ix and xii. Spermathecal duct half as long as ampulla, joined entally by a digitiform diverticulum of same length as duct. Penial setae 0.3 mm. long,

0.008-0.009 mm. thick, ectal portion bent into a gentle, sickle-shaped curve, tip curved in the opposite direction and tapering, ornamentation of marginal indentations (marking off teeth?).

*Distribution.*—Jubbulpore, Bheraghat and Saugor, Central Provinces. (Elevations of 1,000-1,500 feet?).

*Remarks.*—Types acitellate. Gizzards, according to Stephenson, are in vi and vii, but septa anterior to "6/7" were unrecognized and possibly some were destroyed while pinning out the specimen. Male funnels were identified "somewhat doubtfully" Prostates "were scarcely developed" If types are juvenile, spermathecae may not have been developed sufficiently to show important specific characteristics. Nothing is known about the nephridia or main trunks of the circulatory system.

### ***Lenogaster trichochaetus* (Stephenson).**

1920. *Eudichogaster trichochaetus*, Stephenson, *Mem. Ind. Mus.* VII, p. 249. (Type-locality Palchar, Bombay. Type and paratypes from Bombay, in Indian Museum.)

1923. *Eudichogaster trichochaetus*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 419.

1924. *Eudichogaster trichochaetus*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 345.

*Diagnosis.*—Spermathecal pores in *ab*, on viii and ix, on or just behind the setal arcs, on unpaired papillae that reach laterally to *c*. Prostatic pores on *b*? Male pores? Seminal grooves bracket-shaped (?), on or close to *b*, anterior and posterior ends turned mesially and reaching *a*. Female pores? First dorsal pore on 12/13-13/14. Unpigmented? Length 32-100 mm. Diameter  $1\frac{3}{4}$ -3 mm.

Intestine begins in xiv (?). Typhlosole? Holandric; seminal vesicles in ix and xii. Spermathecal duct as long as ampulla, widened entally; diverticulum as long as duct, with ellipsoidal seminal chamber and very short stalk to (? face of) duct entally. Penial setae 2 mm. long, 0.005-0.006 mm. thick, 0.0045 mm. at neck, 0.009 mm. at tip, a triangular web 0.018 mm. long between prongs of bifid tip, undulating, unornamented. Copulatory setae (ventral setae of viii-ix?) 0.42 mm. long, 0.013 mm. thick at midshaft, ornamented with short, transverse ridges (rows of fine spines?) ectally.

*Distribution.*—Palchar, Bombay and Andheri, in the Bombay Presidency. (Lowlands species? All localities below 500 feet.)

*Remarks.*—All of the earlier worms (1920) are acitellate, some of the later specimens clitellate but "much softened" (maceration responsible for the unusual size?). Differences noted between earlier and later worms, such as presence or absence of seminal vesicles in ix, and in length of spermathecal diverticulum relative to ampulla and duct, presumably are explained as result of maturity of second lot, as "examination of the penial and copulatory setae. dispels any doubt as to the specific identification" (Stephenson, 1924, p. 346). Absence of seminal vesicles in ix in the first batch of worms may be an indication of metandry and since penial and copulatory setae may not always be specifically distinctive other characteristics must be accurately described.

The transverse slit-like prostatic pores (1920) are probably, as in *yeicus*, only mesially directed portions of seminal grooves. Nothing

is known as to testes, male funnels, median nephridia of tail segments, main trunks of circulatory system, or location of spermathecal pores in the earlier specimens (1920).

### **Lenogaster yeicus** (Stephenson).

1931. *Eudichogaster yeicus*, Stephenson, *Rec. Ind. Mus.* XXXIII, p. 193. (Type-locality Chaungson, Amherst district. Types in author's collection. Possibly others of type-series in the British Museum.)

*Material examined*.—From local collections: Thaton, October, 2 clitellate specimens. K. John. Kinmunsakhan, Thaton district, October, 2 clitellate specimens. K. John. (Also five clitellate types from Chaungson.)

*External characteristics*.—Length 25 (Kinmunsakhan specimens) to 34 mm. (Thaton worms). Diameter  $1\frac{1}{4}$  (Thaton) to 2 mm. (Kinmunsakhan, measured across clitellum which is protuberant). Unpigmented. The prostomium is epilobous. The first dorsal pore is on 11/12 (3).

The setae begin on ii on which all four couples are usually present. On xx,  $ab < cd = \text{or} > bc$ , both  $cd$  and  $bc < aa$ ; posteriorly  $cd < \text{or} > bc$ , but both always smaller than  $aa$ .

The clitellum is protuberant, reddish, brownish, or yellowish, annular, extending from or just behind 12/13 to or almost to 17/18, lacking ventrally on xvii and laterally on a posterior portion of xvii; dorsal pores and intersegmental furrows lacking, setae present.

Quadrithecal, spermathecal pores minute and superficial, in  $ab$ ; anterior pores on viii, on, just in front of the setal arc or about half way between 7/8 and the arc, posterior pores on 8/9 or on the anterior margin of ix, slightly but definitely behind the intersegmental furrow (locations confirmed by dissecting spermathecal ducts out from the parietes).

The female pores are anteromedian to  $a$ , the pores nearer to  $a$  than to each other, located on a transversely placed area of epidermal whitening with anterior and posterior margins incised at the midventral line.

The seminal grooves are bracket-shaped ( $\{$ ), the longitudinal portion of each groove on or just median to  $b$ , the anterior and posterior ends of the grooves bent mesially almost at right angles on the setal arcs of xvii and xix, the short median limbs reaching to or nearly to  $a$ . The margins of the grooves are swollen, especially around each median limb where the tumescence looks at first glance like a small, transversely placed genital marking. The prostatic pores are minute apertures at the angles of the grooves, close to sites of  $b$  of xvii and xix. Male pores have not been seen but may be in the grooves, on the setal arc of xviii. The lateral margin of the groove is slightly bent laterally on the setal arc of xviii, a transverse groove occasionally continued further along the arc toward  $c$ . Mesially, between the seminal grooves, another furrow may also be visible on the setal arc. A genital shield is not marked off. A midventral region between the seminal grooves may be slightly depressed. A small transversely placed patch of greyish translucence in  $aa$  on a posterior portion of xvii and an anterior portion of

xix is sometimes visible and may be transversely depressed but does not open into the seminal grooves. Intersegmental furrows 17/18-18/19 are lacking ventrally.

*Internal anatomy.*—Septum 6/7 is membranous, very delicate but complete, displaced posteriorly in a funnel-shaped manner by the posterior gizzard; 5/6 slightly stronger and with muscular fibres; 7/8-13/14 membranous but with obvious iridescence due to the presence of muscular fibres; 4/5 present at least ventrally.

The gizzards are in v and vi (7). The calciferous glands are three pairs, in x-xii (7), the anterior the largest, the posterior the smallest, the anterior glands in a posterior part of their segments, the others in contact with both septa. The glands are vertically placed, rather ovoidal to pear-shaped bodies, attached to the lateral wall of the gut dorsally without recognizable stalks, the dorsal surfaces of the glands at or just below the level of the dorsal surface of the gut, the ventral ends reaching below the gut towards the median line to almost touch the corresponding glands of the other side. The lumen of the oesophagus in x-xii is T-shaped in cross section, with a longitudinal slit, crossed only by a very few delicate strands in the lateral wall on each side. The glands open broadly into this slit. The intestine begins in xv (7). The typhlosole begins rather abruptly in xvii-xviii and terminates abruptly in the region of lxxiii-lxxviii; lxxiii (1 from Kinmunsakhan), lxxv (3, from Thaton, Kinmunsakhan and Chaungson), lxxviii (1 from Chaungson). The typhlosole is a simple but high lamella rather regularly zigzagged. Beginning about five segments in front of the hind end and extending anteriorly for several segments is a region of slight modification, the typhlosole slightly thickened, with a low, secondary longitudinal fold at the base, on each side. In xvii-xix or xx, slightly lateral to the main typhlosole, on each side there is a low, interrupted, secondary typhlosole.

The dorsal blood vessel (single) is continued anteriorly to the region of the cerebral ganglia. The ventral trunk is continued to just in front of the suboesophageal ganglia where it bifurcates. A supra-oesophageal trunk is recognizable only in x-xii, receiving in each segment a pair of large vessels from the dorsal poles of the calciferous glands. Extra-oesophageal trunks are first recognizable just behind the nephridial mass of iii where they are formed by the union of several vessels from the body wall two of which cross the nephridial mass. The trunk rises from the parietes just in front of 4/5 and passes posteriorly at the level of the ventral surface of the gizzards, bulged laterally in each of segments v-viii or ix, passing onto the ventral face of the gut only at 9/10 immediately behind which it disappears from sight. Transverse commissures connect the two trunks just in front of 5/6 and 6/7. A latero-parietal trunk, in xvii-xiv on each side, turns mesially just in front of 13/14 and passes up to the dorsal face of the gut. No subneural. The last pair of hearts is in xii (7). The hearts of x-xii bifurcate dorsally, the anterior branch gorged with blood and passing into the vessel from the calciferous gland to the supra-oesophageal trunk, the other branch, slender and empty, passing to the dorsal vessel. Commissures in vii-ix, connect the dorsal and ventral trunks, the hearts of x-xii also passing

into the ventral trunk. A pair of commissures has been found in v, but not in vi.

The nephridia, posterior to the prostatic region, are in three longitudinal ranks on each side, one in *bc*, another in *cd*, and the third lateral to *d*. These nephridia are transversely placed loops, the lateralmost loop the longest. In the posteriormost segments two ranks are still clearly recognizable on each side, one in *ab*, and one in *dd*. Quite possibly there is a middle rank on each side, in *bc*, but as a result of maceration it is difficult to determine whether the tubular mass in *bc* is a discrete nephridium or a lobe of the median tubule. The median nephridium on each side is thickened but is no longer than the lateral tubule. A slender neck passes to and through the septum next in front and close to the ventral parietes is enlarged into a funnel-like structure. Funnels and necks have not been found on lateral nephridia. In xiv-xvi and possibly also in xvii-xix, in *bc* on each side, in place of the median nephridium, there are four smaller tubules. From xiii anteriorly to iv the nephridia are probably also in three longitudinal ranks on each side, but are usually lost in part on opening and pinning out the specimen. In iii there is a wide vertical band of loosely compacted nephridial tubes on the parietes, on each side, the band rather crescentic with the concave side posteriorly.

The testis sacs of x are usually rather ellipsoidal, longitudinally placed on the parietes beneath the gut, just lateral to the hearts. Each sac contains a disc-like testis on the anterior wall, an iridescent male funnel on the posterior wall and a mass of coagulum which has usually shrunk away from the very delicate and transparent, membranous wall of the sac. As a result of this shrinkage of its contents the sac is easily recognizable. In one specimen however the coagulum had not so shrunk (the sac bulged upwards so that the shape is more nearly vertically ellipsoidal) and the membranous wall of the sac is more difficult of recognition. Testes have not been found in xi. Male funnels of xi are of approximately the same size as those of x but have little if any iridescence. Seminal vesicles are lacking or were not found. The prostates are in xvii and xix, rather J-shaped, slightly flattened and shortly elliptical in transverse section. The prostatic duct is short and straight, transversely placed, slender but with brilliant muscular sheen. The vasa deferentia of a side may not come into contact until in xvi or even xvii, both ducts characterized by a similar (spermatozoal ?) iridescence. The deferent ducts pass lateral to the prostatic ducts of xvii into xviii where they apparently penetrate into the parietes midway between the anterior and posterior prostatic ducts (not traced through the body wall). On the posterior face of each prostatic duct are two penisetal follicles, loosely adherent entally but diverging ectally to pass into the parietes separated from each other by a strand of longitudinal musculature. Each follicle contains one functional seta and occasionally a reserve seta. The shaft is nearly straight, base rounded, tip tapering in a triangular and flattened fashion to a sharp point (Thaton specimens) or truncated but with ectal margin slightly jagged as if broken across. Ornamentation of slight serrations of the margins of ectal half of shaft. Penial setae from several follicles of the types were

examined but in each case the tip is truncate, the ectal margin very slightly roughened. Measurements (in mm. by Miss Chapman) are given below.

*Penial setae.*

Segment	Seta	Length	Width		Tip	Locality
			Base	Midshaft		
xvii	<i>a</i>	0.46	0.005	0.005	..	Thaton.
	<i>b</i>	0.35	0.006	0.004	0.002	Thaton.
xix	<i>a</i>	0.39	..	0.004	0.002	Thaton.
	<i>b</i>	0.40		0.005	0.002	Thaton.
xvii	<i>a</i>	0.42	0.005	0.004	..	Kinmunsakhan.
	<i>a</i>	0.40	0.005	0.004	0.002	Kinmunsakhan.
	<i>b</i>	0.38	0.005	0.004	0.002	Kinmunsakhan.
	<i>b</i>	0.40	0.004	0.004	0.002	Kinmunsakhan.
xix	<i>a</i>	0.33	0.004	0.004	0.002	Kinmunsakhan.
	<i>a</i>	0.30	0.004	0.003	0.002	Kinmunsakhan.
	<i>b</i>	0.45	0.004	0.004	0.002	Kinmunsakhan.
	<i>b</i>	0.41	0.004	0.003	0.002	Kinmunsakhan.
xvii	..	0.45	0.004	0.004	0.002	Chaungson. <sup>1</sup>
	..	0.46	0.005	0.004	0.002	Chaungson.
	..	0.45	0.004	0.003	0.002	Chaungson.
	r	0.15	0.004	0.002	0.002	Chaungson.

<sup>1</sup>Types; r, reserve.

The spermathecal ampulla is much shorter than the duct from which it is fairly sharply marked off, shortly ellipsoidal or slightly flattened but still of shortly elliptical outline. An ectal portion of the duct, partly coelomic has a smooth surface and a narrow central lumen. The remaining, longer portion of the duct has a more irregular surface and a wider lumen, but does not clear satisfactorily. Usually there are visible incisions of the margins of duct as if the duct were looped in a rather irregularly and shortly zigzag fashion, with the limbs of the loops bound together, but a corresponding bending of the lumen is

unrecognizable and clear empty spaces when visible within this portion of the duct appear as irregularly scattered small chambers or slit-like cavities. From the ectal portion of this part of the duct a diverticulum usually rather shortly finger-shaped is pendent along the smooth face of the ectal portion of the duct but not quite reaching to the parietes. In the ventral end of the diverticulum is a spheroidal mass of protozoa. The spermathecae may reach into the segment next in front or behind. In Stephenson's figure (1931, p. 195, text-fig. 14) only the portion at the ental end of the spermatheca containing the inner U-shaped line is an ampulla.

Ovisacs are present in xiv (4). Ovaries may reach upwards nearly to the dorsal parietes.

The ventral setae of the spermathecal segments are probably not especially enlarged, at least setal follicles are not protuberant into the coelomic cavities as in *chittagongensis*. Ventral setae of xviii appear to be lacking (could not be found).

*Remarks.*—*E. yeicus* appears to be proandric, with but one pair of seminal vesicles in ix (found only by Stephenson, in but one specimen?) and one pair of testis sacs. However the male funnels of xi are as large as those of x and are usually very slightly iridescent (possibly not due to spermatozoa, *vide chittagongensis*), while the deferent ducts from the posterior funnels are also as iridescent as those from the anterior funnels. Stephenson appears to regard the seminal vesicles in this and other species as rather ephemeral structures. (1931, p. 194.) However it is possible that with the development of testis sacs, seminal vesicles are no longer useful and hence have been lost in most individuals. (Note also absence of vesicles in *chittagongensis* which likewise has testis sacs.)

Each penial seta examined lacks the bifid and webbed tip described by Stephenson. In the Thaton specimens the tip appears to be complete though possibly much worn, but in other specimens the tip may have been broken off at a weak spot in the neck region.

*Diagnosis.*—Spermathecal pores in *ab*, anterior pores on or in front of the setal arc of viii, posterior pores on or just behind 8/9. Prostatic pores at sites of *b* of xvii and xix, at angles of seminal grooves. Male pores on *b* of xviii (?). Seminal grooves bracket-shaped, on or just median to *b*, anterior and posterior ends directed mesially at right angles along the setal arcs of xvii and xix to *a*. First dorsal pore on 11/12. Length 25-45 mm. Diameter  $1\frac{1}{4}$ -2 mm.

Proandric; but with normal posterior male funnels and deferent ducts; testes and anterior funnels in paired testis sacs. Spermathecal duct much longer than ampulla, diverticulum finger-shaped and pendent from the base of an irregular ental portion of duct with widened lumen. Penial setae 0.30-0.46 mm. long, 0.004-0.006 mm. thick at base, 0.003-0.005 mm. at midshaft, 0.002 mm. at neck, 0.004 mm. across tip; tip (according to Stephenson) widened, bifid and with a web between the prongs or tapering or truncate (worn or broken?), ornamentation slight marginal serrations.

*Distribution.*—Lowlands in western portions of Thaton and Amherst districts, Burma.



## II.

*Microscolecine Section.*

Biprostatic ; pores in seminal grooves restricted to xvii (?). Male pores on xvii (united with prostatic pores ?). Bithecal ; spermathecal pores on or behind 7/8. Ventral setae of xviii and xix sigmoid. Lateroparietal trunks pass in xiii to ventral face of oesophagus. (Seminal vesicles, when present, in ix or xi but not xii ?).

*Remarks.*—In this section one species (*chittagongensis*) has been collected in both hills and plains of eastern Bengal and Burma. One species (*barkudensis*) is known only from lowlands at the extreme north of Madras Presidency. The two remaining species are known only from the uplands, one (*pusillus*) from a northern portion of the Deccan while the other (*parvus*, relationships doubtful) is known only from Dehra Dun in the Western Himalayas.

***Lenogaster barkudensis* (Stephenson).**

1921. *Eudichogaster barkudensis*, Stephenson, *Rec. Ind. Mus.* XXII, p. 765. (Type locality Barkuda Island, Chilka Lake, Ganjam district, Madras Presidency. Types in the Indian Museum.)

1923. *Eudichogaster barkudensis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 408.

*Diagnosis.*—Spermathecal pores on *a*, just in front of setal arc. Prostatic pores ? Male pores ? Seminal grooves in *ab*, oblique, diverging posteriorly. Female pores ? First dorsal pore on 11/12. Length 57 mm. Diameter  $1\frac{3}{4}$  mm.

Typhlosole ? Metandric (?), but with large male funnels in *x* ; no seminal vesicles. Spermathecae like those of *chittagongensis* ? Penial setae 0.53 mm. long, 0.0025 thick ; shaft slightly bowed and sinuous ectally, tip flattened, widened (and bifid with web between prongs ? or) spoon-shaped (?).

*Distribution.*—Known only from the type-locality, Barkuda Island, Chilka Lake, at northern boundary of Madras Presidency. (Elevation below 500 feet.)

*Remarks.*—Known only from the types, some at least of which are clitellate. Apparently only one specimen, and that in poor condition, was dissected. Stephenson's "prostatic pores" probably are seminal grooves. The posterior male funnels are smaller than those of *x*, while testes were identified in *xi* but not in *x*. This may indicate that the species is metandric but in absence of information regarding presence of spermatozoal masses, testis sacs, iridescence on male funnels, the condition of the deferent ducts, etc., 'andric' characterization of the male organs remains doubtful. The figure of a spermatheca appears to show a condition like that in *chittagongensis* except that an ampulla is not indicated. The nephridia appear to be much like those of *chittagongensis* but whether the median nephridia of tail segments have preseptal funnels is unknown.

Distinguished for the present though doubtfully from *chittagongensis* by the very slightly more median location of the spermathecal pores, the shape of the tip of the penial setae, and the absence of copulatory setae.

**Lenngaster chittagongensis** (Stephenson).

1917. *Eudichogaster chittagongensis*, Stephenson, *Rec. Ind. Mus.* XIII, p. 411. (Type locality Rangamati, Chittagong Hill Tracts, Bengal. Types in the Indian Museum.)
1923. *Eudichogaster chittagongensis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 411.
1931. *Eudichogaster chittagongensis*, Stephenson, *Proc. Zool. Soc. London*, 1931, p. 78.
1931. *Eudichogaster chittagongensis*, Stephenson, *Rec. Ind. Mus.* XXXIII, p. 192.

*Material examined*.—From local collections :—

Kyaikto, Thaton district, September, 11 clitellate specimens. K. John Wanetchaung, Insein district, September, 1 clitellate specimen. K. John. Taikkyi, Insein district, September, 1 clitellate specimen. K. John. Pegu, September, 2 clitellate specimens. K. John. Paukkaung, Prome district, August, 1 clitellate specimen. K. John. Thanbula, Thayetmyo district, August, 2 clitellate anterior fragments. K. John. Mt. Popa, Myingyan district, September, 3 clitellate specimens. K. John. Indaw Lake, Katha district, September, 1 clitellate specimen. Saw San Shwe. "Hills", Naba, Katha district, September, 7 clitellate specimens. Saw San Shwe. Katha, September, 5 clitellate specimens. Saw San Shwe. Lashio, F. S. S., September, 7 clitellate specimens. H. Young. (Also a number of specimens from Rangoon identified by Stephenson.)

*External characteristics*.—Length 24-78 mm. (Naba specimens 24-30 mm., Wanetchaung specimens *ca.* 50 mm., Lashio specimens 70-78 mm.). Diameter 1-2 mm. (*ca.* 1 mm. Naba worms, *ca.* 1½ mm. Wanetchaung worms, 2 mm. Lashio worms). Unpigmented, clitellum dark reddish, brownish or yellowish. The prostomium is proepilobous or perhaps more accurately epilobous but with a triangular tongue the pointed posterior end of which reaches nearly to 1/2. Setae begin on ii on which all four couples are present. The *a* setae of viii are usually so deeply retracted into the body wall as to be invisible externally.

The first dorsal pore is on 11/12 (30, but with an imperforate though pore-like marking on 10/11 on 2), or 12/13 (1).

The clitellum extends from 12/13 to just in front of 17/18 or to 17/18, annular except on xvii where it is lacking ventrally; dorsal pores and intersegmental furrows lacking, setae present.

Spermathecal pores are minute and superficial, on viii, in *ab*, on or in front of the setal arc, usually nearer to *a* than to *b*. The pores are difficult to see even with high magnification and brilliant illumination, of about the same size or even less conspicuous than the apertures into the *a* follicles of the same segment, but often distinguished from the follicle apertures by the presence of a very fine, opaque, whitish, marginal ring. Identification of the spermathecal pores has been confirmed on a number of specimens by dissecting the spermathecal ducts out from the parietes. In all other specimens that were opened the duct passes into the parietes between *a* and *b*.

There is a pair of female pores (30), the pores anteromedian to *a*, nearer to *a* than to each other.

The male field is a transversely placed, whitened, often rather spindle-shaped area of slight protuberance, fairly sharply demarcated, reaching laterally into *bc* (when the ends are bluntly rounded) or nearly to *c* (if the area is spindle-shaped), probably restricted to xvii; 17/18 usually

unrecognizable ventrally but when visible slightly bulged posteriorly. An anterior portion of the field, in *aa*, may be transversely depressed. The seminal grooves are short, restricted to the male field, the anterior end about on *a*, the posterior end about on *b*, usually crescentic, the concave side facing posteromesially, or with a posterior portion straight, and forming an obtuse angle with a straight anterior portion. The margins of the grooves are usually slightly swollen but the swelling may be more extensive, when a presetal portion of the male field in *aa* is depressed, so that the grooves appear to be on circular or slightly elliptical, low papillae. On a worm with an unusually deep median depression the diagonally placed pseudo-papillae are especially obvious. From the anterior end of a groove there is often protuberant the tip of a penial seta, presumably *a*, a second penial seta never visible externally. Prostatic and male pores have not been identified definitely but the prostatic apertures are probably in the seminal groove just lateral to the penial seta, the male openings at the posterior ends of the grooves (?).

A small area on viii on each side, bearing the ventral setae and the spermathecal pore is often slightly modified, very slightly tumescent, occasionally also dark greyish and glistening, but the area is not clearly demarcated. There are no other genital markings.

*Internal anatomy.*—Septa 4/5-6/7 are membranous, practically transparent and very delicate; 7/8 more translucent; 8/9-12/13 slightly muscular as indicated by iridescent striations.

The gizzards are in v and vi (18). The calciferous glands are three pairs, in x-xii (18), the anterior pair the largest, the posterior pair the smallest though the anterior glands are in the posterior part of the segment while the other glands are in contact with both septa of their segments. The glands are vertically placed, ellipsoidal to ovoidal bodies attached to the lateral wall of the gut dorsally without stalks, the dorsal poles of the glands usually about at the level of the upper surface of the gut, the ventral ends reaching below the oesophagus and slightly towards the median line to almost touch the corresponding glands of the other side so that the gut is practically invisible from the ventral side. In three specimens the upper poles of the glands, perhaps as a result of some unusual contraction, are so low that the glands are invisible in a dorsal dissection until the gut is rolled over to one side or the other. The lumen of the oesophagus in xi-xii and the posteriormost portion of x is T-shaped in transverse section, a fairly thick, median partition on each side separating the main lumen from a longitudinal groove in the wall dorsolaterally. The groove may be shallow with three small openings into the glands on its floor or deeper and with larger lateral apertures into the glands. The calciferous lamellae are few, rather thick, vertically placed and do not reach into the longitudinal slit in the oesophageal wall. On the inner wall of the gut in xii-xiv there are longitudinally placed, lamelliform, white ridges. The intestine begins in xv (18), the valve in the posteriormost portion of xiv and the anteriormost part of xv. The typhlosole begins rather abruptly in the posterior portion of xvii or anteriorly in xviii and is continued into the region of lxxiii-lxxviii where it ends abruptly; lxxiii, one specimen from Naba; lxxiv, one specimen from Lashio; lxxv, one specimen from Lashio; lxxvi, one

specimen from Pegu ; lxxvii, one specimen from Taikkyi and two from Kyaikto ; lxxv-lxxviii, four specimens from Thanbula, Paukkaung and Rangoon. The typhlosole is a simple, relatively rather high, vertical lamella. In the last six to ten segments the typhlosole is enlarged and may reach to the floor of the gut, the apparent increase in thickness due to the presence of six or seven ridges on each lateral face of the lamella, the ridges diagonal and passing anteroventrally from dorsal points close to the roof of the gut, successive ridges often connected with each other by much lower, short ridges.

The dorsal blood vessel (single) is continued anteriorly onto the pharyngeal bulb. The ventral trunk passes (one specimen only) to the anterior margin of the subpharyngeal ganglia. A supra-oesophageal trunk is recognizable only in x-xii, possibly continued into xiii in one specimen, receiving in each segment a pair of large blood-filled vessels from the dorsal poles of the calciferous glands. Extra-oesophageal trunks are first recognizable behind the nephridial mass of iii where they are formed by the union of several vessels from the parietes, one or two of which cross the nephridial mass, the largest vessel underneath the nephridia of iii, on the body wall parallel to the nerve cord. Just in front of 4/5 the trunks pass upwards from the parietes and at the level of the ventral face of the gut through 5/6 and succeeding septa, bowed or looped laterally in each segment, with transverse commissures just in front of 5/6 and 6/7, passing onto the ventral face of the gut posteriorly in ix or anteriorly in x, disappearing from sight near the calciferous glands.<sup>1</sup>

A pair of longitudinal vessels is again visible on the ventral face of the gut in an anterior portion of xiii but instead of passing posteriorly on the gut, these vessels pass off and posteroventrally to the parietes just in front of 13/14 from whence they are continued into xviii in *bc* (lateroparietal trunks). No subneural. The hearts of x-xii bifurcate dorsally (6), the posterior branch slender, white and passing to the dorsal trunk, the anterior bifurcation larger, often filled with blood and opening into the vessel from the dorsal pole of a calciferous gland to the supra-oesophageal trunk. The last pair of hearts is in xii (18). The commissures of viii and ix may be as large as the hearts but connect the dorsal and ventral trunks only. Commissures of vii anteriorly have not been traced, usually small and in part at least empty.

The excretory organs are, so far as can be discovered, integumentary. In iii on each side there is a wide, vertically placed band of rather closely crowded tubules, each band concave posteriorly. From xix posteriorly the nephridia are in longitudinal ranks, in the postprostatic region four usually recognizable on each side, occasionally only three. The rows in this posterior region are in *ab*, *bc*, *cd*, and lateral to *d*, or two rows lateral to *d* and two median. Nephridia are transversely placed loops, the lateralmost the longest. In a small posterior portion of the body (the last 20+ segments) the lateral nephridia are small and the median nephridium on each side is enlarged, extending from *a* to or nearly to *c*

---

<sup>1</sup> In two worms, rather macerated, extra-oesophageals could be traced somewhat dubiously into xii, in the floor of the oesophagus slightly lateral to the median line.

with a preseptal funnel close to the ventral parietes at or near *a* and a slender duct that passes into the parietes midsegmentally and either close to the midventral line or just in front of seta *a*. In xvii on each side there is a group of closely crowded, small nephridia in *ac* and two or three in a transverse row further laterally, with a similar grouping in xviii and xvi, and xv. In xiv there is a transverse row of six on each side, a transverse row of five on each side in xiii just in front of 13/14 and one or two further small nephridia anteriorly in *ab*, a transverse row of five in xii, a transverse row of four in xi. Anteriorly there are probably also transverse rows of four to six on each side. Nephridia are very loosely attached to the parietes and are often broken off and lost in opening and pinning out the specimen, especially in the region between xiii and iii, those in the posterior portion of the body often embedded in coelomic coagulum and very poorly preserved. Fortunately in the large, Lashio worms there is little coelomic coagulum and the nephridia are well preserved posteriorly, the preseptal funnels are easily recognizable.

The male funnels, the button-like testes, and the loose testicular coagulum of x are included in paired testis sacs with very delicate and transparent walls. The sacs may be ventral or may extend dorsally half way up the gut or even to the level of the dorsal face of the gut. The hearts of x are just median to the sacs. Male funnels of x are characterized by a brilliant iridescence. The funnels of xi are of approximately the same size as those of x but lack the brilliant iridescence. On careful examination a slight iridescence is noticeable on the posterior funnels as well as in the ducts from these funnels but this probably is not due to the presence of spermatozoa as similar, slight iridescence also characterizes the rather thick portions of the oviducts in xiv. The vasa deferentia come into contact or nearly so in xii-xiii or posteriorly and can be traced in a few specimens, into xvii where they pass, still not united, lateral to the prostatic duct, penetrating into the parietes slightly behind the duct and just in front of 17/18. The course of the ducts through the parietes has not been traced but the male pores must be on xvii and probably in a posterior portion of the seminal groove, if the deferent duct does not unite with the prostatic duct within the parietes. The iridescence of the ducts from anterior funnels is no more strongly marked than in those from the posterior funnels. Testes have not been found in xi (18) nor have seminal vesicles been seen, either in ix, xi or xii (18). The prostates are in xvii or xvii and xviii, the ducts in xvii, straight, transversely placed, narrower than the glands but slightly thickened ectally, *ca.*  $\frac{1}{2}$  mm. long. The two penisetal follicles of a side are united ectally but distinct ventrally, passing into the parietes separated by a strand of longitudinal musculature, the lateral follicle passing into the body wall on the median face of the prostatic duct. Each follicle contains a single seta.

The shaft of a penial seta is never straight but the bends or curvatures are variable. Margins of the shafts for a distance from 0.01-0.02 mm. behind the tip to about one-half to one-third way along the shaft are serrate. In addition there are visible, under favourable conditions 12-17 transverse, slightly jagged ridges (or circles?) as of very fine teeth. The tip is usually truncate but with a jagged edge as if broken, rarely

(3 setae) terminating in a short spine. Measurements (by Miss Chapman in mm.) are given below :—

*Penial setae.*

Length	Thickness			Seta	Locality
	Base	Midshaft	Tip		
0.60	0.005	0.004	0.002		Lashio
0.54	0.004	0.004	..		
0.58	0.005	0.004	0.002		
0.58	0.005	0.006	0.002		
0.60	0.004	0.006	0.003		
0.54	0.004	0.004	0.002		
0.55	0.003	0.005	0.003		
0.54	0.004	0.006	0.002		
0.55	0.004	0.005	0.002		
0.58	0.004	0.004	0.002		
0.56	0.004	0.004	0.003		
0.50	0.004	0.006	0.002		
0.57	0.005	0.006	0.002		
0.55	0.004	0.005	0.003		
0.58	0.005	0.006	0.003		
0.57	0.005	0.004	0.002	<i>a</i>	Kyaikto
0.57	0.005	0.004	0.002	<i>b</i>	
0.60	0.005	0.005	0.002	<i>a</i>	
0.56	0.006	0.005	0.003	<i>b</i>	
0.56	0.005	0.004	0.002		Mt. Popa
0.55	0.004	0.003	0.002		
0.54	0.003	0.004	0.002		Naba
0.64	0.004	0.004	0.002		
0.65	0.004	0.004	0.002		
0.58	0.005	0.005	0.002		
0.59	0.005	0.004	0.002		

Setae from *a* and *b* follicles are similar.

Setae from large specimens from Lashio are of about the same size as those from much smaller worms.

Thickness at tip is measured just behind the jagged ectal margin.

The spermathecae are elongate, coiled or twisted in viii or penetrating into vii or ix. The duct is three to five times as long as the ampulla, nearly as thick, somewhat irregular, with fairly thick wall, irregularly constricted, twisted or bulged and with circular or irregular ridges internally. This portion of the duct often does not clear satisfactorily and only rarely does the lumen approximate to the condition figured by Stephenson (1923, p. 412, fig. 212). A short ectal portion of the duct, mainly within the parietes, is slightly thinner, has a smoother surface, thick (muscular?) wall, and a narrow, regular lumen. The diverticulum is shortly digitiform, without a stalk, pendent on the anterior face from the ectal end of the irregular portion of the duct to or nearly to the ventral parietes. Like the irregular part of the duct the diverticulum usually does not clear satisfactorily. The lumen is usually quite irregular, often apparently arborescent, occasionally large and then not arborescent. The ampulla is spheroidal to shortly ellipsoidal, marked off from the duct by a slight constriction and further distinguished by a slightly thinner and more nearly smooth wall both internally and externally.

A pair of ovisacs is present in xiv in each specimen. The ovaries are larger, the ova, relative to the size of the worm, unusually large.

The follicle of seta *a* of viii is unusually large and penetrates into the coelomic cavity but is bent over laterally and bound to the parietes. The setal shaft is nearly straight but a short portion at the tip and the base is slightly arced, in opposite directions, or both bends may be on the same side. The tip is slightly flattened and a short region just behind the tip is ornamented with scattered, triangular teeth, or longitudinal rows of slight gouges the ental margins of which are jagged and with an appearance as of very fine teeth. Measurements (in mm. by Miss Chapman) are given below.

*Copulatory setae.*

Length	Thickness <sup>1</sup>	Locality
0.27	0.013	Lashio
0.28	0.014	
0.28	0.013	
0.30	0.013	
0.28	0.014	
0.25	0.011	
0.24	0.011	
0.24	0.013	Kyaikto
0.22	0.013	Mt. Popa
0.26	0.012	
0.23	0.012	Naba
0.25	0.011	
0.23	0.012	
0.16	0.014 r	
0.16	0.015 r	

<sup>1</sup> Measured at region of greatest width, about one-half to one-third from the base.

Reserve seta.

The epidermis of the male field, as seen in a transverse incision across the area, does not appear to be appreciably thickened.

The ventral setae of xviii and xix from several specimens have been examined and are sigmoid, ornamented near the tip with several transversely placed, jagged ridges or rows of fine teeth.

*Remarks.*—One specimen from Mt. Popa has an extra spermatheca on ix (left side), the pore in *ab* just in front of the transverse setal line.

*Diagnosis.*—Spermathecal pores in *ab*, on or just in front of the setal arc. Prostatic pores near anterior ends of seminal grooves? Male pores at posterior ends of seminal grooves? Latter crescentic or with two straight limbs forming an obtuse angle, anterior end at *a*, posterior end on *b*, on a transversely placed male field restricted or nearly so to xvii and reaching laterally into *bc* or nearly to *c*. First dorsal pore on 11/12. Length 24-78 mm. Diameter 1-2 mm.

Proandric, but with normal posterior male funnels and deferent ducts; testes and anterior funnels in paired testis sacs. Spermathecal duct much longer than the ampulla, a short ectal portion with thick, smooth wall and narrow regular lumen, ental portion irregularly constricted, bulged or twisted and with narrower wall and irregular lumen; shortly finger-shaped diverticulum pendent on anterior face from base of the irregular portion of the duct to or nearly to the parietes. Penial setae 0.54-0.64 mm. long, 0.003-0.006 mm. thick at base and midshaft, 0.002-0.003 mm. at tip; margins serrate, ornamentation of 12-17 circles of fine spines, tip terminating in a short spine (?). Copulatory setae; *a* of viii, 0.22-0.28 mm. long, maximum thickness 0.011-0.014 mm., ornamentation of scattered triangular teeth or gouges with jagged ental margins.

*Distribution.*—In India known only from the type-locality, Rangamati in the Chittagong Hill Tracts, just west of Burma. In Burma widely spread in the central portion, but recorded only once from peripheral portions aside from Tenasserim division; Amherst, Thaton, Hanthawaddy, Insein, Pegu, Toungoo, Prome, Thayetmyo, Myingyan, Katha, and Upper Chindwin districts, and Lashio on Shan Plateau.

### ***Lenogaster* (?) *parvus* (Fedarb).**

1898. *Dichogaster parvus*, Fedarb, *Proc. Zool. Soc. London*, 1898, p. 499. (Type-locality, Dehra Dun. No type.)  
 1900. *Trigaster parva*, Michaelsen, *Das Tierreich* X, p. 334.  
 1903. *Eudichogaster parva*, Michaelsen, *Mitt. Mus. Hamburg* XIX, p. 13.  
 1903. *Eudichogaster parva*, Michaelsen, *Geogr. Verbr. Berlin*, p. 109.  
 1909. *Eudichogaster parva*, Michaelsen, *Mem. Ind. Mus.* I, p. 112.  
 1910. *Eudichogaster parva*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), p. 13.  
 1923. *Eudichogaster parvus*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 415.

*Diagnosis.*—Spermathecal pores in *ab*, on or just in front of the setal arc. Prostatic pores? Male pores? Seminal grooves crescentic as in *chittagongensis*? Female pores? First dorsal pore on 11/12. Unpigmented? Length 40 mm. Diameter 2 mm.

Intestine begins? Typhlosole? Last hearts? Proandric (? or metandric?); seminal vesicles (?) in xi (?). Spermathecae tubular, duct longer than the ampulla (?), no diverticulum (?). Penial and copulatory setae?



*Distribution.*—Known only from the type locality, Dehra Dun, in the Western Himalayas. (Elevation 2,000-3,000 feet).

*Remarks.*—Known only from the clitellate type which has been lost. The "male pores" probably are seminal grooves, and may be like those of *chittagongensis* (note anteromesially converging porophores). According to Fedarb the calciferous glands are in xi-xiii and with the "free ends" pointing towards the mid-dorsal line. The tongue-shaped seminal vesicles of xi may have been vertically placed testis sacs,<sup>1</sup> and if the calciferous glands are in the usual locations (in x-xii) would then be in x. (Ovaries may have been overlooked and large ovisacs mistaken for ovaries. If the segmental numbering internally was then determined from the ovisac segment as xiii this would explain the location of the calciferous glands.) Nephridia are said to be diffuse and of considerable size but are not further characterized and nothing is known of the circulatory system. The slightly bulbous swelling at the ental end of the spermatheca is possibly an ampulla, as in *chittagongensis*. Location of the last hearts is not mentioned and spermathecal diverticula as well as penial setae may have been overlooked.

If Fedarb correctly located and described the calciferous glands the generic affiliations of *parvus* will have to be reconsidered.

### ***Lenogaster pusillus* (Stephenson).**

1920. *Eudichogaster pusillus*, Stephenson, *Mem. Ind. Mus.* VII, p. 253. (Type-locality Saugor, C. P. Type in the Indian Museum.)

1923. *Eudichogaster pusillus*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 418.

*Diagnosis.*—Spermathecal pores on or near 7/8? Prostatic pores? Male pores? Seminal grooves transversely placed in *ab*? Female pores? First dorsal pore? Unpigmented? Length 28 mm. Diameter 1½ mm.

Typhlosole? Holandric?; seminal vesicles in ix (?). Spermathecae like those of *chittagongensis*? Penial setae 0.56 mm. long, 0.004 mm. thick at midshaft; shaft almost straight, tip flattened, widened and spear-head shaped.

*Distribution.*—Known only from the type-locality, Saugor, in the Central Provinces. (Elevation *ca.* 1,000 feet?.)

*Remarks.*—Known only from the clitellate holotype. Seminal grooves are not mentioned. The prostatic pores are said to be transverse slits in *ab* but it is unlikely that the apertures are so large and these "pores" may be seminal grooves. The direction however is peculiar. Nephridia are not characterized and nothing is known about the main trunks of the circulatory system. Male funnels were "doubtfully identified" in x and xi, and only one seminal vesicle was found, in ix. The figure of a spermatheca appears to show a condition much like that in *chittagongensis*, with a short ampulla constricted off from a wider, irregular ental portion of the duct with marginal incisions, and a pendent

---

<sup>1</sup> Stephenson at first (1917) referred to the testis sacs of *chittagongensis* as "testis sacs and seminal vesicles conjoined".

diverticulum, and a shorter, smooth-walled ectal portion which is much narrower than the ental part of the duct. As copulatory setae are not mentioned they are assumed to be lacking.

This species can be distinguished at present though doubtfully from *chittagongensis* by the penial setae and the absence of copulatory setae. In specimens of *chittagongensis* from Thaton the tips are similarly flattened but not widened.

### **Pellogaster**, gen. nov.

*Diagnosis*.—Quadriprostatic; prostatic pores (united apertures of prostatic duct and lateral peni-setal follicle?) on xvii and xix; male pores on xviii in seminal grooves. Quadrithecal; spermathecal pores on viii and ix. Female pores paired. Setae lumbricine; ventral setae of xviii as well as *a* on viii and ix lacking, ventral setae of xvii and xix penial, in paired follicles on each side. Clitellum annular; on development of clitellar glandularity intersegmental furrows disappear and dorsal pores are occluded but setae are retained. Unpigmented. Septa present from 4/5. Gizzards in v-vi. Calciferous tissue in vertical lamellae in paired, longitudinally placed, hemi-ellipsoidal protuberances from ventral face of gut in x-xiii, the protuberances not constricted off from oesophagus. Intestine begins in xvi (?). Typhlosole simple and lamelliform throughout. Hearts latero-oesophageal, in x-xii. Extra oesophageal trunks pass into gut in x and through x-xiii within a longitudinally placed, wide, median ridge with flat dorsal surface on the floor of oesophagus. Supra-oesophageal trunk in ix-xiii. (Latero-parietal trunks?) Excretory organs: closed (?), exonephric (?), micronephridia (?) closely crowded into large, paired masses of circular outline vertically placed on parietes in ii (?), on anterior faces of septa in iii-ix on each side; in two (or three?) longitudinal rows on the parietes on each side from xii posteriorly; in posteriormost segments the median nephridium on each side enlarged and with a preseptal funnel. Prostates tubular.

*Genotype*.—*Eudichogaster bengalensis* Michaelsen 1910.

*Distribution*.—North eastern portion of the main peninsular area from Jubbulpore to Orissa, and Bengal.

*Remarks*.—According to Stephenson (1916, p. 344) the calciferous glands are not "set off" from the oesophagus and "are not calcareous glands any more than the similar part of the tube in, for example *Pheretima posthuma*" The condition in *Pellogaster* is not comparable however to that in *Pheretima* as glands are definitely "set off" though sessile (not constricted off so as to be connected to the gut by a pole or stalk). The glandular protuberances were not recognized by Stephenson as a result of failure to examine the ventral face of the gut. The bilobed appearance of the median ridge on the floor of the oesophagus in the calcareous region is the result of slight and unimportant median depression along the dorsal surface and perhaps also of a contraction of the ridge along the line of attachment to the gut floor. The parietal fur of micronephridia mentioned by Stephenson is probably an artefact.

***Pellogaster bengalensis* (Michaelsen).**

1910. *Eudichogaster bengalensis*, Michaelsen, *Abh. Nat. Ver. Hamburg XIX*, pp. 13 and 96. (Type-locality, Tribeni, Bengal. Type in the Indian Museum).
1916. *Eudichogaster bengalensis*, Stephenson, *Rec. Ind. Mus. XII*, p. 344.
1920. *Eudichogaster bengalensis*, Stephenson, *Mem. Ind. Mus. VII*, p. 248.
1923. *Eudichogaster bengalensis*, Stephenson, *Oligochaeta in F. B. I. Series*, p. 410.

*Material examined.*—From the Indian Museum : 1 dissected, clitellate specimen in poor condition labelled “*Eudichogaster bengalensis* Mich. Tribeni, Bengal. R. Hodgart. 31-7-09. ZEV 3506/7”. Referred to hereinafter as “A.”

- 1 undissected, clitellate specimen in poor condition from a tube labelled “*Eudichogaster bengalensis* Mich, Rajmahal, Bengal. N. Annandale, 6-vii-09. ZEV 3503:7/”. Four undissected, a clitellate and macerated specimens were not studied. Genital markings and seminal grooves are either lacking or unrecognizable. These worms may or may not be of the same species as the clitellate specimen. Clitellate specimen referred to hereinafter as “B.”
- 5 a clitellate (1 dissected) specimens from a tube labelled, “*Eudichogaster bengalensis* Michlsn. From the bed of the Chitartala (branch of the Mahanadi) near Kendua, Patna, Cuttack. Dr. B. L. Chaudhuri. 25-iii-10. ZEV 6561:7”. Several a clitellate or juvenile specimens on which sexual markings are lacking or unrecognizable were not examined.
- 1 dissected, a clitellate specimen broken into two across xvi labelled “*Eudichogaster bengalensis* Michlsn. Bheraghat, Marble Rock, Jubbulpore, C. P. W-217/1”.

*External characteristics.*—The prostomium (of A) is tanylobous, the longitudinal furrows continued to 1/2. The first dorsal pore is on 10/11 (B). The clitellum (B) is annular, extending from 13/14 to 16/17 ; intersegmental furrows lacking but dorsal pores and setae present.

Spermathecal pores are tiny, transversely placed, straight or crescentic slits, on or just lateral to *a*, on or a trifle behind the setal arcs of viii and ix. On the type (A) each pore is on a longitudinally placed translucent area of elliptical outline which does not reach to either intersegmental furrow. The *a* setae of viii and ix certainly appear to be lacking, *b* setae present on viii (of B) but unrecognizable on ix on either specimen though sites of setal follicles are recognizable internally and externally.

Female pores are paired (B), anteromedian to *a*.

Seminal grooves are straight, wide and fairly deep, on or just median to *b*, extending nearly to the setal arcs of xvii and xix. On the lateral margin of each seminal groove and on the setal arc of xviii is a very tiny, rounded and soft protuberance, on the ventral face of which there is recognizable, under most favourable conditions, a minute, slit-like aperture, presumably the male pore. Prostatic pores are on xvii and xix but have not been found though looked for with considerable care. Just in front or behind the termini of the seminal grooves are two closely paired apertures of penisetal follicles. Penial setae may be protuberant to the exterior through these apertures, the median seta much more so than the lateral. A genital shield of parietal or epidermal thickening if present is unrecognizable but the epidermis around the seminal grooves appears to be thickened.

Genital markings are tiny, translucent spots, of circular to transversely elliptical outline, sharply demarcated and readily visible under

high magnification and brilliant illumination but only after removal of cuticle. Each marking of *xx* is at the centre of a transversely placed area of epidermal thickening (?) of elliptical outline that reaches from *a* to *b*, the thickened area opaque and white and forming a wide band-like marginal rim around the translucent spot (whole marking, centre and rim, lacking on left side of *A*, present on each side of *B*). Just anterior to each spermathecal pore of the type, except on the left side of *viii*, there is a circular marking and just in front of the penial setae of *xvii*, on the right side there is a transversely placed, elliptical marking. On the other specimen (*B*) there is on each side a transversely placed marking just lateral to the penial setae of *xvii* and *xix*, another transversely placed marking on each side just in front of the ventral setae of *xvii* and just behind the setae of *xix*.

*Internal anatomy.*—Septum 4/5-5/6 are present and membranous, transparent; 6/7-9/10 muscular; 10/11 with slight muscular sheen.

Gizzards are in *v* and *vi*. On the ventral face of the oesophagus in *x-xiii* there are paired, longitudinally placed, hemi-ellipsoidal or half-bean-shaped, conspicuous protuberances that do not quite reach to the septa bounding the segments. A fairly deep but narrow, slit-like longitudinal and median groove separates the protuberances in *x-xii* but in *xiii* the protuberances are united though with a slight depression at the median line. The septa pass to the ventral face of the gut within deep grooves between successive pairs of protuberances. On the floor of the oesophagus in *x-xiii* is a conspicuously raised, wide ridge with flat or nearly flat, smooth dorsal surface, the ridge narrowed in the regions of septa 10/11-12/13. Midsegmentally on each side, in each of segments *x-xiii*, the gut lumen is slightly deepened ventrally and in each of these ventral depressions there are several thin, vertically placed lamellae the dorsal margins of which are free. Between these lamellae there are clusters of fine calcareous granules. The inner wall of the oesophagus is provided laterally and dorsally with short, horizontally placed, rather thick longitudinal ridges or thickly villiform protuberances. The intestine probably begins just behind 15/16 (or possibly in *xv*?), condition of specimen not permitting a more exact determination. The typhlosole which begins in *xviii* (*B*) and ends abruptly in *lxxiii* (*A*, estimate only) is high, slightly zigzagged and lamelliform, somewhat lower posteriorly. Caeca, supra-intestinal glands, grids, posterior thickening ridging, or other modifications of the typhlosole are unrecognizable and probably lacking.

The dorsal blood vessel (single) is recognizable anteriorly nearly to the supra-pharyngeal ganglia. The ventral trunk is continued anteriorly to the subpharyngeal ganglia where it bifurcates. Extra-oesophageal trunks are first visible just behind the subpharyngeal ganglia where they are formed by the union of three large tributaries from the parietes one of which passes across the nephridial mass of *ii*. Just in front of 4/5 the trunks rise from the parietes, with a large transverse commissure just behind 4/5 and another just behind 5/6. In the anterior portion of *x* each trunk passes into the gut and continues posteriorly within the ridge on the floor of the gut. This section of the trunk is as large as or slightly larger than the anterior, coelomic portion, the two trunks occupy-

ing nearly all of the space within the ventral ridge at regions of septal narrowing. A supra-oesophageal trunk ends abruptly on the gut mid-segmentally in ix and just behind 13/14. No subneural trunk. Lateroparietal trunks have not been found and presumably are lacking. Hearts of x-xii bifurcate dorsally, the slender posterior branch passing into the dorsal trunk, the larger, blood-filled anterior bifurcation passing into the supra-oesophageal trunk. Commissures of viii and ix open only into the dorsal vessel. Hearts and commissures of viii-xii have been traced into the ventral trunk. Last hearts in xii (2).

A large nephridial mass of nearly circular outline is flattened against the body wall vertically on each side about in the region of ii (?), the mass covered by a transparent membrane. Just posteromedian and on the anterior face of a vertically placed membrane (ventral rudiment of septum 3/4 ?) is a transversely placed nephridial mass slightly lateral to the nerve cord on each side. In line with this mass and behind it is another nephridial mass. This latter is attached to the anterior face of septum 4/5 close to the parietes in *ab*. Paired nephridial masses are present in similar locations (on anterior faces of septa close to parietes) or in *ac* or *ad* in v-ix. Each of these septal, nephridial masses appears to consist of several anteriorly directed micronephric tubules (probably closed) but the septal attachments are so close that it is difficult or impossible to determine whether the tubules are distinct or merely lobes of a single nephridium. In iii there are six to eight tubules or lobes, three in iv, three or four or perhaps more in v-ix. From xii to xix the nephridia appear to be parietal or occasionally even associated with posterior faces of septa, located in *ad*, the number of tubules or lobes indeterminable because of poor condition. Behind xx (in B) for some distance nephridia are unrecognizable. In the posteriormost segments a large nephridium is visible in *ac* on each side of each segment. Each of these nephridia appears to pass to the posterior face of the septum next in front and to be continued through the septum into a preseptal, funnel-like structure with a very short neck.

Segments xi and x (B) are filled with coagulum. Male funnels (B) of x and xi have a slight spermatozoal iridescence. The seminal vesicles of xii fill the coelomic cavity of the segment and are about twice the size of those in xi. Deferent ducts of a side (B), covered over by diagonal muscles and nephridia, pass posteriorly ununited, though in contact from xii, in xvii somewhat lateral to the ectal portion of the prostatic duct, midsegmentally in xviii uniting and disappearing from sight (presumably passing into the parietes). The prostatic duct is  $1\frac{1}{2}$ -2 mm. long and with muscular sheen. Two penisetal follicles are recognizable on each side of xvii and xix but are united entally, the lateral follicle passing into the body wall on or very close to the posteromedian face of the prostatic duct, a fairly wide strand of longitudinal musculature separating the ectal ends of the two follicles. No ventral setae were found in xviii nor even clefts in the longitudinal musculature for follicles.

The penial seta from a *b* follicle (of B) is curved into a slightly crescentic or bow-shaped arc along the major portion of the shaft, a short ectal portion near the tip with another and distinct though slight curvature. The ornamentation is slightly ental to the tip and is of fifteen

irregular and broken circles of fine spines, an occasional spine enlarged and almost triangular. Ental to the circles a few scattered spines are visible. The narrowed tip, ectal to the ornamented region, does not appear to be especially claw-shaped, the ectal end bluntly rounded. The seta from an *a* follicle is similar except for a hollow just ental to the extreme tip.

The spermathecal duct (B) is about as long as the ampulla, widened entally, with muscular sheen, the lumen transversely elliptical in section entally, transversely slit-like, smaller and eccentric ectally. The single spermathecal diverticulum is anteroposteriorly flattened, sessile, vertically placed on the lateral face of the duct immediately below the ampulla. Three or four shortly ellipsoidal, iridescent masses of spermatozoa are visible in each diverticulum.

The longitudinal musculature is uninterrupted over sites of genital markings.

*Remarks.*—Internal organs had been removed by Michaelsen from the anterior portion of the type (A). The clitellate paratype (B) is in very poor condition and in spite of the greatest care an anterior portion broke into several fragments during the last stages of dissection. Some of the later specimens are in somewhat better condition than the types.

Stephenson found certain differences in his material. Some of these differences are probably of no importance, while others unnoticed by Stephenson may be of importance. The account above and the diagnosis has therefore been based on the types alone.

The clitellate paratype is probably in a postsexual stage of regression, the type, with brilliant iridescence of male funnels, probably sexual.

The single remaining spermatheca of the type appears to be abnormal, with no diverticulum. On the posterior face of the duct just below the ampulla there is a clump of three or four whitish threads that look somewhat like micronephridial tubules. The spermatheca is bound by a membrane to the posterior face of 7/8 and to the parietes of viii.

Michaelsen was unable to recognize male pores but located prostatic apertures just median to *b* lines on xvii and xix. If once visible they are now certainly unrecognizable unless Michaelsen's pores are one of the paired apertures of penisetal follicles. Possibly one of each pair of follicles (and in that case presumably the lateral or *b* follicle) unites with the prostatic duct within the body wall to open to the exterior by a common aperture. Michaelsen's inability to see genital markings is doubtless the result of failure to remove the cuticle.

*Diagnosis.*—Spermathecal pores at or close to sites of missing *a* setae. Seminal grooves on or just median to *b*, straight, wide and deep, reaching nearly to setal arcs of xvii and xix. Each male pore on ventral face of a tiny protuberance from lateral wall of seminal groove, *ca*, on setal arc. Genital markings tiny translucent areas of circular to transversely elliptical outline, in *ab* and on setal annulus (or its equivalent) of xx; additional markings usually present on some of following locations: one marking in front of each pair of penial setae of xvii, one behind each pair of xix, one lateral to each pair of penial setae, one in front of each spermathecal pore (and behind?). Clitellum annular, on xiv-xvi, First dorsal pore on 10/11. Setae widely paired; *ab* <

$cd < bc < aa$ ,  $dd < \frac{1}{2}C$ . Prostomium tanylobous. Length 40-54 mm. Diameter 2-2½ mm.

Typhlosole from xviii to lxxiii. Holandric; seminal vesicles in xi and xii. Spermathecal duct about as long as ampulla, thickened entally; diverticulum sessile on lateral face of duct just below ampulla. Penial setae 1.3 mm. long, 0.02 mm. thick at midshaft, main portion of shaft curved into a crescent or bow-shaped arc, ornamentation of about 15 irregular and interrupted circles of fine spines some of which are enlarged and almost triangular. Longitudinal musculature uninterrupted over genital markings.

*Distribution.*—Tribeni<sup>1</sup> and Rajmahal in Bengal. (Elevations under 500 feet.)

#### Forma **orissanus**, nov.

1916. *Eudichogaster bengalensis*, Stephenson, *Rec. Ind. Mus.* XII, p. 344.

These worms are distinguished from the types of *bengalensis* by the absence of genital markings on xx and from the next form by the absence of genital markings of x. As genital markings are present on spermathecal and prostatic segments, absence of genital markings on other metameres can scarcely be the result of immaturity. This distinction from the types may, of course, be an individual variation and hence of no taxonomic value. It is noteworthy however, that all mature specimens from a particular locality available for examination are uniform with respect to the presence or absence of markings on the segments just mentioned. It is therefore possible that we have to do here with three geographical subspecies or perhaps even distinct species. Just what characteristics are of diagnostic value for species in the genus *Pellogaster* is at present unknown but in other genera locations of genital markings often are specifically diagnostic. Until the necessary information has been accumulated to solve this problem it is advisable to indicate possibility of taxonomic distinction from the types studied by Michaelsen by recognition of formae which can be suppressed later or raised to subspecific or specific status as may be required. Interspecific differences in worms as small as *bengalensis* may be of such a type as to be overlooked easily in the course of a casual examination.

On the first of these specimens there is a genital marking median or anteromedian to each spermathecal pore and on the setal annulus or its equivalent. Each marking is sharply demarcated with a narrow but raised marginal rim and depressed central region. The *b* setae are present on both viii and ix of this and other worms as well. On the second specimen markings are lacking on viii and ix and each spermathecal pore is at the centre of a small, circular, sharply demarcated area with a regularly convex surface. Just lateral to each pair of penial setae on xvii and xix there is a genital marking, another marking present just in front of each pair of setae of xvii and just behind each pair of xix. On the third specimen spermathecal pores are on tubercles as on the second worm and there are markings on viii and ix as on the first

<sup>1</sup> Stated by Michaelsen as being "wenige engl. Meilen von Calcutta"; it is actually situated in the Hooghly District, near Chandernagore about 25 miles from Calcutta.

specimen, but markings on xvii and xix, if present, are unrecognizable (condition of these worms not the best). The fourth worm also has spermathecal pore tubercles and markings on viii and ix, possibly a postsetal marking on xix on each side. On the last specimen there is a marking on each side of viii in front of and behind each spermathecal pore, the centres of the markings slightly median to the centres of the spermathecal pores. On ix anterior markings are alone present. Genital markings may be present on xvii and xix lateral to the penial setae but the surface is roughened so that presetal markings of xvii or postsetal markings of xix would probably be unrecognizable if present.

In the dissected specimen the intestine apparently begins just behind 15/16, the valve very short and restricted to the septal region. The typhlosole begins in xviii or xix.

Two pairs of nephridial masses are visible in each segment behind xxii. One of these masses is in *cd*, extending into *dd*. The other nephridial mass is attached to the parietes close to *b* and is composed of two lobes or two tubules,—ducts are macerated and cannot be traced with any certainty. In the posteriormost segments there are four nephridia per segment, the lateral nephridia with no recognizable attachment to the septa in front, the median nephridia continued to and through the anterior septa and with preseptal funnel-shaped enlargements of the free anterior ends.

Spermathecal diverticula are unpaired and sessile, a paired and stalked condition noted by Stephenson probably abnormal.

*Definition.*—First dorsal pore on 11/12. No genital markings on x or xx. Penial setae 0.7-0.8 mm. long, 0.016 mm. thick; ornamentation of *ca.* six irregular and broken circles of spines.

*Distribution.*—Kenduapatna near Cuttack in Orissa. (Elevation under 500 feet.)

### Forma **jubbulporensis**, nov.

1920. *Eudichogaster bengalensis*, Stephenson, *Mem. Ind. Mus.* VII, p. 248.

Spermathecal pores are tiny, transverse slits with conspicuous whitened margins, on viii and ix, about on the setal arcs but slightly lateral to the *a* lines. The *b* setae of viii and ix are present.

A minute aperture anteromedian to *a* that may be a female pore is visible on the left side of xiv but a corresponding pore on the right side is lacking or unrecognizable.

On x on each side there is a transversely placed, white marking of shortly elliptical outline, presetal but still probably on the equivalent of a setal annulus, in a median portion of *ab*, the marking about in line with the spermathecal tubercles. On ix there is a pair of similar markings the centres of which are very slightly median to the centres of the spermathecal pores. Markings on viii, if present, would be unrecognizable as a result of damage to the surface during a previous removal of anterior spermathecae. On xvii on each side, close to 16/17 and anteromedian to the penial setae is a transversely placed marking.

Septum 5/9 is muscular.

Each extra-oesophageal vessel is connected with the ventral trunk behind the subpharyngeal ganglia by two transverse commissures.



The spermathecal diverticulum doubtless is not fully developed but is an anteroposteriorly flattened ridge sessile on the entalmost portion of the duct. No trace of a stalk or second diverticulum is visible.

*Definition.*—Prostomium proepilobous. First dorsal pore on 11/12. A genital marking in *ab* on setal annulus of *x* on each side.

*Distribution.*—Marble Rocks near Jubbulpore, Central Provinces. (Elevation 1,000-1,500 feet.)

### **Rillogaster**, gen. nov.

*Diagnosis.*—Biprostatic; prostates and penisetal follicles opening to the exterior through separate apertures on *xix*. (Male pores; deferent and prostatic ducts united to open to exterior through a common aperture?) Bithecal, spermathecal pores on or near 7/8. Female pore median. Setae lumbricine; ventral setae of *xix* penial, in paired follicles on each side. Clitellum annular; on development of clitellar glandularity intersegmental furrows disappear and dorsal pores are occluded but setae are retained. Unpigmented (?). Septa present from 4/5; 4/5, 8/9-11/12 muscular. Gizzards in *vi-vii*. Calciferous glands paired in *x-xiii*, reniform and lateral to gut, with long stalks opening directly into oesophageal lumen. Intestine begins in *xv*. Hearts latero-oesophageal, in *x-xii*. Extra-oesophageal trunks connected with each other by transverse commissures in region of 5/6 and 6/7 and united shortly in *x*, passing into calciferous glands of *xiii* after giving off branches to anterior glands. (Lateroparietal trunks?) Excretory organs: paired clusters of (closed enteronephric?) micronephridia on the anterior faces of 4/5 and 5/6; posteriorly (closed, exonephric?) integumentary micronephridia, in transverse rows (of more than eight) on each side or behind the prostatic region in 6-8 longitudinal ranks on each side; from *lxx* posteriorly the median nephridium on each side with preseptal funnel and gradually enlarged towards tail end. Prostates tubular.

*Genotype.*—*Eudichogaster matheranensis* Stephenson 1924.

*Distribution.*—Known only from two localities in the Bombay Presidency.

*Remarks.*—The only evolutionary trend or tendency noticeable in the old *Eudichogaster* complex is towards modification of a posterior portion of the typhlosole (maintenance of size posteriorly or even increase rather than the more usual decrease in height and thickness, thickening, development of lateral ridges), or development in the roof of the gut in association with the posterior end of the typhlosole of structures such as the "grid" of *Barogaster* or the supra-intestinal glands of *Eudichogaster* as now restricted. *Rillogaster* alone is exceptional, lacking typhlosole, grid or supra-intestinal glands. Absence of these structures may be primitive or secondary. The first alternative seems the more probable but cannot be correlated with the balantine condition of the male sex organs, supposedly a secondary derivation from a primitive acanthodriline condition.

As in connection with *Barogaster*, direct derivation of *Rillogaster* from any other portion of the old *Eudichogaster* complex is improbable and impossible unless ventral chaetae of *xvii* once modified to penial setae can revert to a normally sigmoid condition and ventral setae of

xviii once lost (or reduced ?) can be restored. Much more likely would appear to be derivation of acanthodriline, megascolecine and balantine conditions from a common ancestor with unmodified sigmoid setae on xvii-xix.

**Rillogester matheranensis** (Stephenson).

1924. *Eudichogaster matheranensis*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 346. (Type locality Matheran near Bombay. Types in the Indian Museum.)

1926. *Eudichogaster matheranensis*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 261.

*Material examined*.—From the Indian Museum: 1 clitellate (dissected) and 5 a clitellate specimens labelled, "*Eudichogaster matheranensis* Stephenson. "Type." Matheran near Bombay. x.21. Prof. J. P. Mullan. W 1155/1."

*External characteristics*.—Unpigmented (? alcoholic preservation) Setae begin on ii, ventral setae of xvii and xviii sigmoid, an ectal half of the portion between tip and nodulus ornamented with short, transversely placed rows of fine spines, an occasional spine enlarged and almost triangular. Ventral setae of xx are also sigmoid but the ornamentation is more indefinite, perhaps as a result of erosion. The first dorsal pore is on 12/13 (3) but a rather pore-like marking may be present on 11/12 (1). Clitellar thickening of the epidermis is recognizable at the mid-dorsal incision only from a postsetal portion of xii to the level of the setal arc of xviii. The clitellum is annular, dorsal pores and intersegmental furrows lacking, setae present.

The spermathecal pores are fairly large, transversely slit-like apertures, the centres on or just lateral to *b*.

There is a single, median female pore (2).

The male porophores, on the most mature paratype are almost circular, (probably) areas of slight epidermal or parietal thickening, extending from slightly median to *a* nearly to *c* and antero-posteriorly from 18/19 nearly to 19/20. On each of these slightly protuberant porophores there are two transversely slit-like apertures, neither of which is minute, one about on *b*, the other anterior, slightly larger and a trifle more median. When the prostatic duct is dissected out from the body wall a hole is made at the site of the anterior aperture. When the penisetal follicles are dissected out in the same way an opening is left in the epidermis at the site of the posterior aperture. Male porophores on the clitellate type are somewhat eroded but the apertures are similar to those just described. On other a clitellate paratypes the anterior aperture is unrecognizable (although probable sites, perhaps even pores have been located on one worm), the posterior opening represented by a slight transversely placed depression in which two setal pits are visible or the depression may be lacking and the penisetal pits superficial. "Functional" penial setae are markedly protuberant to the exterior on these worms which are almost certainly juveniles.

Genital markings are tiny spots of greyish translucence, almost circular in outline. The postclitellar markings are located on small protuberant tubercles, the preclitellar markings possibly on small areas of epidermal thickening. On the type there is a pair of presetal tubercles on xx, in *ab*; a pair of tubercles on each male porophore; a single

median marking on each of x-xii, in front of the setal arcs but still on the setal annuli; a marking on the anterior margin of viii on each side, slightly behind the spermathecal pore. On the most mature paratype there is also a pair of tubercles on each male porophore, one on or about at the site of *a* and median to the anterior aperture, the other near the anterior margin and about on *b*. Median markings are present on xi-xiii. On another acelitellate specimen there is a marking on the posterior margin of vii on each side just median to the spermathecal pore.

*Internal anatomy.*—Septum 4/5 is thickly muscular; 5/6-7/8 membranous, transparent and very delicate; 8/9-11/12 muscular; 12/13 slightly muscular and translucent.

The gizzards are in vi and vii (3). Calciferous glands, paired in x-xiii, are rather reniform, anteroposteriorly flattened, the hilus mesially or anteromesially, definitely lateral to the gut but connected to it by a (double?) mesentery, the stalks 1 mm. in length passing postero-mesially to the lateral face of the gut just in front of the septa. Calciferous lamellae are vertical in the dorsal and ventral portions of the gland, horizontal in a lateral portion. The inner wall of the oesophagus in ix-xiii is provided with several low, longitudinally placed ridges, the stalks of the calciferous glands opening into the oesophageal lumen directly through vertically placed slit-like apertures. The intestine begins in xv (3), the valve anteriorly in xv and posteriorly in xiv. There is no typhlosole but a slight trace of a mid-dorsal longitudinal ridge is visible in an anterior portion of the intestine (2). No intestinal caeca were found. There are no supra-intestinal glands nor any trace of a grid-like structure such as is present in *barodensis*.

The dorsal blood vessel (single) is continued forwards into the region of iii. The ventral trunk has been traced anteriorly to the region of the sub-pharyngeal ganglia where it bifurcates. Extra-oesophageal trunks are large but have not been found in the region anterior to 5/6. Just behind 5/6 and again in the region of 6/7 (ruptured in the course of the dissections) a large transverse commissure connects the two trunks. Posteriorly in x the two trunks unite but separate just behind 10/11. A large branch on each side passes off in x, xi and xii to the ventral face of the calciferous glands then turning to pass dorsally on the anterior faces of the glands to a point above the hilus where the branch disappears abruptly. In xiii the extra-oesophageal turns laterally and passes to the ventral face of the posterior calciferous gland. A longitudinal vessel on each side, on or within a sub-oesophageal mesentery, passes from xv into xiii where it turns laterally and onto the calciferous gland to run upwards on the anterior or posterior face alongside the extra-oesophageal with which it eventually unites. The two posterior vessels are connected by a rather diagonal commissure in xiv. Before uniting with the extra-oesophageal the posterior vessel may be joined by a vessel that rises from the parietes on the anterior face of 13/14 (anterior portion of a lateroparietal trunk?). Subneural, supra-oesophageal and lateroparietal trunks have not been found, the first two almost certainly lacking. The last hearts are in xii (4). The hearts of x-xii bifurcate dorsally, the slender posterior bifurcation passing into

the dorsal blood vessel. In xi-xiii a large blood vessel emerges onto the dorsal face of the stalk from the calciferous gland and passes to the dorsal face of the gut where it turns and passes anteriorly quite definitely lateral to the median plane. Having reached the anterior limits of the segment these vessels pass dorsally for a short distance on the posterior faces of the septa. The anterior bifurcation of a heart itself divides into two, one branch passing across the gut just in front of the septa to unite with a similar vessel from the opposite side, the other branch passing into the vessel from the calciferous gland. In x the vessel from the calciferous gland does not turn anteriorly but passes across the dorsal face of the gut to unite with a similar vessel from the opposite side. Into this vessel the anterior bifurcation of the heart of x passes. Commissures of ix open into dorsal vessel only.

A large, vertically placed cluster of closely crowded micronephridial tubules is present on the anterior face of 4/5 on each side. From each of these clusters a fairly large strand of tissue passes to the ventral parietes where it runs anteriorly for a short distance on the body wall and then about at level of 3/4 passes into the tissues between the gut and integument but can be traced forwards underneath the pharynx at least to 2/3. This strand may be the duct of a cluster of pharyngeal nephridia or only a blood vessel. A smaller cluster of micronephridia is present on the anterior face of 5/6 on each side but a duct to the pharynx has not been found. Posteriorly the nephridia are on the body wall and in transverse rows reaching on each side from *a* well into the region lateral to *d*, probably six to eight on each side in the postprostatic region, the number larger anteriorly. In the posterior-most portion of the body the median nephridium on each side is much larger than the others in the same segment though restricted to *ab* and is provided with a funnel located on the anterior face of the septum close to the ventral parietes median to *a*. Passing anteriorly the median nephridium gradually assumes an appearance more like that of the lateral tubules though preseptal funnels or funnel-like structures can be found as far forward as segment lxx. There are no vertically placed bands of closely crowded micronephridia on the body wall in the region of iii as in other species of the *Eudichogaster* complex.

Male deferent ducts have not been traced and may be buried in the body wall. In one juvenile specimen, after dissecting apart the longitudinal muscle fibres in xix, a filament was found that appears to be the deferent ducts of that side but this disappeared or was lost in the vicinity of the prostatic duct. The latter is about 4 mm. long, slender but slightly thickened ectally, with muscular sheen. In the clitellate specimen the penial setae are on the anterior face of a tough column of tissue about 2 mm. long covered over by a thin and transparent membrane, the column passing into the parietes behind the prostatic duct. In the juvenile specimens two distinct follicles are present and of the same length as in the clitellate worm (though prostates and spermathecae are rudimentary) but are united entally and just prior to entrance into the parietes. Each of these follicles is rather bow-shaped with the concave side facing posteriorly, the functional penial seta on the anterior face. In one juvenile a reserve seta, apparently fully

developed, is present on the posterior face of each follicle, the reserves distinguished from the yellow functionals by a reddish appearance. Penial setae are from 2-3 mm. long, the main portion of the shaft arched into a crescent or bow shape, an ectal portion beginning in the ornamented region or nearer the tip variously curved or twisted and gradually but continuously narrowed to the bluntly rounded tip. The ornamentation which begins 0.11-0.17 mm. from the tip is of closely crowded circles of large, almost triangular teeth. On one of the reserve setae mentioned above there are widely scattered and isolated teeth ental to the usual circles well towards the base. On this same seta the tip is continued much further than usual as a very slender but not quite thread-like process.

The spermathecal duct (most mature a clitellate specimen) is slightly shorter than the ampulla from which it is clearly demarcated, slightly narrowed ectally and within the parietes, without sheen but with the slightly pink appearance that often indicates muscularity, circular in cross section, the lumen small and transversely slit-like in section. (In the duct of a juvenile specimen the lumen is quite definitely eccentric.) The shortly stalked, small diverticulum passes into the posterior face of the duct just below the ampulla (both spermathecae) and has no iridescence. The spermathecae of the clitellate type also have no spermatozoal iridescence but appear to be fully developed and one was removed for examination. The ampulla is filled with a reddish, finely granular material and is bound down around the entalmost portion of the duct. The latter is large and rather bulbous, with muscular sheen, the lumen larger than in the previous spermatheca and the wall with high vertical ridges. The diverticulum which passes into the posterior face of the duct just below the ampulla is shortly stalked and slightly bifid terminally. The diverticulum of the other spermatheca is not bifid. In one of the juveniles the diverticular anlage are posterior but in another juvenile the anlage appear to be median.

The longitudinal musculature is uninterrupted over the genital markings.

*Remarks.*—The clitellate specimen (type) is probably in a post-sexual stage of regression. One a clitellate paratype is probably fairly near maturity but is not sexual. Other specimens are juvenile, though of about the same size as the clitellate worm. In view of the necessity of leaving the clitellate type in as good condition as possible, the account above has been based largely on the study of a clitellate and juvenile worms although the gut of the type was opened in a posterior portion of the body (penial setae had previously been removed from both sides). Except for the type the specimens are only in fair condition.

It is unfortunate that the posterior relationships of the male deferent ducts could not be determined though it is to be expected that the ducts unite with or open to the exterior together with the prostatic ducts rather than the follicles of the penial setae.

The *Lonavla* specimens (not examined) almost certainly are a clitellate and quite probably juvenile. Septum 6/7, supposedly absent, may have been destroyed in pinning out the worm. The vessel on one side of xiii referred to as a "heart" presumably is no more a heart than the

misidentified anterior portions of the lateroparietal trunks in *barodensis*, unless metameric abnormalities are involved.

*Diagnosis.*—Prostatic (male ?) pores transversely slit-like, just median to *b*, anterior to a slit containing openings of penisetal follicles, both apertures on circular porophores that extend into *aa* and *bc* and nearly to 18/19 and 19/20. Spermathecal apertures large, transversely slit-like, with centres on or just lateral to *b*. Genital markings tiny, circular spots of greyish translucence on tubercles or areas of epidermal thickening: one behind or anteromedian to each spermathecal pore; unpaired, median and presetal but on setal annuli of ix-xiii; one pair on each male porophore; presetal on xx in *ab*. Clitellum  $\frac{1}{2}$ xii- $\frac{1}{2}$ xviii. Setae:  $ab < cd < bc < aa$ ,  $dd$  slightly  $> \frac{1}{2}$  C. First dorsal pore on 12/13. Length 76-100 mm. Diameter 3-5 mm.

Holandric; seminal vesicles in ix and xii. Spermathecal duct slightly shorter than the ampulla, thick, widest entally, circular in section, with slit-like lumen; diverticulum small, shortly stalked, to posterior face of duct entally. Penial setae 2-3 mm. long, 0.35 mm. thick at midshaft, a region beginning 0.11-0.17 mm. from the tip ornamented with 19-26 closely crowded circles of triangular teeth. Longitudinal musculature uninterrupted over genital markings.

*Distribution.*—Matheran and Lonavla in Bombay Presidency. (Elevations 1,000-3,000 feet?).

#### NOTES ON THE EXCRETORY ORGANS, GIZZARD AND PHYLOGENETIC RELATIONSHIPS OF *RAMIELLA*.

According to Stephenson on *Ramiella* is the ancestor of *Eudichogaster*. Yet the former is characterized by the small number and large size of its "micronephric" excretory organs, admittedly a derived and not a primitive condition. Stephenson himself would have denied that a purely micronephridial genus could be the ancestor of a genus in which there are "meganephridia" Although defined as "purely micronephridial" it was at least possible that preseptal funnels in the posteriormost segments had been overlooked in the various species of *Ramiella*, as was the case in *Eudichogaster*. To check on this possibility two species of *Ramiella* have been studied. From one of these nothing of real importance could be learned because of poor preservation of the material examined and the small size of the excretory tubules. In the other species preseptal funnels are present on the median nephridia in the posteriormost segments as in *Eudichogaster*.

The second species studied, *R. pallida* (Stephenson 1920) was selected partly because of its greater size and partly because it was supposed to show the beginning of a double gizzard such as is found in *Eudichogaster*. Only one, quite normal gizzard is present.

In conformity with views expressed on a previous page with regard to the possibility of reversion of penial setae of segments xvii and xix to the ordinary sigmoid condition, *Ramiella* cannot have given rise to the *Barogaster* and *Rillogaster* portions of the old *Eudichogaster* complex, nor to the microscolecine section of *Lenogaster*.

NOTES ON THE NEPHRIDIA OF *EUTYPHOEUS* AND *OCTOCHAETOIDES*.

*Eutyphoeus*, like its supposed parent *Eudichogaster* and grandparent *Ramiella*, has always been defined as "purely micronephridial." Having found "meganephridia" in two of these three genera it seemed to me advisable to check on the condition of the excretory organs in the posteriormost segments of *Eutyphoeus*. Specimens belonging to two species, one Indian and one Burman, were examined, all of this material in rather poor condition. From the median nephridium on each side in the posteriormost segments of each worm a narrow neck is continued to and through the septum next in front and then close to the ventral parietes is widened into an iridescent, definitely funnel-like structure.

All other Indian genera of the subfamily Octochaetinae are also characterized by the presence of meganephridia, except *Octochaetoides* which is defined, like *Eutyphoeus* and *Ramiella*, as purely micronephridial. Several well preserved specimens of Burmese species of *Octochaetoides* have been examined but no traces of funnel-like structures can be found in the posteriormost segments nor any attachment or connection of median nephridia to the septa next in front. *Octochaetoides* is thus set apart by the condition of its excretory apparatus from all other Indian Octochaetinae.

NOTES ON AN INDIAN SPECIES OF *DIPLOCARDIA*.

Stephenson (1924) has referred a species erected for three possibly immature worms from "the very middle of India" to *Diplocardia*. This genus had been known hitherto only from a southern portion of the United States and Mexico where it is supposed to have evolved from the "original Acanthodriline." To explain its presence in India migration "during countless generations" northward through western portions of North America, across to Asia and then south into India through eastern Asia (the route along which *Plutellus* and *Megascolides* are supposed to have passed in a reverse direction to reach the Pacific Coast of North America from some Asiatic region) was assumed. Such a migration seems at least rather improbable in view of the absence of species in all of the intermediate regions. If micronephridia that had been overlooked by the author are present, transfer of the species to an Octochaetine genus would be possible thereby obviating migration around the Northern Pacific. Furthermore *D. indica* has several resemblances to *bengalensis* such as absence of calciferous glands, origin of the intestine in xvi, etc. To discover if micronephridia are present and if the species has other morphological similarities to *bengalensis*, the types have been re-examined. Further resemblances to *bengalensis* such as location of the spermathecal pores, presence of a median ridge on the floor of the oesophagus in x-xiii, presence of penial setae and the beginning of the typhlosole were found, but micronephridia have not been identified though some of the supposed meganephridia are certainly not of the usual type characteristic of *Diplocardia*. In absence of more exact information as to the excretory organs of *D. indica* and the taxonomic importance of those structures, as well as of the simplex condition of the dorsal blood vessel, the generic relationships of the species remain doubtful.

Stephenson criticised the land bridges and migrations postulated to explain Megascolecoid distribution and emphasized as an alternative "convergence" resulting in polyphyletic genera, *i.e.*, genera containing two or more groups of morphologically identical species (so far as generic characteristics are concerned) but derived by local evolution from generically distinct or specifically distinct ancestors. It is therefore curious that such an explanation was not considered in connection with the discontinuous distribution of *Diplocardia*. To derive this genus from the ancestral acanthodriline according to the usual phylogenetic methods, all that is necessary is to double the gizzard, a development which occurred in the course of the supposed evolution of the Octochaetinae in India-Madagascar from similar or the same acanthodriline ancestors that gave rise to *Diplocardia*. As possible evidence for such a diphyletic origin of *Diplocardia* the following may be mentioned; single dorsal vessel in the Indian species and the duplex condition in (all?) the American forms, modified meganephridia in preclitellar segments of the Indian species and normal meganephridia (?) of the American forms.

### ***Diplocardia* (?) *indica* Stephenson.**

1924. *Diplocardia indica*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 353. (Type locality Buldana, Berar, Types in the Indian Museum.)

*Material examined*.—From the Indian Museum: Three aclitellate, possibly juvenile, specimens labelled, "*Diplocardia indica* sp. nov. Gorge below Chota tank, Buldana, Berar, 2190 ft. 17.ii.23. H. S. Rao. W 1148/1".

*External characteristics*.—Clitellum unrecognizable, epidermis of clitellar segments not noticeably thickened at the mid-dorsal incision. Female pores probably paired and anteromedian to *a*. Nephropores unrecognizable.

Quadrithecal, spermathecal pores minute and superficial, on viii and ix, anterolateral to *a* (2).

Seminal grooves are in *ab* slightly median to *b*, deepest and widest on xviii, anterior and posterior ends turned laterally. Prostatic and male pores are unrecognizable, penial setae not visible externally.

The paired clitellar genital markings of the type (dissected specimen) are on 16/17, in *bc*, the median margin just reaching to *b*. In *aa* on viii there is a postsetal pair of markings, a similar pair presetal on ix. On xviii an unpaired median marking. Each marking is transversely placed, with a slightly raised, wide, white rim and a circular, central, greyish translucent area slightly depressed in a regularly concave fashion. On the second specimen the paired clitellar markings are also on 16/17 but on the right side, on xiv and xv, there are postsetal markings with the centres slightly lateral to *b*. A median marking is present on xviii. Of the four preclitellar markings of the type, only one is present here, the right postsetal of viii.

*Internal anatomy*.—Gizzards are in v and vi (2). The oesophagus in ix-xiv is markedly moniliform as the result of deep septal constrictions, large in x-xv and about as wide as the intestine from which it does not appear to be marked off at first glance. A valve is present however (2), posteriorly in xv and anteriorly in xvi, the intestine begin-



ning in xvi (2). The oesophageal wall is thin, lamellae and ridges unrecognizable except perhaps for a few rather rudimentary, vertical lamellae midsegmentally on the floor of the gut on each side in x-xiii. On the ventral face of the gut in x-xiii there are visible transversely placed and regularly alternating bands of opacity and translucence. On the floor of the gut in x-xiii there is a rather typhlosole-like, median ridge. The typhlosole begins abruptly in xviii (2) and is relatively high, simple, lamelliform, rather zigzagged. Intestinal caeca and supra-intestinal glands are lacking.

The dorsal blood vessel is single (2). The last pair of hearts is in xii (2), the hearts of x-xii probably latero-oesophageal. A supra-oesophageal vessel is recognizable in x-xii only (1). Extra-oesophageal and lateroparietal trunks were not found. No subneural.

On the parietes on each side about in the region of ii (or iii ?) there is a vertically placed nephridial mass in *bc*, perhaps reaching slightly into *ab* and *cd*. In (iii ?) iv-ix on each side there is a small nephridial mass, in *ab*, on the anterior face of the septum, and in vi-ix at least vertically placed. No connection with the anterior septum has been found, nor neck, nor funnel. In some at least of segments x-xx nephridia appear to be more numerous than one pair per segment and without connections to anterior septa (?). In the macerated postprostatic region a single pair of nephridial masses is visible in each segment, each mass flattened against the body wall in the region from *a* to *d*. Small, pre-septal funnel-like structures are recognizable but the main nephridial mass is so decayed that details of structure are almost unrecognizable. In segments near the tail end the pre-septal funnel is very small, close to the ventral parietes and slightly median to *b*. In this region the coelomic cavity is filled with coagulum that is adherent to the parietes, nephridia and intestine. After removal of the coagulum only one nephridium is visible on each side in each segment, or two masses that may well be parts of a single nephridium.

A very slight iridescence (spermatozoal ?) is recognizable on the male funnels of x of one specimen, of xi in the other. Deferent ducts were not found. Seminal vesicles are acinous, reaching into contact with the dorsal blood vessel and filling the coelomic cavity between the gut and the body wall. The prostatic ducts are nearly straight, transversely placed, about 1 mm. long, with marked muscular sheen. Associated with each prostatic duct is a white cord about 2 mm. long, attached entally to the free end of the prostate, splitting ectally into two portions one of which passes into the parietes on the median face of the prostatic duct, the other passing into the body wall a short distance median to the prostatic duct. Each portion of the cord contains a single penial seta that is recognizable even with the low power of the binocular. Length of penial setae 1.4 + and 1.6 + mm, diameter at base 0.007 mm, at midshaft 0.006 mm, near tip 0.002 mm. A major portion of the shaft entally is curved into a wide and smooth arc, a shorter ectal portion also arched, a region between the two arcs sinuous. The tip is thin, flattened and truncate.

The lumen of the spermathecal duct is narrow, the lumen of the diverticulum small and quite irregular.

The longitudinal musculature is uninterrupted over the genital markings.

*Remarks.*—Only one of the specimens had been dissected previously. A second specimen is broken across through a macerated region behind the prostates. On this worm genital markings are clearly visible but seminal grooves do not appear to be as well developed as on the type. The third specimen, lacking a posterior portion, and apparently even more juvenile was left undissected. A portion of the intestine had been removed from the type so that the posterior termination of the typhlosole could not be determined (typhlosole ends abruptly and without marked posterior decrease in height, 36 segments from the hind end in the second specimen). Seminal vesicles and prostates quite possibly are fully developed, but spermathecae do not seem to be mature. An attempt to clear one spermatheca was unsuccessful, the ampulla apparently solid.

As the integument of the male genital region is contracted and hard, location of male and prostatic pores and of apertures of penisetal follicles is impossible without damage to the surface. (A certain amount of maceration is sometimes favourable for locating such minute pores.)

Spermathecal pores are definitely recognizable only with brilliant illumination and high magnification but each pore is surrounded by a white rim (in sharp contrast to the rest of the epidermis) that is clearly visible (as a tiny circular patch) even with low magnification. The spermathecal duct has not been traced through the body wall but obviously passes into the parietes close to the *a* follicle. A fine insect pin pushed through the body wall just behind the spermathecal duct made an opening in the epidermis just behind the spermathecal pore.

Miss Chapman, who measured the penial setae, maintains that the shaft ectal to the sinuous portion is sparsely ornamented with triangular teeth but I have been unable to see them myself.

Micronephridia were not found and quite possibly are lacking as Stephenson thought but confirmation from better material is necessary. It is however extremely unlikely that the nephridial masses from ix anteriorly (perhaps also for a few segments posteriorly) are of the ordinary meganephric type, as connection with an anterior septum, a neck region and a preseptal funnel apparently are lacking. Similarly defective "meganephridia" are present in anterior segments of certain species of genera such as *Plutellus* and *Woodwardiella* that are defined as purely meganephridial.

The condition of the dorsal blood vessel (*i.e.*, whether single or double) apparently has not been considered of any taxonomic importance hitherto. Indian species formerly included in the New Zealand genus *Octochaetus* are however distinguished by the single dorsal trunk (*vide* Gates 1933, p. 555) and the Indian species of *Diplocardia* is similarly distinguished from (some at least of) the North American forms.

Of all Indian species, *D.* (?) *indica* appears to be closest to the Octochaetine *Ramiella bishambari* (Stephenson) 1914, from which it is distinguished, except for the presence of a second gizzard in v and of preseptal funnels on the nephridia (?), only by the following apparently unimportant characteristics; intestinal origin in xvi rather than xiv,

absence of seminal vesicles in x, longer penial setae and segmental location of the spermathecal pores. Unfortunately *R. bishambari* is imperfectly characterized, the types have been lost and further material has not been available for study.

*Diagnosis.*—Quadriprostatic; pores on xvii and xix and in seminal grooves (?), latter slightly median to *b*, widened on xviii, bent laterally on posterior portion of xvii and anterior portion of xix. Male pores on xviii (?) in seminal grooves? Quadrithecal; spermathecal pores minute, on viii and ix, antero-lateral to *a*. Female pores paired (?) anteromedian to *a* (?). Genital markings transversely placed, with raised, white rims and greyish translucent, depressed, circular, central areas: unpaired and median on xviii; paired,—postsetal on viii and presetal on ix in *aa*, postsetal on xiv and xv with centres lateral to *b*, and on 16/17 in median portion of *bc*. Setae lumbricine:  $ab=cd$ ,  $aa > bc$ : ventral setae of xvii and xix penial and in paired follicles on each side (opening to exterior?), ventral setae of xviii lacking (?). Clitellum? Nephropores? First dorsal pore on 10/11. Unpigmented? Length 50 mm. Diameter  $2\frac{1}{2}$  mm.

Gizzards in v-vi. A median, typhlosole-like ridge on floor of oesophagus in x-xiii. Intestine begins in xvi. Typhlosole simple and lamelliform from xviii (to ?). Hearts latero-oesophageal (?) in x-xii. Extra-oesophageal trunks? Dorsal blood vessel single. Excretory organs: open, exonephric (?) meganephridia with preseptal funnels in segments behind clitellum; anteriorly, at least in ii-ix, nephridia on anterior faces of septa, without necks and preseptal funnels; micro-nephridia (?). Holandric; seminal vesicles in xi and xii. Penial setae 1.4-1.6 + mm long, 0.007 mm. thick at base, 0.006 mm. at mid-shaft, 0.002 mm at tip, margins sinuous near tip, (ornamentation?). Spermathecal diverticulum digitiform, of about the same length as duct into the ental end of which it passes. Longitudinal musculature uninterrupted over sites of genital markings.

*Distribution.*—Known only from the type locality, Buldana, Berar.

#### REFERENCES.

- Gates, G. E., 1933.—The earthworms of Burma. IV *Rec. Ind. Mus.* XXXV, pp. 413-606.
- Gates, G. E., 1937.—Indian earthworms. II. *Scolioscolides*, gen. nov. *Rec. Ind. Mus.* XXXIX, pp. 305-310.
- Gates, G. E., 1938.—Indian earthworms. III. The genus *Eutyphoeus*. *Rec. Ind. Mus.* XL, pp. 39-119.
- Michaelsen, W., 1910.—Die Oligochäten fauna der vorderindisch-ceylonischen Region. *Abh. Nat. Ver. Hamburg.* XIX, (5).
- Michaelsen, W., 1921.—Die Oligochäten vom westlichen Vorderindien und ihre Beziehungen zur Oligochätenfauna von Madagaskar und den Seychellen. *Mitt. Zool. Mus. Hamburg* XXXVIII.
- Pickford, G. E., 1937.—*A monograph of the Acanthodrilina earthworms of South Africa* (Cambridge).
- Stephenson, J., 1916.—On a collection of Oligochaeta belonging to the Indian Museum. *Rec. Ind. Mus.* XII, pp. 299-354, pls. xxx-xxxiii.

- Stephenson, J., 1920.—On a collection of Oligochaeta from the lesser known parts of India and from eastern Persia. *Mem. Ind. Mus.* VII, pp. 191-261, pls. ix-xi.
- Stephenson, J., 1923.—*Oligochaeta*, in *Fauna of British India* (London).
- Stephenson, J., 1924.—On some Indian Oligochaeta, with a description of two new genera of Ocnero-drilinae. *Rec. Ind. Mus.* XXVI, pp. 317-365, pls. xxi-xxiii.
- Stephenson, J., 1930.—*The Oligochaeta*, (Oxford).
- Stephenson, J., 1931.—Descriptions of Indian Oligochaeta. II. *Rec. Ind. Mus.* XXXIII, pp. 173-202.