



# *Fauna of India*

**MEGADRILE OLIGOCHAETA  
(EARTHWORMS)**

**FAMILY OCTOCHAETIDAE**

**J.M. JULKA**

## ABOUT THE BOOK

Earthworms play an important role in enhancing soil fertility and improving soils polluted with sewage sludge and toxic materials. The most comprehensive taxonomic account on the Indian earthworms was that of Stephenson (1923) published under the 'Fauna of British India' series which became obsolete due to nomenclatural changes and discovery of new taxonomic characters. This volume under the 'Fauna of India' series deals with the detailed taxonomic studies on the family Octochaetidae including descriptions of 6 new genera and 16 new species. Useful information on the classification, biogeography, biology, ecology and economic importance of earthworms has also been incorporated. It is intended to bring out more such volumes on the remaining families of the Indian earthworms.

**THE FAUNA OF INDIA  
AND THE ADJACENT COUNTRIES**

**MEGADRILE OLIGOCHAETA  
(EARTHWORMS)**

**HAPLOTAXIDA : LUMBRICINA  
MEGASCOLECOIDEA : OCTOCHAETIDAE**

*By*  
**J.M. JULKA**  
**Zoological Survey of India**



*Edited by the Director, Zoological Survey of India*  
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**Dedicated to Dr. G.E. Gates, the doyen of modern  
oligochaete taxonomy and to the memory of my parents.**

## FOREWORD

Earthworms dominate macrofaunal biomass in the soil and their beneficial effects on the soil structure, aeration and fertility are well documented. Long ago, Aristotle and Darwin described them as 'the intestine of earth' and 'the nature's ploughman'. Recent studies show their capability in improving soils polluted with waste materials, sewage sludge and toxic materials.

The latest comprehensive taxonomic account on the Indian earthworms is that of Stephenson (1923), which is now outdated because of nomenclatural changes and discovery of new taxa. The present work is, therefore, a vital tool for those who are interested in the systematics of Indian earthworms. Besides taxonomic descriptions of species, including several new ones, the work also synthesizes valuable information on their biology and ecology. This will be of immense use to the soil biologists.

Dr. Julka has been actively working on the taxonomy of earthworms for the last 22 years. With his expertise in this field it is expected that he shall bring out more such works on the remaining earthworm families.

Calcutta  
6th January, 1988

B.S. LAMBA  
*Acting Director*  
*Zoological Survey of India*

## PREFACE

Stephenson (1923) published a taxonomic monograph on the earthworms of the Indian subcontinent in the '*Fauna of British India*' series. But it became obsolete with the recognition of new taxa and new taxonomic characteristics, mainly through manifold publications by Gates. It was, therefore, felt to bring out an up-to-date comprehensive taxonomic account on the earthworms of India and adjacent countries (excluding Burma) in the '*Fauna of India*' series. This volume is a first step in this direction and deals with 128 species belonging to 26 genera of the family Octochaetidae including 6 new genera and 16 new species. The 'types' of some species in the Zoological Survey of India are either immature or have become softened or macerated because of a prolonged period of preservation. For these reasons, topotypes of 14 species were collected and examined. Most of the illustrations in the text are either based on the fresh material or on the 'syntypes' in the Zoological Survey of India.

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Lastly, I would like to thank my wife Shashi who endured my late working hours in the laboratory and at home without which it would have not been possible to complete this book.

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J.M. JULKA

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## INTRODUCTION

The Oligochaeta are bilaterally symmetrical coelomate invertebrates with internal and external metameric segmentation throughout the body. They lack suckers and parapodia but possess setae on all segments except the peristomium and pygomere. They are hermaphrodite and ova are fertilized in cocoons secreted by a clitellum; development being direct without the intervention of a free larval stage in the life cycle. On the basis of size and habitat, the oligochaetes are often divided into two convenient groups: Microdrili (small, mainly aquatic worms including the terrestrial family Enchytraeidae) and Megadrili (larger, mostly terrestrial worms and their aquatic representatives). It is the latter group that consists of earthworms and corresponds to the orders Moniligastrida and Haplotaxida excluding suborder Tubificina (Brinkhurst and Jamieson, 1971):

Systematic studies on the earthworms of the Indian subcontinent were initiated by Templeton (1844) when he described a new species, *Megascolex caeruleus*, from Sri Lanka. Subsequently, our knowledge was enriched by Schmarda (1861), Vaillant (1867), Beddard (1883-1902), Bourne (1886-1894), Rosa (1888-1894), Benham (1893), Ude (1893), Fedarb (1898a, 1898b) and Michaelsen (1897-1907). This scattered information in various journals was brought together in a systematic monograph by Michaelsen (1909a), which gave considerable impetus to serious taxonomic studies on the earthworms of this subcontinent. Michaelsen (1909b, 1913), Stephenson (1913-1922) and Rao (1922) further added several species to the earthworm fauna of the region. Stephenson (1923) consolidated the information available till that time and published a comprehensive taxonomic account in the Fauna of British India series. Between 1924 and 1972, although

some papers were published by Stephenson (1924-1931), Aiyer (1929), Cernovitov (1937), Bhatti (1962a), Sims (1963), Khan (1966), Soota (1970), Soota and Julka (1970, 1972) and Sharma and Chacko (1970), the taxonomic studies on the earthworms of the Indian subcontinent were dominated by Gates who in a series of papers revised and erected several new genera and species on the basis of hitherto unrecognized but taxonomically important somatic characters which rendered Stephenson's Fauna of British India obsolete. Gates' studies culminated with the publication of an excellent monograph on the Burmese earthworms in 1972, but much remained to be done in consolidating the information on the earthworms of the other regions of the subcontinent.

During the last decade, the earthworms of the following underexplored areas in the Indian subregion have been surveyed to some extent: Eastern Himalayas (Julka, 1975a, 1976a, 1981; Julka and Halder, 1975b, 1977; Soota and Halder, 1977a, 1977b, 1981), Khasi and Garo Hills (Julka, 1977), Orissa (Julka, 1975b, 1976b, 1978), South India (Jamieson, 1977; Easton, 1982; Julka and Rao, 1982; Julka, 1983), Western Himalayas (Julka, 1979; Soota and Halder, 1980a), and Andaman and Nicobar Islands (Julka and Halder, 1975a; Soota and Halder, 1980b).

## CLASSIFICATION

The oligochaetes are considered to have close affinities to the leeches and to indicate this relationship Michaelsen (1928) combined the orders Oligochaeta and Hirudinea in a Class, the Clitellata. This system was accepted by Stephenson (1930) and Gates (1972) in their monographic works. Recently, the group comprising oligochaetes has been assigned the status of a subclass (Brinkhurst and Jamieson, 1971; Reynolds and Cook, 1976) or a class (Gavrilov, 1981; Brinkhurst, 1982; Gates, 1982); the latter system is adopted in this work.

During the nineteenth century various classifications of the Oligochaeta were presented, notably by D'Udekem (1862), Vaillant (1868), Perrier (1872), Vejdovsky (1884), Benham (1890), Beddard (1895) and Michaelsen, 1896, 1899), but none of these were considered satisfactory. Michaelsen (1900) was the first to construct a comprehensive classification of the oligochaetes in which 11 families including about 1200 species and 152 genera were recognized. Michaelsen (1921) rearranged his earlier classification and grouped 21 families in 7 series and 2 suborders, Archioligochaeta and Neo-oligochaeta, the terms which he himself abandoned in 1928. Generic and suprageneric taxa were defined by the genital characteristics, especially the male genital system. Michaelsen's system of classification was adopted by Stephenson (1930) with slight modifications which remained in use for quite a long time. Gates (1959) rejected Michaelsen's 'Classical' system as he considered male genital characters variable and taxonomically of no value for defining suprageneric categories of earthworms. Instead, he recognized several somatic characters which were markedly resistant to variation and evolutionary conservative.

The most recent monograph on the Oligochaeta by Brinkhurst and Jamieson (1971) recognized its 3 orders based on the reproductive system and supported by ancillary somatic characters: Lumbriculida, Moniligastrida and Haplotaxida. This scheme excluded the Aeolosomatidae from the oligochaetes for various anatomical reasons. The Haplotaxida comprised all oligochaete families apart from the Lumbriculidae (Lumbriculida) and the Moniligastridae (Moniligastrida). It was subdivided into 3 suborders: Haplotaxina (stem family Haplotaxidae), Tubificina (microdriles) and Lumbricina (earthworms and their aquatic stem forms). The Tubificina comprised 2 superfamilies, Tubificoidea and Enchytraeidea, and the Lumbricina consisted of 3 superfamilies, Alluroidoidea, Lumbricoidea and Megascolecoidea; the Alluroidoidea elevated to another suborder Alluroidina by Jamieson (1978). In a computer based investigation of the opisthophorous Oligochaeta, Jamieson (1978) proposed to reduce the Moniligastrida to a suborder in the order Haplotaxida. Sims (1980, 1982) disagreed with this proposal. The basic classification of the Oligochaeta into orders and suborders as proposed by Brinkhurst and Jamieson (1971) was accepted by various oligochaetologists, but much disagreement existed on the suprageneric constituents of the restricted suborder Lumbricina (excluding the Alluroidoidea). Sims (1980) considered Jamieson's (1978) composition of the superfamilies of the Lumbricina as artificial which was based on adaptive characters and the distributional implications were incompatible with zoogeographical knowledge. Instead, he defined superfamilies of the Lumbricina by using characteristics of the morphology of the ovaries and the budding of the oocytes and explained their distribution in accordance with the zoogeography.

Apart from the Eudrilidae, there are different views about the constituent families of the superfamily Megascolecoidea and these have been defined variously during the last 25 years. Omodeo (1958) recognized the megascolecoid groups by the structure, number and location of the calciferous glands. Lee (1959) assigned

all the New Zealand megascolecoids into a single family, the Megascolecidae, dividing the latter into 2 subfamilies, the Megascolecinae and Acanthodrilinae, according to the position of the male and prostatic pores. Gates (1959) disagreed with these classifications and raised all the main groups to the familial rank, the Ocnerodrilidae, Acanthodrilidae, Octochaetidae and Megascolecidae on the basis of structure of the prostatic glands, location of calciferous glands and morphology of the excretory system. Sims (1966) using computer techniques examined these conflicting classifications from a selection of megascolecoid genera, and found that pattern of arrangement of the genera coincided to a large extent with the classification proposed by Gates, but he (1967) assigned them to 2 families, the Megascolecidae (*sensu stricto*) and Acanthodrilidae, dividing the latter into 3 subfamilies, the Ocnerodrilinae, Acanthodrilinae and Octochaetinae. Jamieson (1971a) questioned the taxonomic significance of the structure of the prostatic glands in the megascolecoids. He proposed another classification by retaining all megascolecoids in a single family, the Megascolecidae, dividing it into 3 subfamilies, the Ocnerodrilinae, Acanthodrilinae and Megascolecinae, according to the position of the calciferous glands, lateral hearts, male and prostatic pores, and the structure of the excretory system. The Acanthodrilinae and Megascolecinae were subdivided into tribes employing the characteristics of the excretory system. The morphology of the excretory system in several megascolecoid species and genera is not adequately known and these structures require further investigations before Jamieson's views could be accepted (Easton, 1979; Sims, 1980). Moreover, Jamieson's (1971a) grouping of megascolecoid species with two types of prostatic glands of different origin (tubular of ectodermal and racemose of mesodermal origin) in the same genus is not acceptable. In this work Brinkhurst and Jamieson's (1971) basic classification of the Oligochaeta as modified by Sims (1980, 1982), and Gates' (1959) convenient system of classification for the megascolecoides are adopted.

## BIOGEOGRAPHY AND ORIGIN

The biogeography and evolution of earthworms are obscured due to paucity of fossil records. Nevertheless, attempts have been made to infer their origin by studies on the distribution and comparative anatomy of present day earthworms. On the basis of feeding habits of earthworms, Stephenson (1930) believed that they appeared in the Cretaceous when dicotyledenous plants came into existence. Michaelsen (1910) was of the opinion that they evolved in the upper Jurassic, while Arldt (1908) estimated their origin much earlier, as far back as the upper Triassic period. Sims (1980) assumed that ancestors of present day earthworms were widespread in the undivided palaeocontinent of Pangaea which was formed at the end of the Palaeozoic. The division of Pangaea in the Triassic resulted in the separation of a northern continent of Laurasia and a large southern land mass of Gondwana. These further broke up into smaller land masses during the subsequent periods and moved apart carrying with them the precursors of the present day earthworms. According to Sims (op. cit.) the continental drift theory adequately explains the patterns of biogeographical distribution of his superfamilies of the Lumbricina as observable today: Criodriloidea and Lumbricoidea (Euramerica), Biwadri-loidea (Pacifica, eastern Gondwana), Glossoscolecoidea (western Gondwana), Megascolecoidea (Gondwana).

The biogeography of earthworms is sometimes not clear because of presence of widely distributed peregrine species which have been transported by man for culture or accidentally in soil around the roots of exotic plants. These species therefore must be disregarded for biogeographical considerations.

## TERMINOLOGY AND TAXONOMIC CHARACTERS

***Age groups*** : Details of sexual maturity of each earthworm specimen are usually given in the material examined. This may be in the form of 2C, 4A (2 clitellate, 4 aclitellate) or a set of figures united with dashes, e.g. 2-0-4-3 means 2 juveniles, 0 aclitellate, 4 clitellate or adults and 3 postsexual worms. Juveniles lack genital markings, tumescences, tubercula pubertatis or clitellum. Aclitellate worms are without clitellum but have genital markings, tumescences or tubercula pubertatis. Specimens with a clitellum are referred to the adults. Postsexual worms (a rarely used category) are difficult to distinguish but are usually characterized by the discolouration or absence of the clitellum, hardened seminal vesicles with 'black bodies' and small testes or ovaries.

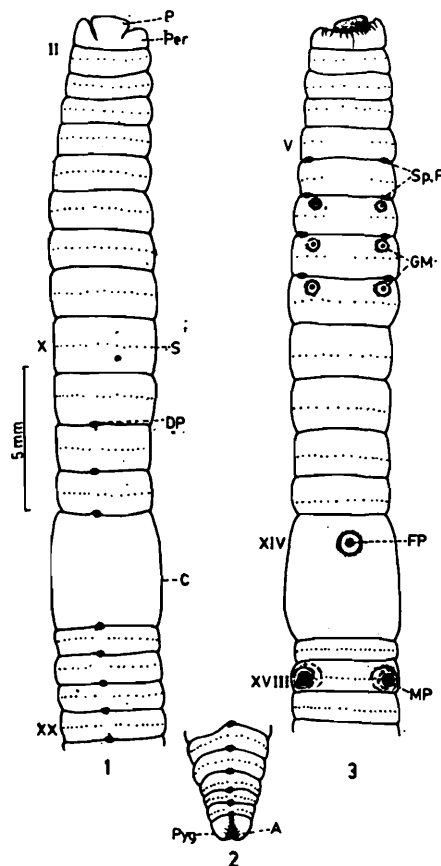
### ***External characters***

***Colour***: The colour of the worms due to iridescence of the cuticle, blood vessels in the body wall, intestinal ingesta, etc. is of no importance. But pigmentation of the body wall may be of some taxonomic value and should be recorded in life since strong fixing fluids usually destroy the pigment.

***Body form*** : Earthworms are elongate and vermiform. They are usually circular in cross-section and deviation to any other form (square or trapezoidal) may be of systematic importance. The anterior and posterior ends are, sometimes enlarged, and ventral surface flattened.

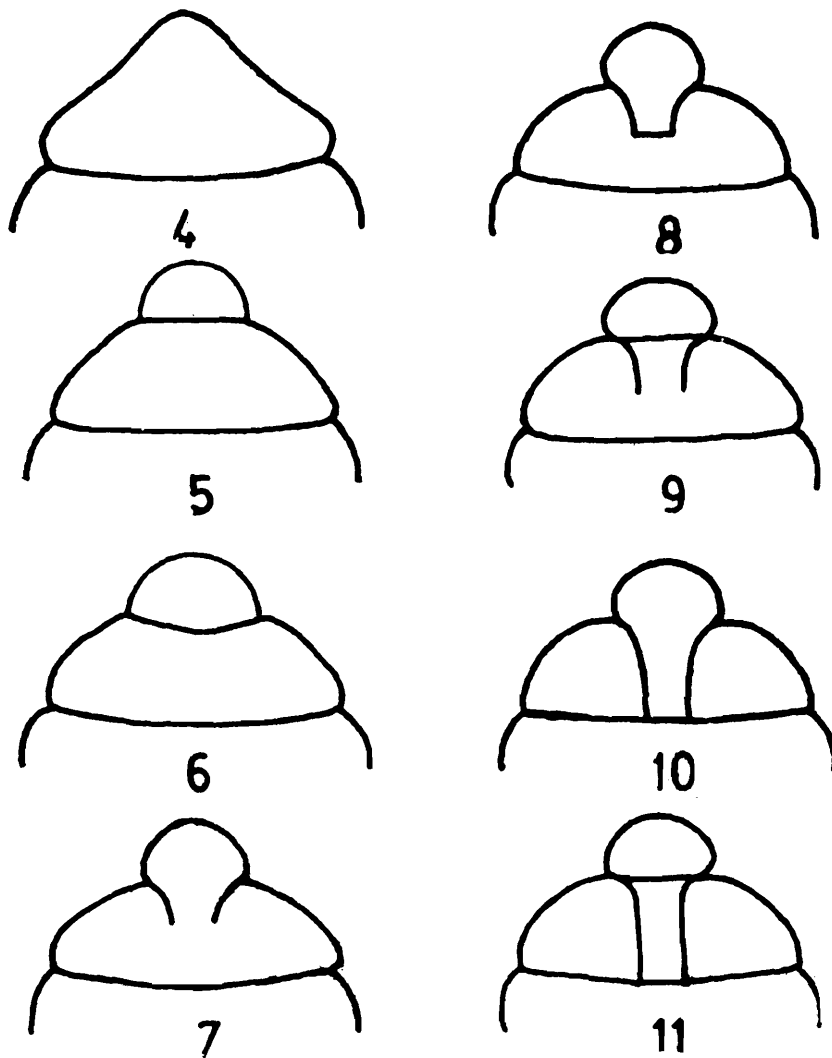
***Size*** : The length and diameter of earthworms are of little taxonomic value, since they vary considerably within a species. Method of preservation, amputation and regeneration can also affect body dimensions to a great extent. Measurements are taken on strongly contracted worms, the diameter is usually taken in front of the clitellum.

**Segmentation:** An earthworm's body is divided externally into segments by furrows which coincide with the positions of septa dividing the body internally (Fig. 1). Some or all segments may be superficially subdivided into two or three or more annuli by secondary grooves. The first and the last body segments, usually asexual, are called the peristomium and pygome respectively (Figs. 1-2). The number of segments vary intraspecifically. This character can be of taxonomic importance only when its limits of variations have been determined in each species. In the taxonomic descriptions, they are numbered in roman numerals, i.e. i, ii, iii..... (capitalized by some authors) beginning with the peristomium. The intersegmental furrows are designated by the numbers of segments on either side as 2/3, 3/4, 4/5, etc.



FIGS. 1-3. *Amyntas diffringens* (Baird). Dorsal views of the anterior (1) and posterior (2) regions, ventral view of the anterior region (3) A-anus, C-clitellum, DP-dorsal pore, FP-female pore, Mp-male pore, P-prostomium, Per-peristomium, Pyg-pygidium, S-setae, Sp. P-spermathecal pores.

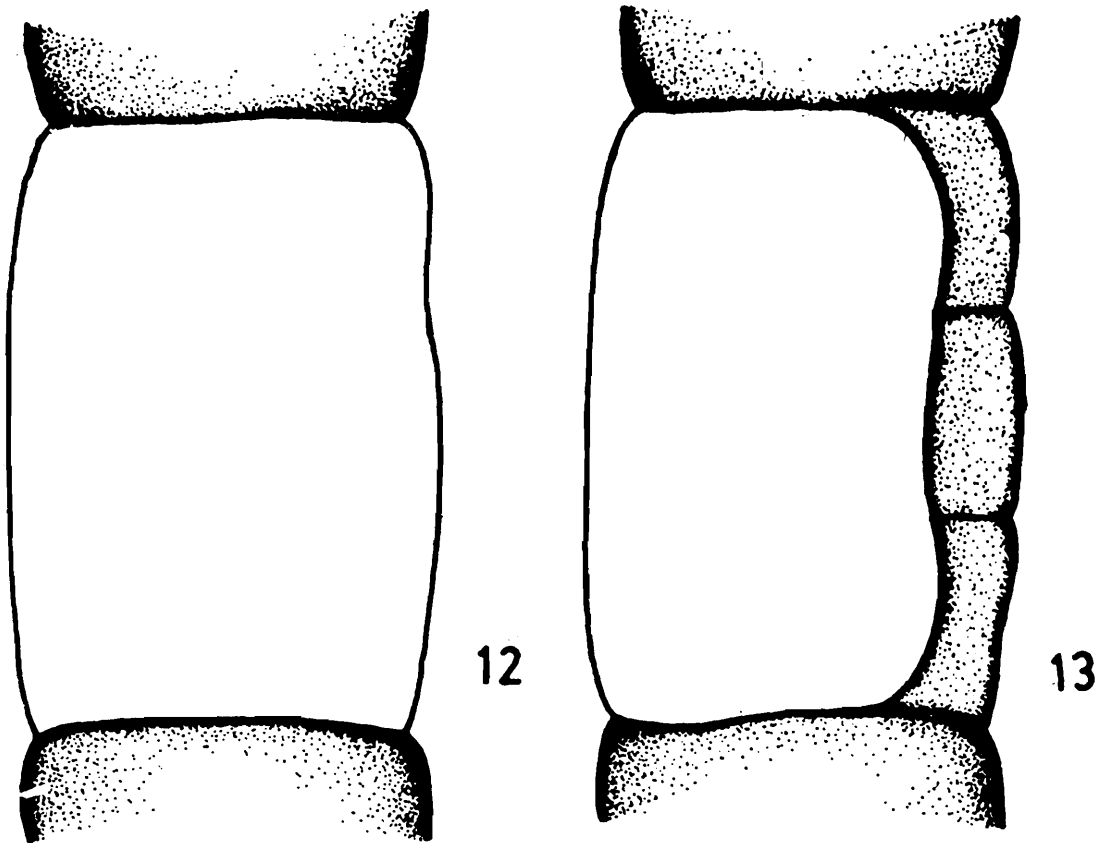
**Prostomium** : It is a small fleshy lobe, overhanging the mouth on the dorsal surface of the first segment. Its size may vary from rudimentary to an elongated proboscis-like structure. The different shapes of the prostomium, zygalob, prolob, proepilob, epilob, tanylob, combined pro/epilob and combined pro/tanylob (Figs. 4-11), are sometimes of taxonomic importance. The tongue in the epilob condition may be delimited posteriorly by a transverse groove (close epilob) or without any posterior demarcation (open epilob).



4-11. Various forms of prostomium (diagrammatic), 4. zygalob, 5. prolob, 6. proepilob, 7. open epilob, 8. close epilob, 9. combined pro/epilob, 10. tanylob, 11. combined pro/ tanylob.

*Dorsal pores* : They are small openings located in inter-segmental furrows on the mid-dorsal line leading to the coelomic cavity (Fig. 1). They are present in most earthworms, but are usually absent in worms with subaquatic or aquatic habitats. The position of the first functional dorsal pore is of very limited systematic importance as it is subject to intraspecific variations. Moreover, it is often difficult to distinguish between the first functional dorsal pore and a few anterior non-functional pore-like markings.

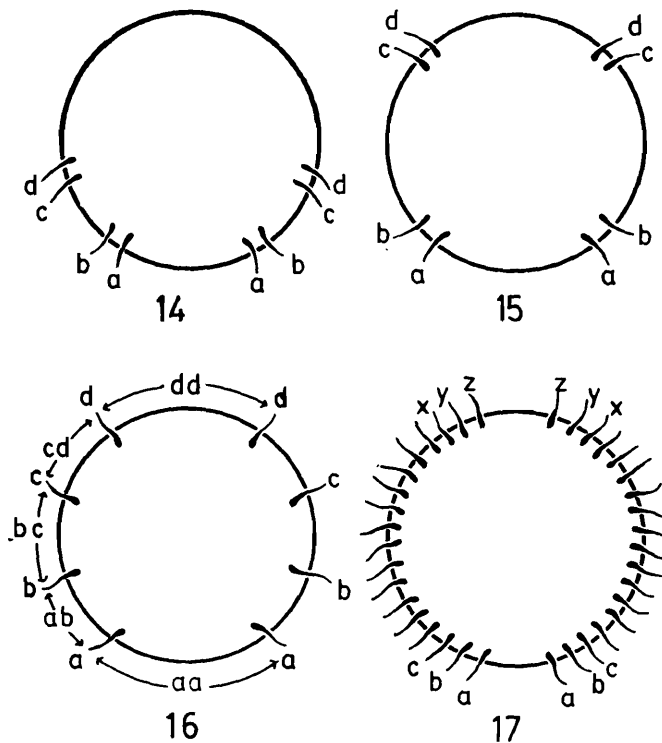
*Clitellum* : It is an epidermal swelling restricted to certain segments in sexually matured worms where gland cells secrete material to form the cocoon. It is either annular (extending all round the body, Fig. 12) or saddle-shaped (restricted to dorsal and lateral parts of the body, Fig. 13). The position and extent of clitellum may vary in certain families, genera and species, but are of specific importance in the Lumbricidae.



FIGS. 12-13. Lateral view of clitellum (diagrammatic). 12. annular, 13. saddle-shaped.

**Setae** : They are bristle-like retractile structures borne on follicles and arranged in a single ring around the periphery of each segment. The normal setae are usually sigmoid in shape, each with a nodule at about the middle. The positions of the setae provide reference points for describing location of genital and nephridial pores, grooves, genital markings, etc. Their number, modifications and distance between them are of some taxonomic importance.

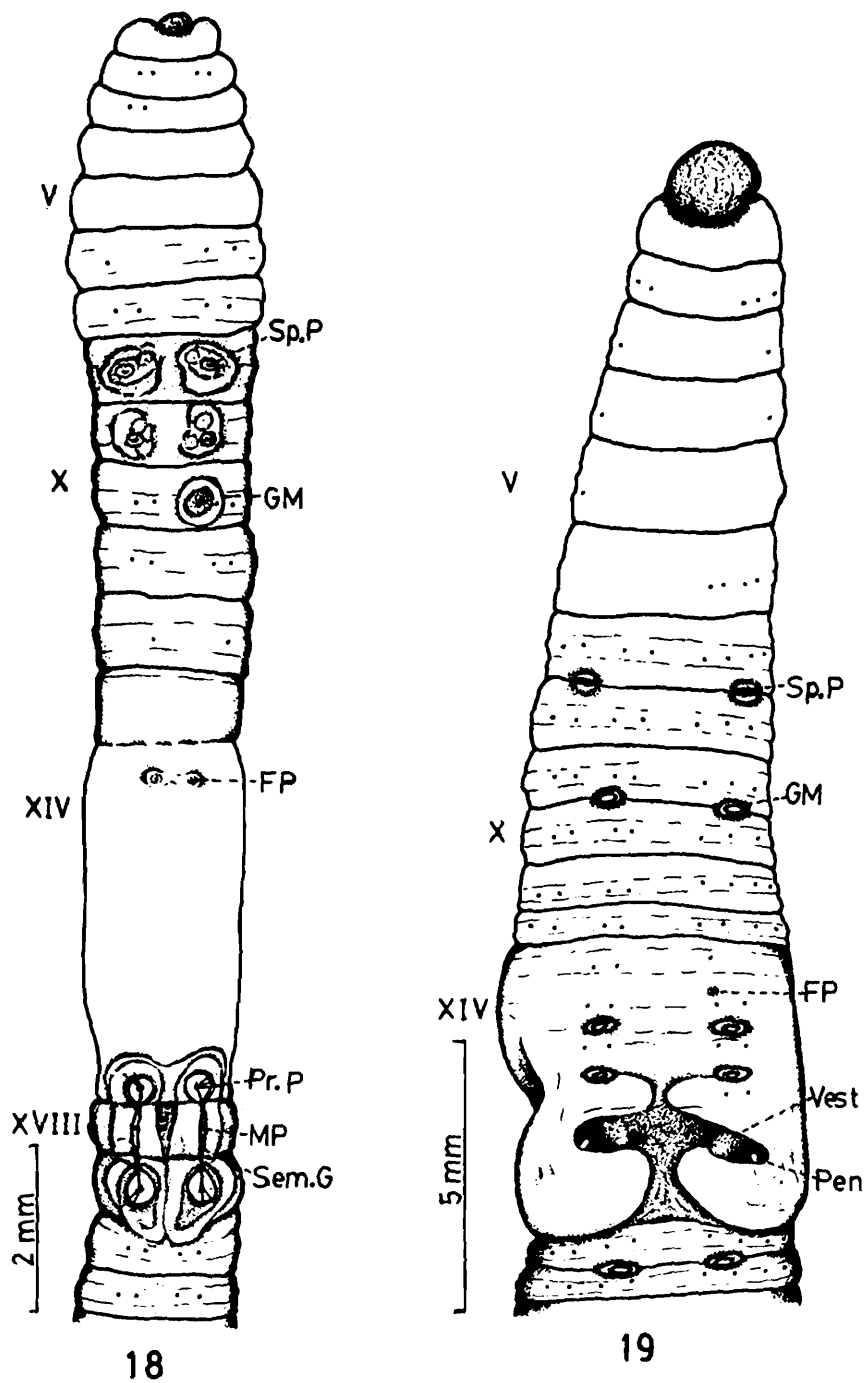
The arrangement of setae according to their number are expressed by the terms, lumbricine (8 setae per segment in 4 pairs, Figs. 14-16) or perichaetine (more than 8 setae per segment usually with a gap in the mid-dorsal and mid-ventral regions, Fig. 17). In taxonomic descriptions, individual setae on each side are designated by italicized letters, i.e. in the lumbricine arrangement by *a*, *b*, *c*, *d* beginning with the most ventral one and in the perichaetine arrangement by *a*, *b*, *c*, *d*, *e*, ..... beginning with the most ventral seta and *z*, *y*, *x*,.... beginning with the most dorsal one irrespective of the actual number in the ring.



FIGS. 14-17. Arrangements of setae (diagrammatic). 14-16. lumbricine, 14. closely paired, 15. widely paired, 16. separate. 17. perichaetine.

The distance between the setae is expressed in the form of an equation; in the lumbricine arrangement by  $aa = 3 ab = bc = 2 cd = 0.5 dd$  (meaning distance between setae  $aa$  is thrice  $ab$ , equal to  $bc$ , twice  $cd$  and half of  $dd$ ) and in the perichaetine arrangement by  $aa = 2ab = 1.5 bc = 1.5 yz = zz$  (meaning  $aa$  is twice  $ab$ , one and a half times  $bc$  and  $yz$ , and equal to  $zz$ ). Some authors express it as a ratio of distance between setae  $a$  and  $b$  in the form of  $aa: ab \ bc \ cd \cdot dd = 3 \ 1 \ 2 \ 1: 20$  in the lumbricine species and  $aa \ ab \ bc \cdot yz \ zz = 2 \ 1: 1. \ 1.2 \ 1.5$  in the perichaetine species. The total number of setae in the perichaetine species are counted, usually on segments ii, vii or viii, xii and xx; these are expressed as 16/ii, 32/viii ..... (meaning 16 setae on segment ii, 32 on viii and so on). The number of setae between the spermathecal and male pore lines are also given, but the figures are inverted as vii/8, viii/12 and xviii/6.

*Genital pores* : (Figs. 18-21). The segmental location and size of the openings of the vasa deferentia (male pores) and the oviducts (female pores) furnish useful taxonomic characteristics. Variation in their location within a species is regarded as an abnormality which may result due to regeneration. In the Ocnerodrilidae, Acanthodrilidae, Octochaetidae and Megascolecidae, the male pores are associated with the prostatic pores (openings of the ducts of prostates, accessory reproductive glands). The prostatic ducts and vasa deferentia may discharge to the exterior either separately or at combined male and prostatic pores. The basic conditions of these openings are sometimes termed as: acanthodriline (male pores on xviii, prostatic pores on xvii and xix, all pores in seminal grooves), microscolecine (prostatic pores along side or combined with male pores on xvii), balantine (prostatic pores along side or combined with male pores on xix) and megascolecine (prostatic pores along side or combined with male pores on xviii). Male pores are sometimes located on papillae of various shapes or at tips of intromittant organs, the penes. They may open directly on the body surface or into poche-like invaginations of the ventral body wall, the copulatory pouches (also known as copulatory chambers or bursae copulatrices), the external openings of which are often referred to as 'male pores'



**FIGS. 18-19.** Ventral view of the anterior region. 18. *Pellogaster bengalensis* (Michaelsen), 19. *Eutyphoeus waltoni* Michaelsen. FP-female pore, GM-genital marking, MP-male pore, Pen-penis, Pr. P-prostatic pore, Sem. G-seminal groove, Sp. P-spermathecal pore, Vest-vestibulum.

The size, number and location of the spermathecal pores (openings of the spermathecae), as well as single or paired, are of taxonomic value. These characters, however, are known to vary intraspecifically as a result of regeneration or parthenogenesis. The spermathecal ducts may open directly on the body surface or into small chambers, the external openings of which, although secondary, are often called 'spermathecal pores'

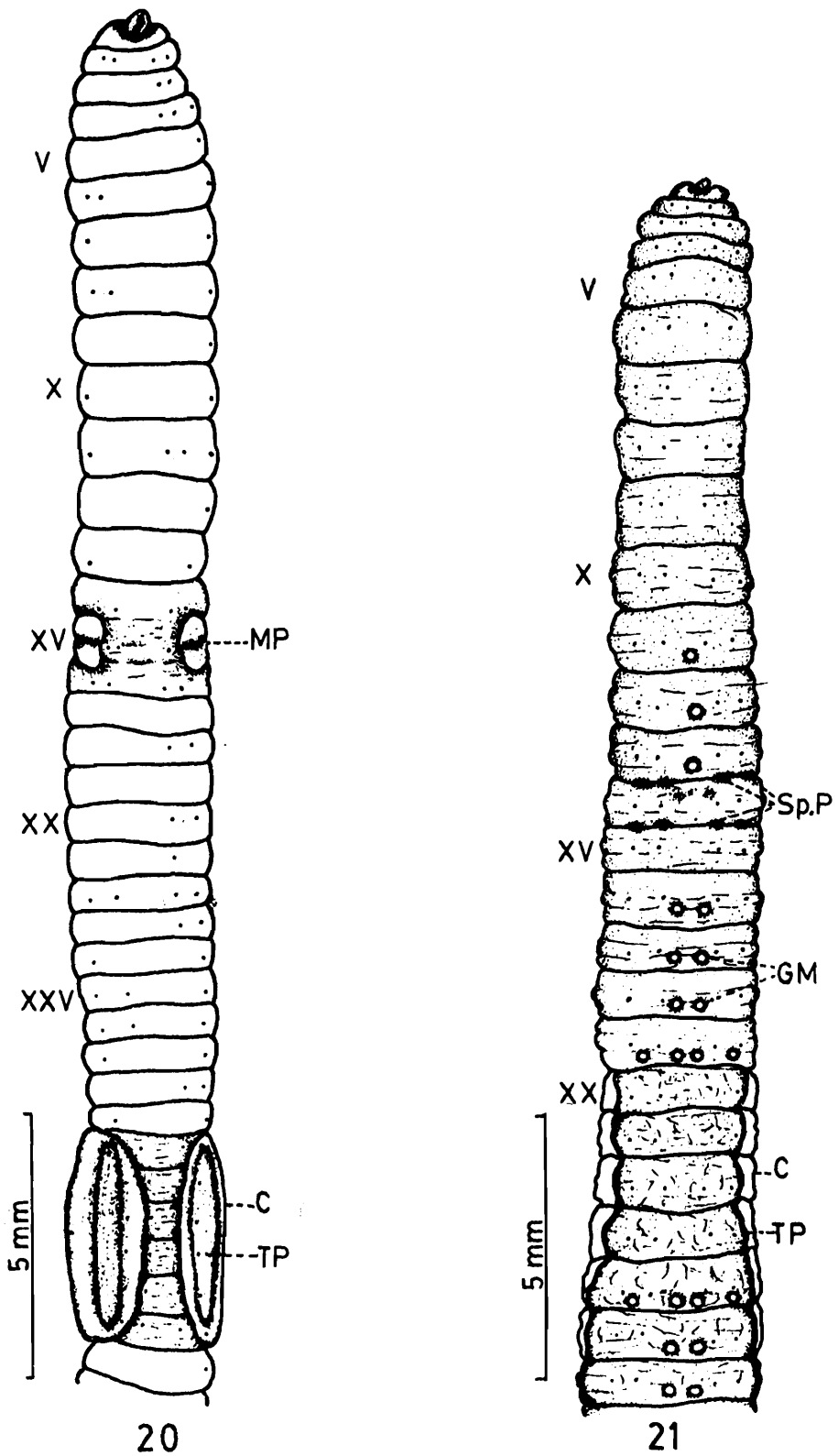
*Genital markings, tumescences, tubercula pubertatis, etc.* Certain areas of the epidermis on the ventral surface of sexually mature worms may be modified in the form of genital markings or papillae, genital and copulatory tumescences, pits and ridges. Their shape, number and location, although variable, are sometimes of systematic value. Tumescences are without distinct boundaries surrounding the modified setae; those around genital setae are known as genital tumescences and those around copulatory setae as copulatory tumescences. Genital markings (Figs. 3, 19) are usually more distinctly delimited and have slightly depressed central areas. Tubercula pubertatis (Fig. 20) are more or less swollen longitudinal ridges on the ventro-lateral margins of clitellum.

*Nephridiopores* : The external openings of nephridia are the nephridiopores (also called as nephropores or nephridial pores). They are very small and generally unrecognizable in the meronephric species, but may be obvious in the holonephric species (Fig. 22), in that case their axial position provides important distinguishing characters.

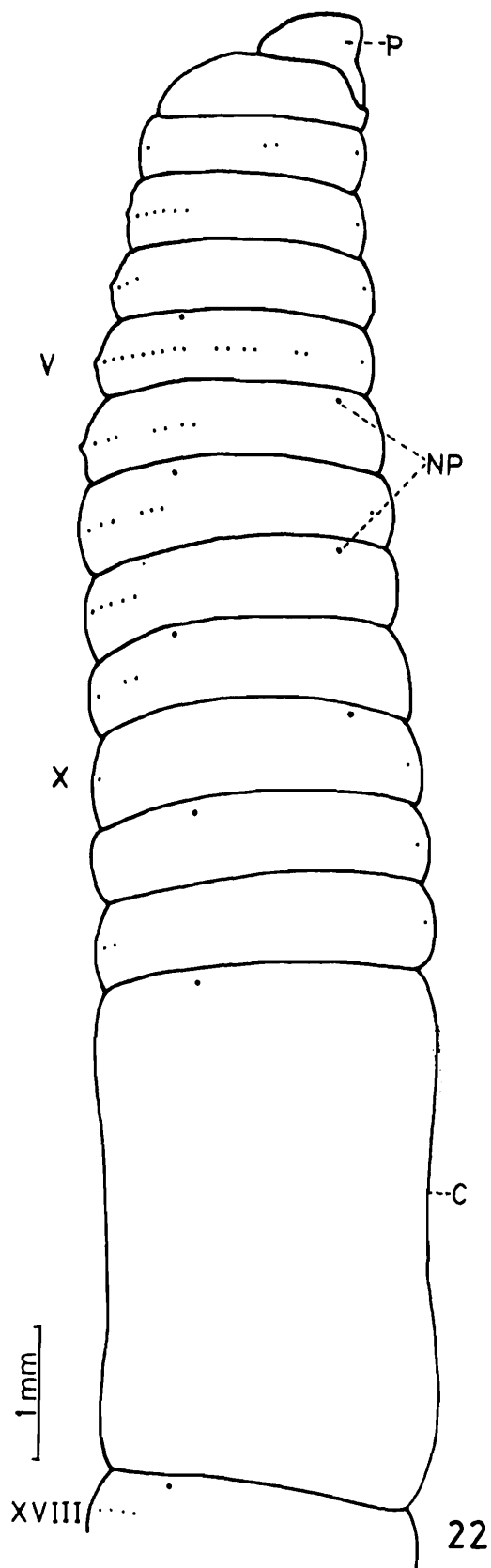
#### *Internal characters*

*Pigmentation* : The pigments are usually associated with the circular muscle layer of the body wall. In the preserved specimens, pigmentation can be observed to some extent at the dorsal incision of the body wall.

*Septa* : Absence of some septa in the gizzard region is of taxonomic value. Thickening (muscularization) of anterior septa is



FIGS. 20-21. Ventral view of anterior region. 20. *Octolasion tyrtaeum* (Savigny), 21. *Glyphidrilus tuberosus* Stephenson. C-clitellum, GM-genital marking, MP-male pore, Sp. P-spermathecal pore, TP-tubercula pubertatis.



FIGS. 22. *Perionyx sansibaricus* Michaelsen, lateral view of the anterior region. C-clitellum, NP-nephridial pores, P-prostomium.

also considered important, but assessment of the degree of thickening is highly subjective.

*Digestive system*: The main characters of taxonomic importance in the alimentary canal (Fig. 23) are the gizzard (s), calciferous glands or lamellae, beginning of the intestine, intestinal caeca, supra-intestinal glands and typhlosole.

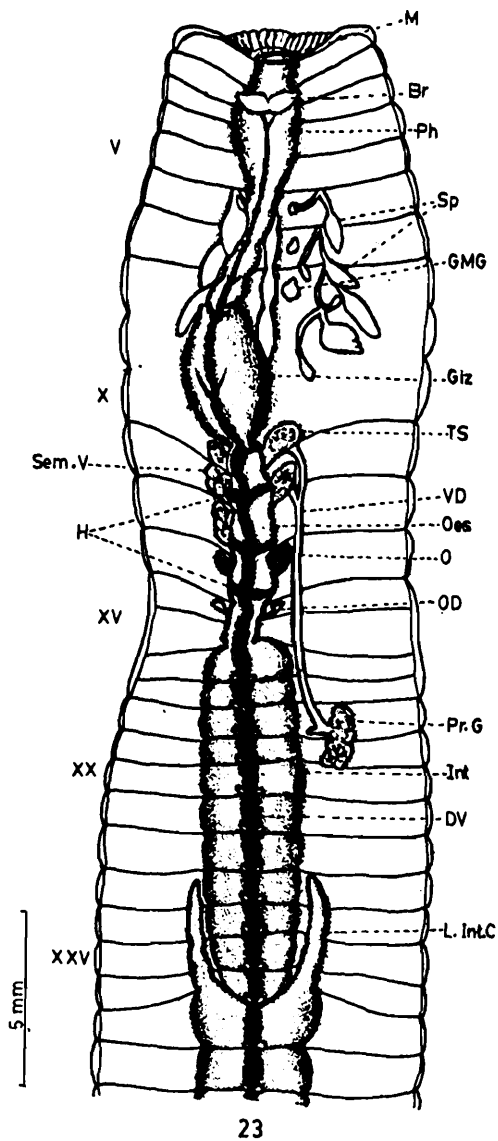
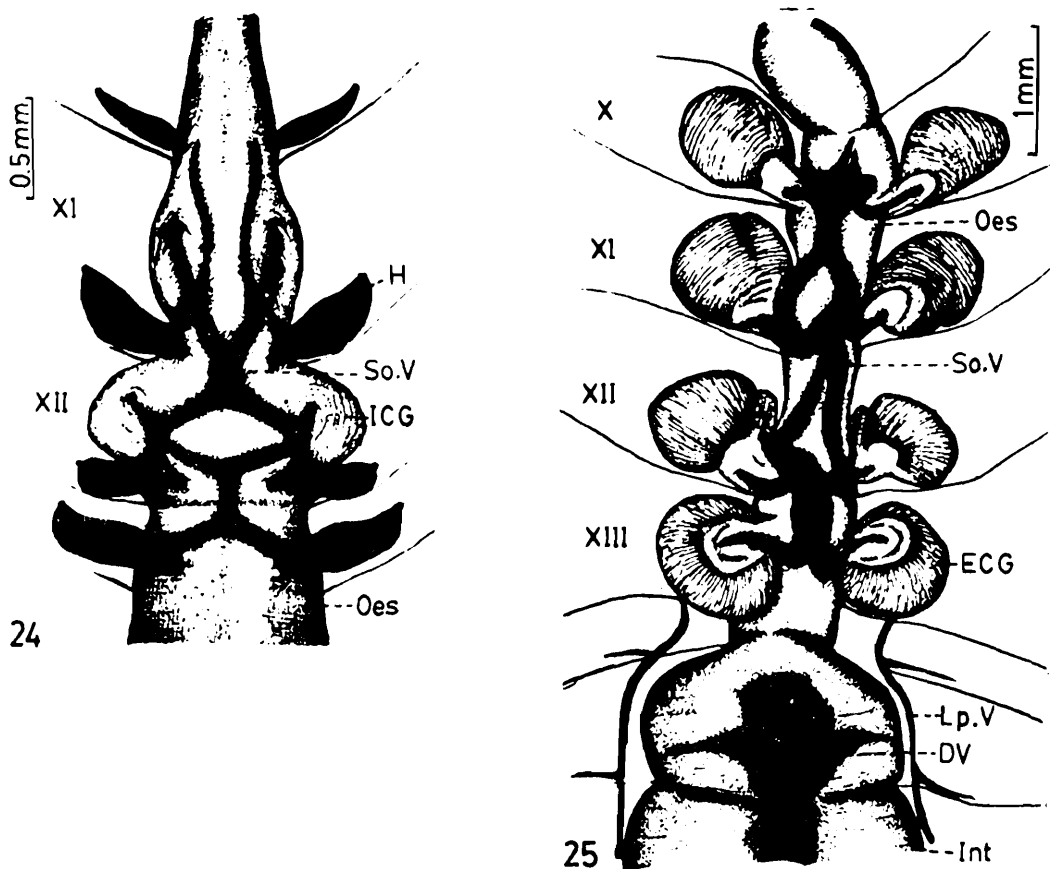


FIG. 23. Dorsal view of *Amynthes diffringens* (Baird) showing digestive, circulatory and reproductive systems. Br-brain, DV-dorsal vessel, Giz-gizzard, GMG-genital marking gland, H-hearts, Int-intestine, L. Int. C-lateral intestinal caeca, M-mouth, O-ovary, OD-oviduct, Oes-oesophagus, Ph-pharynx, Pr. G-prostatic gland, Sem. V-seminal vesicle, Sp-spermatheca, TS-testis sac, VD-vas deferens.

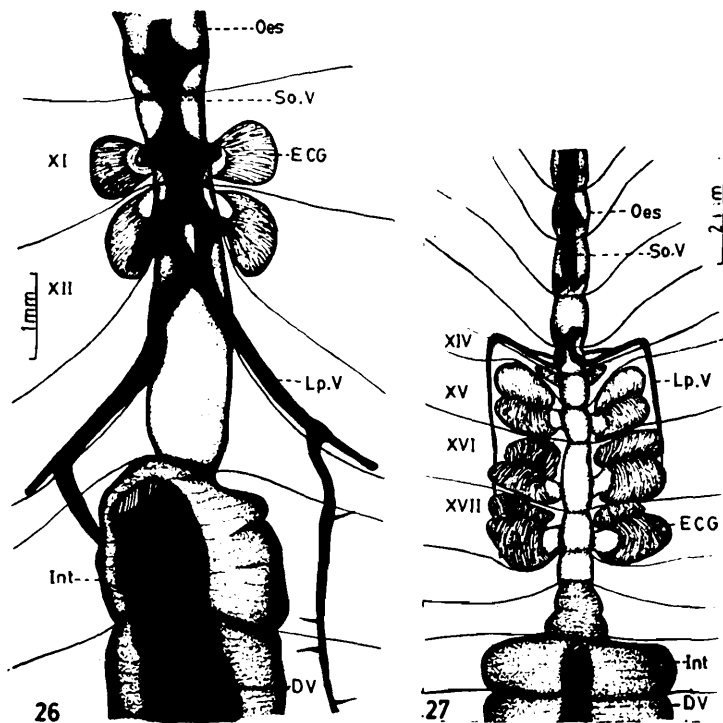
The number and position of the gizzard(s) have been used in distinguishing the earthworm genera, but their position should be determined carefully as some of the septa in this region are either absent or very delicate which may break as the worm is opened.

Calciferous glands are associated with oesophagus. They are whitish and highly vascular organs provided internally with lamellae. Their shape, number, segmental position as well as whether they are stalked or sessile, paired or unpaired, external (extramural; Figs. 25-27) or within the oesophageal wall (intramural; Fig. 24) provide useful distinguishing characters. In the absence of discrete calciferous glands, oesophagus may sometimes be markedly widened and provided internally with calciferous ridges or lamellae.



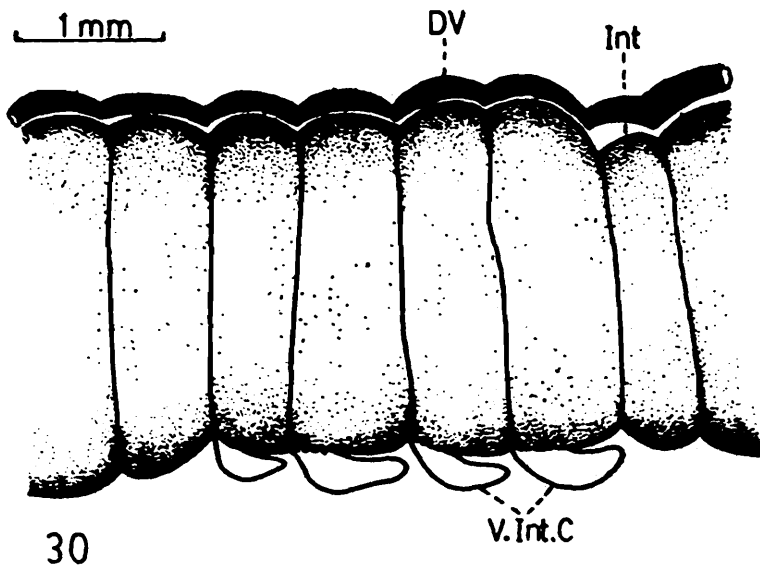
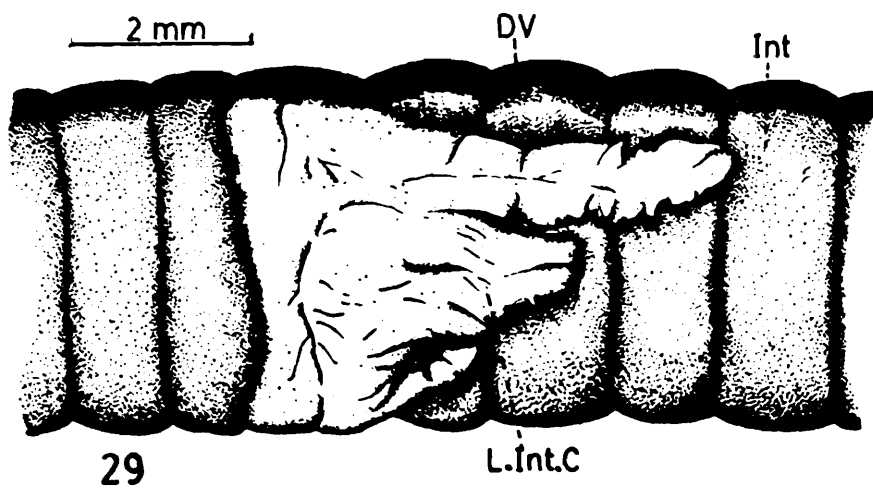
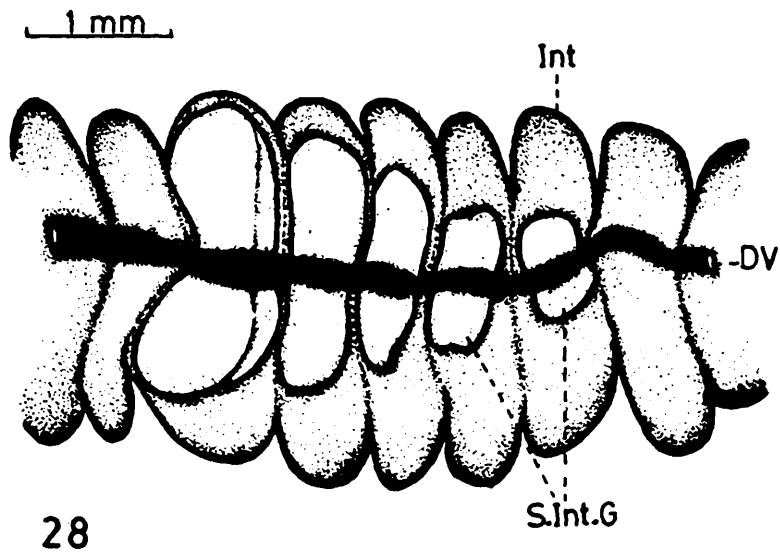
FIGS. 24-25. Dorsal views of oesophageal calciferous glands. 24. intramural, *Bahlia albida* Gates. 25. extramural, *Rillogaster matheranensis* (Stephenson).

## TERMINOLOGY AND TAXONOMIC CHARACTERS

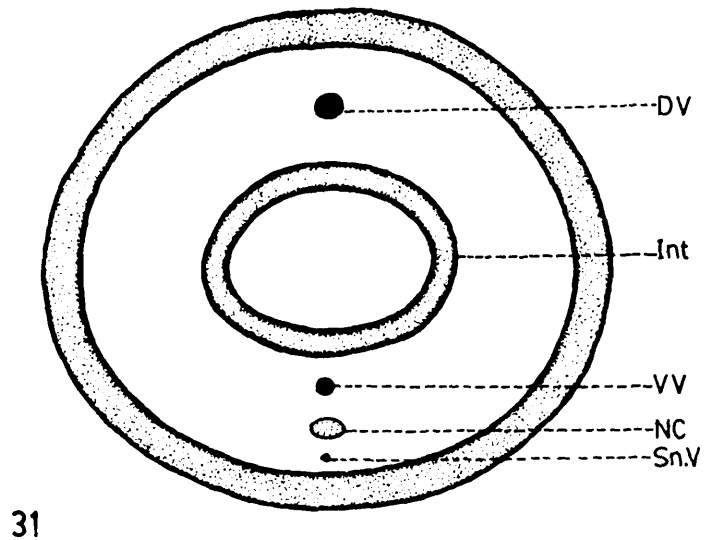


**FIGS. 26-27.** Dorsal views of calciferous glands. 26. *Eudichogaster prashadi* Stephenson, 27. *Priodoscolex montanus* Gates. DV-dorsal vessel, ECG-extramural calciferous glands, H-heart, ICG-intramural calciferous glands, Int-intestine, Lp. V-lateroparietal vessel, Oes-oesophagus, So. V-supra-oesophageal vessel.

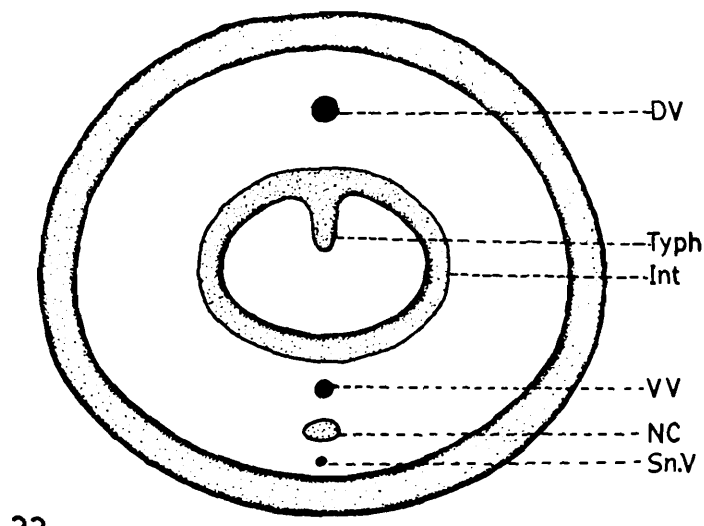
The beginning of the intestine seems to be usually constant within a species. However, it is sometimes difficult to recognize the posterior limit of oesophagus and anterior limit of intestine especially in the badly preserved specimens. These limits can be recognized by the presence of a valve at the posterior end of oesophagus. Intestinal caeca (Figs. 29-30) are small tubular outgrowths of the intestinal wall; their shape, position, number and whether single or paired are of systematic value. The internal surface of the intestine may be increased by a large dorsal fold, the typhlosole. Its absence or presence, shape, and anterior and posterior limits are of taxonomic importance. Its shape varies from a low ridge to a well-developed lamella which may be simple or ventrally bifid or trifid (Figs. 31-33). Several pairs of glands, the supra-intestinal glands (Fig. 28), are sometimes present on the



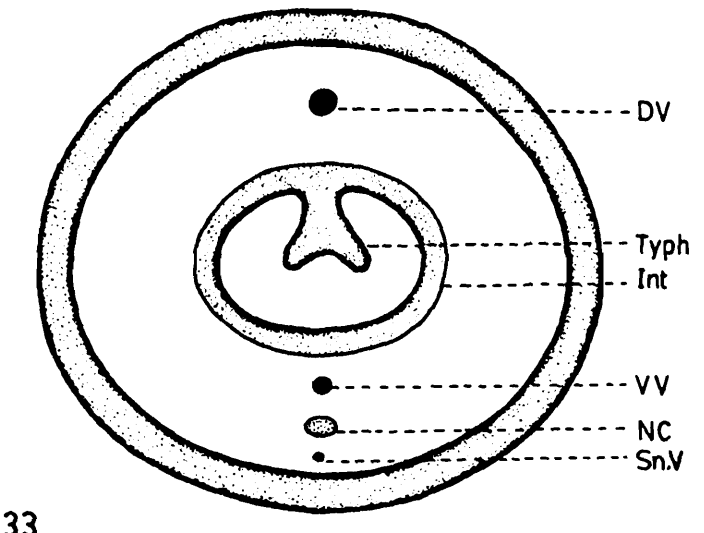
FIGS. 28-30. *Eutyphoeus festivus* Gates, dorsal view showing suprainestinal glands (28), lateral view showing ventral intestinal caeca (30). 29. *Metaphire birmanica* (Rosa), lateral view showing manicate intestinal caecum.



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**FIGS. 31-33.** Diagrammatic cross sections of earthworms. 31. intestine without typhlosole, 32. intestine with simple lamelliform typhlosole, 33. intestine with ventrally bifid typhlosole. DV-dorsal vessel, Int-intestine, NC-nerve cord, Sn. V- subneural vessel, Typh-typhlosole, VV-ventral vessel.

dorsal wall of the intestine in successive segments at the posterior end of the typhlosole. Their absence or presence is probably of generic importance, but their number vary intraspecifically.

*Vascular system* (Fig. 34): Gates (1972) emphasizes the importance of the dorsal, ventral, subneural, supra-oesophageal, extra-oesophageal (or latero-oesophageal) and latero-parietal vessels in earthworm taxonomy. But these characteristics should be used with caution as some of the vessels are drained of blood and unrecognizable in the preserved specimens.

The dorsal vessel is closely associated along the mid-dorsal line of the alimentary canal. The systematically useful characters of the dorsal vessel are: whether it is single or double, or aborted anteriorly. The ventral vessel lies immediately below the gut and is suspended from it by a mesentary. The subneural vessel is located beneath the nerve cord; its presence or absence is considered to be of generic importance. The supra-oesophageal vessel runs along the dorsal wall of the gut in the anterior segments; its presence or absence and whether single or double may be of taxonomic value.

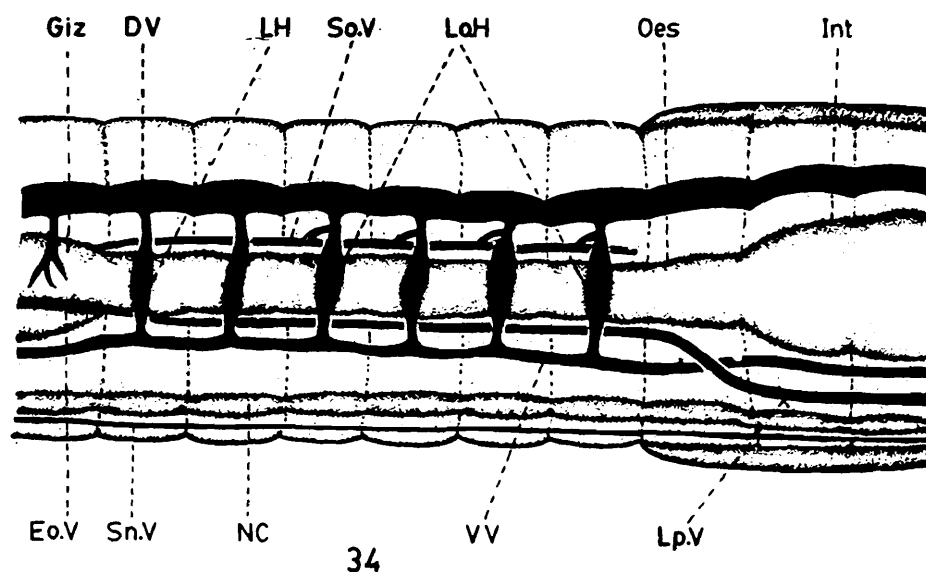


FIG. 34. Diagrammatic lateral view of circulatory system of an earth-worm. DV-dorsal vessel, Eo.V- extra-oesophageal vessel, Giz-gizzard, Int-intestine, LH-lateral heart, Lo.H-latero-oesophageal hearts, Lp. V-latero-parietal vessel, NC-nerve cord, Oes-oesophagus, Sn. V-subneural vessel, So. V-supra-oesophageal vessel, VV- ventral vessel.

Extra-oesophageal and latero-parietal vessels are paired; the former are situated anteriorly on the latero-ventral aspects of the gut and the latter lie laterally on the body wall. Their presence or absence and connections to other longitudinal vessels may provide distinguishing characters at the generic level.

Paired commissural vessels connect the ventral vessel with the dorsal or supra-oesophageal or both these vessels. Some of these in the anterior region of the body are enlarged, contractile and provided with valves internally, and they are known as the 'hearts'. The hearts opening into the dorsal vessel are the lateral hearts, those opening into the supra-oesophageal vessel are the oesophageal hearts and those opening into both dorsal and supra-oesophageal vessels are the latero-oesophageal hearts. The number and position of the hearts are considered to be of taxonomic importance.

*Reproductive system* : The reproductive system comprising of testes, ovaries, seminal vesicles, spermathecae and prostates provide useful taxonomic characters. The basic arrangement of the gonads in the megascolecid earthworms is paired testes in segments *x* and *xi* (holandry) and paired ovaries in segments *xii* and *xiii* (hologyny). The number of testes may be reduced to a single pair (meroandry); the term proandry is used for one pair of testes in segment *x* or a homotic equivalent and metandry for one pair of testes in segment *xi* or a homotic equivalent. The number of ovaries may also undergo reduction, i.e. one pair of ovaries in segment *xii* (progyny) or in *xiii* (metagyny). The morphology of the ovaries and process of shedding oocytes have been used for defining suprageneric categories of earthworms.

The testes and male funnels may lie free in their segments or are enclosed in special coelomic chambers, the testis sacs. Their shape and whether paired or unpaired are of taxonomic value. Septa of the testis and ovarian segments may be evaginated, those of the testis segments forming the seminal vesicles and those of the ovarian segment form ovisacs. The shape, size, number and segmental position of seminal vesicles are of systematic importance. The male

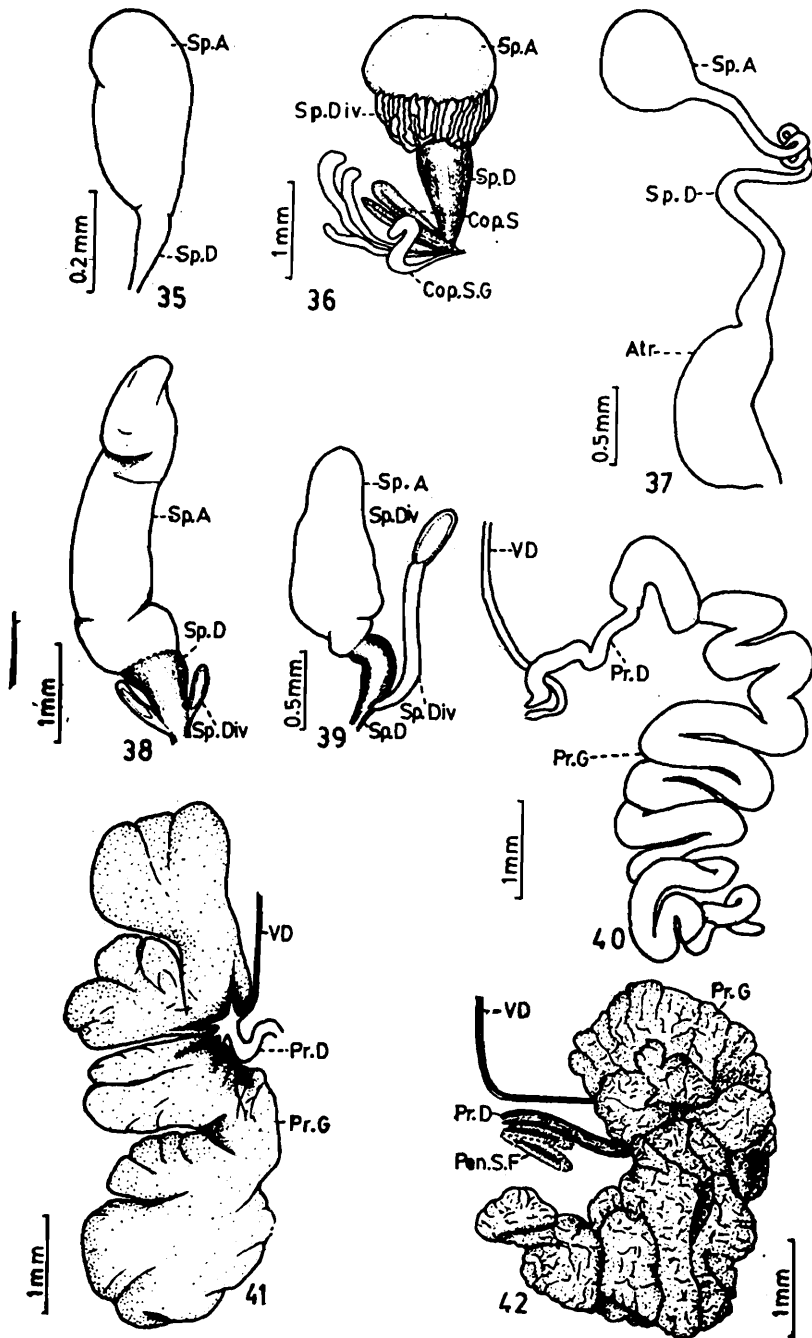
funnels open into straight or coiled male ducts, the vasa deferentia. In holandric species, the anterior and posterior male ducts on each side run backwards; they may unite with each other before opening to the exterior or they may discharge independently on the body surface. The posterior end of the vas deferens is sometimes enlarged into an ejaculatory bulb (bulbus ejaculatrice).

Accessory reproductive organs, the prostates, are associated with the posterior ends of vasa deferentia in most megadrile families, and are of various types. They are tubular (Fig. 40) with a central canal and of ectodermal origin in the Ocnerodrilidae, Acanthodrilidae and Octochaetidae, and racemose (Figs. 41-42) without a central canal and of mesodermal origin in the Megascolecidae. In the Eudrilidae, they are in the form of outgrowths from the male ducts and are called as 'euprostates'. In the Moniligastridae, the prostates (also termed as male atria) have an outer and inner glandular and a middle muscular layer, the latter forming a prostatic capsule and its various forms are useful in distinguishing species.

The spermathecae (Figs. 35-39), which receive sperms from another individual during copulation, are present in most earthworms. A spermatheca, typically, consists of an ental sac-like structure, the ampulla, and a duct by which it opens to the exterior. One or more diverticula may arise from the duct. Shape and size of the spermatheca and its various parts vary in different species.

Setae associated with genital tumescences, spermathecal and prostatic pores are sometimes modified to subserve a copulatory function; those associated with genital tumescences are called as genital, those with spermathecal pores as copulatory and those with prostatic pores as penial setae. The modified setae may be curved in different ways and usually variously ornamented or sculptured ectally. Their size, shape and ornamentation are of limited taxonomic importance, since they vary intraspecifically or may be similar in different species. But their presence or absence and distribution provide important specific characters.

TERMINOLOGY AND TAXONOMIC CHARACTER



FIGS. 35-42. 35-39. Various forms of spermathecae. 35. *Malabarbia biprostata* Aiyer, adiverticulate, 36. *Hoplochaetella stuarti* (Bourne), polydiverticulate, 37. *Drawida calebi* Gates, adiverticulate with an atrium, 38. *Lampito mauritii* Kinberg, bidiverticulate, 39. *Amynthas diffringens* (Baird), unidiverticulate, 40-42. Prostatic glands. 40. *Eutyphoeus festivus* Gates, tubular, 41. *Tonoscolex striatus* (Stephenson), racemose, 42. *Lampito mauritii*, racemose. Atr.-atrium, Cop. S-copulatory setae, Cop. S.G.-copulatory setal gland, Pen. F-penisetal follicle, Pr. D-prostatic duct, Pr.G-prostatic gland, Sp. A-spermathecal ampulla, Sp. D-spermathecal duct, Sp. Div-spermathecal diverticulum, VD-vas deferens.

*Excretory system* : The nephridia are the main organs of nitrogenous excretion in earthworms. They are of various kinds and have recently become increasingly important for megadrile taxonomy. For the study of nephridia, the whole worm is to be checked as different types of nephridia may occur within a species or they may be absent in a few anterior segments. The nephridia may be one pair (holonephridia, Fig. 43) or more than one pair (meronephridia, Fig. 44) in each segment. Either type of nephridia may be 'open' (stomate, Fig. 45), if nephrostomes persist or 'closed' (astomate), if nephrostomes are absent. Their ducts may open to

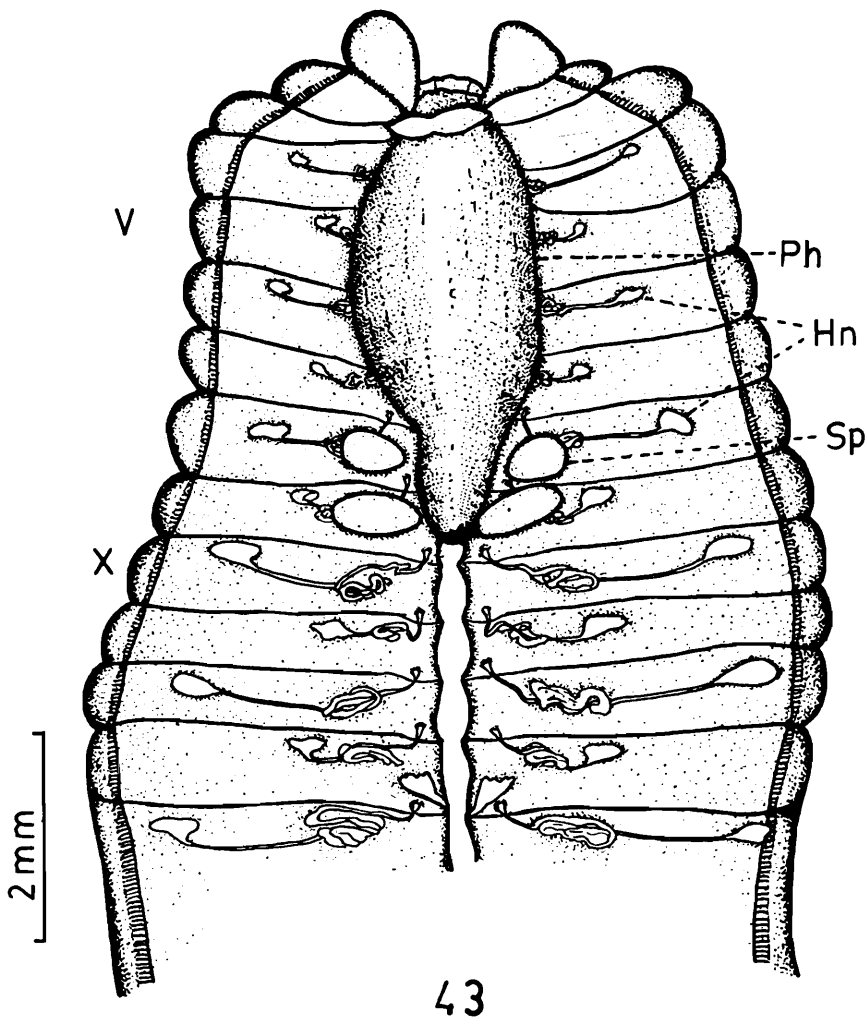
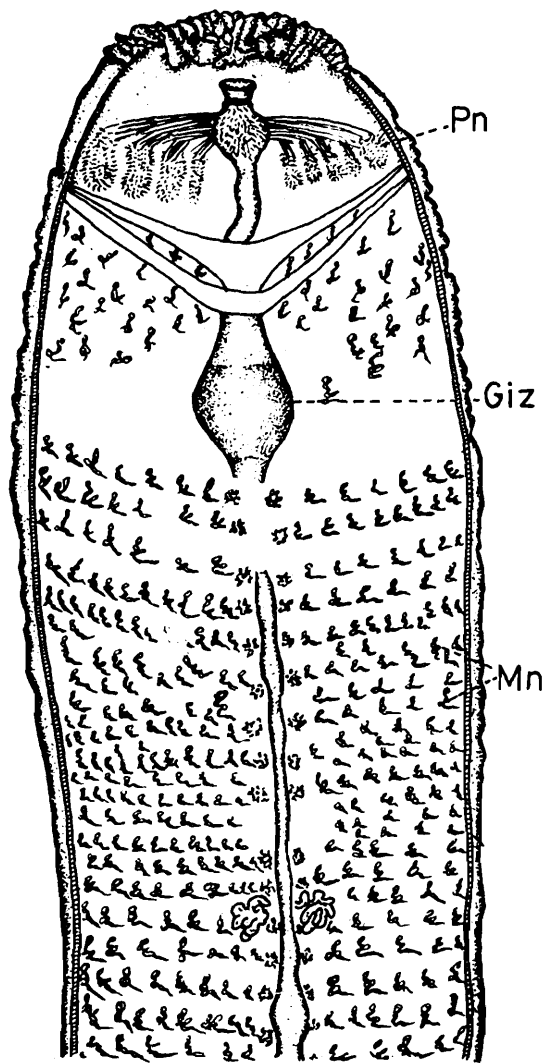


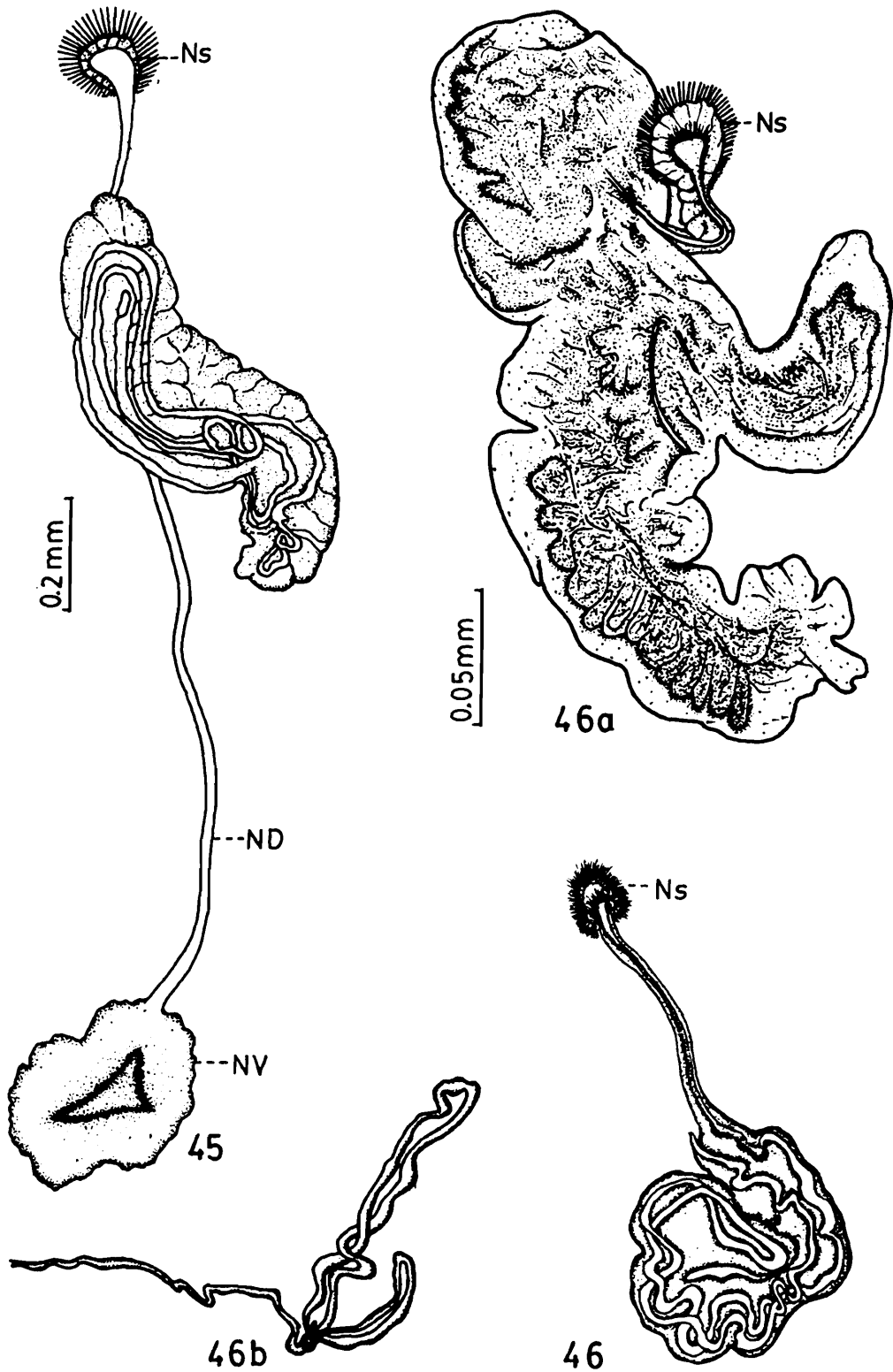
FIG. 43. *Perionyx sansibaricus* Michaelsen, holonephric, excretory system. Hn-holo nephridia, Ph-pharynx, Sp-spermatheca.



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FIG. 44. *Eutyphoeus nicholsoni* (Beddard), meronephric excretory system (redrawn, after Menon *et al.* 1969). Giz-gizzard, Mn-meronephridia, Pn-pharyngeal nephridia.

the exterior (exonephric) or into the alimentary canal (enteronephric), but astomate enteronephric holonephridia are not yet known in the earthworms. Meronephridia may be either very small (micromeronephridia, Figs. 46a, 46b) or relatively conspicuously enlarged into megameronephridia (Fig. 46). The ectal ends of the ducts of holonephridia are sometimes dilated into nephridial bladders or vesicles, which may be of various shapes. The terms vesiculate and avesiculate are used to describe the presence and absence of nephridial vesicles respectively.



FIGS. 45-46b. Various forms of nephridia. 45. *Perionyx sansibaricus* Michaelsen, holonephridium. 46, 46b. *Eutyphoeus nicholsoni* (Beddard), meronephridia (redrawn, after Menon et al. 1969), 46 stomate megameronephridium, 46b. astomate micromeronephridium. 46a. *Octochaetona beatrix* (Beddard), stomate micromero-nephridium. ND-nephridial duct, Ns- nephrostome, NV-nephridial vesicle.

Some species have tufted nephridia in some of the anterior segments. These may be of two or three distinct types: holonephridia which are incompletely branched into a number of meronephridium-like lobes with or without a single nephrostome and retain a single duct; meronephridia with ducts in a sheaf (composite ducts) or secondarily (?) united to form a single duct.

*Accessory glands* : Genital markings, tubercula pubertatis, copulatory and genital setae are sometimes associated with glands internally. The variations in the shape and size of these glands are of systematic interest.

## BIOLOGY AND ECOLOGY

### *Reproduction* :

Earthworms are hermaphrodite and mating is required in most species to exchange sperm from one individual to another. Fertilization is external in the cocoon, although internal fertilization has been recorded in the Eudrilidae (Stephenson, 1930). Sims (1964) presumed self-fertilization in the Eudrilidae on the basis of anatomical evidence. Parthenogenesis is common in some species and is indicated by the reduction or absence of testes, seminal vesicles, vas deferens, copulatory chambers, penes, prostates, spermathecae, etc. Absence of iridescence on male funnels, vasa deferentia and spermathecae may indicate occasional or obligatory parthenogenesis. In introduced species, parthenogenesis is considered to be of advantage as a worm has not to find a mate to reproduce.

### *Copulation* :

In earthworms, copulation results possibly due to pheromonal attraction between two worms (Olive and Clark, 1978). It may occur above or below the surface of the soil, and may last as long as an hour. Some species copulate periodically throughout the year except during unfavourable conditions, while in others mating is restricted to a particular period of the year. During copulation, two

worms lie side by side with their anterior ventral surfaces firmly attached and their heads in opposite directions. In lumbricids like *Lumbricus terrestris* and *Eisenia foetida*, the spermathecal region of one worm is closely applied to the ventral clitellar region of the other and the two are enclosed in a mucous tube, and sperm are carried to spermathecae in seminal grooves. In megascolecids and octochaetids, the male pores are opposite to the spermathecal pores and sperm are directly deposited in the spermathecae. Bahl (1927) observed sperm transference through the insertion of "penes" into spermathecal pores in *Eutyphoeus waltoni*. After copulation, the two worms separate and around the clitellar region of each worm a mucous tube is secreted which hardens on exposure to the air. The worm moves backwards to wriggle out of this tube and discharges into it ova through the female pore (s) and the partner's spermatozoa through the spermathecal pores as the tube moves forwards. The ends of the released tube close to form a lemon-shaped or ovoid cocoon, in which the embryonic development takes place. The colour and size of cocoons vary between species. The mode of copulation in a few Indian species is known from the works of Bahl (1927), Tembe and Dubash (1961), Menon *et al.* (1968), and Rao and Bhat (1978).

#### *Life cycle :*

Earthworms after copulation embark on a prolonged period of cocoon production which may be interrupted by adverse conditions or obligatory diapause. Cocoons, containing ova and nutrient albuminous fluid, are deposited usually near the surface of the moist soil, but are laid deeper if the soil is too dry. The cocoon production is markedly affected by environmental conditions, such as soil temperature, moisture and nutrition of the adult worms. It varies with species and is known only in a few Indian species. *Pheretima* sp. produces most cocoons from March to June and few during the rainy months of July and August (Bahl, 1950). On the other hand, cocoons laid by *Octochaetona surensis*, *Lampito mauritii* and *Drawida willsi* increase in number from August and

reach a peak density in October (Dash and Senapati, 1980). The incubation period varies interspecifically. Among the Indian species, it is 28-30 days for *Octochaetona surensis* and *Lampito mauritii*, and 14-18 days for *Drawida willsi* during October to December (Dash and Senapati, 1980) as compared to longer incubation period of 8.5 to 30 weeks in the European lumbricids as estimated by Evans and Guild (1948), Wilcke (1952), Nordstrom (1976) and Rundgren (1977). The short incubation period in the Indian species may be due to higher soil temperature (Dash and Senapati, 1980). Gerard (1967) also reported that temperature affected the incubation of cocoons in *Allolobophora chlorotica*, which was 36 days at 20°C, 50 days at 15°C and 112 days at 10°C. Soil moisture is another factor that seems to have a considerable influence on the hatching of cocoons; they do not hatch in complete hydric and very dry conditions (Dash and Senapati, 1980). Each cocoon contains one to twenty fertilized ova but only a few, usually one or two, survive and hatch (Edwards and Lofty, 1977). However, there are reports of one to six young worms hatching from cocoons of *Eisenia foetida* and *Bimastos tumidus* (Vail, 1974).

The period from hatching to sexual maturity is affected by temperature and the type of available food, and varies with species. It has been estimated as 18 to 74 weeks in the lumbricids (Evans and Guild, 1948; Wilcke, 1952), about 16 weeks in *Hoplochaetella suctorica* (Rao and Bhat, 1978) and 10-14 months in *Millsonia anomala* (Lavelle, 1971). The breeding season in earthworms occur at different times and is known only in few Indian species. In the Gangetic plain with a tropical climate, the peregrine species *Ocnerodrilus occidentalis*, *Ramiella bishambari*, *Perionyx sansibaricus*, *Dichogaster bolau* and *Lampito mauritii* that are active throughout the year become sexually mature as early as July and have a long breeding season while the endemic species *Eutyphoeus incommodus*, *E. nicholsoni*, *E. waltoni*, *Pellogaster isabellae*, *Bahlia albida* and *Ramiella nainiana* with a restricted activity during the monsoons possess a short breeding season of 2-3 months

(September to November) after the rains (Gates, 1945C). *Octolasion tyrtaeum*, a peregrine lumbricid, seems to breed in the Simla Hills (with a temperate-like climate) throughout the year, but the reproduction peak occurs in Autumn and winter (Julka and Mukherjee, 1984).

### *Diapause and Quiescence*

Activity of many species of earthworms is interrupted when the soil becomes too dry or soil temperature is either very low or very high. To tide over these adverse periods, they move deeper into soil where the temperature and moisture conditions are adequate or they may become comparatively inactive and enter *diapause* or become *quiescent*. Edwards and Lofty (1977) use the general term '*aestivation*' for this phenomenon of inactivity. Diapause is restricted to condition, when the worm stops feeding, empties the alimentary canal and constructs in the soil a spherical chamber lined with mucus, within which it rolls into a tight ball or a loose knot. In this condition, the worm loses weight but without any tissue dehydration (Olive and Clark, 1978). There are two states of diapause: *facultative* and *obligatory*. Facultative diapause occurs in response to adverse environmental conditions, but is terminated only after a certain critical period even when the conditions become favourable. Obligatory diapause takes place at a certain time of the year and is usually initiated by an internal rhythm or a certain sequence of environmental changes irrespective of current environmental conditions. In quiescence, the worms respond directly to deteriorating environmental conditions and become active as soon as the conditions are favourable. Unlike diapause, quiescence is accompanied by severe tissue dehydration (Olive and Clark, 1978).

### *Habitat and habits :*

Earthworms can be found in all types of soils provided there is sufficient moisture and food. They occur in forests, grasslands, cultivated lands, orchards, gardens, plant nurseries and green

houses. They have been found living in caves. Organic materials like compost, manure, forest litter and humus, municipal dumps, soils wetted with effluents and kitchen drainage are highly attractive to some species. They are also found under stones and logs, and at the axils of tree leaves. Some earthworms are very hydrophilous and occur near bodies of fresh and salt water. A few species can live under snow on high mountains. The process of soil formation leads to horizontal layers and earthworms inhabiting different layers are usually divided into three groups: (i) soil surface or litter dwellers (epigés) which are deeply pigmented and very active, (ii) topsoil dwellers (endogés) which are less pigmented and also less active, and (iii) subsoil dwellers (aneciqués) which are unpigmented or only light pigmented and slow-moving.

Earthworms construct burrows in the soil, ingest large amount of soil and deposit their faecal matter in the form of surface or subsurface castings. Surface or litter dwelling species do not have burrows and it is usually topsoil and subsoil species that make permanent burrows. The burrowing activity is generally restricted to top 30-45 cm layer of soil, but may be extended to deeper layers due to the scarcity of food or soil moisture. *Drawida grandis*, an Indian moniligastrid, is known to burrow to a depth of 2.7-3.0 m (Bahl, 1950). Burrows in some species are extensive, while in others they are simple, vertical or U- or Y-shaped, etc. The castings are of different forms often varying between species and are known in only a few Indian species. They are little heaps of individual spherical or oval pellets in *Metaphire posthuma*, *Hoplochaetella suctoria*, *H. anomala* and *H. powelli*. *Eutyphoeus incommodus*, *E. nicholsoni* and *E. waltoni* excrete faeces in the form of small towers of coiled tubes. *Curgiona narayani* and *Thatonia* sp. produce casts that are thin and thread-like and are arranged in small mounds. The faeces of *Pithemera bicincta* look like beaded-strings. Large tower - like castings of *Tonoscolex birmanicus* may attain heights of 20-25 cm (Gates, 1961b). The annual wormcast production in India has been estimated at a few sites; it is 1.4-5.0 tonnes/ha in arable sandy loam soil (Roy, 1957) and 3.9-77.8

tonnes/ha in grasslands (Roy, 1957; Dash and Patra, 1979) as compared to larger amounts of 2100-2600 tonnes/ha in Africa (Edwards and Lofty, 1977).

Earthworms are omnivorous and use a wide variety of dead organic matter in their nutrition. Since the proportion of organic matter in soil is generally small they swallow large quantities of earth in order to obtain sufficient nourishment. They also consume nematodes, protozoans, rotifers, bacteria, fungi and other microorganisms. According to their feeding habits earthworms are generally divided into three groups: (i) litter feeding, (ii) geophagous and (iii) limiphagous. Most litter feeding species can distinguish between different kinds of leaves, but prefer senescent leaves to freshly fallen ones, and also show preference for particular shape and species of leaves. It has been shown that food preference in earthworms is dependent on chemoreception. Most subsoil dwelling species are geophagous that pass much soil through the intestine for obtaining sufficient nourishment since the subsoil horizon is usually poor in organic matter. The limiphagous species ingest large quantities of mud alongwith humified plant debris accumulated on the margin or bottom of water bodies. The amount of food taken by earthworms has been estimated to vary from 100 to 300 mg/g body weight/day (Edwards and Lofty, 1977).

Most earthworms respond to various kinds of stimuli in different ways. *Eutyphoeus waltoni* and *Lumbricus terrestris* when feeding on the soil surface keep their caudal ends in burrows, if touched or at the slightest vibration of ground, they retreat quickly into their burrows. *Metaphire posthuma*, if disturbed, slowly coils into a series of circles. The surface or litter feeding species usually respond vigorously to tactile stimuli; *Amyntas diffringens*, *Hoplochaetella khandalaensis*, *H. inornata* and *H. powelli* move quickly in a serpentine manner; *Perionyx excavatus*, *Ramiella pallida* and *Hoplochaetella kinneari* produce a series of rapid lashing movements of anterior and posterior ends; other thigmotactic responses include autotomy of posterior segments as in

*Hoplochaetella inornata*, *H. stuarti* and *H. suctoria*, and death-feigning as in *Pheretima* sp. and *Hoplochaetella suctoria*. Most worms emerge onto the soil surface in response to vibrations, chemical and electrical stimuli. They also respond to light stimuli, some species, e.g. *Lumbricus terrestris*, are photopositive to very weak source of light and photonegative to strong ones, while other species such as *Pheretima* spp. are completely photonegative (Edwards and Lofty, 1977). Ultra-violet light is injurious to earthworms unless the intensity is very low. Some earthworms are known to produce luminescence when irritated by some chemical or electricity, or in response to vibration. Among Indian earthworms luminescence has been reported in a few species of *Eutyphoeus* and *Ramiella nainiana* by Gates (1944), and in *Lampito mauritii* by Ismail and Kaleemurrahman (1981). The luminescent system in earthworms may be due to the luciferin-lucifer reaction (Ismail and Kaleemurrahman, 1981).

*Population distribution, density and seasonal abundance :*

Several factors, often intercorrelated, are known to affect the distribution, density and seasonal abundance of earthworms. Most important of these are physico-chemical properties of soil, available food, reproductive potential and dispersive powers of the species.

Distribution of earthworms in the soil may be normal, random or aggregated and is sometimes influenced by the type of soil. For example, the endemic species of *Eutyphoeus* are mainly found in alluvial soil of the Indo-Gangetic plains and those of *Hoplochaetella* occur in laterite and red soils of the Western Ghats and the Peninsular plateaus, while most of the circummundane or peregrine species are able to live in different kinds of soils. Earthworms thrive best in moist soils and for this reason there are few worms in arid and semi-arid soils. Some worms (e.g. *Glyphidrilus*, *Ocnerodrilus*, *Malabaria*, *Thatonia* and *Perionyx*) are very hydrophilous and are usually associated with more or less submerged habitats. The soil pH has distinct influence on the distribution of worms. Most of them prefer neutral soils, but some can tolerate acid or alkaline soil

and some are ubiquitous that can withstand both acid and alkaline soils. The availability of food supply (organic matter) greatly influences the distribution of these organisms. There are usually few worms in soils with little organic matter whereas some species (e.g. *Perionyx excavatus*, *Eisenia foetida*, *Dichogaster bolau*, *D. saliens*), that consume high amount of organic matter, aggregate in compost or under dungpats and forest litter. The proportion of carbon to nitrogen (C/N ratio) in soil may also regulate their distribution. Different soil horizons have different species of earthworms, but the vertical distribution of each species changes seasonally depending upon food, moisture and temperature.

Earthworm populations are commonly expressed in terms of numbers or biomass (wet weight) per unit area of soil. Their population density varies in different habitats depending upon a variety of physico-chemical factors. Most species attain higher densities in light and medium loams than in heavier clays or more gravelly sands or alluvial soils. They are abundant in mull soils than in mor and fallow soils and moorlands. Although an extensive literature is available on earthworm densities in temperate soils, the size of population of these organisms has been estimated in a few Indian ecosystems (Table 1). These estimates show that pasture soils contain more worms than woodland, orchard, arable and barren soils. The density is higher in barren land than in arable land, and mixed woodland has more worms as compared to pine woodland.

The seasonal abundance of earthworms is affected by many ecological factors and the two most important are soil temperature and moisture. In Indian subtropical climate, especially in the plains, earthworms are mainly active and abundant during the summer rains with maximum density occurring in September-October and minimum density in May-June (Gates, 1961b; Dash and Patra, 1977; Chauhan 1980). On the contrary, an introduced species of the Lumbricidae, *Octolasion tyrtaeum*, in temperate western Himalaya was active throughout the year in a mixed woodland and

the phases of high density coincided with early summer and winter rains in July and December respectively (Julka and Mukherjee, 1984). In a pine forest in Meghalaya, the maximum and minimum densities occurred in July and April respectively (Reddy and Alfred, 1978).

*Dispersal :*

Earthworms possess both active and passive means of dispersal, although mountains, deserts and oceans are effective physical barriers that impede their active dispersal. Some species emerge from the soil, often on a mass scale, during or after the periods of heavy rainfall, and move actively for a considerable distance on the soil surface. This may be in response to oxygen deficiency or increased concentration of hydrogen sulphide in soil. In some parts of the western Himalaya, *Perionyx excavatus* and *Amyntas diffringens* are usually seen migrating in large numbers at the end of the monsoons. This phenomenon may be triggered off due to rapid depletion of soil moisture, low temperature and structure of the subsoil stratum as suggested by Julka *et al.* (1984). Although mass emergence or migration of the worms involves heavy mortality of individuals because of desiccation or exposure to ultra-violet rays of the sun or trampling by animals and man, it may be a strategy for resource exploitation, rapid expansion of range distribution, genetic exchange among scattered populations of species and decreasing population pressure during peak reproduction (Schwert, 1980).

TABLE 1. Density (no/m<sup>2</sup>) and biomass (g/m<sup>2</sup>) of Indian earthworms in different habitats.

Habitat	no/m <sup>2</sup>	g/m <sup>2</sup>	Site	Reference
Pasture	64-800	5.98- 60.95	Berhampur, Orissa	Dash & Patra, 1977
Pasture	25-936.1		Bangalore, Karnataka	Kale & Krishna- moorthy, 1978
Pasture		5.35-107.00	Sambalpur, Orissa	Senapati <i>et al.</i> , 1979

Contd.....

Habitat	no/m <sup>2</sup>	g/m <sup>2</sup>	Site	Reference
Orchard (grass)	38.2-420.5	-	Bangalore, Karnataka	Kale & Krishna- moorthy, 1978
Barren land	138.6-398.1	-	Bangalore, Karnataka	Kale & Krishna- moorthy, 1978
Arable land	51.9-274.4	-	Bangalore, Karnataka	Kale & Krishna- moorthy, 1978
Mixed woodland	30.4-118.4	-	Solan, H.P.	Julka & Mukherjee, 1984
Pine woodland	8.8-52	4.4 - 9.4	Shillong, Meghalaya	Reddy & Alfred, 1978

The passive means of dispersal are by stream drift and through mud on the feet of animals and birds. Man has also played an important role, though unintentional, in the passive dispersal of several widely distributed species by carrying them in mud around the roots of plants. A number of species are suspected to have been brought to India in this manner (Table 2).

#### *Predators and parasites :*

Earthworms are preyed upon by a variety of animals such as: leeches; flatworms (*Bipalium* spp.); slugs (*Testacella* spp.); carabid and staphylinid beetles, and ants; salamanders, toads; blackbirds, starlings, thrushes, gulls, crows, robins, common Myna and Shrike Babbler; snakes; hedgehogs, badgers and moles. They harbour several kinds of protozoan, helminth, rotatorian and dipterous larval parasites. The common protozoan parasites are *Monocystis*, *Distichopus*, *Nematocystis*, *Rhyncocystis*, *Echinocystis*, *Aikinetcystis*, *Grayallia*, *Nellocystis*, *Craterocystis* and *Pleurocystis* amongst the gregarines, *Anoplophrya*, *Maupasella*, *Parabursaria*, *Hopliophrya*, *Plagiotoma* and *Metaradiophrya* amongst the ciliates, and a few sporozoans. The helminth parasites include *Taenia cuneata*, *Polycerus*, *Rhabditis*, *Heterakis*, *Syngamus*, *Dicelis*, *Dionyx*, *Stephanurus*, *Metastrongylus*, *Spiroptera* and *Synoeconema*. Amongst Diptera, the larvae of *Pollenia rudis*, the cluster fly, and some species of *Onesia* and *Sarcophaga* are parasitic on the worms. Cocoons of some worms are attacked by mites. Dash *et al.*

(1979) reported that a parasitic fungi, *Thielovia terricole*, caused the loss of weight, degeneration of clitellum and ultimate death of the senescent worms of *Octochaetona surensis*.

TABLE 2. List of peregrine (circum-mundane) earthworm species which are suspected to have been introduced to the Indian sub-continent, possibly by unintentional transportation by man.

Family/species	Original home
<b>ACANTHODRILIDAE</b>	
<i>Microscolex dubius</i>	South America
<i>M. phosphoreus</i>	"
<i>Pontodrilus bermudensis</i>	?
<b>CRIDRILIDAE</b>	
<i>Criodrilus lacuum</i>	Europe
<b>EUDRILIDAE</b>	
<i>Eudrilus eugeniae</i>	Central Africa
<b>GLOSSOSCOLECIDAE</b>	
<i>Pontoscolex corethrurus</i>	Tropical America
<b>LUMBRICIDAE</b>	
<i>Aporrectodea trapezoides</i>	Europe
<i>A. tuberculata</i>	"
<i>A. turgida</i>	"
<i>Bimastos parvus</i>	North America
<i>Dendrobaena octaedra</i>	Europe
<i>D. rubida</i>	"
<i>Eisenia foetida</i>	"
<i>E. hortensis</i>	"
<i>E. rosea</i>	"
<i>Eiseniella tetraedra</i>	"
<i>Lumbricus castaneus</i>	"
<i>L. rubellus</i>	"
<i>L. terrestris</i>	"
<i>'L.' eiseni</i>	"
<i>Octolasion cyaneum</i>	Europe
<i>O. tyrtaeum</i>	"
<b>MEGASCOLECIDAE</b>	
<i>Amyntas alexandri</i>	Southeast Asia
<i>A. diffringens</i>	China

Family/species	Original home
<i>A. hawayanus</i>	"
<i>A. morrisi</i>	"
<i>A. robustus</i>	"
<i>Metaphire anomala</i>	Southeast Asia
<i>M. californica</i>	China
<i>M. houletti</i>	Southeast Asia
<i>M. peguana</i>	"
<i>M. planata</i>	(?) "
<i>M. posthuma</i>	"
<i>Pithemera bicincta</i>	Malay Archipelago or Philippines
<i>Polypheretima elongata</i>	Borneo
<b>OCNERODRILIDAE</b>	
<i>Eukerria kukenthali</i>	South America
<i>E. saltensis</i>	"
<i>Gordiodrilus elegans</i>	Tropical Africa
<i>Nematogenia panamaensis</i>	Africa
<i>Ocnerodrilus occidentalis</i>	Central America
<b>OCTOCHAETIDAE</b>	
<i>Dichogaster affinis</i>	(?) West Africa
<i>D. bolau</i>	"
<i>D. modiglianii</i>	"
<i>D. saliens</i>	"

## ECONOMIC IMPORTANCE

### *Usefulness of earthworms :*

*Effect on soil structure and fertility :* Earthworms play a multisided role in enhancing the soil fertility by changing its physico-chemical properties. They form extensive burrows by literally eating their way through the soil and deposit the ingested material as surface or subsurface casts. In this way, they transport large quantities of soil from deeper layers to the surface and take down decaying organic matter into the soil. Soils rich in earthworms remain loose and have a greater capacity to retain air and

water. Formation of water-stable aggregates in soil is of great importance as such soils remain well aerated and drained. Most of the soil biologists agree that earthworm castings contain higher amount of stable aggregates than the surrounding soil. Earthworms also help to maintain the soil almost in the neutral pH range.

A large amount of organic matter accumulates on the soil surface with the decay of plant material, which must be degraded first into humus and then into simple products before it can be used by plants. Earthworms play a major role in breaking up organic matter, combining it with soil particles, and thus enhance microbial activity when humification is well advanced. Organic matter alongwith soil ingested by earthworms is pulverized and subjected to digestive enzymes in their alimentary canal, and excreted as a colloidal humus which is rich in plant nutrients. Although the bulk of humification process is due to the microbial activity, the process seems to be accelerated during the passage of organic matter through the digestive tracts of earthworms. Compared to parent soil, the wormcasts contain more available nitrate nitrogen, calcium, magnesium, phosphorus and potassium. Plants cannot assimilate mineral nitrogen unless the ratio of carbon to nitrogen (C

N ratio) is around 20: 1, which is much higher in freshly fallen litter. It has been shown that earthworms feeding on litter gradually lower its C N ratio. A large number of earthworms die during unfavourable period when the chemical demand in the soil is maximum due to growing plants. The microbial decomposition of the dead worms releases considerable amount of nitrogen and other nutrients. It has been estimated that the decomposed worm tissue releases nitrogen as 25% in the form of nitrate, 45% as ammonia, about 3% as soluble organic compounds, and the rest 27% is unaccounted (Satchell, 1967). Thus, introduction of earthworms in agricultural land improves the yield of most of the crops.

*Earthworms and waste treatment* : Pollution due to increase in the waste materials, especially with the growth of human population and industrialisation, is one of the major hazards for the maintenance of a clean environment. It is, therefore, very essential that

these waste materials are recycled into utilisable organic materials. Because of their food and feeding habits, earthworms are nature's most useful converters of wastes especially those of agricultural origin. Hartenstein *et al.* (1979) indicated that earthworms are able to process household garbage, city refuse, sewage sludge and wastes from wood, paper and food industries. These days sewage sludge and animal slurries are used as soil conditioners and fertilizers due to their organic constituents and high levels of inorganic nutrients. Addition of earthworms in sewage sludge and sludge amended soils hastens in sludge decomposition and stimulates metabolic activity of the bacterial populations (Mitchell and Horner, 1980). Earthworms can also be important in the redistribution of certain toxic heavy metals in sludge by their burrowing, feeding and excretory activities.

*Earthworms as bioindicators* : Soil is being polluted by an indiscriminate spray of pesticides, and release of toxic heavy metals and lethal radioactive materials, which adversely affect life in the soil. Since earthworms form a major component of the soil fauna as well as their sensitiveness to these toxic and lethal materials, they can serve as convenient bioindicators of polluted soils.

*Earthworms as food* : They are commonly used as bait for fish throughout the world. The tissues of earthworms contain high amount of protein. With suitable processing they could benefit the livestock and aquaculture industry by augmenting or even replacing traditional feeds. There are also reports of earthworms being used for human consumption. Maoris in New Zealand and natives of New Guinea consider worms a delicacy (Edwards and Lofty, 1977).

*Earthworms in medicine* : They are known to be associated with medicine since ancient times to cure various human diseases. In Indian Unani system of medicine, preparations from dried worms, when applied externally, have been used in treating wounds, chronic boils, piles, sore throat, hernia and impotency, and when taken internally, they are useful in curing chronic cough, diphtheria, jaundice, rheumatic pains, T.B., bronchitis, facial paralysis and

impotency. They have been used in folk-medicine to treat pyorrhoea and small pox and to enable mothers to nurse their children in Burma, and for hair growth and expulsion of stones from the bladder in Iran (Stephenson, 1930). The Cherokee Indians of the Great Smoky Mountains use earthworm poultices to draw out thorns (Reynolds and Reynolds, 1972).

*Other benefits of earthworms* : They are important in the dispersal of fungi or bacteria, which play a significant role in the decomposition of organic matter. The ascospores from the perithecia of a fungus *Ventura inaequalis* on overwintering dead leaves of apple cause apple scab. Certain species of earthworms are known to carry these infected leaves from soil surface to subsoil horizon, thus preventing to some extent the spread of this serious disease in apple orchards. Earthworms are also known to prey upon soil nematodes and can be utilized to control both parasitic and non-parasitic nematodes in agrosystems (Dash *et al.*, 1980).

Earthworms carry pesticides absorbed in their tissues from soil surface into deeper soil where most pests live and control them more effectively. They are also killed by some kinds of pesticides, but can tolerate other kinds, and are considered to be sufficiently important test organisms to require pesticide firms to provide earthworm toxicity data (Edwards, 1980). Earthworms have been used in testing pregnancy. Their activity can increase the amount of vitamin B<sub>12</sub> in soil upto seven times (Edwards and Lofty, 1977). Flooded areas that are subsequently drained and cultivated can be reclaimed by the addition of earthworms (Rhee, 1969).

#### *Harmfulness of earthworms* :

*As enemies of plants* : Certain habits of earthworms have been found to be responsible to damage plants in India as well as in other parts of the world. Some species sieze the leaves of growing plants and pull them into their burrows, often killing the plants (Edwards and Lofty, 1977). A fungus, *Pythium aphanidermatus*, causes stem rot in *Carica papaya*, and a small species of earthworm *Megascolex insignis* has been observed to intensify the damage by feeding on the

diseased plant tissue (Rao, 1979). An intense burrowing activity of the worms sometimes retards germination, growth and root development of tobacco, paddy and vegetable crops (Patel and Patel, 1959; Puttarudriah and Sastry, 1961, Edwards and Lofty, 1977; Veeresh and Rajagopal, 1981).

*As carriers of diseases* : Earthworms are known to help in the spread and development of many parasites and diseases of both animals and plants. They may ingest spores of pathogenic fungi and eggs of parasites, which remain viable in their guts and throughout the soil. These pathogens and parasites are carried by the worms down to deeper soil, thus protecting them against adverse conditions and control measures used by man. The foot and mouth viral disease of domestic animals has been reported to be transmitted by these organisms (Dhennin *et al.*, 1963). They also act as essential intermediate hosts to protozoan, cestode and nematode parasites of birds and mammals.

*Adverse effects on soil* The castings of some species of worms on drying become cement like hard clods rendering the soil compact and hard. As a result, the normal percolation in the soil is affected and it becomes unproductive to raise vegetable crops, especially root crops like carrot, turnip, radish, etc. There are several reports that the worms cause soil erosion on hill slopes by bringing fine soil to the surface.

*As carriers of toxic pesticides and heavy metals* Earthworms form an important component in the diet of various kinds of birds and mammals. Since they are known to accumulate certain pesticides and toxic heavy metals in their body tissues, they can become a serious threat to the animals feeding on them.

## METHODS OF COLLECTION, PRESERVATION AND DISSECTION

The best method for collecting earthworms is by digging soil with a shovel or spade or any other suitable implement and

handsorting. The other commonly used method is by the application of 0.40% formalin or other chemicals, but this technique is not suitable for taxonomic purposes since deep burrowing and aestivating worms do not respond to chemicals. For a comprehensive survey of earthworms of an area, they should be collected from different ecological niches, viz., litter, kitchen drainage, manure heaps, different types of soils, margins of freshwater bodies, pastures, grasslands, forests, cultivated fields, etc.

The worms are killed by dropping them in 70% ethyl alcohol. When the movement stops, they are removed from alcohol and placed on a piece of blotting paper or any other absorbent paper in a straight position. They are then transferred to a flat-bottomed container with 10-15% formalin for fixation for a period of at least 24 hours. It is essential that the worms be straight because curled and twisted specimens are difficult to handle during dissection. The specimens are stored in suitable sized vials or bottles filled with 70% ethyl alcohol or 10-15% formalin. A label with locality and altitude data, name of collector and date of collection is to be added to each vial. For best results, the preservative should be changed within a week, especially for large worms. Sometimes for lack of adequate time in the field it is not possible to follow this programme, it is then recommended to preserve the specimens directly in 4-10% formalin depending on the size of the worm. Fixation of specimens in alcohol is not desirable as they become soft and macerated, and are unsuitable for dissection. Some workers anaesthetise and relax the worms before fixation by placing them in a container filled with water and gradually adding alcohol to it. The main disadvantage of this method is that length of the relaxed specimens may be twice, thrice or even more than the contracted specimens as obtained by dropping them directly into alcohol or formalin. The latter condition is preferable because uniform contraction is often more easily obtained than uniform relaxation of a worm.

Earthworms cannot be identified without resorting to dissection since their generic or even suprageneric identification is dependent on internal characteristics. Before dissecting a worm, its various

external characters like shape of prostomium, location of genital and nephridial apertures, and form and extent of clitellum should be recorded. It is then pinned in a dissecting dish, containing water, by fine entomological pins at the anterior and posterior ends, taking care to avoid injury to the prostomium. Using a fine scissors or scalpel or even a sharp shaving blade, the body is cut open longitudinally slightly to the left or right side of the mid-dorsal line in order to avoid damage to dorsal pores. By carefully cutting septa, the flaps of the body wall are slowly pinned out with a fine forceps, preferably first at the post-prostatic region and then continuing forward, care being taken to record exact location of missing and delicate septa in the gizzard region. To determine the presence of oesophageal calciferous lamellae and openings of calciferous glands, it is necessary to slit open the oesophagus along the mid-dorsal line. The beginning of intestine and form of typhlosole can be determined by giving a slit just below the mid-dorsal line on one side of the intestine. Penial and copulatory setae are easily removed along with their enlarged follicles from inside; they cannot be pulled from outside without some damage to them. After cleaning the adhering tissue, the setae are mounted on a slide in glycerine or any other media, provided the refractive index is sufficiently different from that of the setae. Canada Balsam is not satisfactory for this reason, unless the setae are stained.

**FAMILIES AND HIGHER CATEGORIES  
OF CLASS OLIGOCHAETA**

**Order LUMBRICULIDA**

1. Family Lumbriculidae<sup>1</sup>

**Order MONILIGASTRIDA**

- \*2. Family Moniligastridae<sup>2</sup>

**Order HAPLOTAXIDA**

**Suborder HAPLOTAXINA**

3. Family Haplotaxidae<sup>2</sup>

**Suborder TUBIFICINA**

**Superfamily Enchytraeidea<sup>1</sup>**

- \*4. Family Enchytraeidae

**Superfamily Tubificoidea<sup>1</sup>**

- \*5. Family Tubificidae

- \*6. Family Naididae

7. Family Phreodrilidae

8. Family Opisthocystidae

9. Family Dorydrilidae

**Suborder ALLUROIDINA**

10. Family Alluroididae<sup>2</sup>

11. Family Syngenodrilidae<sup>2</sup>

**Suborder LUMBRICINA**

**Superfamily Biwadriloidea<sup>2</sup>**

12. Family Biwadrilidae

**Superfamily Criodriloidea<sup>2</sup>**

- \*13. Family Criodrilidae

**Superfamily Lumbricoidea<sup>2</sup>**

14. Family Sparganophilidae

- 15. Family Ailoscolecidae
- 16. Family Hormogastridae
  - i. Subfamily Hormogastrinae
  - ii. Subfamily Vignysinae
- \*17. Family Lumbricidae
  - \*i. Subfamily Lumbricinae
  - ii. Subfamily Diporodrilinae
- 18. Family Lutodrilidae
- Superfamily Glossoscolecoidea<sup>2</sup>
- 19. Family Kynotidae
- 20. Family Microchaetidae
- \*21. Family Glossoscolecidae
- \*22. Family Almidae
- Superfamily Megascolecoidea<sup>2</sup>
- \*23. Family Ocnerodrilidae
  - i. Subfamily Ocnerodrilinae
  - ii. Subfamily Malabarinae
- \*24. Family Acanthodrilidae
- \*25. Family Octochaetidae
- \*26. Family Megascolecidae
- \*27. Family Eudrilidae
  - \*i. Subfamily Eudrilinae
  - ii. Subfamily Pareudrilinae

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Families and subfamilies marked with an asterisk (\*) have been reported from the Indian subcontinent. Families/ superfamilies marked with (1) are microdriles and (2) are megadriles.

## KEY TO THE FAMILIES OF INDIAN MEGADRILE OLIGOCHAETA\*

- |   |  |
|---|--|
| 1. Testes and male funnels intraseptal, male pores at the posterior margin of the segments as their corresponding tests; clitellum single-cell thick; eggs large, yolky .....           | O. MONILIGASTRIDA<br>(MONILIGASTRIDAE) |
| Tests and male funnels interseptal, male pores at least two segments posterior to the segment bearing testes; clitellum formed by multiple layers of cells; eggs small, not yolky ..... | 2. O. HAPLOTAXIDA<br>(S.O. LUMBRICINA) |
| 2. Male pores anterior to or on segment xvi.....  | 3                                      |
| Male pores posterior to segment xvi (not easily recognizable in Glossoscolecidae and Almidae)   | 4                                      |
| 3. Dorsal pores present .....   | LUMBRICIDAE                            |
| Dorsal pores absent .....   | CRIODRILIDAE                           |
| 4. Prostatic glands present .....   | 5                                      |
| Prostatic glands absent .....   | 9                                      |
| 5. Spermathecal pores anterior to testis segments or mostly so located (not associated with ovaries or oviducts .....   | 6                                      |
| Spermathecal pores in or posterior to testis segments (always? associated with ovaries or oviducts) .....   | EUDRILIDAE                             |
| 6. Last pair of hearts in segment xi .....  | OCNERODRILIDAE                         |
| Last pair of hearts posterior to segment xi.....  | 7                                      |
| 7. Prostatic glands racemose without central canal  | MEGASCOLECIDAE                         |
| Prostatic glands tubular with central canal .....   | 8                                      |

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\*The key is not applicable to anatomically degraded parthenogenetic morphs of some ocnerodrilid and megascolecoid species which may lack spermathecae, male pores and prostatic glands.

8. Holonephric ..... ACANTHODRILIDAE  
Meronephric ..... OCTOCHAETIDAE
9. Extramural calciferous glands present ..... GLOSSOSCOLECIDAE  
Extramural calciferous glands absent ..... ALMIDAE

## Order HAPLOTAXIDA

## Suborder LUMBRICINA

## Superfamily MEGASCOLECOIDEA

*Diagnosis* : Earthworms with ovaries large, fan- to rosette-shaped, oocytes form several egg-strings; lateral line absent; supra-oesophageal vessel often present; some of hearts latero-oesophageal.

*Distribution* : Indigenous throughout tropics and southern Hemisphere (excluding Antarctica), also middle and western North America, eastern U.S.S.R., Japan, Korea and China.

## ABBREVIATIONS USED FOR TYPE DEPOSITARIES

BLSS	—	Biological Laboratory, The Science Society of China, Shanghai.
BMNH	—	British Museum (Natural History), London.
HAZFS, ZSI	—	High Altitude Zoology Field Station, Zoological Survey of India, Solan (H.P.).
MGDG	—	Museo Civico di Storia Naturale "Giacomo", Genova.
MNHU	—	Zoologisches Museum für Naturkunde der Humboldt Universität, Berlin.
MZUT	—	Museo ed Istituto di Zoologia Sistemica dell'Università di Torino, Torino.
NHRS	—	Naturhistoriska Riksmuseet, Stockholm.
RNHL	—	Rijksmuseum van Natuurlijke Histoire, Leiden.
USNM	—	United States National Museum, Washington.

- ZMUH — Zoologisches Institut and Zoologisches  
Museum Universität Hamburg, Hamburg.
- ZSIC — Zoological Survey of India, Calcutta.

## Family OCTOCHAETIDAE

**Diagnosis :** Body cylindrical; dorsal pores usually present; male pores posterior to segment xvi; spermathecae in pretesticular segments (sometimes the posteriormost pair in testicular segment), not associated with ovaries or oviducts; intestinal gizzards absent; last pair of hearts posterior to segment xi, supra-oesophageal vessel commonly present; prostatic glands tubular with central canal, ectodermal in origin; meronephric.

**Distribution :** Tropical America and Africa, Australasia, India and Burma. Peregrine species of *Dichogaster*, *Ramiella* and *Octochaetona* introduced into other regions. Geographical distributions of the Indian octochaetid genera are shown in Figs. 47-52.

**Remarks :** The Indian Octochaetidae comprises 26 genera (including 6 new described in this work), of which 25 are restricted in their distribution to the Indian subcontinent (excluding peregrine species) and one genus, *Dichogaster*, with endemism in Africa and South America is represented by widely-distributed peregrine species. Attempts had been made in the past to establish relationships between the Indian and Malagassian octochaetids through *Howascolex*, but the Indian section of the genus is considered in this work as generically distinct on the characteristics of the excretory and digestive systems.

Barring *Eutyphoeus*, *Scolioscolides* and *Bahlia*, the Indian octochaetids are endemic in the peninsular India. It therefore appears that they originated and had subsequent development in the peninsular India - an ancient land mass that has never been submerged under the sea. *Eutyphoeus*, *Scolioscolides* and *Bahlia* are morphologically closely related to each other. *Eutyphoeus* has endemic species in Burma, Eastern Himalayas and North-east Ranges, and Indo-Gangetic plains, while monospecific *Scolio-*

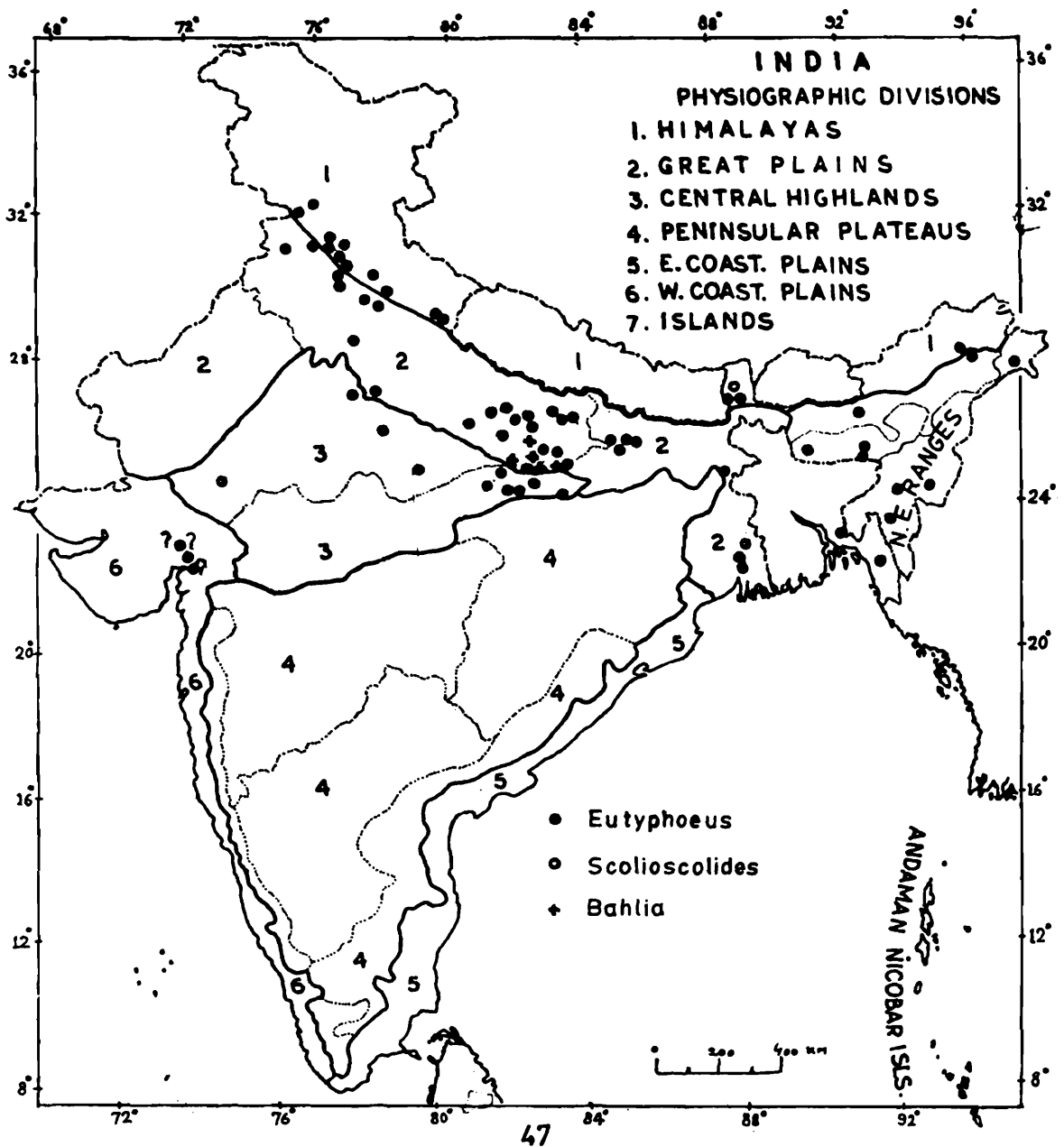


FIG. 47. Distribution of *Eutyphoeus*, *Scolioscolides* and *Bahlia*.

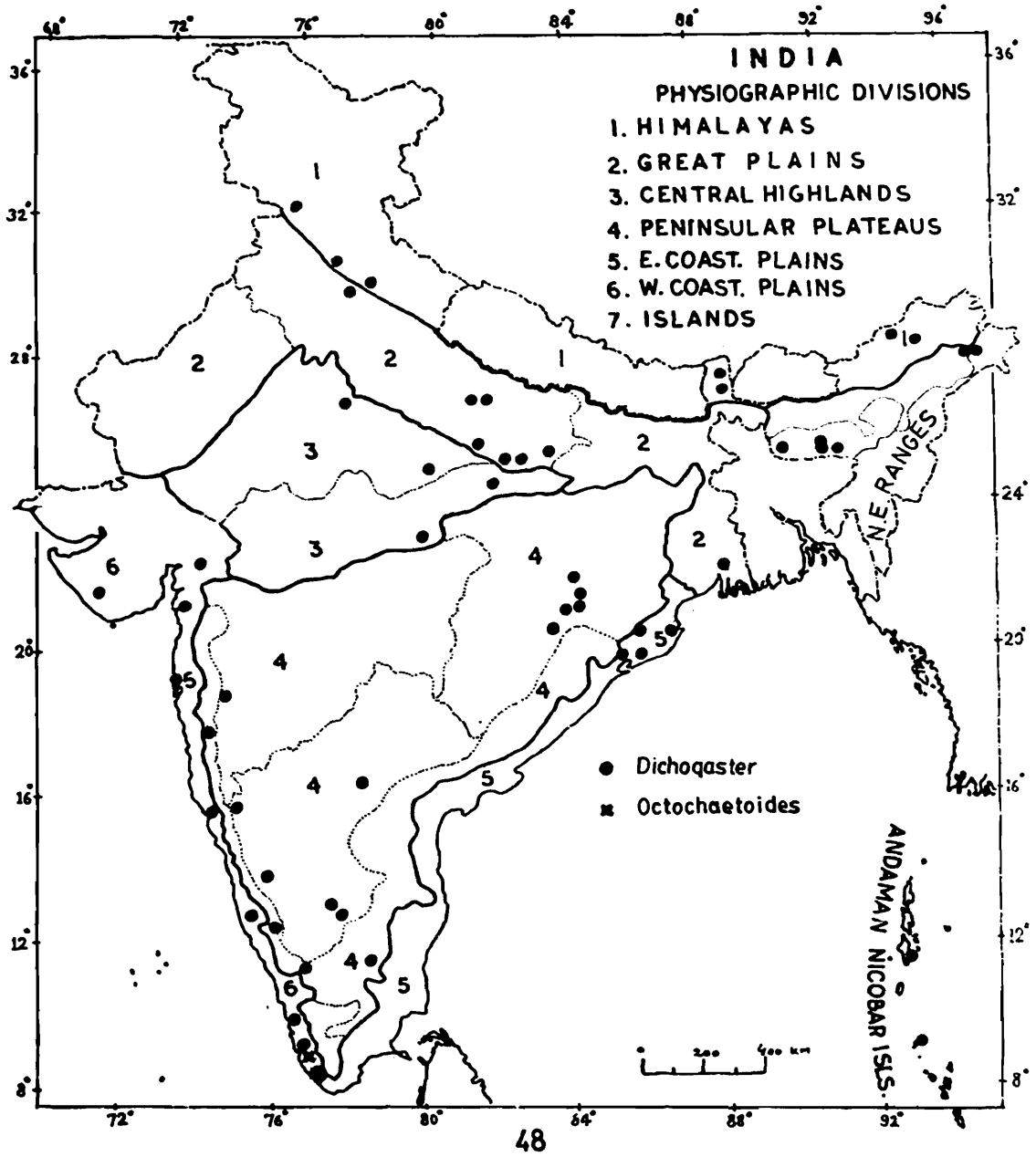


FIG. 48. Distribution of *Dichogaster* and *Octochaetoides*.

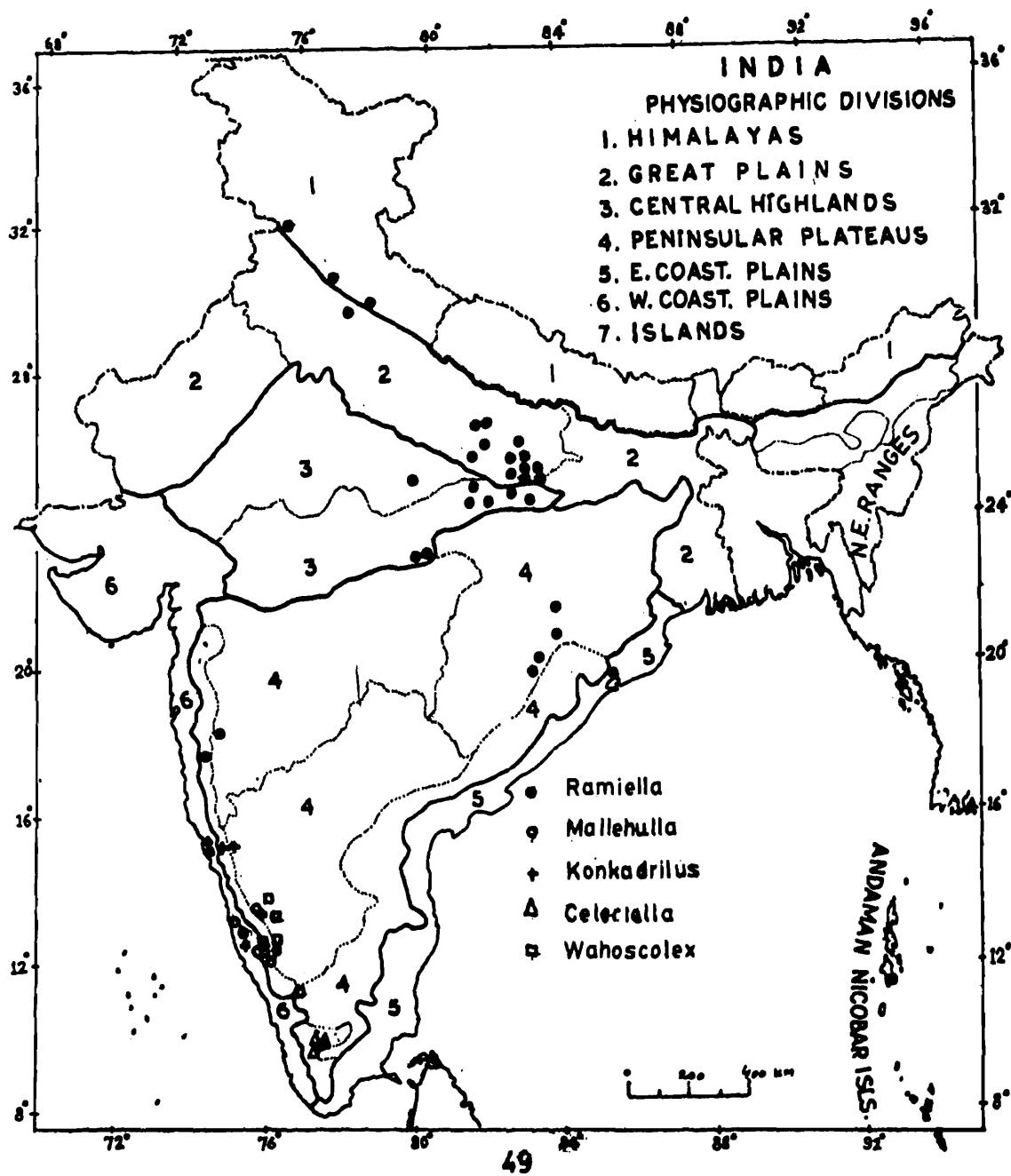


FIG. 49. Distribution of *Ramiella*, *Mallehulla*, *Konkadrilus*, *Celeriella* and *Wahoscolex*.

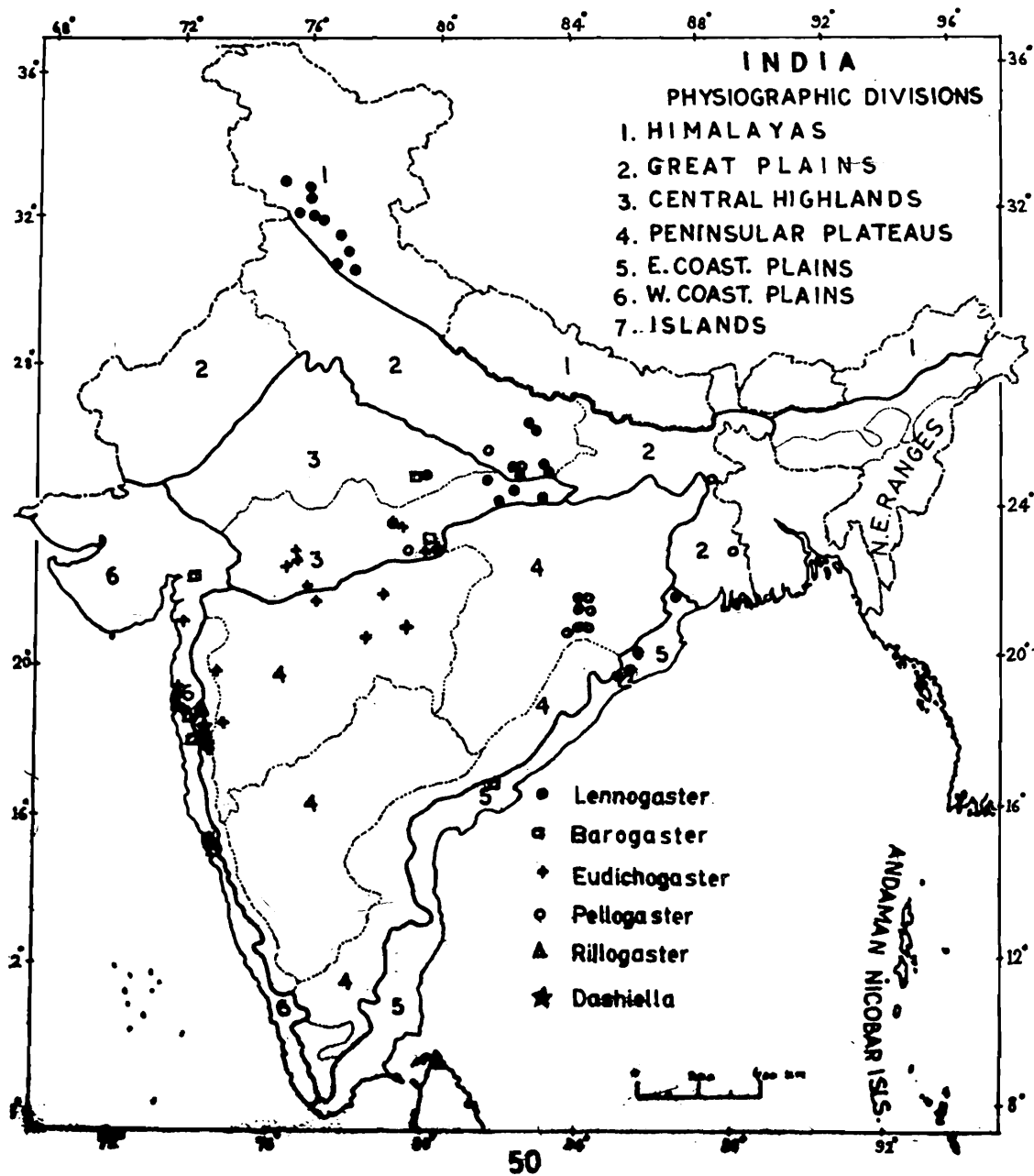


FIG. 50. Distribution of *Lenogaster*, *Barogaster*, *Eudichogaster*, *Pellogaster*, *Rillogaster* and *Dashiella*.

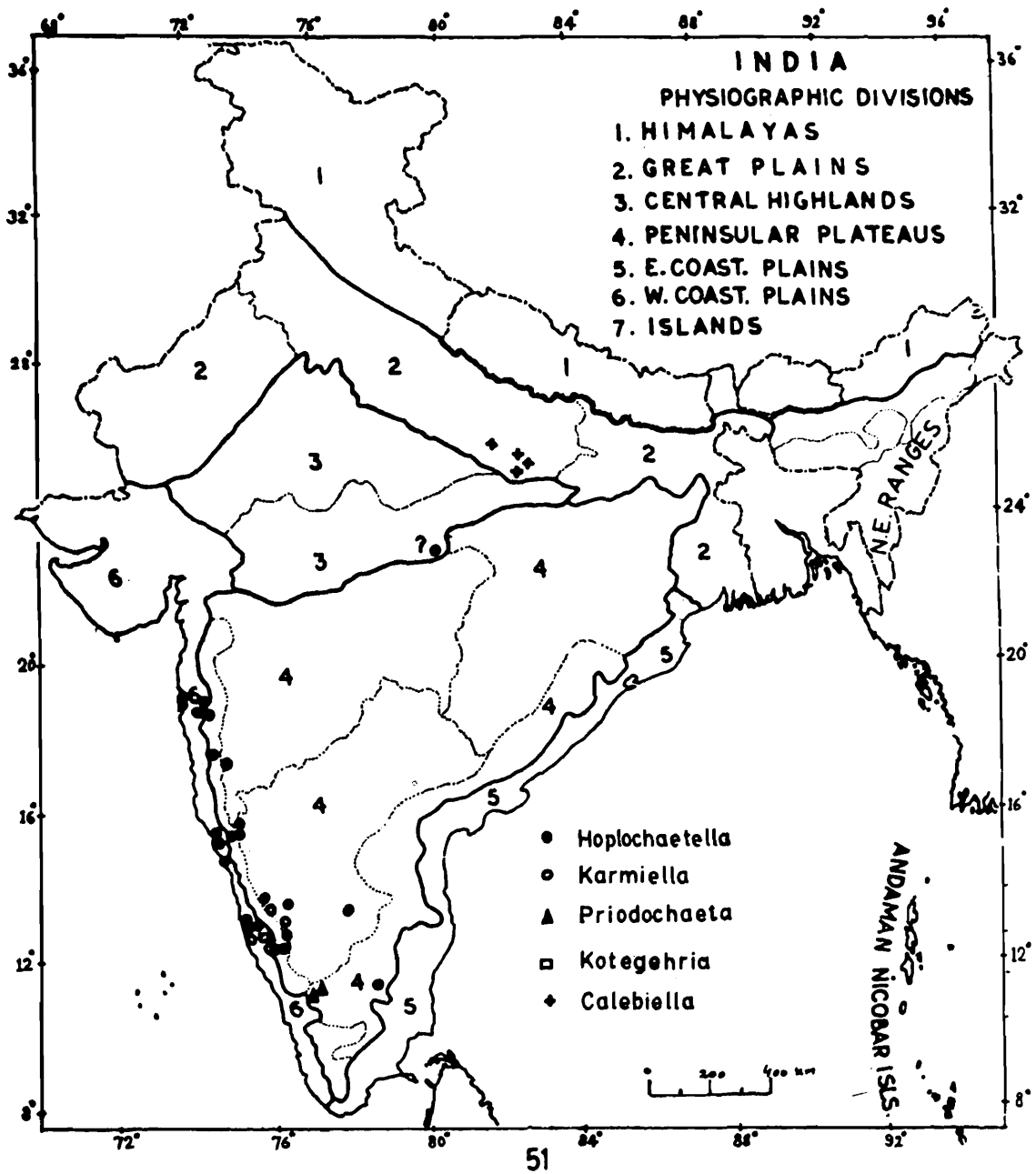
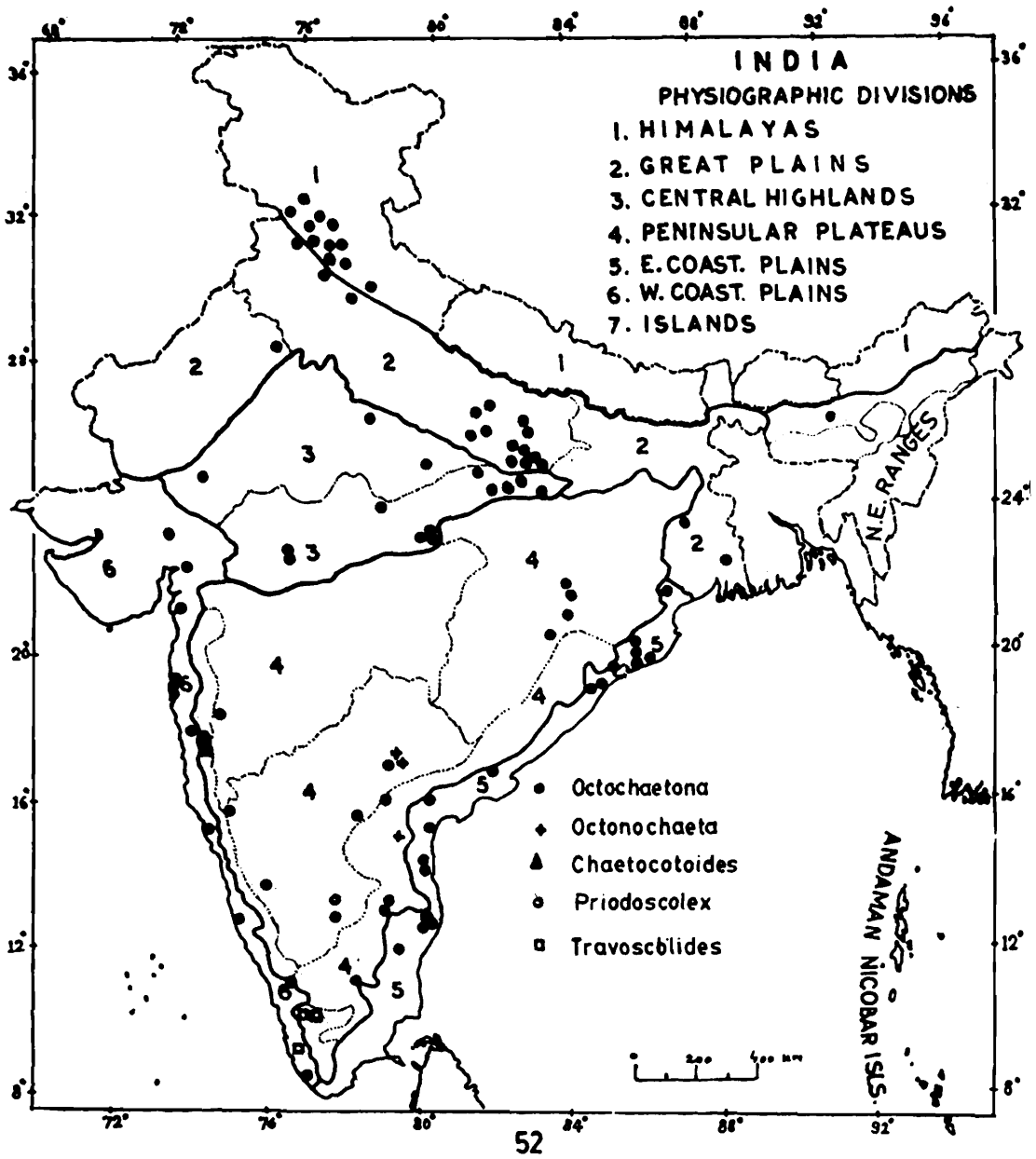


FIG. 51. Distribution of *Hoplochaetella*, *Karmiella*, *Priodochaeta*, *Kotegehria* and *Calebiella*.



*scolides* and *Bahlia* are restricted to small areas, the former near Darjeeling in the Eastern Himalayas and the latter near Allahabad in the Gangetic plain. According to Gates (1972), these genera are the culmination of one of the major octochaetid lines that also evolved in the Indian Peninsula and may have crossed over the Rajmahal Gap to the North-east Ranges. Geological evidence is available in support of a land bridge formed during the Miocene times by a Rajmahal spur between the Satpura Hills of the peninsula and North-east Ranges (Hora, 1938).

## Key to the genera of Indian OCTOCHAETIDAE

- |  |                       |
|--|-----------------------|
| 1. Oesophagus with a single gizzard .....  | 2                     |
| Oesophagus with 2 gizzards.....  | 19                    |
| 2. Discrete calciferous glands present .....   | 3                     |
| Discrete calciferous glands absent.....  | 15                    |
| 3. Stomate megameronephridia present at least in<br>caudal segments; micromeronephridia astomate<br>throughout the body .....                              | 4                     |
| Megameronephridia absent; micromerone-<br>phridia stomate, at least in caudal segments .....   | 11                    |
| 4. Megameronephridia exonephric .....  | 5                     |
| Megameronephridia enteronephric .....  | 10                    |
| 5. Calciferous glands intramural.....  | 6                     |
| Calciferous glands extramural .....  | 8                     |
| 6. Calciferous glands one pair, in xii .....   | 7                     |
| Calciferous glands 2 pairs, in xi-xii .....  | <b>Bahlia</b>         |
| 7. Combined male and prostatic pores on xviii;<br>typhosole rudimentary .....  | <b>Scolioscolides</b> |
| Male pores slightly posterior to prostatic pores<br>on porophores or in fissures or invaginated into<br>vestibula, on xvii, typhosole well-developed ..... | <b>Eutyphoeus</b>     |
| 8. Calciferous glands one pair, in xv .....  | <b>Kotegeharia</b>    |
| Calciferous glands more than one pair .....  | 9                     |
| 9. Calciferous glands 3 pairs, in xiv-xvi; typhlo-<br>sole rudimentary.....  | <b>Priodochaeta</b>   |
| Calciferous glands 4 pairs, in x-xiii; typhlosole<br>well-developed, ventrally bifid .....   | <b>Calebielia</b>     |
| 10. Calciferous glands one pair, each gland bilobed,<br>one lobe in xv and the other in xvi.....   | <b>Karmiella</b>      |

Calciferous glands 4 pairs, in x-xiii .....	<b>Hoplochaetella</b>
11. Calciferous glands one pair .....	12
Calciferous glands 4 pairs .....	14
12. Typhlosole simple .....	<b>Octonochaeta</b>
Typhlosole ventrally bifid .....	13
13. Calciferous glands <b>asymmetrical</b> , one gland in xv and the other in xvi; clitellum annular, xiii-xvi, xvii, xviii.....	<b>Octochaetona</b>
Calciferous glands <b>symmetrical</b> , each gland bilobed, one lobe in xv and the other in xvi; clitellum saddle-shaped, extending xii-xix .....	<b>Chaetocotoides</b>
14. Calciferous glands in x-xiii; stomate micromeronephridia enteronephric in xv and posterior segments.....	<b>Travoscolides</b>
Calciferous glands in xiv-xvii, stomate micromeronephridia exonephric in caudal segments .	<b>Priodoscolex</b>
15. Oesophagus with calciferous lamellae in viii-xi .	<b>Ramiella</b>
Oesophagus with calciferous lamellae posterior to xi .....	16
16. Megameronephridia in caudal segments exonephric .....	17
Megameronephridia in caudal segments enteronephric .....	18
17. Oesophagus enlarged and with calciferous lamellae, in xiv-xv .....	<b>Mallehulla</b>
Oesophagus enlarged and with calciferous lamellae in xvi, slightly extending to adjacent segments .....	<b>Konkadrilus</b>
18. Oesophagus enlarged and with calciferous lamellae, in xii-xiv; typhlosole absent; prostates very long extending to several segments.....	<b>Celeriella</b>
Oesophagus enlarged and with calciferous lamellae, in xvi, extending slightly to adjacent segments; typhlosole present; prostates short, extending to 1-3 segments .....	<b>Wahoscolex</b>

19. Calciferous glands anterior to xiv ..... 20  
 Calciferous glands posterior to xiii..... 25
20. Calciferous glands 2 pairs, in xi-xii; supra-intestinal glands or 'grid-like' thickening at the posterior end of typhlosole present ..... 21  
 Calciferous glands more than 2 pairs; supra-intestinal glands or 'grid-like' thickening absent 22
21. Intestinal roof with 'grid-like' thickening at posterior end of typhlosole; combined male and prostatic pores on xviii, seminal grooves absent. **Barogaster**  
 Intestinal roof with equatorially separated supra-intestinal glands at posterior end of typhlosole; male pores on xviii, prostatic pores or xvii and xix at the ends of seminal grooves ... **Eudichogaster**
22. Calciferous glands 3 pairs, in x-xii or xi-xiii ..... 23  
 Calciferous glands 4 pairs, in x-xiii ..... 24
23. Calciferous glands in x-xii; setae lumbricine..... **Lennogaster**  
 Calciferous glands in xi-xiii; setae perichaetine.. **Dashiella**
24. Gizzards in v-vi; male pores on xviii, prostatic pores on xvii and xix, at the ends of seminal grooves ..... **Pellogaster**  
 Gizzards in vi-vii, combined male and prostatic pores on xix, seminal grooves absent ..... **Rillogaster**
25. Typhlosole present; calciferous glands one pair, each gland trilobed, one vertical lobe in each of segments xv-xvii ..... **Dichogaster**  
 Typhlosole absent; calciferous glands not so lobed or placed ..... **Octochaetoides**

### Genus 1. *Bahlia* Gates, 1945

1945. *Bahlia* Gates, *Proc. Indian Acad. Sci.*, (B) 21: 236.

*Diagnosis* : Lumbricine. Male and prostatic pores paired, in seminal grooves, on xvii. Oesophagus with a single gizzard in vi and 2 pairs of discrete intramural calciferous glands in xi-xii; supra-intestinal glands present; typhlosole lamelliform, simple. Micromeronephridia astomate; paired, exonephric, small tufts on the body wall in iii-ix; few, exonephric on the body wall in x and posteriad segments. Paired, stomate, exonephric megameronephridia in each of segments posterior to the supra-intestinal glands' region.

*Type species* : *Bahlia albida* Gates, 1945.

*Description* : As for the only species, *albida*.

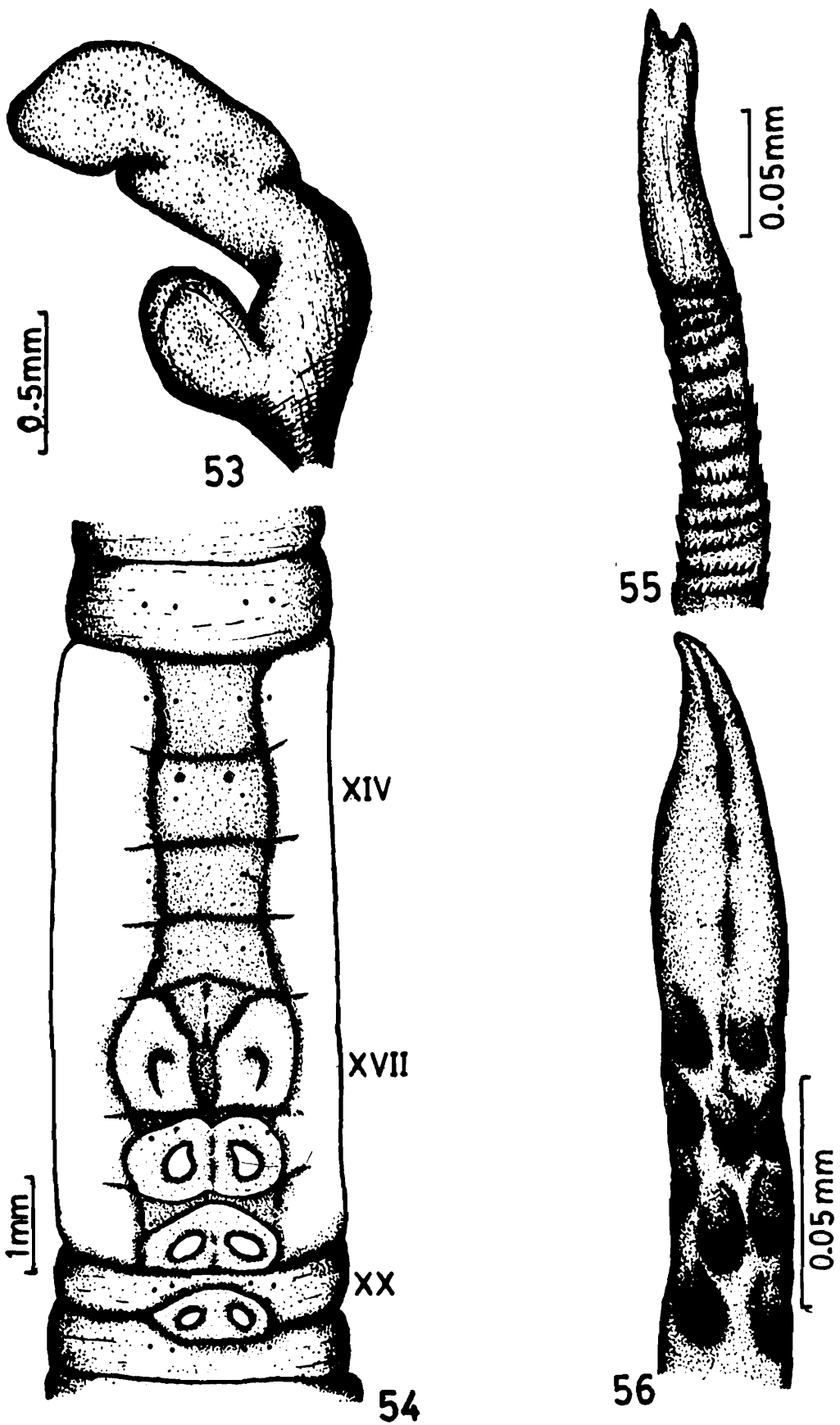
*Distribution* : Southernmost portion of the Gangetic plain in Uttar Pradesh, India.

#### 1. *Bahlia albida* Gates

(Figs. 53-56)

1945. *Bahlia albida* Gates, *Proc. Indian Acad. Sci.*, (B) 21: 237.

Length 50-70 mm, diameter 3-3.5 mm, 155-174 segments. Prostomium tanylobic. First dorsal pore 8/9, sometimes 7/8 or 9/10. Clitellum saddle-shaped, xiii-xix, xx. Setae lumbricine throughout the body,  $aa = 2.2$   $ab = bc = 1.8$   $cd = 0.23$   $dd$  on xii,  $aa = 2.5$   $ab = 0.8$   $bc = 2.2$   $cd = 0.23$   $dd$  on xxiv,  $a$  and  $b$  on iii-x enlarged, and on ix copulatory being surrounded by an unpaired tumescence. Prostatic and male pores paired, minute, at anterior and posterior ends of short seminal grooves respectively, on xvii, at about  $b$ ; seminal grooves crescent-shaped from the setal arc of xvii to 17/18. Female pores paired, presetal, within  $a$  lines on xiv. Spermathecal pores paired, large, transverse slits in or slightly posterior to 8/9, at or just median to  $b$ . Genital markings unpaired and median but with 2 central translucent areas, postsetal on xviii-xix, sometimes on xvi, xx, xxi, at  $aa$  or  $bb$ . Nephridiopores not recognized.



FIGS. 53-56. *Bahlia albida* Gates. 53. spermatheca, 54. genital region, 55. penial seta, 56. copulatory seta (all drawn from a syntype).

Septa 4/5 slightly muscular, 5/6/7 thickly muscular, 7/8/9/10 muscular. Oesophagus with a single gizzard in vi and two pairs of intramural calciferous glands in xi-xii. Intestine begins in xv; supra-intestinal glands 6-8 pairs in lxxii-xcii; intestinal caeca absent; typhlosole simple, lamelliform, xix-xxi to the region of supra-intestinal glands. Dorsal vessel single and complete; supra-oesophageal vessel in xi-xiii and may be double in all or any of these segments but the two vessels unite with each other at points of attachment of septa with the oesophagus; extra-oesophageal vessels paired, united mesially in ix or x; latero-parietal vessels paired, joining the extra-oesophageal vessels in xiii; subneural vessel absent; lateral hearts originating from supra-oesophageal with delicate connectives to the dorsal vessel in xi-xiii; last pair of hearts in xiii. Metandric, testes and male funnels free, in xi; seminal vesicles in xii, extending posteriorly to xiii. Prostates one pair, in xvii. Penial setae ornamented with 20-30 complete or interrupted circles of triangular spine-like teeth, tip slightly indented, lateral margins curved, 1 mm long, *c.* 40  $\mu$  diameter. Spermathecae one pair, each with a lateral, flattened, disc-shaped diverticulum at about the middle of a short duct. Copulatory setae ornamented with shallow depressions, tip claw-shaped, 0.65-0.7 mm long, 23-26  $\mu$  diameter. Genital marking glands absent. Micromeronephridia astomate; exonephric, small paired tufts on body wall in iii-ix, 5-8 on each side in x-xvi arranged in transverse rows, 4 on each side arranged in longitudinal rows in post-prostatic region. Megameronephridia stomate, exonephric, paired, in each segment posterior to the supra-intestinal glands' region, funnels close to the nerve cord.

*Type locality* : Allahabad, Uttar Pradesh, India.

*Type specimens* : In ZSIC, W 3461/1, W 3629/1.

*Material examined* : 0-0-1, 0-0-2, syntypes, W 3461/1, W 3629/1, in ZSIC.

*Distribution* : India: *Uttar Pradesh*: Allahabad, Madhosingh Junction, Mirzapur, Tanda Falls, Varanasi, Chunar, Zafarabad, Jaunpur, Jhusi, Sohagi.

*Biology* : Its activity is restricted to April, and July to October.

**Genus 2. Barogaster** Gates, 1939

1920. *Megascolides*, Stephenson, *Mem. Indian Mus.*, 7: 202.

1923. *Megascolides* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 192.

1923. *Eudichogaster* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 402.

1939. *Barogaster* Gates, *Rec. Indian Mus.*, 41: 154.

**Diagnosis** : Lumbricine. Combined male and prostatic pores paired, on xviii, seminal grooves absent. Oesophagus with 2 gizzards in v-vi and 2 pairs of discrete extramural calciferous glands in xi-xii; supra-intestinal glands present; typhlosole lamelliform, simple. Micromeronephridia astomate; paired exonephric tufts on the body wall in iii; numerous, exonephric on the body wall in iv and posteriad segments. Paired, stomate, exonephric megamero-nephridia in each of few posteriormost segments.

**Type species** : *Eudichogaster barodensis* Stephenson, 1914.

**Description** : Setae lumbricine throughout the body. Clitellum annular. Combined male and prostatic pores paired, on xviii. Female pore single, median, on xiv. Spermathecal pores paired, in or close to 7/8. Genital markings present. Nephridiopores not recognized.

Septa all present from 4/5, slightly to moderately muscular. Gizzards 2, in v-vi. Calciferous glands discrete, extramural, ovoidal, 2 pairs, in xi-xii, opening into oesophagus through short stalks dorsolaterally. Intestine begins in xv; intestinal caeca absent; supra-intestinal glands in the form of a longitudinal 'grid-like' thickening on the roof of the intestine at the posterior end of typhlosole, which is simple and a folded lamella. Dorsal vessel single and complete; supra-oesophageal vessel single, viii-xiii; extra-oesophageal vessels paired, passing posteriorly into the calciferous glands in xii; latero-parietal vessels paired, uniting with the supra-oesophageal vessel in xiii. subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric. Vasa deferentia join the ectal ends of the prostatic ducts beneath the longitudinal muscle layer. Prostates one

pair, in xviii, extending posteriorly usually to a few segments. Penial setae present, sometimes absent. Spermathecae paired, in vii. Ovisacs paired, in xiv. Micromeronephridia astomate, exonephric, paired tufts on the body wall in iii, numerous on the body wall in iv and posterior segments, arranged in c. 6-10 longitudinal rows on each side from about middle of the body to caudal end; paired stomate exonephric megameronephridia in caudal segments, funnels close to the nerve cord.

*Distribution* : Peninsular India.

### Key to the species of *Barogaster*

1. Penial setae present ..... 2  
     Penial setae absent ..... *B. prashadi*
2. Penial setae ornamented with circles of fine spines, genital markings in a single transverse row on segments xviii and xix ..... *B. barodensis*  
     Penial setae unornamented, genital markings in two transverse rows on xviii ..... *B. annandalei*

### 2. *Barogaster annandalei* (Stephenson)

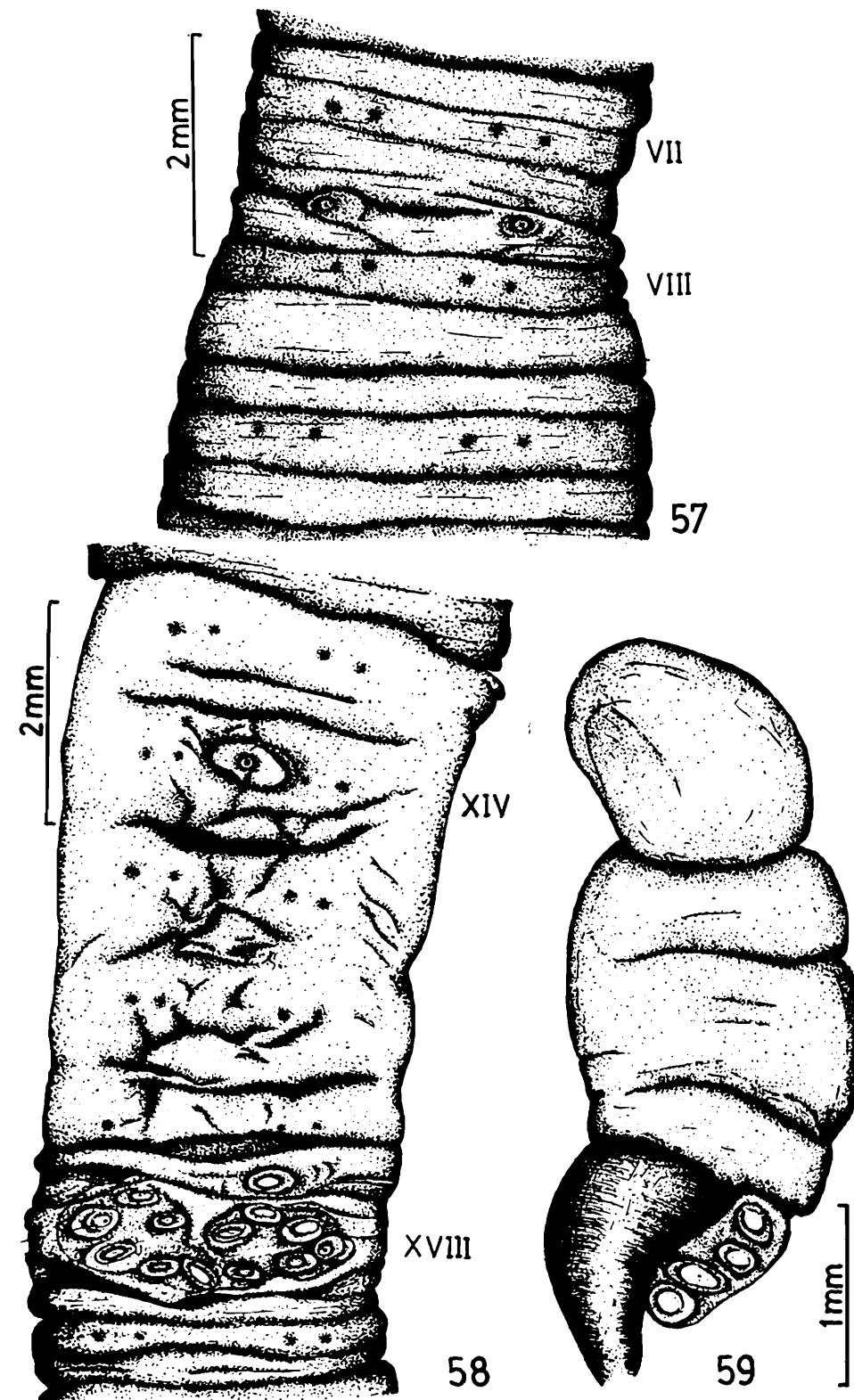
(Figs. 57-59)

1921. *Megascolides annandalei* Stephenson, *Rec. Indian Mus.*, 22: 757.

1923. *Megascolides annandalei*, Stephenson, *Fauna Br. India, Oligochaeta*: 195.

1940. *Barogaster annandalei*, Gates, *Rec. Indian Mus.*, 42: 130.

Length 95-115 mm, diameter 4-5 mm, 130 segments. Prostomium prolobic, retracted. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 2.4-3.6$   $ab = 1.2-2.1$   $bc = 2.2-3.6$   $cd = 0.18$   $dd$  on xii,  $aa = 3.6-4.7$   $ab = 1.5-1.6$   $bc = 2.5-3.5$   $cd = 0.2$   $dd$  on xxiv. Male genital field transversely depressed, on xviii. Combined male and prostatic pores minute, discharging on oval porophores, at *b*. Female pore slightly anterior to the setal arc. Spermathecal pores minute, on anterior margin of viii, slightly posterior to 7/8, at or



FIGS. 57-59. *Barogaster annandalei* (Stephenson). 57. spermathecal pore region, 58. genital region, 59. spermatheca (all drawn from a syntype).

just lateral to *b*. Genital markings small, oval, 3-6 in transverse rows, at *bb*, 2 rows, pre- and postsetal, on xviii, sometimes additional single rows, presetal on vii, post-setal on viii and xvii.

Supra-intestinal 'grid-like' thickening extends through 6(+) or 10 segments, lxi or lxxxvi to lxvi (+) or xcv; typhlosole in xxvii-xxix to the last 'grid' segment. Testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae unornamented, 0.58-0.66 mm long, 16-22  $\mu$  diameter. Each spermatheca with a median flattened ental diverticulum, adherent to the duct, which is shorter than ampulla. Genital marking glands absent.

*Type locality* : Dowlaisheram, Godavari district, Andhra Pradesh, India.

*Type specimens* In ZSIC, W 562/1, BMNH, 1933: 5: 5: 25: 1340.

*Material examined* : 0-0-5, syntypes, W 562/1, in ZSIC.

*Distribution* : So far known from the type locality.

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

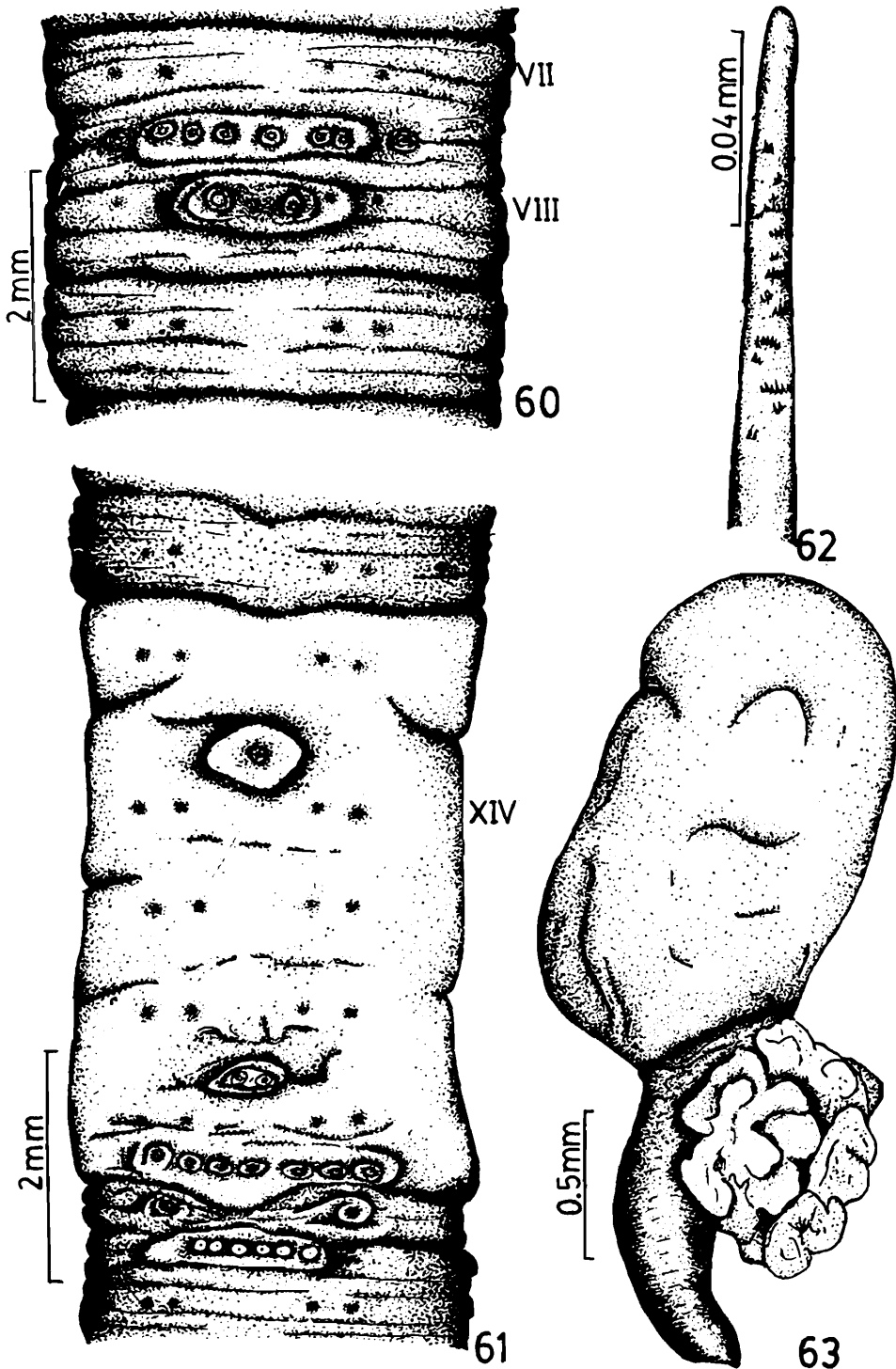
(Figs. 60-63)

1914. *Eudichogaster barodensis* Stephenson, *Rec. Indian Mus.*, 10: 358.

1923. *Eudichogaster barodensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 409.

1939. *Barogaster barodensis*, Gates, *Rec. Indian Mus.*, 41: 156.

Length 65-100 mm, diameter 3-4 mm, 138-167 segments. Prostomium prolobic. First dorsal pore 12/13. Clitellum 1/3 xii, xiii-xvii, 1/3 xviii. Setae *aa* = 4 *ab* = 1.4 *bc* = 2.4 *cd* = 0.24 *dd* on xii, *aa* = 5.3 *ab* = 1.4 *bc* = 2.7 *cd* = 0.24 *dd* on xxiv. Combined male and prostatic pores minute, discharging on oval porophores, at *b*. Female pore presetal. Spermathecal pores minute, on oval tumescences, in 7/8, at or just lateral to *b*. Genital markings small, circular to oval, 2-11, in single transverse rows, at *aa* or *bb*, presetal or on setal arc on viii, postsetal on vii, xvi-xix, rarely on setal annulus of ix.



FIGS. 60-63. *Barogaster barodensis* (Stephenson). 60. spermathecal pore region, 61. genital region, 62. penial seta, 63. spermatheca (all drawn from a syntype).

Supra-intestinal 'grid-like' thickening extends through 8-12 segments, in lxxviii-lxxix to lxxviii-lxxxix; typhlosole in xxiv-xxvi to the last 'grid' segment. Testes and male funnels free, in x and xi; seminal vesicles in ix, x and xii, those of x vestigial. Penial setae ornamented with 6-11 circles of fine spines, tip bluntly rounded, 0.43-0.59 mm long, 11-16  $\mu$  diameter. Each spermatheca with a cauliflower-shaped sessile ental diverticulum, duct shorter than ampulla. Genital marking glands absent.

*Type locality* : Baroda, Gujarat, India.

*Type specimens* : In ZSIC, W 27/1; BMNH, 1925: 5: 12: 64.

*Material examined* : In ZSIC: 0-3-9, syntypes, W 27/1; 0-0-1 Nowgong, coll. Prof. G.E. Gates, W 3630/1.

*Distribution* : India: *Gujarat*: Baroda; *Madhya Pradesh*: Nowgong, Chaubara, Baraila.

#### 4. *Barogaster prashadi* (Stephenson)

1920. *Megascolides prashadi* Stephenson, *Mem. Indian Mus.*, 7: 202.

1923. *Megascolides prashadi*, Stephenson, *Fauna Br. India, Oligochaeta*: 201.

1940. *Barogaster prashadi*, Gates, *Rec. Indian Mus.*, 42: 135.

Length 42 mm, diameter 4 mm, 140 segments. Prostomium prolobic. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 3.7$   $ab = bc = 3$   $cd = 0.23$   $dd$  on xii,  $aa = 3.7$   $ab = bc = 2.5$   $cd = 0.21$   $dd$  on xxiv. Combined male and prostatic pores minute, on oval, slightly raised porophores, at *b*. Female pore presetal (?). Spermathecal pores tiny, transverse slits, in 7/8, a little lateral to *b*. Genital markings small, 4-7, in single transverse rows, at about *bb*, postsetal on viii, xix and xx, on setal annulus on xvii.

Supra-intestinal 'grid-like' thickening extends from about lxx to (?); typhlosole from (?) to the last 'grid' segment. Testes and male funnels free, in x and xi; seminal vesicles in ix, x and xii, those of x vestigial. Penial setae absent. Each spermatheca with an anteroposteriorly flattened ental diverticulum, adherent to the duct,

which is slightly shorter than ampulla. Genital marking glands absent.

*Type locality* : Sakarwari, Maharashtra, India.

*Type specimens* : In ZSIC, W 291/1.

*Material examined* : 0-0-1, holotype, W 291/1, in ZSIC.

*Distribution* : So far known from the type locality.

*Remarks* : The holotype in the Zoological Survey of India, Calcutta is in poor condition and anterior portion of its intestine has been removed. The beginning of the typhlosole and the extent of the supra-intestinal 'grid-like' thickening can only be determined from the fresh material.

### Genus 3. *Calebiella* Gates, 1945

1945. *Calebiella* Gates, *Proc. Indian Acad. Sci.*, (B) 21: 242.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in vi and 4 pairs of discrete extramural calciferous glands in x-xiii; supra-intestinal glands absent; typhlosole lamelliform, bifid ventrally at the anterior portion. Micromeronephridia astomate; paired, exonephric, large tufts on the body wall in iv; few, exonephric on the body wall in x and posteriad segments. Paired, stomate, exonephric megameronephridia in each of few posteriormost segments.

*Type species* : *Calebiella parva* Gates, 1945.

*Description* : As for the only species, *parva*.

*Distribution* : Uttar Pradesh, India.

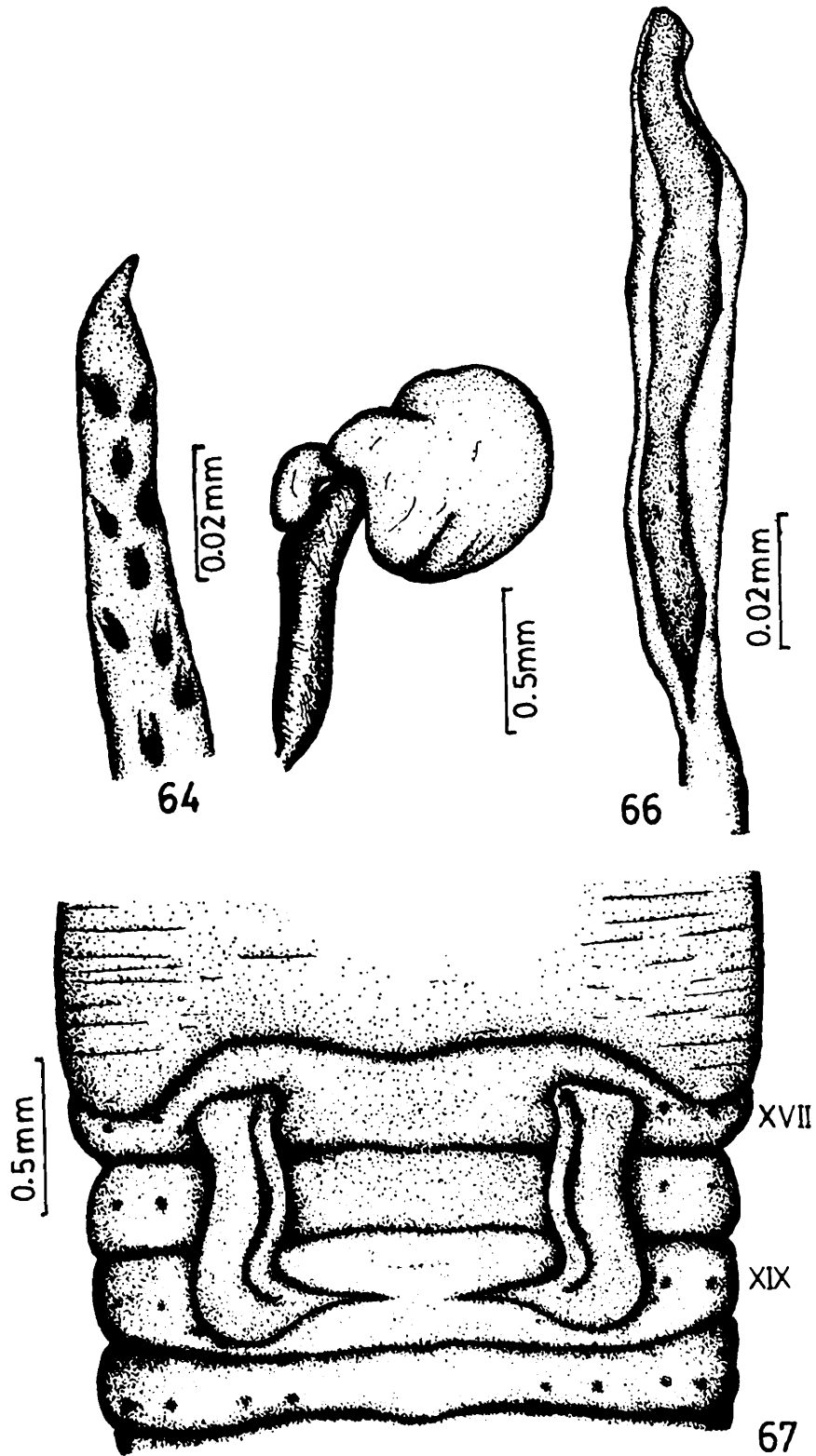
### 5. *Calebiella parva* Gates

(Figs. 64-67)

1945. *Calebiella parva* Gates, *Proc. Indian Acad. Sci.*, (B): 21: 242.

Length 65 mm, diameter 2.5 mm, 140-143 segments. Prostomium prolobic or pro/epilobic. First dorsal pore 9/10, 10/11. Clitellum annular, xiii-xvii. Setae lumbricine throughout the body,  $aa = 3.7$   $ab = 1.6$   $bc = 3.7$   $cd = 0.33$   $dd$  on xii,  $aa = 4.8$   $ab = 1.7$   $bc = 4.8$   $cd = 0.36$   $dd$  on xxiv,  $a$  and  $b$  on ix copulatory being surrounded by an unpaired tumescence. Male pores paired, minute, in seminal grooves on the setal arc of xviii, slightly median to  $b$ ; prostatic pores paired, minute, at the ends of slightly concave seminal grooves on setal arcs of xvii and xix, at  $ab$ . Female pores paired, presetal, within  $a$  lines, on xiv. Spermathecal pores paired, minute, presetal, on viii and ix, at  $b$ . Genital markings possibly represented by paired, presetal, translucent areas on xvii and xix, at  $aa$ . Nephridiopores not recognized.

Septa 4/5/6/7 thickly muscular, 7/8-13/14 muscular. Oesophagus with a single large gizzard in vi. Calciferous glands 4 pairs, in x-xiii, discrete, extramural, reniform, stalkless, opening directly into oesophagus laterally, each gland bilobed. Intestine begins in xv; supra-intestinal glands and intestinal caeca absent; typhlosole bifid ventrally (T or Y-shaped in cross section) at the anterior portion, simple at the posterior portion, in xvii to xcix-ciii. Dorsal vessel simple and complete; supra-oesophageal vessel single, in x-xiii; extra-oesophageal vessels paired, latero-parietal vessels paired, from xiii to some distance behind prostatic region; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles small, acinous, in ix and xii. Prostates 2 pairs in xvii and xix, extending posteriorly to 5-6 segments. Penial setae ornamented with a few, scattered, small teeth in the basal half of the ectal scoop-shaped portion,  $c$ . 3 mm long, 10  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a short ental diverticulum, duct longer than ampulla. Copulatory setae ornamented with longitudinally placed gouges, tip claw-shaped, 0.4-0.45 mm long, 12-16  $\mu$  diameter. Genital marking glands sessile. Micromeronephridia



FIGS. 64-67. *Calebiella parva* Gates, 64. copulatory seta, 65. spermatheca, 66. tip of a penial seta, 67. genital region (all drawn from a syntype).

astomate, exonephric, large paired tufts on the body wall in iv, 2-3 on each side on the body wall, arranged in longitudinal rows in x and posteriad segments; paired stomate, exonephric megameronephridia in caudal segments, funnels close to the nerve cord.

*Type locality* : Partabgarh, Uttar Pradesh, India.

*Type specimens* In ZSIC, W 3635/1.

*Material examined* 0-1-2, syntypes, W 3635/1, in ZSIC.

*Distribution* : India: *Uttar Pradesh* : Partabgarh, Jhangai, Jhusi, Rae Bareli.

#### Genus 4. *Celeriella* Gates, 1958

1923. *Spenceriella* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 190.

1958. *Celeriella* Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 1: 612.

1977. *Celeriella*, Jamieson, *Bull. Mus. natn. Hist. nat., Paris (ser. 3)*, no. 450, Zool. 313: 484.

*Diagnosis* : Perichaetine. Combined male and prostatic pores paired, on xviii. Oesophagus with a single gizzard in vi and lacking discrete calciferous glands but with calciferous lamellae in enlarged portions or pouches in xiii-xiv; supra-intestinal glands and typhlosole absent. Micromeronephridia astomate; paired, enteronephric tufts in ii and iii, larger in iv and v; paired, exonephric tufts in vi; few, exonephric on the body wall in vii and posteriad segments; stomate with preseptal funnels at least in caudal segments. Stomate, paired enteronephric megameronephridia in each of caudal segments.

*Type species* : *Spenceriella duodecimalis* Michaelsen, 1907.

*Description* : Setae perichaetine throughout the body. Clitellum annular. Combined male and prostatic pores paired, on xviii. Female pores paired, presetal, on xiv. Spermathecal pores paired, in 7/8 or 7/8/9.

Gizzard large, in vi. Oesophagus tubular, enlarged (or with paired pouches) and with calciferous lamellae in xiii-xiv; discrete

calciferous glands, intestinal caeca, supra-intestinal glands and typhlosole absent. Dorsal vessel single and complete; supra-oesophageal vessel single, viii-xiii; extra-oesophageal vessels paired, joining the latero-parietal vessels in xii; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric, testes and male funnels free, in x and xi. Prostates paired, in xviii, extending posteriorly through several segments; vasa deferentia on each side joins the prostatic duct entally. Penial setae absent. Spermathecae paired, in viii or viii and ix. Ovisacs paired, in xiv. Micromeronephridia astomate, paired enteronephric tufts in ii and iii, larger in iv and v, paired exonephric tufts in vi, few exonephric on the body wall in vii and posterior segments, stomate with preseptal funnels at least in caudal segments; stomate, paired enteronephric megameronephridia in each of caudal segments, with large nephrostomes close to the nerve cord and loops extending laterally.

*Distribution* : Palni Hills, S. India.

*Remarks* : In *Celeriella*, the loops of stomate, median, enteronephric megameronephridia in the caudal segments are often embedded in the coelomic coagulum. This may possibly be the reason that Jamieson (1977) could not recognize the megameronephridia in this genus.

### Key to the species of *Celeriella*

1. Setae paired, 10-12 per segment, at least in the anterior part of the body ..... 2
  - Setae not paired, c. 40-50 per segment, throughout the body ..... 6
2. Spermathecal pores 2 pairs, in 7/8/9 ..... 3
  - Spermathecal pores one pairs, 7/8 ..... 4
3. Spermathecal pores at or close to *a* lines, longitudinal tubercula pubertatis each with a longitudinal row of minute orifices, in xvii-½xix *C. punctata*

- Spermathecal pores at *bc*, tubercula pubertatis absent ..... *C. ditheca*
4. Spermathecal pores at or slightly lateral to *b* lines ..... 5
- Spermathecal pores at or close to *d* lines ..... *C. quadripapillata*
5. Setae in 12 regular rows throughout the body ... *C. regularis*
- Setae *a*, *b* in regular rows throughout the body; in the posterior region other rows irregular and number increased to 14-17 per segment ..... *C. duodecimalis*
6. Male porophores medianly contiguous; male pores in a transverse midventral groove ..... *C. kempi*
- Male porophores not medianly contiguous, male pores each at the anterior end of a comma-shaped seseminal groove ..... *C. bursata*

### 6. *Celeriella bursata* Jamieson

1977. *Celeriella bursata* Jamieson, *Bull. Mus. natn. Hist. nat., Paris (ser. 3)*, no. 450, Zool. 313: 487.

Length 82 mm, diameter 2.6 mm, 110 segments. Prostomium epilobic, tongue open. First dorsal pore 5/6. Clitellum (?). Setae  $aa = 3$   $ab = 3$   $bc = 2$   $yz = c$ . 0.6  $zz$  on xii, 40 on xii, 42 on xx. Combined male and prostatic pores on conspicuous, hemispherical paired porophores, at *d*, *c*. 0.11 body circumference apart, each pore at the anterior end of a broad, comma-shaped seminal groove, which extends posteromedianly to the posterior margin of xviii. Female pores within *a* lines. Spermathecal pores minute, in 7/8/9, at *ab*, *c*. 0.04 body circumference apart. Genital markings absent.

Septa 4/5-9/10 slightly muscular (?), 10/11/12 muscular. Oesophagus with paired pouches with calciferous lamellae, in xiii-xiv. Intestine begins in xvii. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxxiii. Spermathecae paired, in viii and ix, each with a digitiform ental diverticulum which is about as long as the combined length of the duct and ampulla, duct very short.

*Type locality* : Vandaravu Range, border between Kerala and Tamil Nadu, Palni Hills, S. India.

*Type specimens* : In Paris Museum, holotype, AH 328.

*Distribution* : So far known from the type locality.

*Biology* : It inhabits montane, humic, ferralite soil with high organic matter (up to 25%) and pH 4.9 in upper horizon, at 2490 m altitude.

### 7. *Celeriella ditheca* (Stephenson)

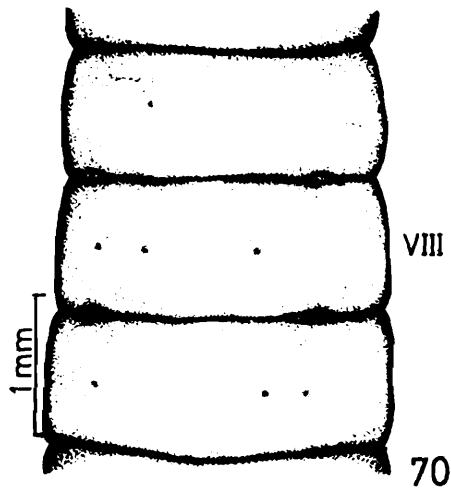
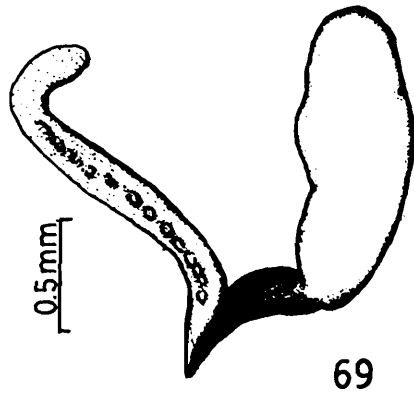
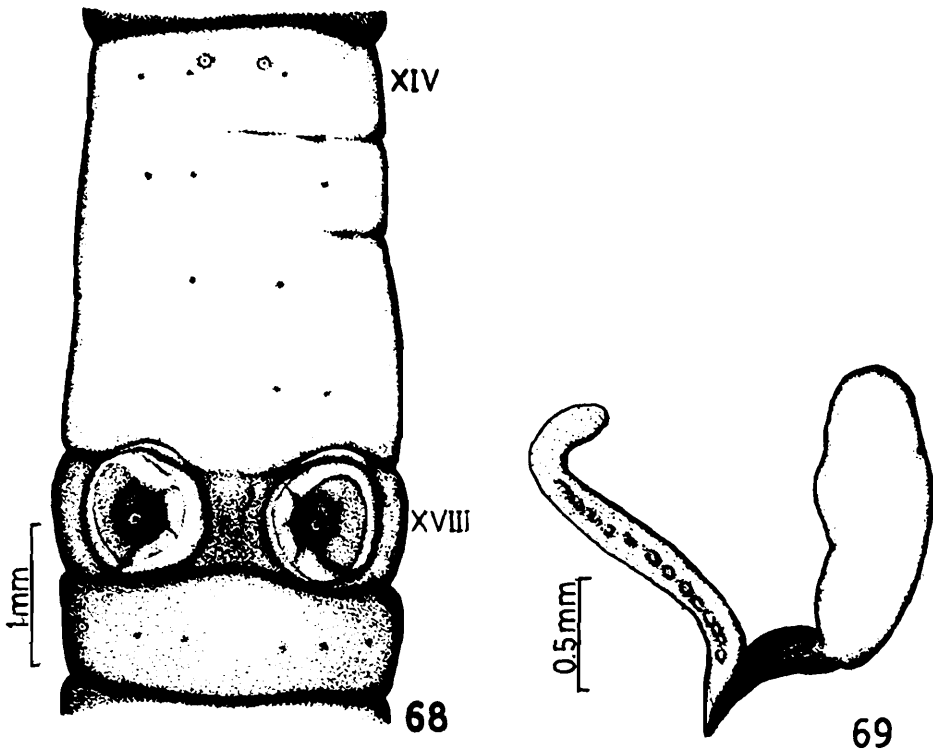
(Figs. 68-70)

1924. *Spenceriella duodecimalis* f. *ditheca* Stephenson, *Rec. Indian Mus.*, **26**: 332.

1958. *Celeriella ditheca*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, **1**: 613.

Length 70-92 mm, diameter 2-3 mm, 97-137 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum xiv-xvii. Setae *aa* = 2-2.1 *ab* = 1.4-1.6 *bc* = 1.4-1.6 *yz* = 1.2-1.3 *zz* on xii, *aa* = 1.7-2 *ab* = 1.3-1.6 *bc* = 1.1 *yz* = 0.9-1.1 *zz* on xxiv, 7-10 on ii, 10-12 on iii, 12 on iv and posteriad segments arranged in longitudinal rows, number increasing to 13-14 in caudal segments. Combined male and prostatic pores minute, discharging at the centres of large, circular, paired porophores, on the setal arc of xviii, at *c. b* lines, 0.18-0.20 body circumference apart, each porophore depressed in the middle, between 17/18 and 18/19, extending laterally to *c*. Female pores within *a* lines. Spermathecal pores minute, on small oval papillae, in 7/8/9, at or just lateral to *b*, 0.17-0.18 body circumference apart. Genital markings absent.

Septa 4/5/6 delicate, 6/7-11/12 slightly muscular. Oesophagus with paired pouches with calciferous lamellae, in xiii-xiv. Intestine begins in xvi. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxxvi-xxxvii. Spermathecae paired, in viii and ix, each with a digitiform ectal diverticulum which is about as long as combined length of the duct and ampulla, duct shorter than ampulla.



FIGS. 68-70. *Celeriella ditheca* (Stephenson). 68. genital region, 69. spermatheca, 70. spermathecal pore region.

*Type locality* : Kodaikanal, Palni Hills, S. India.

*Type specimens* : In ZSIC, W 1118/1.

*Material examined* : In ZSIC: 0-0-1, type, W 1118/1. In HAZFS, ZSI, Solan: 4-38-9 Kodaikanal, 18 Sept 1979, coll. J.M. Julka, An 710.

*Distribution* : So far known from the type locality.

*Remarks* : Stomate caudal megameronephridia discharge into rectum through lateral canals.

### 8. *Celeriella duodecimalis* (Michaelsen)

(Figs. 71-73)

1907. *Spenceriella duodecimalis* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 152.

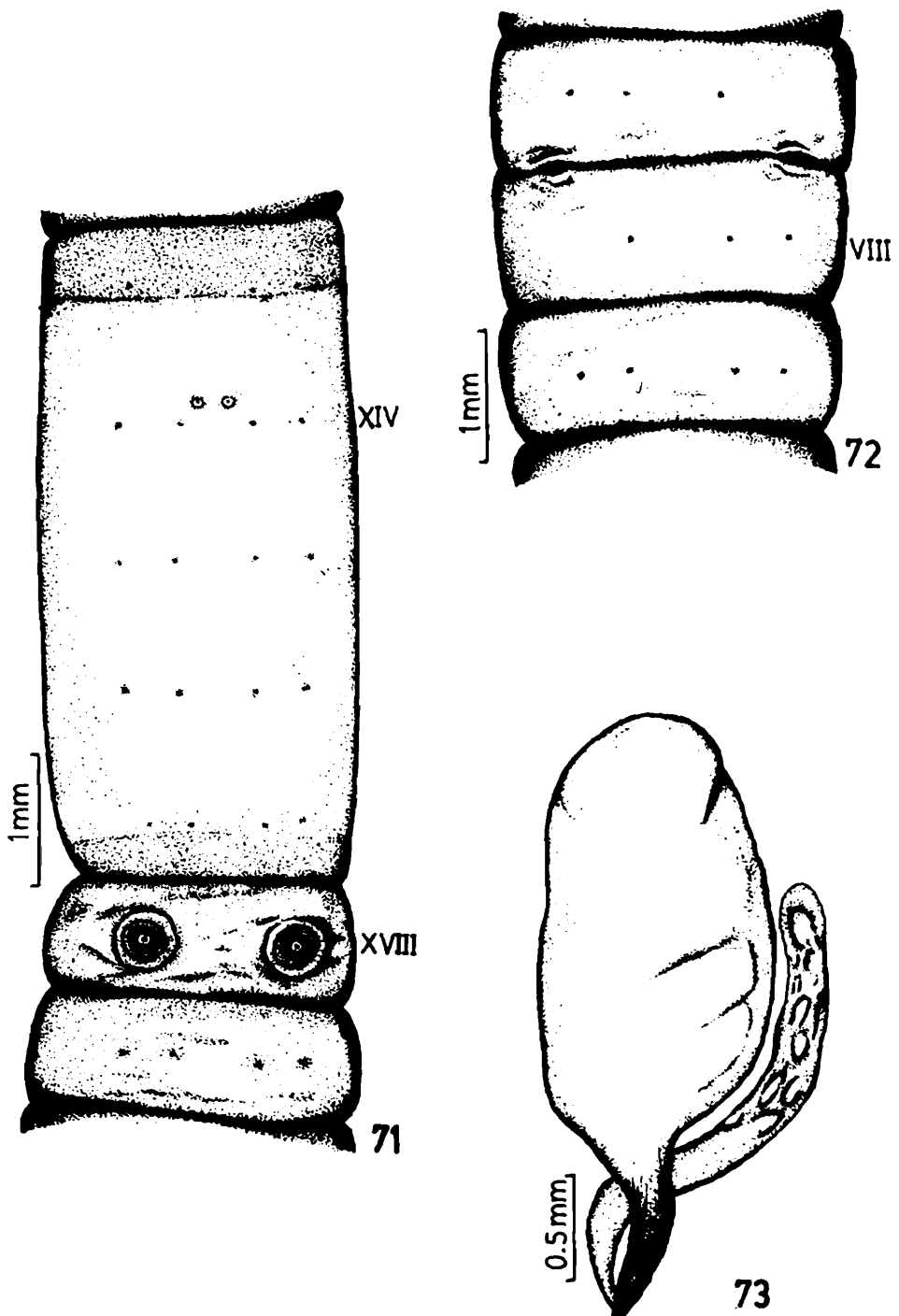
1923. *Spenceriella duodecimalis*, Stephenson, *Fauna Br. India, Oligochaeta*: 191.

1924. *Spenceriella duodecimalis* f. *typica* Stephenson, *Rec. Indian Mus.*, **26**: 330.

1958. *Celeriella duodecimalis*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, **1**: 613.

Length 32-82 mm, diameter 1.5-2.5 mm, 94-127 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5, sometimes 5/6. Clitellum ½xiii-½xvii, xvii, rarely xiv-½xvii, xvii. Setae *aa* = 1.5-1.8 *ab* = 1-1.1 *bc* = 1.2-1.8 *yz* = 1.2-1.3 *zz* on xii, *aa* = 1.6-2 *ab* = 1.2-1.3 *bc* = 1.6-1.7 *yz* = 1.5 *zz* on xxiv, 7-12 on ii, 12 on iii and posteriad segments, arranged in longitudinal rows, number increasing to 14-18 and irregularly arranged in a few to several caudal segments. Combined male and prostatic pores minute, discharging at the centres of paired, spheroidal porophores, on the setal arc of xviii, slightly median to *b*, 0.15-0.17 body circumference apart. Female pores within *a* lines. Spermathecal pores minute, in 7/8, slightly lateral to *b*, 0.22 body circumference apart. Genital markings absent.

Septa 4/5/6 delicate, 6/7-11/12 slightly muscular. Oesophagus much enlarged and with calciferous lamellae, in xiii-xiv. Intestine



FIGS. 71-73. *Celeriella duodecimalis* (Michaelsen). 71. genital region, 72. spermathecal pore region, 73. spermatheca.

begins in xvi. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxxiv-xlii. Spermathecae paired, in viii, each with a digitiform ectal diverticulum which is about three-fourth as long as combined length of the duct and ampulla, duct about one third as long as ampulla.

*Type locality* : Kodaikanal, Palni Hills, S. India.

*Type specimens* : In ZSIC, ZEV 2950/7; in ZMUH, 7148.

*Material examined* : In ZSIC: 0-0-1, syntype, ZEV 2950/7. In HAZFS, ZSI, Solan: 4-11-13 Kodaikanal, 18 Sept 1979, coll. J.M. Julka, An 711.

*Distribution* : So far known from the type locality.

*Remarks* : Stomate megameronephridia in caudal segments discharge into intestine in each segment on either side of the dorsal blood vessel (? through paired longitudinal excretory canals).

### 9. *Celeriella kemp*i (Stephenson)

1924. *Spenceriella kemp*i Stephenson, *Rec. Indian Mus.*, 26: 332.

1958. *Celeriella kemp*i, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 1: 613.

Length 58 mm, diameter 2.5 mm, 112 segments. Prostomium epilobic, tongue closed. First dorsal pore 5/6. Clitellum (?). Setae  $aa = 2.5 ab$ ,  $zz = 2 yz$  on anterior segments, 28 on ii, 51 on xii, 49 on xix, not paired. Combined male and prostatic pores minute, discharging in a groove (?), on xviii, at *cd* or *d*. Female and spermathecal pores (?).

Septa 4/5/6/7 delicate, 7/8/9 slightly muscular, 9/10-12/13 muscular. Oesophagus enlarged and with calciferous lamellae, in xiii-xiv. Intestine begins in xvii. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxix-xxx. Spermathecae (?).

*Type locality* : Marian Shola, Palni Hills, S. India.

*Type specimens* : In ZSIC, W 1119/1.

*Material examined* : 1-0-0, holotype, W 1119/1, in ZSIC.

*Remarks* : *C. kempi* cannot be characterized adequately as its description is based on a juvenile holotype.

*Distribution* : So far known from the type locality.

### 10. *Celeriella punctata* Jamieson

(Figs. 74-76)

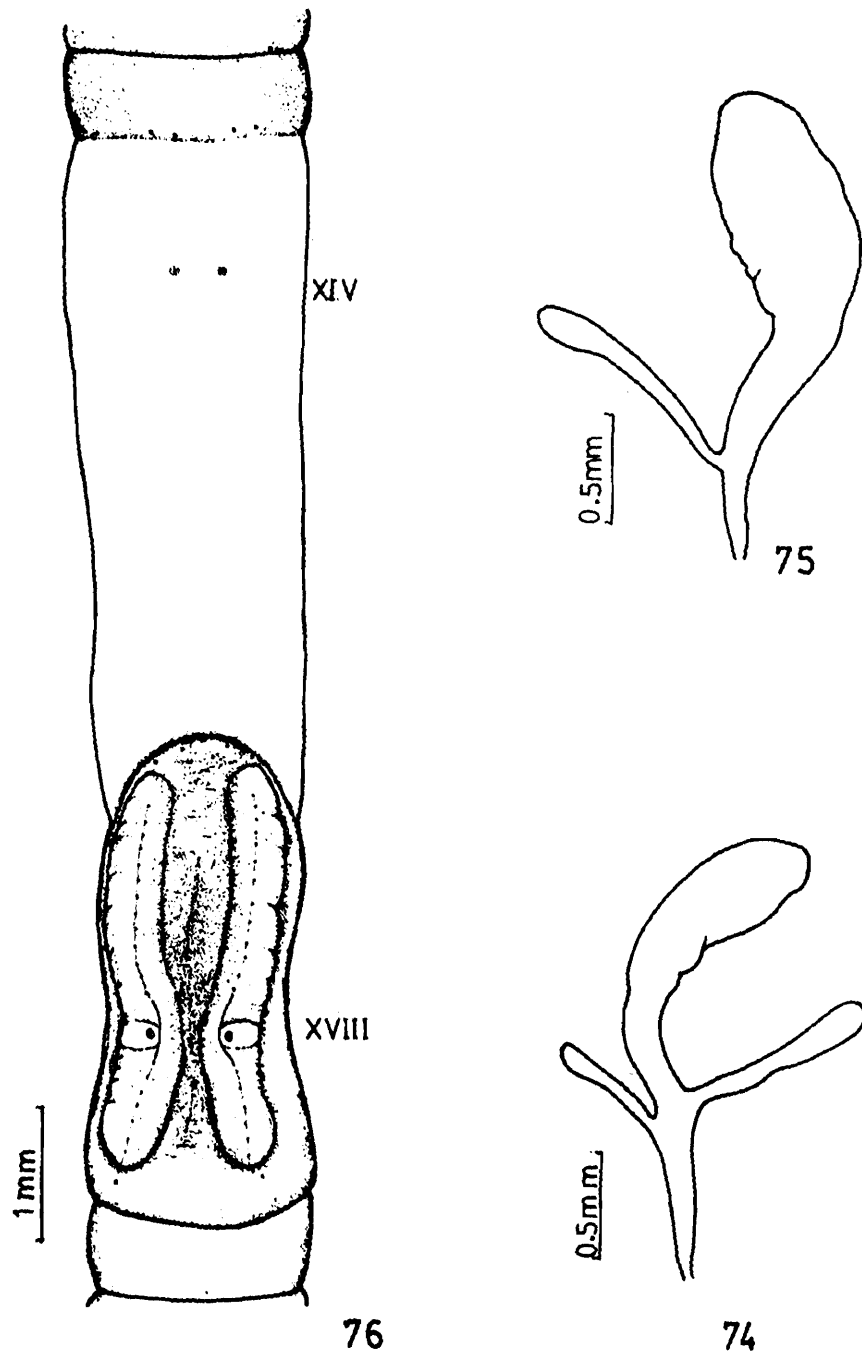
1977. *Celeriella punctata* Jamieson, *Bull. Mus. natn. Hist. nat., Paris (ser. 3)*, no. 450, Zool. 313: 489.

Length 75-84 mm, diameter 1.8-2.1 mm, 127-139 segments. Prostomium epilobic, tongue closed. First dorsal pore 5/6. Clitellum  $\frac{1}{2}$ xiii-xvii. Setae  $aa = 2.2-2.4$   $ab = 1.5-1.7$   $bc = 1.3-1.8$   $yz = 0.4-0.6$   $zz$  on xii,  $aa = 2.6-3$   $ab = 1.3-2$   $bc = 1.8$   $yz = 0.5-0.6$   $zz$  on xxiv, arranged in 12 longitudinal rows throughout the body. Combined male and prostatic pores minute, discharging on indistinct porophores on the setal arc of xviii, at  $a$ , 0.11-0.13 body circumference apart; a pair of longitudinal tumescences (tubercula pubertatis) including the male porophores extend from the setal arc of xvii to  $c$ . setal arc of xix, at  $ab$ , each bearing a longitudinal row of about 15 orifices of hemispheroidal muscular organs. Female pores within  $a$  lines. Spermathecal pores minute, in 7/8/9, slightly lateral to  $a$ , 0.10-0.11 body circumference apart. Genital markings absent.

Septa 4/5/6 delicate, 6/7 slightly muscular, 7/8-10/11 muscular. Oesophagus with paired pouches with calciferous lamellae, in xii-xiv. Intestine begins in xvi. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxvii. Spermathecae paired, in viii and ix, each with a median clavate diverticulum which is  $c$ . one-third the combined length of the duct and ampulla, and joins the duct at mid-length (rarely one of the spermathecae may be bidiverticulate -abnormality?).

*Type locality* : Gundar Shola, Palni Hills, S. India.

*Type specimens* : In Paris Museum: holotype, AH 329, 2



FIGS. 74-76. *Celeriella punctata* Jamieson. 74. spermatheca (abnormal), 75. spermatheca (normal), 76. genital region.

paratypes, AH 330-331. In Jamieson's Collection: 2 paratypes, BJ 1976.5.7-8.

*Material examined* : 17-1-9 Kodaikanal, 18 Sept 1979, coll. J.M. Julka, An 712, HAZFS, ZSI, Solan.

*Distribution* : India: *Tamil Nadu*: Gundar Shola, Kodaikanal, Palni Hills.

*Biology* : It inhabits forest montane ferrallitic gibbsite soil with high organic matter and pH 6.3 at 2100 m altitude.

*Remarks* : Stomate caudal megaomeronephridia discharge into intestine in each segment on either side of the dorsal vessel (? through paired longitudinal excretory canals).

### 11. *Celeriella quadripapillata* (Stephenson)

1924. *Spenceriella duodecimalis* f. *quadripapillata* Stephenson, *Rec. Indian Mus.*, 26: 331.

1958. *Celeriella quadripapillata*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 1: 613.

Length 27-84 mm, diameter 1.4-1.75 mm, 81-105 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5, sometimes 3/4, 5/6. Clitellum annular, ½xiii-xvi, ½xvii. Setae paired, in 12 longitudinal rows throughout the body,  $aa = 2.2$   $ab = 1.7$   $bc = 1.8$   $yz = 1.1$   $zz$  on xii. Combined male and prostatic pores minute, at the centres of spheroidal tumescences on xviii, at  $ab$ , each pore almost concealed by a pair of small papillae. Female pores within  $a$  lines. Spermathecal pores minute, in 7/8, at  $d$ . Genital markings absent.

Septa 4/5/6 delicate (?), 6/7/8 muscular. Oesophagus enlarged and with calciferous lamellae, in xiii-xiv. Intestine begins in xvi. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxvi-xxix. Spermathecae paired, in viii, each with a digitiform ectal diverticulum which is longer than the combined length of the duct and ampulla, duct shorter than ampulla.

*Type locality* : Kodaikanal, Palni Hills, S. India.

*Type specimens* : In ZSIC, W 1117/1.

*Distribution* : India: *Tamil Nadu*: Kodaikanal. Outside India: Burma.

## 12. *Celeriella regularis* (Stephenson)

(Figs. 77-78)

1924. *Spenceriella regularis* Stephenson, *Rec. Indian Mus.*, 26: 330.

1958. *Celeriella regularis*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 1: 613.

Length 26(+)-84 mm, diameter 1-1.25 mm, 85(+)-125 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum annular,  $\frac{1}{2}$ xiii, xiv-xvi,  $\frac{1}{2}$ xvii. Setae *aa* = 1.8-2.4 *ab* = 1.3-1.7 *bc* = 1.3-1.4 *yz* = 0.8-0.9 *zz* on xii, *aa* = 2.1-2.2 *ab* = 1.4-1.6 *bc* = 1.4-1.6 *yz* = 0.7-0.9 *zz* on xxiv, 3-4 on ii, paired and in 12 longitudinal rows from iii to the posterior end. Combined male and prostatic pores minute, discharging on slightly raised circular porophores, on xviii, at *b*, 0.13-0.14 body circumference apart. Female pores within *a* lines. Spermathecal pores minute, in 7/8, at *b*, 0.16 body circumference apart. Genital markings absent.

Septa 4/5/6 delicate, 6/7-11/12 slightly muscular. Oesophagus much enlarged and with calciferous lamellae, in xiii-xiv. Intestine begins in xvi. Testes and male funnels free, in x and xi; seminal vesicles racemose, in xi and xii. Prostates extend posteriorly to xxix-xxxiv. Spermathecae paired, in viii, each with a clavate ectal diverticulum which is about one-third as long as combined length of the duct and ampulla, duct longer than ampulla.

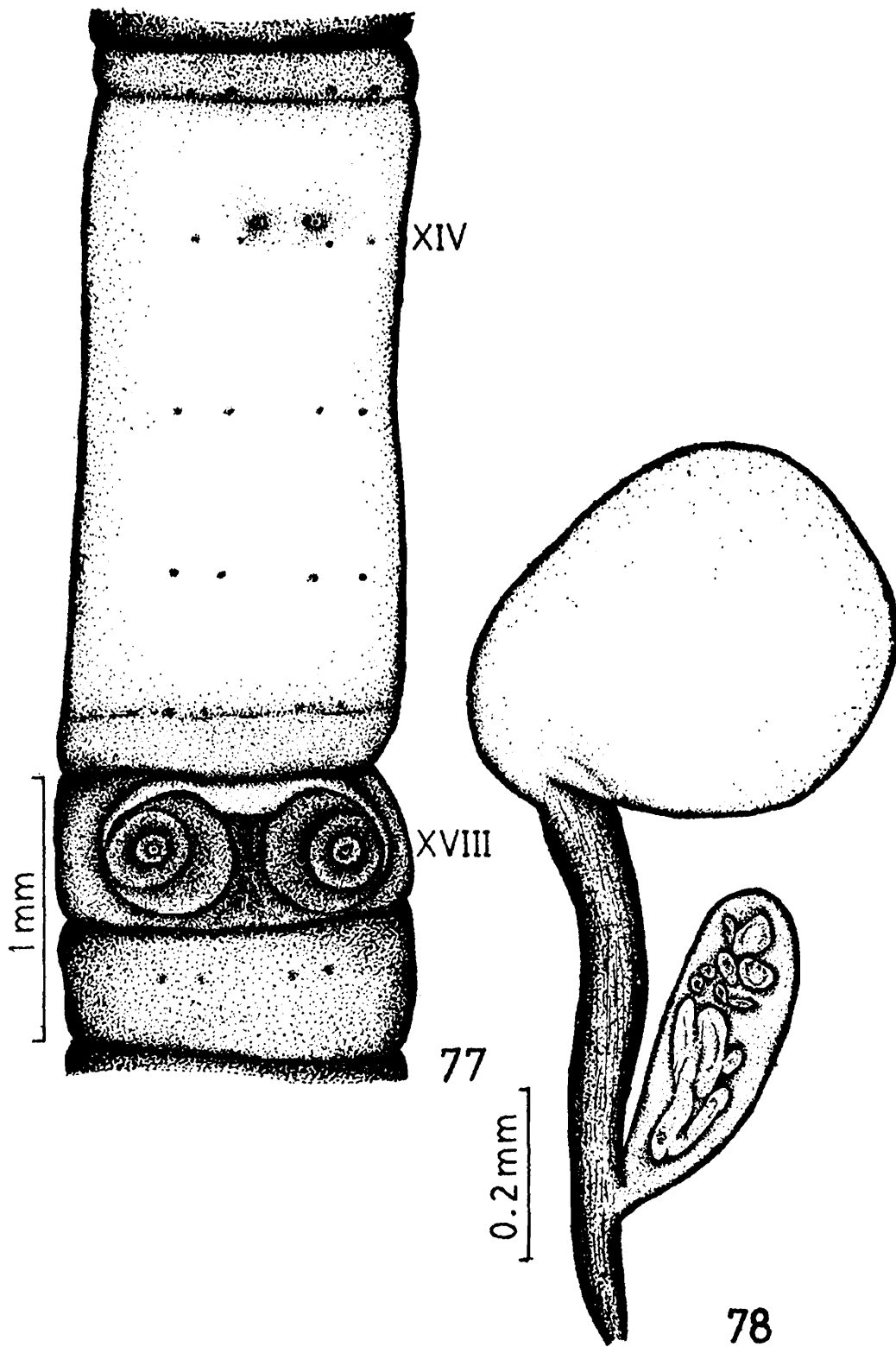
*Type locality* : Kodaikanal, Palni Hills, S. India.

*Type specimens* : In ZSIC, W 1115-1116/1.

*Material examined* : 0-0-3 Kodaikanal, 18 Sept 1979, coll. J.M. Julka, An 713, HAZFS, ZSI, Solan.

*Distribution* : So far known from the type locality.

*Remarks* : Stomate caudal megameronephridia discharge into rectum through lateral paired longitudinal excretory canals.



FIGS. 77-78. *Celeriella regularis* (Stephenson). 77. genital region, 78. spermatheca.

**Genus 5. *Chaetocotoides* gen. nov.**

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in vi and one pair of discrete, extramural, symmetrical calciferous glands, each gland bilobed, one lobe in xv and the other in xvi, opening into gut in xv slightly anterior to septum 15/16; supra-intestinal glands absent; typhlosole lamelliform, ventrally bifid. Micromeronephridia astomate, paired enteronephric tufts in iv, several exonephric on the body wall in v and posteriad segments; stomate, exonephric with preseptal funnels in caudal segments; megameronephridia absent.

*Type species* : *Octochaetus montanus* Stephenson, 1920.

*Description* : As for the only species, *montanus*.

*Etymology* : *Chaetocotoides*, anagram of *Octochaetoides* in which the species was assigned.

*Remarks* : Gates (1962b) restricted the genus *Octochaetoides* Michaelsen, 1901 to include *O. aitkeni* (Fedarb, 1898b) with 2 oesophageal gizzards and referred most of its other species (with a single oesophageal gizzard) to his genus *Octochaetona*. However, he retained *O. montanus* (Stephenson, 1920) along with *O. kurmagarensis* Gates, 1945, *O. raoi* Gates, 1945 and *O. castellanus* (Stephenson, 1917a) with a single oesophageal gizzard in *Octochaetoides* but pointed out that each of them deserved a separate generic status by the characteristics of the calciferous glands and typhlosole.

A re-examination of the type material of *O. montanus* in ZSI, Calcutta and several other specimens from the type locality (Panchgani) reveals: "one pair of discrete, extramural, symmetrically placed calciferous glands, each gland being bilobed, one lobe in xv and the other in xvi, the two lobes open into oesophagus through a common duct in xv, slightly anterior to septum 15/16; typhlosole lamelliform, ventrally bifid; stomate, exonephric micromeronephridia in caudal segments; megameronephridia absent"

*O. montanus*, herein assigned to a new genus *Chaetocotoides*, belongs to a group of octochaetid genera with a single oesophageal gizzard, one pair of discrete extramural calciferous glands and stomate exonephric micromeronephridia in caudal segments, and lack megameronephridia. It can be distinguished from other members of the group, *Octochaetona* Gates, 1962 and *Octonochaeta* gen. nov. (described elsewhere in this work) by the characters given in Table 3.

*Octochaetoides kurmagarensis*, *O. raoi* and *O. castellanus* are to be regarded as *species incertae sedis* till more is known about their digestive and excretory systems.

### 13. *Chaetocotoides montanus* (Stephenson)

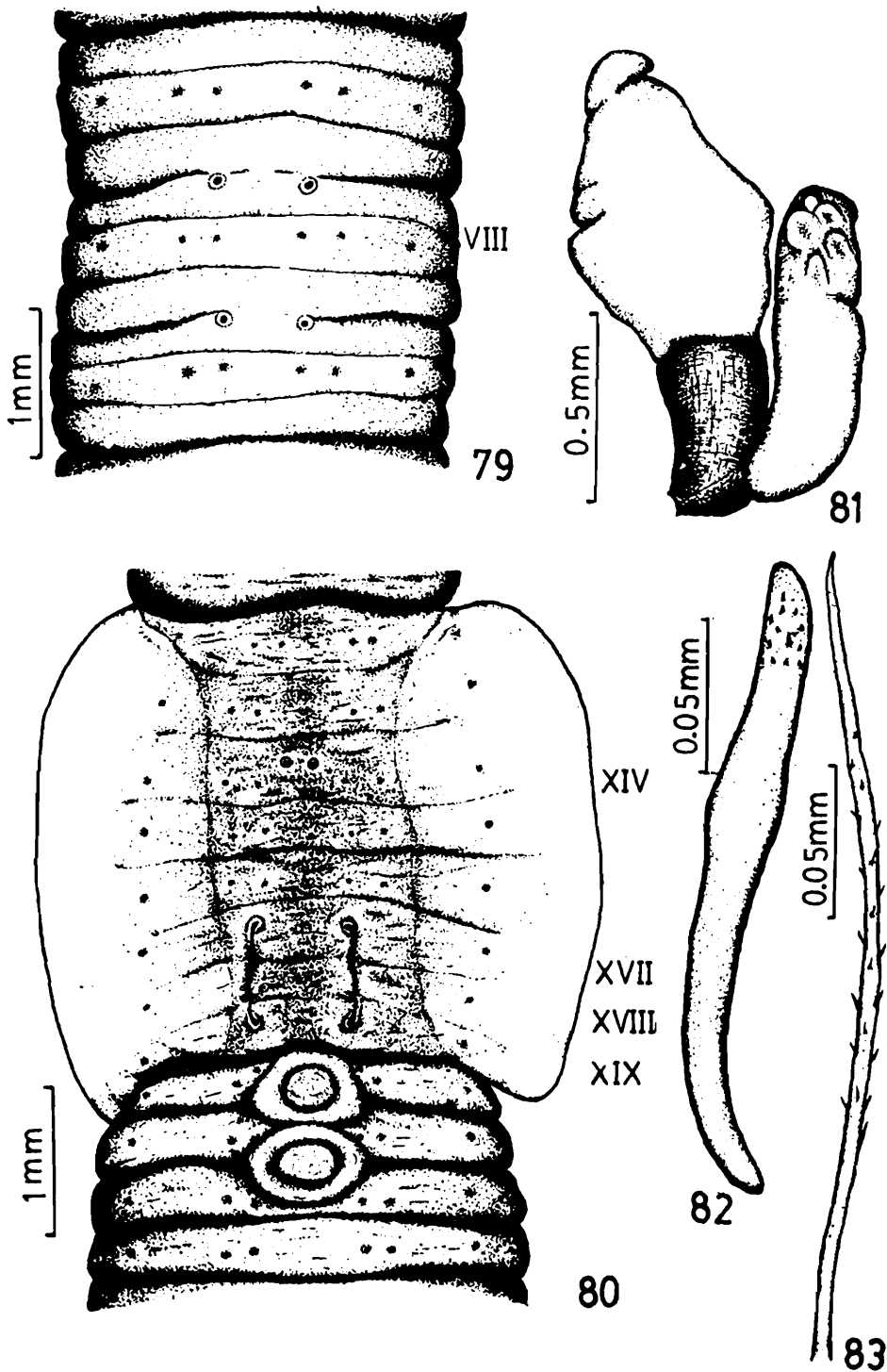
(Figs. 79-83)

1920. *Octochaetus montanus* Stephenson, *Mem. Indian Mus.*, 7: 234.

1923. *Octochaetus (Octochaetoides) montanus*, Stephenson, *Fauna Br. India, Oligochaeta*: 384.

1962. *Octochaetoides montanus*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 211.

Length 60-100 mm, diameter 3-4 mm, 143-181 segments. Prostomium epilobic, tongue closed and narrowed posteriorly. First dorsal pore 10/11. Clitellum saddle-shaped, xii-xix. Setae lumbricine,  $aa = 2.1-2.3$   $ab = 0.9-1$   $bc = 1.1$   $cd = 0.09-0.11$   $dd$  on xii,  $aa = 3.1-3.4$   $ab = 1.2$   $bc = 1.5-1.7$   $cd = 0.13-0.14$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix not copulatory. Male genital field somewhat rectangular, slightly depressed. Male pores paired, minute, in seminal grooves, on the setal arc of xviii, at  $a$ ; prostatic pores paired, minute, at the ends of seminal grooves, on xvii and xix, at  $a$ ; seminal grooves almost straight, between setal arcs of xvii and xix. Female pores paired, presetal, within  $a$  lines, on xiv. Spermathecal pores paired, minute, on viii and ix, slightly posterior to 7/8 and 8/9, at  $a$ . Genital markings oval, unpaired and median, on 20/21, 21/22, sometimes on 22/23, at  $aa$ , sometimes paired, on setal annulus of viii, at  $aa$  (one of the pair may be absent). Nephridiopores not recognized.



FIGS. 79-83. *Chaetocotoides montanus* (Stephenson). 79. spermathecal pore region, 80. genital region, 81. spermatheca, 82. seta *a* on ix, 83. penial setae.

TABLE 3. A comparison between *Chaetocotoides*, *Octonochaeta* and *Octochaetona*.

Character	<i>Chaetocotoides</i>	<i>Octonochaeta</i>	<i>Octochaetona</i>
Clitellum	saddle-shaped, xii-xix (8 segments)	annular, xiii-xvii (5 segments)	annular, xiii-xvi, xvii, xviii (4-6 segments)
Calciferous glands	one pair, symmetrical, each gland bilobed, one lobe in xv and the other in xvi, opening into oesophagus in xv	one pair, symmetrical, in xvi, opening into oesophagus in the same segment	one pair, asymmetrical, one gland in xv and the other in xvi, opening into oesophagus close to attachment of septum 15/16
Typhlosole	bifid ventrally	simple	bifid ventrally
Caudal micromeronephridia	with preseptal funnels	with preseptal and intra-segmental funnels	with preseptal and intra-segmental funnels
Extraoesophageal vessels	v-xiii, without any connection to supra-oesophageal vessel	v-xv, with branches to supra-oesophageal vessel in viii	v-viii, opening into supra-oesophageal vessel in viii.
Lateroparietal vessels	join extra-oesophageal vessels in xiii	bifurcate in xiii, one branch to supra - oesophageal and the other to extra-oesophageal vessels	join supra - oesophageal vessel in xiii

Septa 4/5, 7/8-9/10 muscular, 5/6/7 delicate, aborted ventro-laterally. Gizzard large, in vi; discrete, extramural calciferous glands one pair, each gland bilobed, one lobe in xv and the other in xvi, both opening into oesophagus through a short common duct laterally, in xv, just anterior to septum 15/16; caeca and supra-intestinal glands absent; intestine begins in xviii; typhlosole lamelli-form, ventrally bifid, xxii to cxx-cxxxiv. Dorsal vessel single and complete; supra-oesophageal vessel single, viii-xiii; extra-oesophageal vessels paired, v-xiii; latero-parietal vessels paired, joining the extra-oesophageal vessels in xiii; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric, testes and male funnels free, in x and xi; seminal vesicles racemose, in ix and xii. Prostates paired, in xvii and xix. Penial setae ornamented with a few longitudinal rows of small and sharp teeth, ectal end slightly undulating, tip pointed, 1.02-1.52 mm long, 5-7  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a digitiform diverticulum at about the middle of duct, which is as long as or slightly shorter than ampulla. Setae *a*, *b* on viii and ix sigmoid, with a nodule at the middle, ornamented with a few scattered, small spines, 0.19-0.22 mm long, 24  $\mu$  diameter. Ovisacs paired, in xiv. Genital marking glands absent. Micromeronephridia astomate, paired enteronephric tufts in iv, several to numerous exonephric on the body wall in v and posteriad segments, slightly enlarged, stomate with preseptal funnels, exonephric in caudal segments; megameronephridia absent.

*Type locality* : Panchgani, Western Ghats, Maharashtra, India.

*Type specimens* : In ZSIC, W 259/1; BMNH, 1933: 5: 25: 904-5.

*Material examined* : In ZSIC: 0-0-1, syntype, W 259/1; 0-0-5 Panchgani, 26 Aug 1979, coll. J.M. Julka, An 1837/1. In HAZFS, ZSI, Solan: 7-11-23 Panchgani, 26 Aug 1979, coll. J.M. Julka, An 714-715; 0-0-1 Panchgani, 21 Aug 1964, coll. K.K. Tiwari, An 716.

*Distribution* : So far known from the type locality.

Genus 6. **Dashiella** gen. nov.

**Diagnosis** : Perichaetine. Combined male and prostatic pores paired, on xvii; seminal grooves absent. Oesophagus with 2 gizzards in v-vi and 3 pairs of discrete extramural calciferous glands in xi-xiii; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate, exonephric paired tufts in ii-x, several exonephric on the body wall in xi and posteriad segments. Paired, stomate, exonephric megameronephridia in each segment posterior to the typhlosole region.

**Type species** : *Dashiella khandalaensis* sp. nov.

**Description** : As for the only species, *khandalaensis*.

**Distribution** : Western Ghats, Maharashtra, India.

**Etymology** : *Dashiella*, gender feminine, named after Dr. M.C. Dash, Sambalpur University, Orissa, India for his considerable contributions on the ecology of Indian earthworms.

**Remarks** : *Dashiella* gen. nov. belongs to a group of octochaetid genera with 2 oesophageal gizzards and more than 2 pairs of discrete extramural calciferous glands anterior to segment xiv, and without supra-intestinal glands or 'grid-like' supra-intestinal thickening. It can be distinguished from the other members of the group, *Rillogaster*, *Pellogaster* and *Lenlogaster*, all of Gates (1939b), by the characters noted in Table 4.

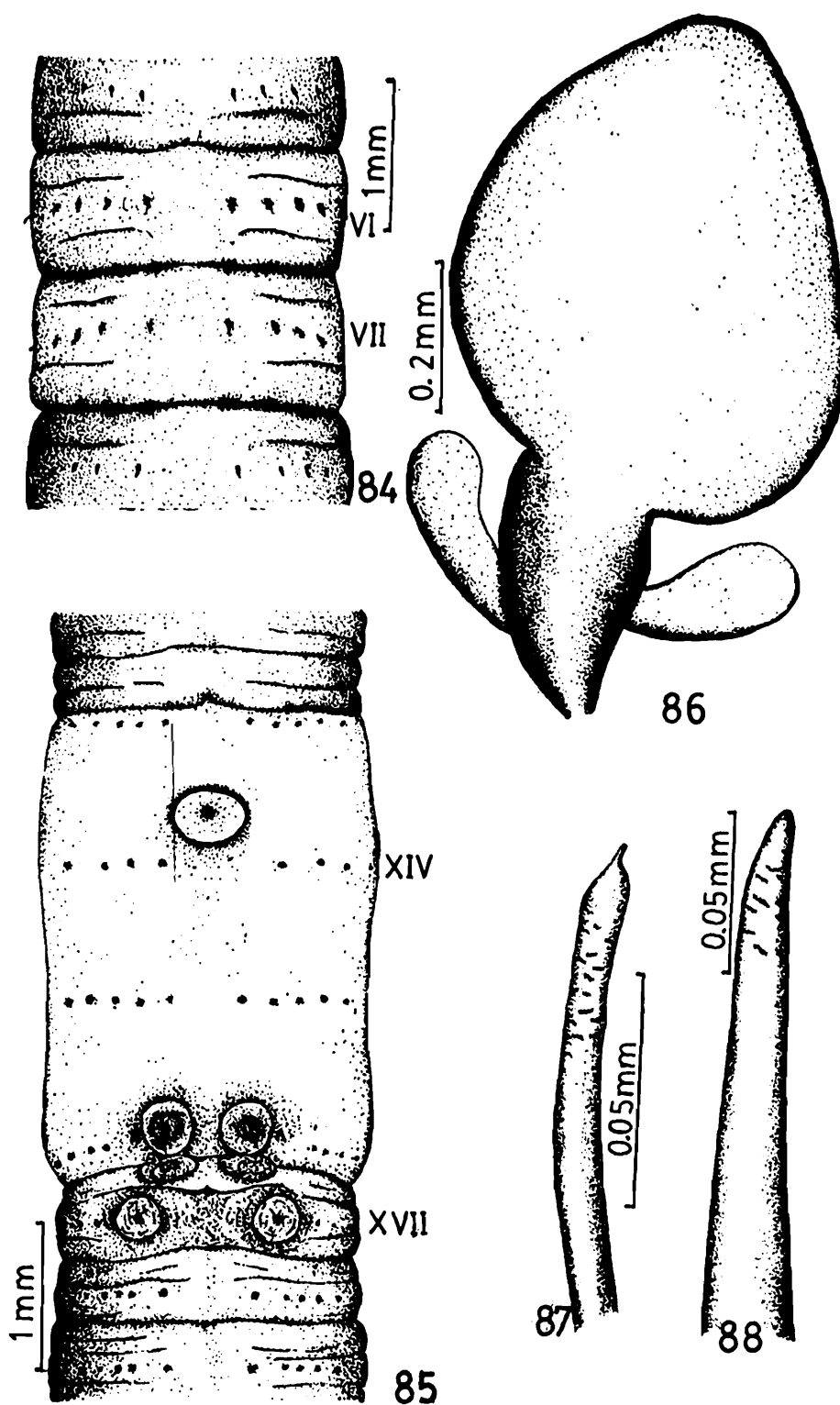
14. **Dashiella khandalaensis** sp. nov.

(Figs. 84-88)

Length 44-107 mm, diameter 2-3 mm, 94-139 segments. Prostomium tanylobic. First dorsal pore 11/12, sometimes 10/11. Clitellum annular,  $\frac{1}{2}$ xiii-xvi. Setae perichaetine,  $aa = 1.6-2.3$   $ab = 1.3-2.3$   $bc = 1.3-1.8$   $yz = 0.17-0.18$   $zz$  on xii,  $aa = 2.5-3$   $ab = 2.3-2.9$   $bc = 2.5-3$   $yz = 0.23-0.28$   $zz$  on xx, 8-13 on ii, 11-12 on vii, 12 on xii, 16-22 on xx, setae *a*, *b* and sometimes *c* ornamented and enlarged on preclitellar, clitellar and some of postclitellar segments,

those on xvi much enlarged and located at the centres of genital markings. Combined male and prostatic pores paired at the centres of circular porophores, on xvii, at or slightly lateral to *b*, *c*. 0.13-0.15 body circumference apart. Female pore single, median, presetal, on xiv. Spermathecal pores in paired batteries of 1-4 (polythecal), on 6/7/8, the ventralmost pair *c*. 0.08-0.10 body circumference apart. Genital markings circular to oval, paired, presetal, on xvi and xvii, at *ab*. Nephridiopores not recognized.

Septa 4/5, 8/9-11/12 slightly muscular, 5/6/7/8 delicate. Oesophagus with 2 large gizzards, in v-vi, and 3 pairs of discrete, extramural, reniform calciferous glands, in xi-xiii, opening dorso-laterally into gut through short stalks; intestine begins in xv, caeca and supra-intestinal glands absent; typhlosole lamelliform, simple, xxiii-xxv to ci-cv. Dorsal vessel single, complete; supra-oesophageal vessels paired, x-xiii, connected with each other by transverse commissures anterior to septa 11/12 and 12/13; extra-oesophageal vessels paired, iii-xiii; latero-parietal vessels paired, joining the extra-oesophageal vessels in xiii; lateral hearts originating from the supra-oesophageal vessels with delicate connectives to the dorsal vessel in x-xii; subneural vessel absent. Holandric, testes and male funnels free, in x and xi; seminal vesicles racemose, in ix, x and xii, those of x small. Vasa deferentia uniting before opening into the enlarged ectal end of the prostatic duct in xvii below the longitudinal musculature. Prostates paired, tubular, in xvii, extending posterior to xix-xx. Penial setae ornamented with short transverse rows of fine spines, tip with a short spine, 0.81-0.84 mm long, 9-11  $\mu$  diameter. Ovisacs paired, in xiv. Spermathecae in paired batteries of 1-4 (usually 3), in vii and viii, each with a median and a lateral club-shaped diverticula, at about the middle of a short duct. Micromeronephridia astomate; small paired exonephric tufts on the body wall in ii-iv, slightly larger on septa in v-x; several exonephric on the body wall in xi and posteriad segments, *c*. 16-20 on each of clitellar segments, fewer in other segments. Paired, stomate, exonephric megameronephridia in each segment posterior to the typhlosolar region, funnels close to the nerve cord.



FIGS. 84-88. *Dashiella khandalaensis* gen. et sp. nov. 84. spermathecal pore region, 85. genital region, 86. spermatheca, 87. penial seta, 88. genital seta on xvi.

TABLE 4. A comparison of *Dashiella* with related genera.

Character	<i>Dashiella</i>	<i>Pellogaster</i>	<i>Rillogaster</i>	<i>Lenngaster</i>
Setae	Perichaetine	lumbricine	lumbricine	lumbricine
Male terminalia	one pair of combined male and prostatic pores on xvii	one pair of male pores on xviii; 2 pairs of prostatic pores on xvii and xix	one pair of combined male and prostatic pores on xix	one pair of male pores on xviii or 17/18; 2 pairs of prostatic pores on xvii and xix or one pair of prostatic pores on xvii
Seminal grooves	absent	present	absent	present
Calciferous glands	3 pairs, in xi-xiii	4 pairs, in x-xiii	4 pairs, in x-xiii	3 pairs, in x-xii
Gizzards	v-vi	v-vi	vi-vii	v-vi
Typhlosole	lamelliform	lamelliform	a low ridge	lamelliform

Genital marking glands absent. Genital setae *a*, *b* on xvi ornamented with short transverse serrated ridges, tip pointed, follicles long with 1-2 reserve setae, 0.43-0.55 mm long, 27-32  $\mu$  diameter.

*Material examined* : 5-14-67 grassland, soil red sandy loam with pH 6.5, Khandala, 18.44 N, 73.28 E, altitude c. 1065 m, 14 Sept 1979, coll. K. Mathew (holotype and 6 paratypes in ZSIC, An 1831-32/1, 79 paratypes in HAZFS, ZSI, Solan, An 717); 10-4-5 grassland, Khandala, 24 Aug 1979, coll. J.M. Julka, paratypes, in HAZFS, ZSI, Solan, An 718.

*Distribution* : India: *Maharashtra*: Khandala, Western Ghats.

### Genus 7. *Dichogaster* Beddard, 1888

1888. *Dichogaster* Beddard, *Q. Jl microsc. Sci.*, 29: 251.  
 1890. *Trigaster* (in part), Benham, *Q. Jl microsc. Sci.*, 31: 231.  
 1892. *Microdrilus* Beddard, *Proc. zool. Soc. Lond.*, 1892: 683.  
 1895. *Dichogaster* (in part), Beddard, *A monograph of the order of Oligochaeta*: 476.  
 1895. *Millsonia* (in part), Beddard, *A monograph of the order of Oligochaeta*: 479.  
 1895. *Benhamia* (in part), Beddard, *A monograph of the order of Oligochaeta*: 559.  
 1897. *Balanta* Michaelsen, *Jb. hamb. wiss. Anst.*, 15: 165.  
 1900. *Dichogaster* (in part), Michaelsen, *Tierreich*. 10: 334.  
 1923. *Dichogaster*, Stephenson, *Fauna Br. India, Oligochaeta*: 470.  
 1972. *Dichogaster*, Gates, *Trans. Am. phil. Soc.*, 62: 227.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii or 17/18; prostatic pores 2 pairs, at the ends of seminal grooves, on xvii and xix, or one pair on xvii. Oesophagus with 2 gizzards anterior to septum 8/9 and one pair of discrete extramural calciferous glands, each gland trilobed, a vertically reniform lobe in each of segments xv-xvii with a common duct opening into the gut in xvi; supra-intestinal glands absent; typhlosole lamelliform,

simple. Micromeronephridia astomate; paired enteronephric tufts in ii-iv; several, exonephric on the body wall in v and posteriad segments. Paired, stomate, exonephric megameronephridia in each of few posteriormost segments.

*Type species* : *Dichogaster damonis* Beddard, 1888.

*Description* : Setae lumbricine throughout the body. Clitellum annular though often thinner ventrally between setae *aa*. Male pores paired, in seminal grooves on xviii, prostatic pores paired at the ends of seminal grooves on xvii and xix, or male pores at posterior ends of short seminal grooves in 17/18 and prostatic pores one pair at anterior ends of seminal grooves on xvii. Female pore (s) single or paired, on xiv. Spermathecal pores paired, at or near 7/8/9. Genital markings sometimes present. Nephridiopores not recognized.

Some of the septa in the gizzard region absent. Oesophagus with 2 gizzards in front of the septum 8/9. Calciferous glands one pair, discrete, extramural, trilobed; each lobe reniform, vertical, in each of xv-xvii, the common duct of the three lobes opening into oesophagus dorsolaterally in xvi. Intestine begins in xix; caeca and supra-intestinal glands absent; typhlosole simple, lamelliform. Dorsal vessel single and complete; supra-oesophageal vessel single, ix-xiii; extra-oesophageal vessels paired with connectives to the supra-oesophageal vessel in x-xii, latero-parietal vessels paired, joining the supra-oesophageal vessel (and/or extra-oesophageal vessels) in xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric. Ovaries paired, fan-shaped, in xiii, ovisacs paired, in xiv. Prostates one pair in xvii or 2 pairs in xvii and xix. Spermathecae paired in viii and ix. Micromeronephridia astomate, enteronephric paired tufts in ii-iv, several exonephric on the body wall in v and posteriad segments, arranged in 3-5 longitudinal rows on each side in postclitellar region; paired stomate exonephric megameronephridia in each of few posteriormost segments, funnels close to the nerve cord.

*Distribution* : Tropical Africa and America, India. Species of *bolau* group widely transported to various parts of the world.

*Remarks* : The genus *Dichogaster* cannot be adequately characterized due to the paucity of information on somatic anatomy in most of over 200 species, including the type species *D. damonis* Beddard, 1888. However, Gates (1958a, 1972) recognizes a *bolau* group comprising Asiatic species, and the above diagnosis and description for the genus is based on this group.

### Key to the species of *Dichogaster*

- |   |                       |
|---|-----------------------|
| 1. Prostates 2 pairs, in xvii and xix ..... | 2                     |
| Prostates one pair, in xvii .....           | <i>D. saliens</i>     |
| 2. Female pore single, median .....         | <i>D. bolau</i>       |
| Female pores paired.....                    | 3                     |
| 3. Median genital markings present .....    | <i>D. affinis</i>     |
| Genital markings absent.....                | 4                     |
| 4. Spermathecal duct bulbous .....          | <i>D. modiglianii</i> |
| Spermathecal duct not bulbous .....         | <i>D. curgensis</i>   |

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*Note* : Two species, *D. parva* (Michaelsen, 1896) and *D. travancorensis* (Fedarb, 1898), are omitted from the above key. The description of *D. parva* from Sri Lanka is inadequate but appears to be similar to *curgensis*. *D. travancorensis* from Kerala in South India is regarded as species incertae sedis, described elsewhere in this work.

### 15. *Dichogaster affinis* (Michaelsen)

(Figs. 89-92)

1890. *Benhamia affinis* Michaelsen, *Jb. hamb. wiss. Anst.*, 7:29.

1900. *Dichogaster affinis*, Michaelsen, *Tierreich*, 10: 345.

1923. *Dichogaster affinis*, Stephenson, *Fauna Br. India, Oligochaeta*: 471.

1931. *Dichogaster sinuosus* Stephenson, *Proc. zool. Soc. Lond.*, 1931: 74.

1972. *Dichogaster affinis*, Gates, *Trans. Am. phil. Soc.*, 62: 278.

1978. *Dichogaster affinis*, Righi *et al.*, *Acta Amazonica*, 8(3), suppl. 1: 38.

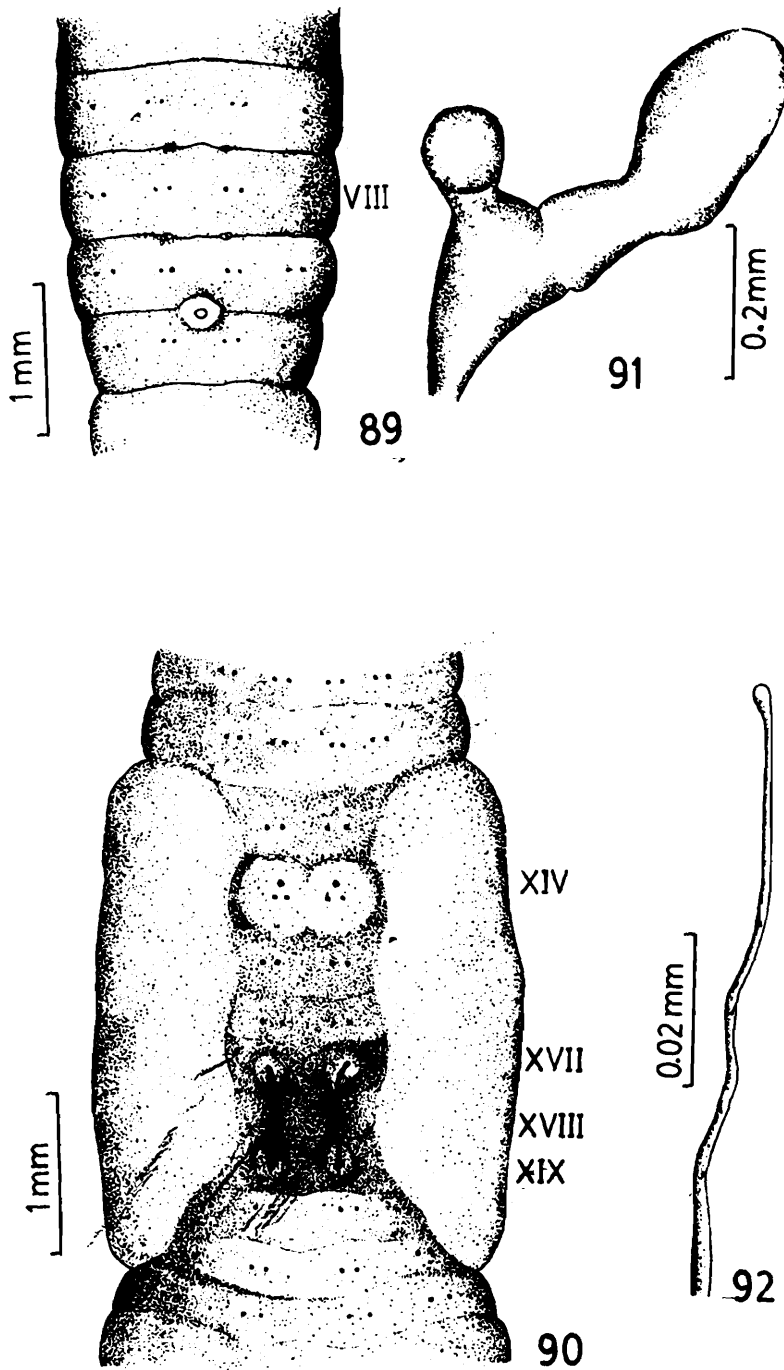
Length 27-60 mm, diameter 1-2 mm, 105-140 segments. Prostomium epilobic, tongue closed. First dorsal pore 5/6. Clitellum xiii, xiv-xxi, xxii. Setae  $aa = 3$   $ab = bc = 3$   $cd = 0.07$   $dd$  on xii,  $aa = 4.5-4.7$   $ab = 1.4-1.5$   $bc = 4.5-4.7$   $cd = 0.14$   $dd$  on xxiv. Male pores minute, in seminal grooves on the setal arc of xviii, at *a*; prostatic pores minute, at the ends of seminal grooves on xvii and xix, at *a*; seminal grooves almost straight or slightly concave between the setal arcs of xvii and xix. Female pores paired, presetal, at or just lateral to *a*. Spermathecal pores minute, at or close to *a*. Genital markings often present, unpaired and median on 8/9/10, sometimes on 7/8, 10/11/12.

Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 absent. Gizzards between septa 4/5 and 7/8; typhlosole xxi to lxxviii-lxxxvi (?), xc-xci. Last pair of hearts in xii. Testes and male funnels in unpaired sacs, in x and xi, formed by the peripheral apposition of septa 9/10/11/12; seminal vesicles vestigial, in xi and xii. Prostates 2 pairs, in xvii and xix. Penial setae slightly sinuous ectally, ornamented with scale-like markings or teeth in the sinuosities, tip bluntly rounded, knobbed or truncate, 0.29-0.43 mm long, 4-7  $\mu$  diameter. Each spermatheca with a shortly stalked ental diverticulum. Genital marking glands circular to slightly dome-shaped, concealed beneath the longitudinal muscle layer.

*Type locality* : Quilimane, Zanzibar.

*Type specimens* : *Benhamia affinis*: in ZMUH, 303; *D. sinuosus* in BMNH, 1930: 5: 9: 22-4.

*Material examined* : In HAZFS, ZSI, Solan - Maharashtra, coll. J.M. Julka: 0-0-6 Poona, 23 Aug 1979, An 548, 0-0-3 Panchgani, 25 Aug 1979, An 550; Meghalaya, coll. J.M. Julka: 0-0-1 Tura, Garo Hills, 17 July 1977, An 551, Karnataka, coll. R. Kale: 0-0-3 Bangalore, An 552, 654.



FIGS. 89-92. *Dichogaster affinis* (Michaelsen). 89. spermathecal pore region, 90. genital region, 91. spermatheca, 92. penial seta.

*Distribution* : India: *Arunachal Pradesh*: Taliha; *Meghalaya*: Tura; *Madhya Pradesh*: Nowgong, Jubbulpore; *Orissa*: Antrakyari nr. Balugaon; *Gujarat*: Baroda; *Maharashtra*: Bombay, Poona, Panchgani; *Karnataka*: Bangalore; *Kerala*: Shasthancottah, Trivandrum.

Outside India: Sri Lanka, Burma, Thailand, Pacific Ocean Islands, Cape Verde Island, Southwest Africa, Madagascar, Zanzibar, Comoro Island, Mexico, El Salvador, French Guiana, Brazil, West Indies (Haiti, St. Thomas).

*Biology* : It inhabits soil on river bank and sea shore, in rotten wood, under decaying leaves and soils rich in organic matter. It has also been recorded from caves (Pickford, 1938).

*Remarks* : *D. affinis* is a circummundane species and has successfully colonized in several countries.

## 16. *Dichogaster bolau* (Michaelsen)

(Figs. 93-96)

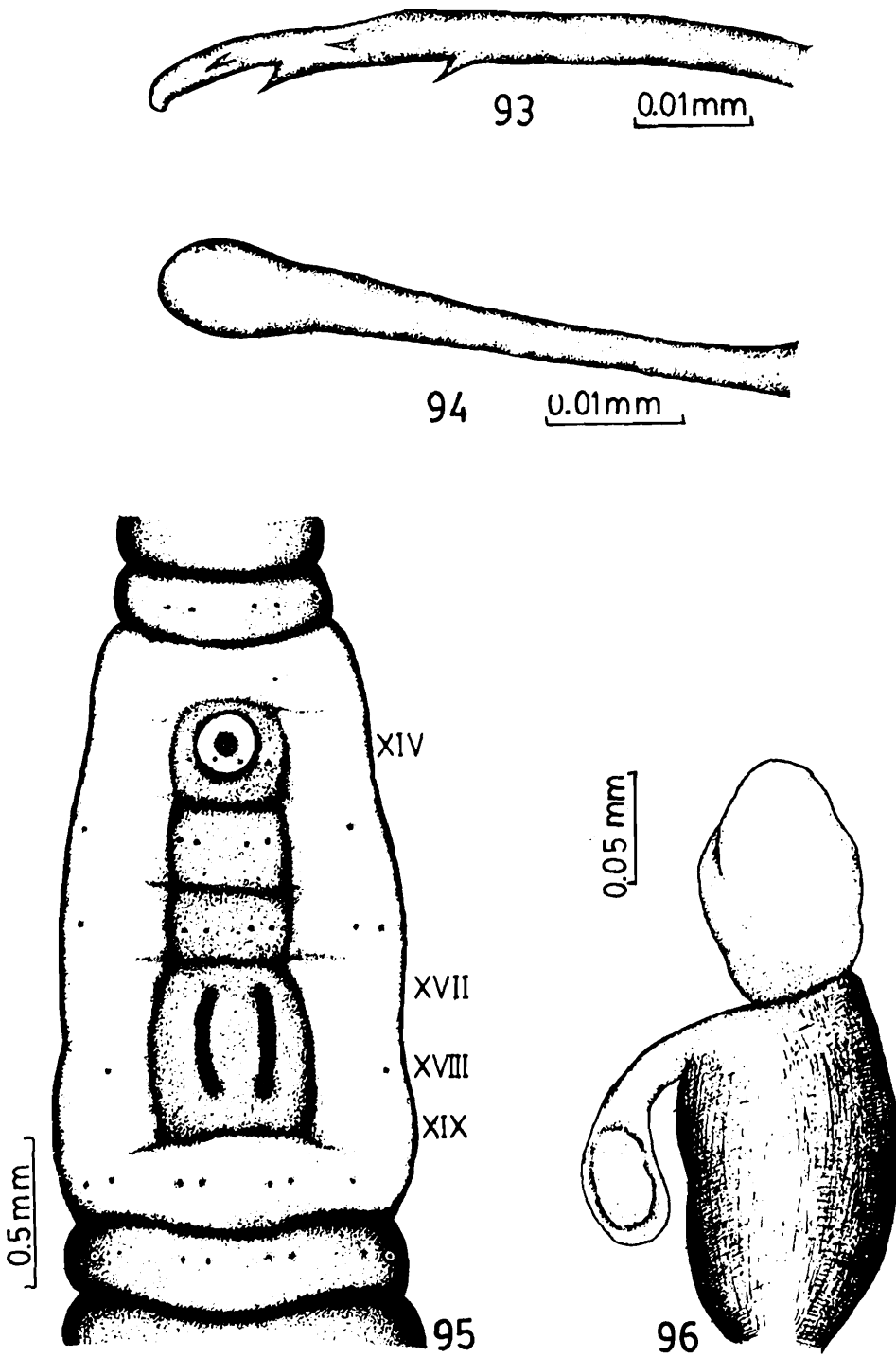
1891. *Benhamia bolavi* Michaelsen, *Jb. hamb. wiss. Anst.*, 8: 9.
1893. *Benhamia malayana* Horst, *Zoologische Ergebnisse einer Reise in Niederlandisch Ost Indian*, 3: 35.
1895. *Benhamia octonephra* Rosa, *Boll. Mus. Torino*, 10(204): 2.
1896. *Benhamia "bolavi" palmicola* Eisen, *Mem. Calif. Acad. Sci.*, (3) 2: 132.
1896. *Benhamia rugosa* Eisen, *Mem. Calif. Acad. Sci.*, (3) 2: 136.
1900. *Benhamia bolavi pacifica* Eisen, *Proc. Calif. Acad. Sci.*, (3) 2: 209.
1900. *Dichogaster bolau*, Michaelsen, *Tierreich*, 10: 340.
1900. *Dichogaster malayana*, Michaelsen, *Tierreich*, 10: 341.
1903. *Dichogaster bolau* var. *nec. nom.*, Michaelsen, *Zool. Jb. Syst.*, 14: 443.
1905. *Dichogaster bolau octonephra*, Cognetti, *Boll. Mus. Torino*, 20 (495): 2.
1905. *Dichogaster bolau palmicola*, Cognetti, *Mem. R. Acad. Sci. Torino*, (2) 55: 40.
1905. *Dichogaster bolau pacifica*, Cognetti, *Mem. R. Acad. Sci. Torino*, (2) 55: 40.

1920. *Dichogaster bolau* var. *malabaricus* Stephenson, *Mem. Indian Mus.*, 7: 257.
1923. *Dichogaster bolau*, Stephenson, *Fauna Br. India. Oligochaeta*: 472.
1923. *Dichogaster bolau* var. *malabaricus*, Stephenson, *Fauna Br. India, Oligochaeta*: 473.
1923. *Dichogaster malayana*, Stephenson, *Fauna Br. India, Oligochaeta*: 475.
1957. *Dichogaster* sp. (?), Gates, *Nat. Hist. Rennel Island, Brit. Solomon Island*, 2: 21.
1968. *Dichogaster bolau bolau*, Righi, *Rev. Brasil Biol.*, 28(4): 374.
1972. *Dichogaster bolau*, Gates, *Trans. Am. phil. Soc.*, 62: 279.
1978. *Dichogaster bolau bolau*, Righi et al., *Acta Amazonica*, 8(3), suppl. 1: 38.

Length 19-23 mm, diameter 1-3 mm, 70-98 segments. Prostomium epilobic, tongue closed. First dorsal pore 5/6, sometimes 6/7. Clitellum xiii, xiv-xviii, xix, xx, ½xxi. Setae *aa* = 2.5-3.3 *ab* = 0.8 *bc* = 2.5-3.3 *cd* = 0.08-0.09 *dd* on xii, *aa* = 2.3-2.8 *ab* = 0.9 *bc* = 2.3-2.8 *cd* = 0.1 *dd* on xxiv. Male pores minute, in seminal grooves on the setal arc of xviii, at *a*; prostatic pores minute, at the ends of seminal grooves on xvii and xix, at *a*; seminal grooves slightly concave between the setal arcs of xvii and xix. Female pore single, median, presetal. Spermathecal pores at or near *a*. Genital markings absent.

Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 absent. Gizzards between septa 4/5 and 7/8; typhlosole xxi-xxii to lxviii-lxxvi. Last pair of hearts in xii. Testes and male funnels in unpaired sacs, in x and xi, formed by the peripheral apposition of the septa 9/10-11/12; seminal vesicles acinous, vestigial, in xi and xii. Prostates 2 pairs, in xvii and xix. Penial setae unornamented or ornamented with a few to several triangular teeth, tip hooked or widened then scalpel-, oar-, spatula- or spoon-shaped, 0.23-0.4 mm long, 3-7.5  $\mu$  diameter. Each spermatheca with a small, digitiform to pyriform, ventrally directed, ental diverticulum, duct rather barrel-shaped, as long as or longer or smaller than ampulla.

*Type locality* : Bergedorf, Hamburg, Germany.



FIGS. 93-96. *Dichogaster bolaii* (Michaelson). 93-94. penial setae, 95. genital region, 96. spermatheca.

*Type specimens* : *Benhamia bolavi*: in ZMUH, 285; BMNH, 1924: 3: 1: 244; MNHU, 7334; MZUT, 52; NHRS, 1247; RNHL: USNM, 34166. *Benhamia malayana*: in RNHL, 1794. *Benhamia octonephra*: ZMUH, 4501. *Benhamia bolavi palmicola*: ZMUH, 279. *Benhamia rugosa*: Typus amissus. *Benhamia bolavi pacifica*: (?). *Dichogaster bolau*i var. *malabaricus*: BMNH, 1933: 5: 25: 16-9.

*Material examined* : In HAZFS, ZSI, Solan - *Himachal Pradesh*: 0-0-1 Deli, Solan District, 5 May 1971, coll. H.P. Agarwal, An 568; 0-0-1 Nurpur, Kangra district, 8 Aug 1978, coll. J.M. Julka, An 567. *Arunachal Pradesh*, coll. J.M. Julka, 1969: 0-0-2 Chowkham, Lohit division, 27 Nov, An 554; 0-0-8 Wakro, Lohit division, 4 Dec, An 553. *Meghalaya*, coll. J.M. Julka, 1977: 0-0-4 Barapani, 11 July, An 555; 0-0-3 Cherrapunji, 12 July, An 556. *Gujarat*: 0-0-6 Surat, 8 July 1917, coll. Beni Prashad, An 569. *Maharashtra*: 0-0-2 Poona, 23 Aug 1979, coll. J.M. Julka, An 566. *Andhra Pradesh*: 0-1-0 Hyderabad, 27 Sept 1979, coll. J.M. Julka, An 565. *Karnataka*: coll. Prashad & Rao: 0-0-1 Gokak Head Works, Belgaum district, Nov 1928, An 570; coll. R. Kale: 0-0-5 Bangalore, An 653; coll. J.M. Julka, 1979: 0-0-1 Londa, 29 Aug, An 557, 0-0-2 Shimoga, 3 Sept, An 558, 0-0-1 Kotegehar, 7 Sept, An 563, 0-0-2 Bhagamandala, Coorg, 10 Sept, An 560, 0-0-1 Mercara, Coorg, 12 Sept, An 561, 0-0-1 Somwarpet, 11 Sept, An 559, 0-0-1 Nandi Hills, 23 Sept, An 562. *Tamil Nadu*: 0-0-1 Coonoor, Nilgiri Hills, 14 Sept 1979, coll. J.M. Julka, An 564.

*Distribution* : India: *Andaman & Nicobar Islands*: Nancowry vill., Car Nicobar; *Arunachal Pradesh*: Chowkham, Wakro, Taliha, Ayumuring; *Meghalaya*: Siju Cave in Garo Hills, Barapani, Cherrapunji in Khasi Hills; *West Bengal*: Sibpur, Calcutta; *Sikkim*: Rimbi; *Uttar Pradesh*: Saharanpur, Dehra Dun, Moghul Serai, Jhusi, Allahabad, Lucknow, Bara Banki, Fatehpur; *Himachal Pradesh*: Deli, Nurpur; *Madhya Pradesh*: Rewa, Nowgong, Jubbulpore; *Rajasthan*: Bayana; *Orissa*: Paradip, Puri, Balugaon, Sundargarh, Sankara village, Jharsuguda, Sambalpur, Bolangir,

Harishankar, Kantabanji, Bhawanipatna, Kesinga, Atabaria, Bargarh, Burla, Kharmunda; *Gujarat*: Datar Hill nr. Junagarh, Baroda, Surat; *Maharashtra*: Bombay, Bassein Road, Poona; *Goa*: Yelle village; *Andhra Pradesh*: Hyderabad; *Karnataka*: Bangalore, Nandi Hills, Londa, Kotegehar, Shimoga, Mercara, Bhagamandala, Somwarpet, Gokak Head Works; *Tamil Nadu*: Coonoor, Nilgiri Hills, Courtallam; *Kerala*: Ernakulum, Trivandrum, Terkumalai, Neyattinkara.

Outside India: Sri Lanka, Pakistan, Bangla Desh, Burma, Malay Peninsula, Vietnam, China, Hainan Island, Indonesia, Philippines, New Caledonia, New Ireland, New Hebrides, Caroline, Marianas, Hawaiian Islands, Palau, Loyalty, Solomon, Easter Islands, ? Rennel Island, New Guinea, Japan, Australia, Camerouns, Congo, Madagascar, Sechelles, Guyana, Mozambique, Nigeria, Southern Rhodesia, Uganda, Angola, South Africa, Cape Verde Island, Comoro Island, Germany, U.S.A., Mexico, Panama, Colombia, French Guiana, Brazil, Argentina, Bolivia, Venezuela, West Indies (Haiti, Jamaica, Dominican Republic, Trinidad).

*Biology* : *D. bolau* has been recorded from a wide variety of habitats: top 5 cm soil with high organic matter ( $\geq 10$  g%), soil around roots of potted plants, green houses, plant nurseries, gardens, river banks, sea shore, drainage ditches, bath tubs, fermenting bark of a tannery, trees, a bundle of 'pan' leaves (*Piper betle*), soils watered with sewage drains, kitchen waste, compost pits, rotten wood, in tree holes, in soil around palm and coconut leaves, thatched roof of a house and caves. Its altitudinal range extends from the plains to an elevation of c. 2200 m.

Activity is usually restricted to 2-3 months from early rainy to post-rainy period in mid-June to mid-September, but may be year round under favourable conditions of adequate moisture. Population in a thatched roof of a house upto 800/m<sup>2</sup> has been recorded. Reproduction is biparental; copulation occurring during heavy rains in July. Cocoons are small, thin-walled, light coloured and oval in shape with distinct ornamentations. Clitellum degenerates during

post-reproductive period. This species undergoes diapause during unfavourable period. Young worms hatch in about 12-18 days of incubation. Casts are deposited on the soil surface in small heaps of tiny globular pellets.

A heterotrichous ciliate, *Plagiotoma dichogasteri*, has been recorded from its body cavity (Mandal and Nair, 1975). Mishra and Dash (1980) report a decomposing enzyme like cellulase from its gut. Regeneration of the lost head and tail parts is possible in this species (Gates, 1972).

*Remarks* : *D. bolau* is a circummundane species which has successfully colonized different habitats in several countries. The original home of the species is believed to be somewhere in West Africa.

### 17. *Dichogaster curgensis* Michaelsen (Figs. 97-99)

1921. *Dichogaster curgensis* Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 54.

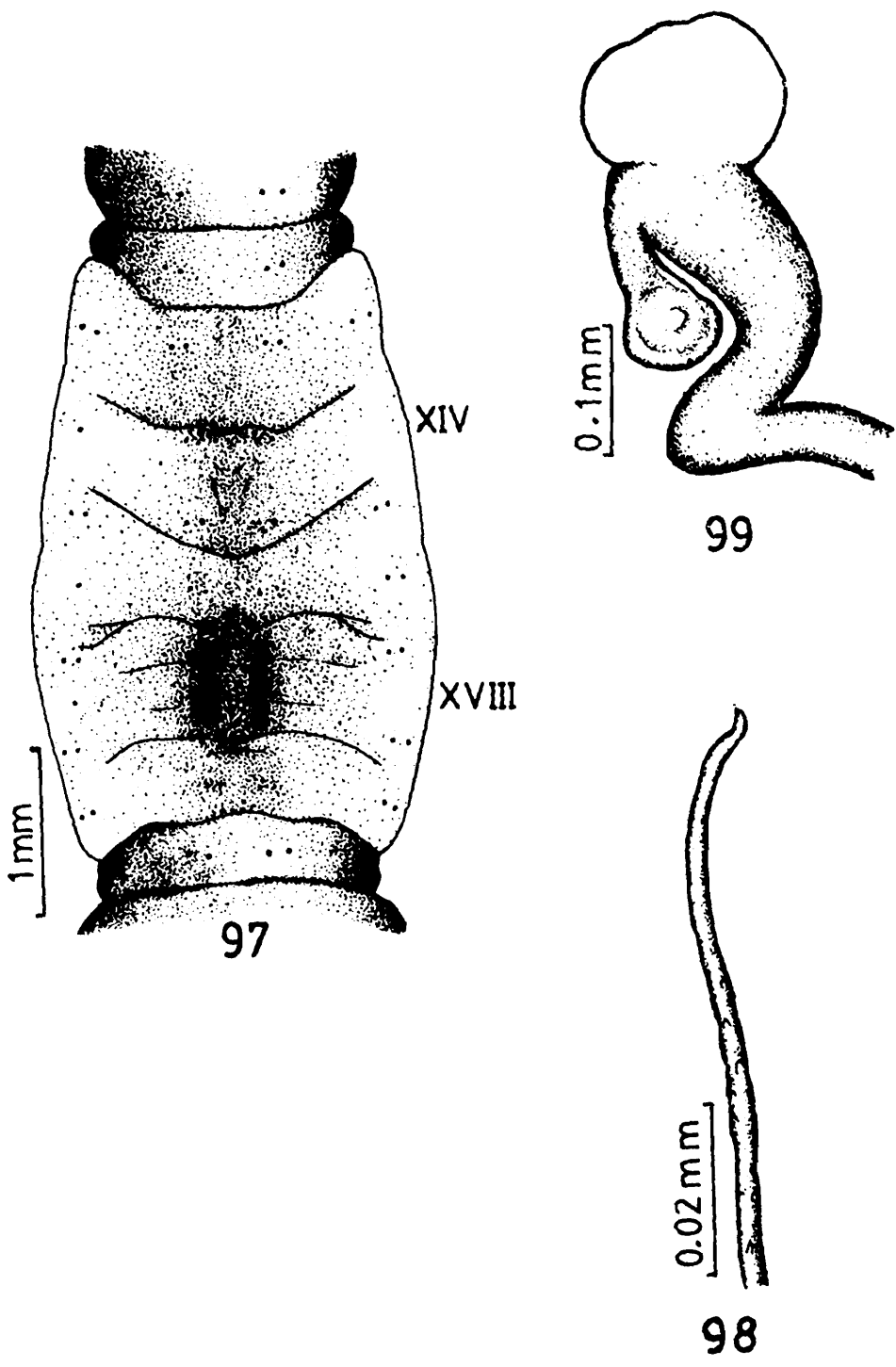
1923. *Dichogaster curgensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 474.

1931. *Dichogaster curgensis* var. *unilocularis* Stephenson, *Proc. zool. Soc. Lond.*, 1931: 69.

1972. *Dichogaster curgensis*, Gates, *Trans. Am. phil. Soc.*, 62: 280.

Length 21-75 mm, diameter 1-2.5 mm, 81-110 segments. Prostomium epilobic, tongue closed. First dorsal pore 5/6, sometimes 4/5. Clitellum xii, xiii-xx. Setae  $aa = 2.3$   $ab = 0.9$   $bc = 2.3$   $cd = 0.09$   $dd$  on xii,  $aa = 2.3$   $ab = 0.6$   $bc = 1.8$   $cd = 0.08$   $dd$  on xxiv. Male pores minute in seminal grooves on the setal arc of xviii, at *a*; prostatic pores minute, at the ends of seminal grooves on xvii and xix, at *a*; seminal grooves almost straight between the setal arcs of xvii and xix. Female pores paired, presetal and slightly within *a* lines. Spermathecal pores at or close to *a*. Genital markings absent.

Septa 4/5, 7/8-12/13 slightly muscular, 5/6 absent, 6/7 delicate. Gizzards between septa 4/5 and 6/7; typhlosole xx to lxxviii-lxxvi. Last pair of hearts in xii. Testes and male funnels free,



FIGS. 97-99. *Dichogaster curgensis* Michaelsen. 97. genital region. 98. penial seta, 99. spermatheca.

in x and xi; seminal vesicles absent or vestigial in xi and xii or in xii only. Prostates 2 pairs, in xvii and xix. Penial setae irregularly sinuous ectally, ornamented with tooth-like projections at ental sides of sinuosities or double series of scars at the proximal border of which is a single tooth, 0.58-1 mm long, 3-6.5  $\mu$  diameter. Each spermatheca with a ventrally directed ental diverticulum, duct sinuous, much longer than ampulla.

*Type locality* : Moonad, Coorg, Karnataka, India.

*Type specimens* : *D. curgensis*: In ZMUH, 9152-3. *D. curgensis* var. *unilocularis*: In BMNH, 1930: 5: 9: 15-6.

*Material examined* : In HAZFS, ZSI, Solan - *Tamil Nadu*: 0-0-2 Yercaud, Shevaroy Hills, 19 Feb 1966, coll. G. Ramakrishna, An 536; 0-0-1 Coonoor, Nilgiri Hills, 14 Sept 1979, coll. J.M. Julka, An 537.

*Distribution* : India: *Karnataka*: Moonad, Bhagamanola (presumably misprinted for Bhagamandla); *Tamil Nadu*: Coonoor, Yercaud.

Outside India: Burma.

*Remarks* : *D. curgensis* obviously is exotic in India and Burma, but it has yet to be recorded from the domain of the genus in tropical Africa and America.

### 18. *Dichogaster modiglianii* (Rosa)

(Figs. 100-102)

1896. *Benhamia modiglianii* Rosa, *Annali Mus. civ. Stor. nat. Giacomo Doria*, 16(36): 510.
1896. *Benhamia papillata* Eisen, *Mem. Calif. Acad. Sci.*, 2(4-5): 135.
1900. *Benhamia papillata hawaiiensis* Eisen, *Proc. Calif. Acad. Sci.*, (3)2: 212.
1900. *Dichogaster papillata*, Michaelsen, *Tierreich*, 10: 341.
1900. *Dichogaster papillata* var. *hawaiiensis*, Michaelsen, *Tierreich*, 10: 342.
1900. *Dichogaster modiglianii*, Michaelsen, *Tierreich*, 10: 346.
1923. *Dichogaster modiglianii*, Stephenson, *Fauna Br. India, Oligochaeta*: 477.

1931. *Dichogaster doveri* Stephenson, *J. Fed. Malay States Mus.*, 16: 276.

1972. *Dichogaster modiglianii*, Gates, *Trans. Am. phil. Soc.*, 62: 280.

1978. *Dichogaster modiglianii*, Righi *et al.*, *Acta Amazonica*, 8(3), suppl. 1: 39.

Length 20-60 mm, diameter 1-2.2 mm, 76-120 segments. Prostomium proepilobic. First dorsal pore 4/5 or 5/6. Clitellum xii-xx. Setae  $aa = 3.5$   $ab = 0.7$   $bc = 2.8$   $cd = 0.08$   $dd$  on xii,  $aa = 5$   $ab = 1.2$   $bc = 5$   $cd = 0.15$   $dd$  on xxiv. Male pores minute, in seminal grooves on the setal arc of xviii, at or close to *a*; prostatic pores minute, at the ends of seminal grooves, on xvii and xix, at *a*; seminal grooves straight or slightly concave between setal arcs of xvii and xix. Female pores paired, slightly median or posteromedian to *a* setae. Spermathecal pores minute, at or close to *a*. Genital markings absent.

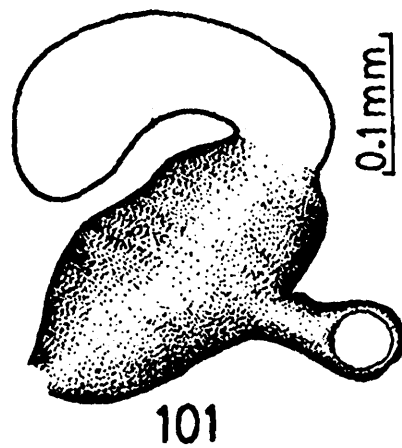
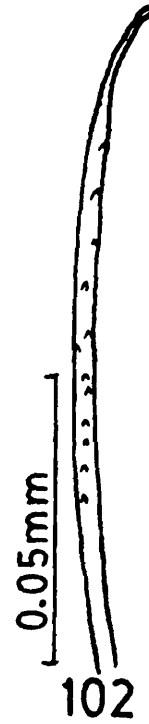
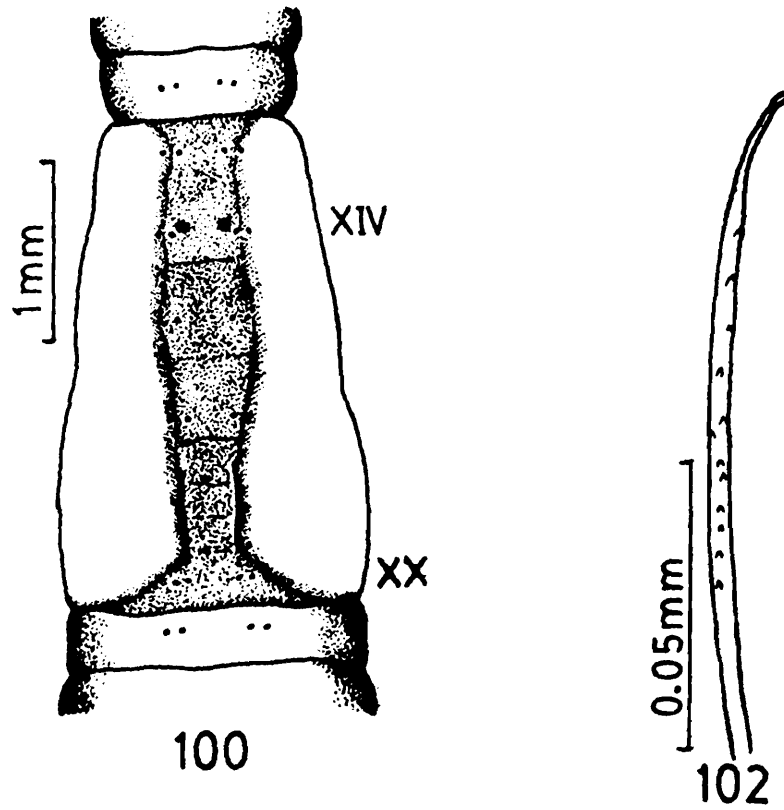
Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 delicate. Gizzards between septa 4/5 and 7/8; typhlosole xxii-xxiii to lxxviii-lxxx. Last pair of hearts in xii. Testes and male funnels in unpaired sacs, that of x ventral and that of xi formed by the peripheral apposition of septa 10/11/12; seminal vesicles vestigial in xii or absent. Prostates 2 pairs, in xvii and xix. Penial setae ornamented with scale-like markings, tip slightly knobbed or truncate or narrowed to a short filament, 0.31-0.42 mm long, 5-9  $\mu$  diameter. Each spermatheca with a shortly, stalked diverticulum at about the middle of barrel-shaped duct, which is longer than ampulla.

*Type locality* : Pedang, Sumatra, Indonesia.

*Type specimens* : *Benhamia modiglianii*: In MGDG, 4405<sup>^</sup>. *Benhamia papillata*: (?). *Benhamia papillata hawaiiensis*: (?). *Dichogaster doveri*: BMNH, 1933: 2: 14: 60-1.

*Material examined* : In HAZFS, ZSI, Solan - Meghalaya: 0-0-1 Tura, 17 July 1977, coll. J.M. Julka, An 538.

*Distribution* : India: *Andaman & Nicobar Islands*: Port Blair, Haddo, Pachargaon; *West Bengal*: Calcutta, Kalimpong; *Meghalaya*: Tura, Garo Hills; *Orissa*: Sundargarh.



FIGS. 100-102. *Dichogaster modiglianii* (Rosa). 100. genital region, 101. spermatheca, 102. penial seta.

Outside India: Pakistan, Burma, Malay Peninsula, Indonesia, Philippines, Pacific Ocean Islands (New Caledonia, New Britain, New Hebrides, Banks Island, Hawaiian Islands), Angola, Colombia, French Guiana, Brazil, Venezuela, ? Ecuador, Mexico.

*Biology* : It has been recorded from soils watered by sewage drains, rich in humus, on banks of water channels, edges of drains, sea shore, flower pots, plant nurseries, gardens, under bark of a rotten tree. Bhatti (1962a) stated that its activity is restricted to March-October at Lahore, Pakistan.

*Remarks* : *D. modiglianii* is also a circummundane species, which has successfully colonized in several countries.

### 19. *Dichogaster saliens* (Beddard)

(Figs. 103-105)

1893. *Microdrilus saliens* Beddard, *Proc. zool. Soc. Lond.*, 1892: 683.  
 1893. *Microdrilus asiaticus* (laps.) Beddard, *Proc. zool. Soc. Lond.*, 1892: 706.  
 1900. *Dichogaster crawi* Eisen, *Proc. Calif. Acad. Sci. (ser. 3)*, 2: 228.  
 1900. *Dichogaster saliens*, Eisen, *Proc. Calif. Acad. Sci. (ser. 3)*, 2: 226.  
 1923. *Dichogaster crawi*, Stephenson, *Fauna Br. India, Oligochaeta*: 474.  
 1923. *Dichogaster saliens*, Stephenson, *Fauna Br. India, Oligochaeta*: 478.  
 1972. *Dichogaster saliens*, Gates, *Trans. Am. phil. Soc.*, 62: 481.  
 1978. *Dichogaster saliens*, Righi *et al.*, *Acta Amazonica*, 8(3), suppl. 1: 39.

Length 17-70 mm, diameter 1.5-2.5 mm, 65-122 segments. Prostomium proepilobic. First dorsal pore 5/6, sometimes 3/4 or 4/5 or 6/7. Clitellum xiii-xix, ½xx. Setae  $aa = 2.5-3.5$   $ab = 0.7$   $bc = 2.5-3.5$   $cd = 0.06-0.09$   $dd$  on xii,  $aa = 3.2-3.7$   $ab = 0.7-0.9$   $bc = 3.2-3.7$   $cd = 0.11-0.16$   $dd$  on xxiv. Male pores minute, at posterior ends of seminal grooves, on or close to 17/18, at *a*; prostatic pores minute, at anterior ends of seminal grooves on the setal arc of xvii, at *a*; seminal grooves almost straight between the setal arc of xvii and 17/18, on protuberances from a transverse diamond-shaped male genital field. Female pores paired, presetal or setal or slightly

posterior to setal arc, within *a* lines. Spermathecal pores minute, at or close to *a*. Genital markings, when present, unpaired, median, on 15/16.

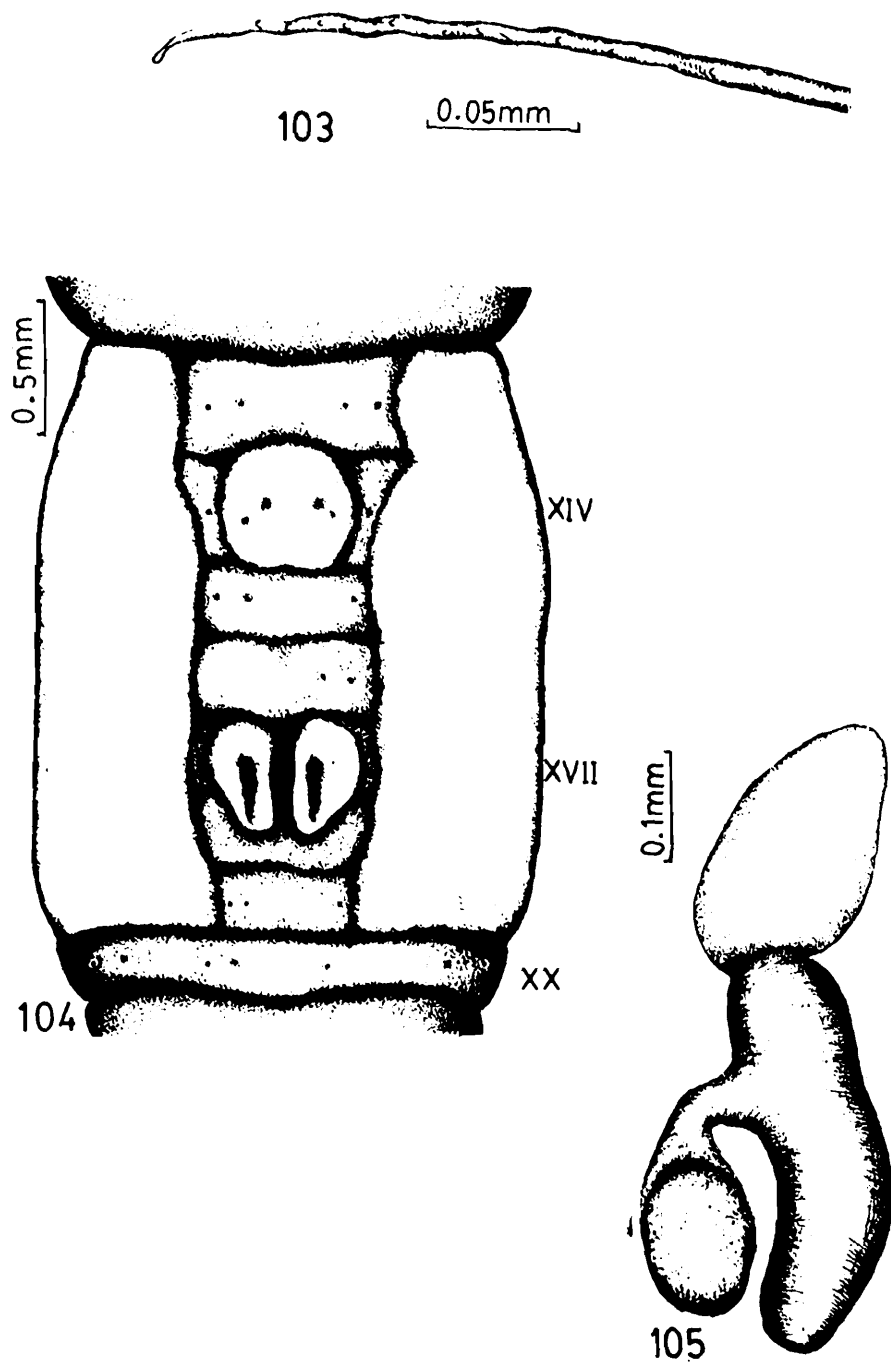
Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 absent. Gizzards between septa 4/5 and 7/8; typhlosome xxii-xxiii to lxxxi-lxxxviii. Last pair of hearts in xii. Testes and male funnels in unpaired sacs formed by the peripheral apposition of septa 9/10/11/12, in x and xi; seminal vesicles vestigial in xi and xii or xii only or absent. Prostates one pair, in xvii. Penial setae sinuous ectally, ornamented with scale-like markings or faint ridges in sinuosities, tip knobbed or pointed, 0.4-0.71 mm long, 6-13  $\mu$  diameter. Each spermatheca with a shortly stalked, ventrally directed diverticulum at about the middle of slightly bulbous duct, which is longer than ampulla. Genital marking glands\* enclosed in thin capsules, concealed beneath the longitudinal muscle layer.

*Type locality* : Undesignated (?). Types supposedly from Penang, Singapore and Java, but were obtained from earth in Wardian cases at the Kew Gardens.

*Type specimens* : *Microdrilus saliens*: In BMNH, 1904: 10: 5: 536-40. *Dichogaster crawi*: Typus amissus.

*Material examined* : In HAZFS, ZSI, Solan - coll. J.M. Julka, *Arunachal Pradesh*, 1969: 0-0-4 Chowkham, 24 Nov, An 543, 0-0-22 Wakro, 4 Dec, An 539; *Meghalaya*, 1977: 0-0-2 Barapani nr. Shillong, 11 July, An 541, 0-0-7 Sumer nr. Shillong, 11 July, An 540, 0-0-1 Tura, 17 July, An 542; *Karnataka*, 1979: 0-0-2 Bhagamandla, Coorg, 10 Sept, An 545. coll. G. Ramakrishna - *Sikkim*, 1962: 0-0-1 Rongli, 40 km S.E. of Gangtok, Rongli-Chu river bed, 29 April, An 547, 0-0-1 Makaibari, 4 km E. of Rongli, An 546.

*Distribution* : India: *Arunachal Pradesh*: Chowkham, Wakro, Taliha; *Meghalaya*: Mawphlang, Barapani, Sumer, Tura; *Sikkim*: Rongli, Makaibari, Rimbi; *West Bengal*: Pashok; *Karnataka*: Bhagamandla.



FIGS. 103-105. *Dichogaster saliens*(Beddard). 103. penial seta, 104. genital region, 105. spermatheca.

Outside India: Sri Lanka, Burma, Malay Peninsula, Java, Christmas Island, Australia, U.S.A., El Salvador, Panama, Brazil, Argentina, Mexico, Uganda, Zaire, Angola, Swaziland, South Africa.

**Biology :** It has been recorded from different kinds of habitats: sandy clay soil, elephant dung, manure, under stones on banks of streams, edges of drains, gardens, around roots of potted plants in green-houses. Reproduction is presumably biparental (Gates, 1972).

**Remarks :** *D. saliens* like other members of the *bolau* group is a circummundane species.

### Genus 8. *Eudichogaster* Michaelsen, 1902

1896. *Benhamia* (in part), Beddard, *Proc. zool. Soc. Lond.*, 1896: 209.  
 1900. *Trigaster* (in part), Michaelsen, *Tierreich*, 10: 330.  
 1902. *Eudichogaster* (in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 19: 13.  
 1923. *Eudichogaster* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 402.  
 1939. *Eudichogaster*, Gates, *Rec. Indian Mus.*, 41: 160.

**Diagnosis :** Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with 2 gizzards, in v-vi and 2 pairs of discrete extramural calciferous glands, in xi-xii; supra-intestinal glands present; typhlosole lamelliform, simple. Micromeronephridia astomate; paired, enteronephric tufts on the body wall in iii; several exonephric on the body wall in iv and posteriad segments, fewer and arranged in longitudinal ranks behind the clitellum. Stomate; paired, exonephric megameronephridia in each of caudal segments.

**Type species :** *Benhamia indica* Beddard, 1896.

**Description :** Setae lumbricine throughout the body. Clitellum annular. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Female pore single and median, presetal, on xiv. Spermathecal

pores paired, on viii and ix or 7/8/9 (?). Genital markings present. Nephridiopores not recognized.

Septa present from 4/5, 5/6/7/8 (at least). muscular. Gizzards 2, in v-vi. Calciferous glands discrete, extramural, ovoidal to retort-shaped, 2 pairs, in xi-xii, opening into oesophagus dorsolaterally close to the attachment of septum 11/12, through short stalks. Intestine begins in xv; caeca absent; supra-intestinal glands present at the posterior end of typhlosole, which is lamelliform and simple. Dorsal vessel single and complete; supra-oesophageal vessel single, in ix-xii; extra-oesophageal vessels paired, entering the calciferous glands in xi; latero-parietal vessels paired, joining the supra-oesophageal vessel in xiii, subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Prostates paired, in xvii and xix, coiled, extending posteriorly to a few segments. Spermathecae paired, in viii and ix. Micromeronephridia astomate; paired, enteronephric tufts on the body wall in iii, several; scattered, exonephric on the body wall in iv and posteriad segments, fewer, arranged in longitudinal ranks in postclitellate segments. Stomate, paired, exonephric megameronephridia in each of caudal segments, funnels close to the nerve cord.

*Distribution* : Western India from Poona to Central India just in Rajasthan and east to Jubbulpore and Nagpur.

*Remarks* : Gates (1939b) restricted the genus *Eudichogaster* to include 6 species, *ashworthi*, *indicus*, *kinneari*, *mullani*, *poonensis* and *prashadi* with supra-intestinal glands, 2 pairs of calciferous glands in xi-xii and acanthodriline condition of the male genitalia, and absence of penial setae. Gates (1960b) considered the location of spermathecal pores and seminal vesicles of taxonomic importance in distinguishing the species of the genus. The descriptions of these characteristics in the original accounts of all the species are suspected to be incorrect as these are based on juvenile or immature specimens. Although 2 species, *ashworthi* and *prashadi* have been redefined with reference to spermathecal pores

and seminal vesicles by Gates (1960b), the following key utilizing these and variable characteristics of genital markings should be considered as provisional.

### Key to the species of *Eudichogaster*

1. Seminal vesicles in ix, x and xii ..... *E. ashworthi*  
     Seminal vesicles absent in x ..... 2
2. Seminal vesicles in ix and xii ..... 3  
     Seminal vesicles in xii ..... 5
3. Paired genital markings on xvi and xx, at *ac* or *bc* ..... 4  
     Paired genital markings on xvi, xx absent ..... *E. mullani*
4. Paired genital markings postsetal on xvi and xx ..... *E. kinneari*  
     Paired genital markings postsetal on xvi and presetal on xx ..... *E. prashadi*
5. Genital markings in a transverse row, in 9/10 and 10/11; paired markings on xvii and xix absent ..... *E. indicus*  
     Genital markings in the region of ix and x absent; paired markings postsetal on xvii, presetal xix ..... *E. poonensis*

### 20. *Eudichogaster ashworthi* Michaelsen

1902. *Eudichogaster ashworthi* Michaelsen, *Jb. hamb. wiss. Anst.*, 19: 14.

1923. *Eudichogaster ashworthi* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 405.

1939. *Eudichogaster ashworthi*, Gates, *Rec. Indian Mus.*, 41: 162.

1939. *Eudichogaster ashworthi* (?), Gates, *Rec. Indian Mus.*, 41: 163.

1960. *Eudichogaster ashworthi* (?), Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 3: 645.

Length 84-210 mm, diameter 4-7 mm, 163-192 (+) segments. Prostomium prolobic. First dorsal pore 12/13. Clitellum ½xiii-xvi. Setae *aa* = 4.3-5 *ab* = 1.3-1.4 *bc* = 2.5-2.6 *cd* = 0.19-0.20 *dd* on xii,

$aa = 6.6$   $ab = 1.5$   $bc = 3.3$   $cd = 0.23$   $dd$  on xxiv,  $a$ ,  $b$  on viii-xxxiv enlarged (absent on xvii-xix). Male genital field with a pair of crescentic longitudinal tumescences, each with a seminal groove, between setal arcs of xvii and xix, slightly lateral to  $b$ . Male pores minute, in seminal grooves, on the setal arc of xviii; prostatic pores minute, at the ends of seminal grooves, on xvii and xix, at  $b$ . Spermathecal pores minute, at  $ab$ , those of viii on setal annulus (equatorial), those of ix on presetal annulus, slightly nearer to  $8/9$  than to the setal arc and within genital markings. Genital markings tiny, circular, greyish trans-lucent areas, in transverse rows of 4-9 on a postsetal area of epidermal tumescence on xvi, at  $bb$ . In addition, similar rows or single markings on some of the following locations: postsetal on xvii, xviii and presetal on xix between seminal grooves, postsetal on ix, xx at  $aa$ , presetal and postsetal on viii at  $ab$ , presetal on ix at  $ab$ , postsetal on ix at  $ab$  or  $bc$ , presetal and postsetal on xx in median half of  $bc$ ; single and paired markings, postsetal on viii, xix at  $aa$ , setal on xvi at lateral to  $bc$ , setal annulus on xviii, xix between seminal grooves, presetal on xx at median half of  $bc$ ; single and unpaired markings, postsetal or setal on ix, presetal and postsetal on x, at  $aa$ .

Supra-intestinal glands 8 pairs, in lxxviii-lxxxvii to lxxxv-xciv. Testes and male funnels in x and xi, male funnels all of same size; seminal vesicles in ix, x and xii. Each spermatheca with a flat, disc-like, vertically placed ental diverticulum. Enlarged setae  $a$ ,  $b$  on viii-xxxiv ornamented with short transversely placed ridges or rows of very fine thorn-like teeth, 0.20-0.47 mm long. Genital marking glands absent.

*Type locality* : Nagpur, Maharashtra, India.

*Type specimens* : In MNHU, 5202; BMNH, 1912: 11: 8: 112.

*Material examined* : 2-4-0 Betul, 28 June 1949, coll. B.S. Chauhan & G. Ramakrishna, An 723, HAZFS, ZSI, Solan.

*Distribution* : India: Maharashtra: Nagpur; Madhya Pradesh: Betul.

*Remarks* : Gates (1939b) pointed out that Michaelsen's (1902) original account of the species was inadequate and erroneous in some respects. After an examination of 4 specimens in the Indian Museum from the same batch that formed the types of the species, he observed that they were distinguishable from the types of *ashworthi* (as known from Michaelsen's original description) in the location of spermathecal pores, genital markings and seminal vesicles. Gates (1960b) also examined another specimen (syntype ?) from the part of the type material in the British Museum, and he found it morphological similar with those in the Indian Museum. Since the types of the species in the Hamburg Museum could not be examined by Gates, a new species for the specimens in the Indian and British Museums was not erected. Pending further information on the types in the Hamburg Museum, the species is defined in this work as characterized by Gates (1939b, 1960b).

## 21. *Eudichogaster indicus* (Beddard)

1896. *Benhamia indica* Beddard, *Proc. zool. Soc. Lond.*, **1896**: 209.

1900. *Trigaster indica*, Michaelsen, *Tierreich*, **10**: 333.

1902. *Eudichogaster indica*, Michaelsen, *Jb. hamb. wiss. Anst.*, **19**: 13.

1923. *Eudichogaster indicus*, Stephenson, *Fauna Br. India, Oligochaeta*: 414.

1939. *Eudichogaster indicus*, Gates, *Rec. Indian Mus.*, **41**: 170.

Length 75-100 mm, diameter *c.* 4 mm. Segments, prostomium and first dorsal pore (?). Clitellum xiii-xvi. Setae *ab* closely paired, *cd* = 2.5 *ab*, *a*, *b* on ix copulatory being surrounded by epidermal tumescences. Male genital field tumescent, xvii-xix, with a transverse oval depression on xviii. Male pores in seminal grooves (?), on xviii; prostatic pores at the ends of seminal grooves (?), on xvii and xix, at *a*, each pair connected across the middle line by a transverse groove. Spermathecal pores probably on viii and ix. Genital markings tiny, circular, in a transverse row, on 9/10, 10/11, at *aa*.

Supra-intestinal glands (?). Metandric, but with small funnels in x; seminal vesicles in xii. Spermathecae paired, in viii and ix, each with an inconspicuous, apparently tri- or quadrifid ectal diverticulum. Copulatory setae on ix ornamented with semicircular ridges.

*Type locality* : Thana, near Bombay, Maharashtra, India.

*Type specimens* : Presumably lost.

*Distribution* : So far known from the type locality.

*Remarks* : The above characterization of the species is inadequate and perhaps incorrect in certain aspects. The metandric condition of the testes requires confirmation. The species is to be treated as dubius until clitellate specimens from the type locality are studied.

## 22. *Eudichogaster kinneari* Stephenson

1920. *Eudichogaster kinneari* Stephenson, *Mem. Indian Mus.*, 7: 255.

1923. *Eudichogaster ashworthi* var. *kinneari*, Stephenson, *Fauna Br. India, Oligochaeta*: 407.

1939. *Eudichogaster kinneari*, Gates, *Rec. Indian Mus.*, 41: 171.

Length 80 mm, diameter 5 mm, 120 segments. Prostomium prolobic. First dorsal pore 12/13. Clitellum xiii-xvi. Setae *aa* = 3-4 *ab* = 1-2 *bc* = 2.2-3 *cd* posterior to the clitellum, *a*, *b* (at least) copulatory, on viii and ix, being surrounded by epidermal tumescences. Male genital field H-shaped, on xvii-xix. Male pores in seminal grooves (?), on xviii, at about *b*; prostatic pores on papillae in corners of H-shaped depression, at the ends of laterally biconvex seminal grooves, at about *b*. Spermathecae presetal, at the centres of low, square papillae, on the setal annuli of viii and ix, at *a*. Genital markings paired, oval, postsetal, on xvi and xx, at *ac*; unpaired and median, circular, on xvi, xx, presetal on x-xii; one or two in lateral portion of *bd* on viii and ix.

Supra-intestinal glands (?). Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Each spermatheca

with a shortly stalked, acinous, multiloculate ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with longitudinal rows of excavations, tip claw-shaped, 0.73-0.83 mm long, 25  $\mu$  diameter.

*Type locality* : Nasik, c. 128 km from Bombay, Maharashtra, India.

*Type specimens* : In BMNH, 1933: 5: 25: 341-3.

*Distribution* : So far known from the type locality.

*Remarks* : *E. kinneari*, at present, is distinguished from *E. prashadi* by the postsetal location of paired genital markings on xx, which in the latter are presetal. Since individual variations in the position of genital markings in *kinneari* are not known, its distribution from *prashadi* is considered doubtful.

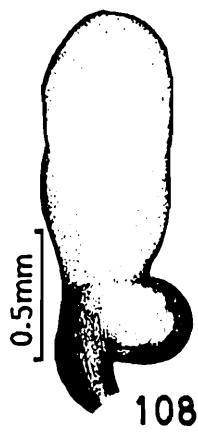
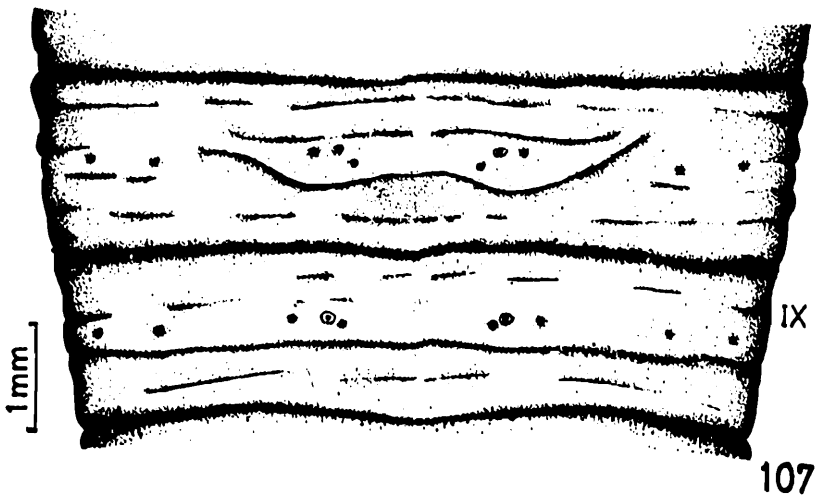
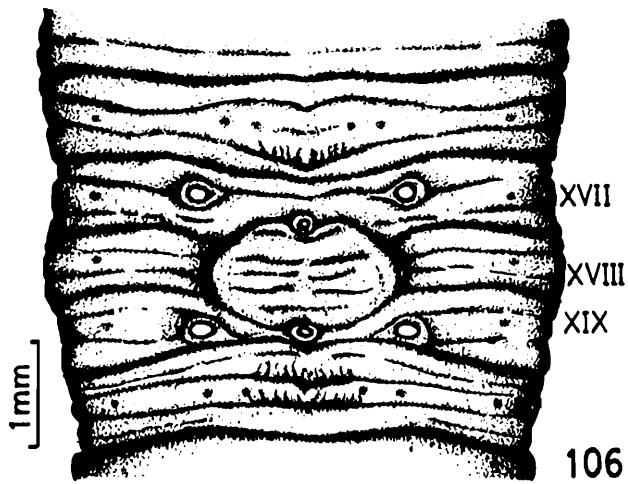
### 23. *Eudichogaster mullani* Stephenson (Figs. 106-108)

1922. *Eudichogaster mullani* Stephenson, *Rec. Indian Mus.*, 24: 438.

1923. *Eudichogaster mullani*, Stephenson, *Fauna Br. India, Oligochaeta*: 414.

1939. *Eudichogaster mullani*, Gates, *Rec. Indian Mus.*, 41: 173.

Length 134 mm, diameter 6 mm, 200 segments. Prostomium prolobic. First dorsal pore 11/12 or 12/13. Clitellum (?). Setae  $aa = 4.2$   $ab = 1.1$   $bc = 2.1$   $cd = 0.14$   $dd$  on xii,  $aa = 5$   $ab = 1.4$   $bc = 2.3$   $cd = 0.15$   $dd$  on xxiv,  $a$ ,  $b$  on viii copulatory, being surrounded by slight epidermal tumescences. Male genital field indistinct. Male pores minute, in seminal grooves, on xviii, at  $b$ ; prostatic pores minute, at the ends of laterally convex seminal grooves, on xvii and xix, slightly median to  $b$ . Spermathecal pores minute, on or slightly anterior to the setal arcs of viii and ix, slightly lateral to  $a$ . Genital markings circular, unpaired and median, postsetal on xvii and xix; paired, presetal on xvii, postsetal on xix, just lateral to seminal grooves.



FIGS. 106-108. *Eudichogaster mullani* Stephenson. 106. genital region, 107. spermathecal pore region, 108. spermatheca (all drawn from a syntype).

Supra-intestinal glands 10 pairs, in xc-xcix. Holandric, testes and male funnels free in x and xi; seminal vesicles in ix and xii, x (?).

Each spermatheca with a small, wart-like ental diverticulum, duct much shorter than ampulla. Copulatory setae unornamented, tip bluntly pointed, 0.7 mm or (+) long, 16  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Bombay, Maharashtra, India.

*Type specimens* : In ZSIC, W 705/1, BMNH, 1933: 2: 25: 1383-4.

*Distribution* : So far known from the type locality.

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

1898. *Benhamia poonensis* Fedarb, *J. Bombay nat. Hist. Soc.*, 11: 434.

1900. *Trigaster poonensis*, Michaelsen, *Tierreich*, 10: 333.

1902. *Eudichogaster poonensis*, Michaelsen, *Jb. hamb. wiss. Anst.*, 19: 13.

1923. *Eudichogaster poonensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 416.

1939. *Eudichogaster poonensis*, Gates, *Rec. Indian Mus.*, 41: 176.

Length 134 mm, diameter 3 mm, 157 segments. Prostomium, first dorsal pore and clitellum (?). Setae *bc* rather less than *aa*, *cd* = 1.33 *ab*. Male genital field, male pores, seminal grooves (?); prostatic pores paired, on tiny, conical porophores (?), on xvii and xix, at *ab*. Spermathecal pores on 7/8/9 (?). Genital markings small, paired, postsetal on xvii, presetal on xix including setae *a*, *b* on xx.

Supra-intestinal glands (?). Metandric; seminal vesicles in xii. Spermathecae paired in viii and ix, each with a multiloculate ental diverticulum, duct as long as ampulla, relatively very thin and sinuous near its ectal end. Copulatory setae ornamented with a small number of relatively stout spines, 3-4 times as long as ordinary setae.

*Type locality* : Poona, Maharashtra, India.

*Type specimens* : ?

*Distribution* : So far known from the type locality.

*Remarks* : The original description of the species is inadequate and perhaps partly incorrect. The metandric condition of the testes and location of spermathecal pores in 7/8/9 need confirmation. The species is regarded as dubius until more specimens from the type locality are studied.

## 25. *Eudichogaster prashadi* Stephenson

(Figs. 109-112)

1920. *Eudichogaster ashworthi* (in part), Stephenson, *Mem. Indian Mus.*, 7: 246.

1920. *Eudichogaster prashadi* Stephenson, *Mem. Indian Mus.*, 7: 250.

1923. *Eudichogaster ashworthi* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 405.

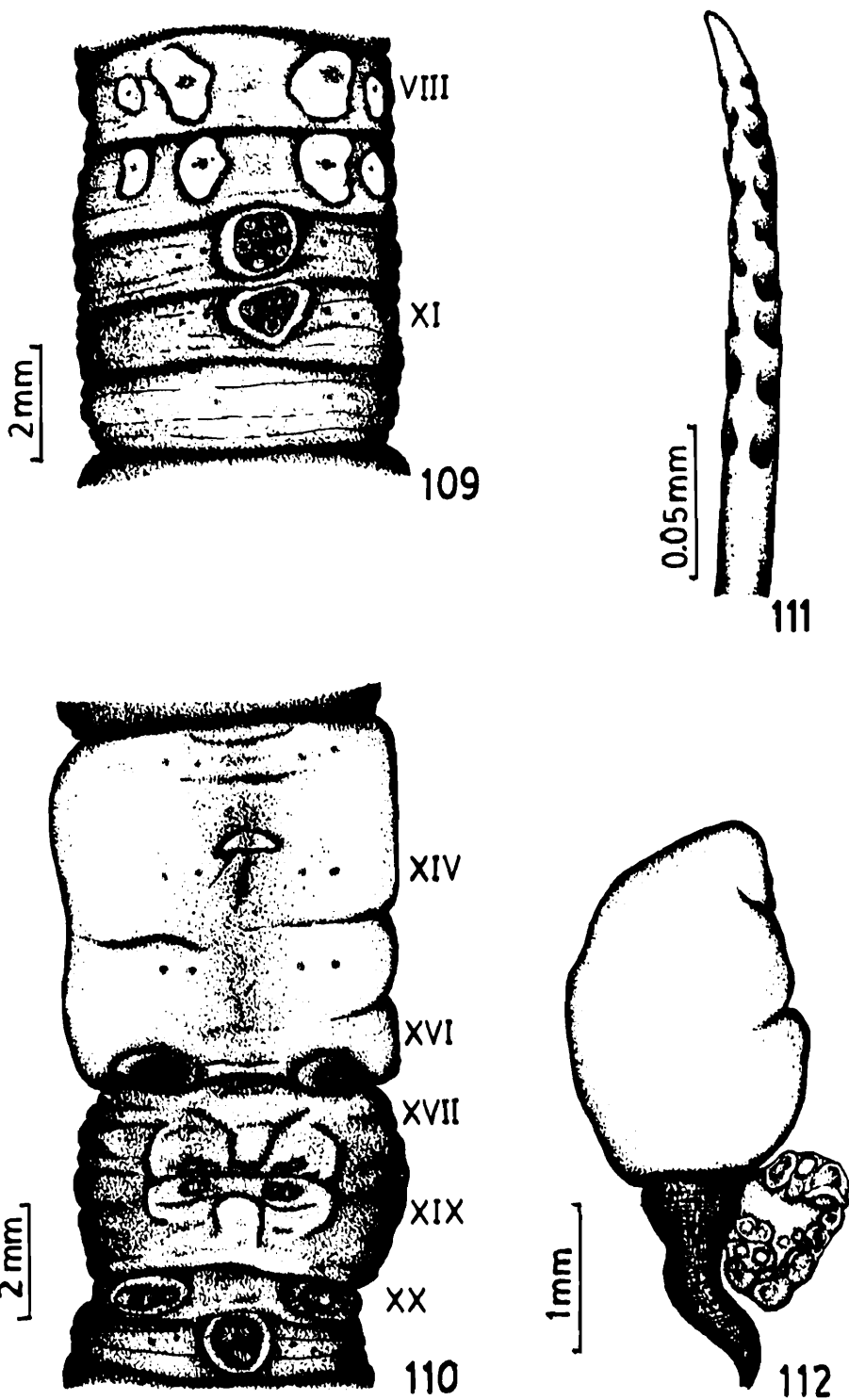
1923. *Eudichogaster prashadi*, Stephenson, *Fauna Br. India, Oligochaeta*: 416.

1939. *Eudichogaster kinneari*?, Gates, *Rec. Indian Mus.*, 41: 172.

1939. *Eudichogaster* sp., Gates, *Rec. Indian Mus.*, 41: 177, 179, 182.

1960. *Eudichogaster prashadi*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 3: 647.

Length 35, 60-145 mm, diameter 3, 4-7 mm, 140-190 segments. Prostomium prolobic. First dorsal pore 12/13. Clitellum xiii-xvi, xvii. Setae  $aa = 3.3-3.7$   $ab = 1.4-1.8$   $bc = 2.5-2.6$   $cd = 0.22-0.23$   $dd$  on xii,  $aa = 4.3-5.3$   $ab = 1.5-1.6$   $bc = 2.5-3.5$   $cd = 0.22$   $dd$  on xxiv, usually  $a$ ,  $b$  on viii and ix, sometimes  $c$  on ix copulatory, being surrounded by epidermal tumescences. Male genital field tumescent without special demarcation, on xvii-xix, with or without a deep slit-like depression along eq/xviii, and with a deep longitudinal depression on xvii and xix. Male pores minute, in seminal grooves, on the setal arc of xviii, at  $ab$ ; prostatic pores minute, at the ends of seminal grooves, on xvii and xix, at  $ab$ ; seminal grooves biconcave, wide and shallow or narrow and deep. Spermathecal pores minute, on the setal arcs of viii and ix, at  $ab$ . Genital markings circular to



FIGS. 109-112. *Eudichogaster prashadi* Stephenson. 109. spermathecal pore region, 110. genital region, 111. copulatory seta, 112. spermatheca.

oval, with 1-9 small circular translucent areas that are irregularly distributed or in transverse rows. They are located as follows: unpaired and median, at *aa*, primarily presetal on ix, x, xi, xxi and some of posteriad segments, primarily postsetal on xiv, xv, xvi; paired, extending from *a* or *b* well into *bc*, primarily postsetal on xvi, primarily presetal on xx.

Supra-intestinal glands 7-9 pairs, in lxxvi-lxxxix. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii, pseudovesicles in xiii-xiv. Each spermatheca with a flat, disc-like, multiloculate ental diverticulum, duct about as long as or slightly shorter than ampulla. Copulatory setae ornamented with several longitudinal rows of excavations, tip claw-shaped, 0.47-0.74 mm long, 16-19  $\mu$  diameter.

*Type locality* : Palia, between Indore and Ujjain, Madhya Pradesh, India.

*Type specimens* : In ZSIC, W 282/1; BMNH, 1925: 5: 12: 100-2.

*Material examined* : In HAZFS, ZSI, Solan: 0-6-0 Betul, 28 June 1949, coll. B.S. Chauhan & G. Ramakrishna, An 719; 0-0-23 Poona, 23 Aug 1979, coll. J.M. Julka, An 721-722; 0-0-1 Poona, 31 July 1969, coll. R.N. Chopra, An 720.

*Distribution* : India: *Madhya Pradesh*: Palia, Teor, Indore, Mhow Cantt., Khandwa, Bheraghat, Safraha, Baraila, Saugar, Gaurighat, Choral (?), Bina (?), Betul; *Rajasthan*: Partabgarh (?); *Gujarat*: Surat, Amravati; *Maharashtra*: Poona, Wahi.

*Remarks* : There are several clitellate specimens, labelled as *Eudichogaster barailanus* Gates, W 3653/1, in the Zoological Survey of India, Calcutta. These were collected by Prof. G.E. Gates from Jubbalpore. A perusal of the literature shows that the description of this species has not been published, and it is to be regarded as a museum species. However, an examination of the specimens reveals that they belong to *prashadi*.

### Genus 9. *Eutyphoeus* Michaelsen, 1900

1883. *Typhoeus* Beddard, *Ann. Mag. nat. Hist. (ser. 5)*, 12: 219 (non Leach, 1815, *Brewster's Edin. Encycy.*, 9(1): 97).
1888. *Typhaeus*, Beddard, *Q. Jl microsc. Sci.*, 28: 403.
1900. *Eutyphoeus* Michaelsen, *Tierreich*, 10: 322.
1923. *Eutyphoeus*, Stephenson, *Fauna Br. India, Oligochaeta*: 420.
1938. *Eutyphoeus*, Gates, *Rec. Indian Mus.*, 40: 60.
1972. *Eutyphoeus*, Gates, *Trans. Am. phil. Soc.*, 62: 281.

**Diagnosis** : Lumbricine. Male pores paired, just posterior to prostatic pores, on xvii; seminal grooves absent. Oesophagus with a single gizzard between septa 5/6 and 8/9, and one pair of discrete intramural calciferous glands in xii; supra-intestinal glands present; typhlosole lamelliform, simple. Micromeronephridia astomate; 4-5 pairs of enteronephric tufts in iii; numerous exonephric on the body wall in v and posteriad segments. Paired, stomate, exonephric megameronephridia in each of segments behind supra-intestinal glands region.

**Type species** : *Typhoeus orientalis* Beddard, 1883.

**Description** : Setae lumbricine throughout the body. Clitellum annular. Prostatic and male pores paired near the setal arc of xvii, discharging within vestibula or directly into the body surface; male pores near but slightly posterior to the prostatic pores. Female pores minute, paired, presetal on xiv, sometimes the pore of the right side rudimentary or absent. Spermathecal pores large, paired, in 7/8. Genital markings usually present. Nephridiopores not recognized.

Septa 4/5/6, 8/9-10/11 muscular, 6/7/8 absent. A single large oesophageal gizzard between septa 5/6 and 8/9. Discrete calciferous glands one pair, intramural, longitudinally hemiellipsoid with flat faces mesially, in xii, each gland with numerous vertical lamellae, the interlamellar spaces communicating dorsally with the oesophageal lumen. Intestine begins in xv; typhlosole lamelliform, ending posteriorly with a short series of supra-intestinal

glands; unpaired, anteriorly directed, midventral intestinal caeca anterior to supra-intestinal glands present; paired, lateral intestinal caeca sometimes present. Dorsal vessel single, complete or aborted anteriorly; supra-oesophageal vessel single, x-xiii; extra-oesophageal and latero-parietal vessels paired, passing to anterior and posterior ends of calciferous glands respectively; subneural vessel absent; lateral hearts with connectives to the dorsal and supra-oesophageal vessels in xi-xiii, last pair of hearts in xiii. Prostates paired; vas deferens enlarged ectally into bulbus ejaculatrice. Spermathecae paired, diverticulate. Ovisacs absent. Micromeronephridia astomate, 4-5 pairs of enteronephric tufts in iii, numerous, biramous and y-shaped, exonephric on the body wall in v and posterior segments; paired stomate, exonephric, megameronephridia in each segment posterior to the supra-intestinal glands, funnels close to the nerve cord.

*Distribution* : India (from Burma border into the Gangetic plain and west through the Himalayas, and Orissa), Burma, Bangla Desh, Nepal, Pakistan.

### Key to the species of *Eutyphoeus*

1. Holandric; seminal vesicles in ix and xii..... 2  
     Metandric; seminal vesicles in xii..... 5
2. Spermathecal pores at *ab* ..... 3  
     Spermathecal pores at *bc* ..... 4
3. Spermathecae unidiverticulate; seminal vesicles in xii extend posteriorly at most into xiv; lateral intestinal caeca present ..... *E. manipurensis manipurensis*  
     Spermathecae polydiverticulate; seminal vesicles in xii very long, extending posteriorly at least into xxiv-xxx; lateral intestinal caeca absent ..... *E. quadripapillatus*
4. Spermathecae bidiverticulate..... *E. annandalei*  
     Spermathecae polydiverticulate ..... *E. incommodus*

5. Avestibulate .....	6
Vestibulate .....	15
6. Spermathecae bidiverticulate.....	7
Spermathecae polydiverticulate .....	13
7. Lateral intestinal caeca present .....	8
Lateral intestinal caeca absent .....	10
8. Lateral intestinal caeca in xxiv.....	<i>E. lippus</i>
Lateral intestinal caeca in xxviii .....	9
9. Female pores paired; genital markings paired ...	<i>E. turaensis</i>
Female pore single, on the left side; genital markings paired and unpaired.....	<i>E. gigas</i>
10. Spermathecal pores at <i>ab</i> .....	11
Spermathecal pores lateral to <i>b</i> .....	12
11. Genital markings preclitellar, segmental .....	<i>E. comillahnus</i>
Genital markings postclitellar, intersegmental ...	<i>E. festivus</i>
12. Genital markings paired, segmental on xvi .....	<i>E. assamensis*</i>
Genital markings unpaired, intersegmental on 15/16 .....	<i>E. scutarius</i>
13. Seminal vesicles in xii very long, extending posteriorly into xxxiii .....	<i>E. pharppingianus</i>
Seminal vesicles in xii shorter, at the most extending into xx .....	14
14. Genital markings intraclitellar, on xvi .....	<i>E. nainianus</i>
Genital markings intra- and post-clitellar, on xiv-xv, 18/19-21/22 .....	<i>E. nepalensis</i>
15. Univestibulate .....	16
Bivestibulate .....	17
16. Spermathecal pores at <i>ab</i> ; penes conical .....	<i>E. kherai</i>
Spermathecal pores at median half of <i>bc</i> ; penes annular .....	<i>E. gammiei</i>
17. Penes present .....	18
Penes absent.....	<i>E. assamensis*</i>

- |   |                      |
|---|----------------------|
| 18. Penes annular .....   | 19                   |
| Penes elongate .....  | 21                   |
| 19. Genital markings present on xv, usually also on<br>xvi .....                            | <i>E. orientalis</i> |
| Genital markings on xv-xvi absent .....   | 20                   |
| 20. Genital markings preclitellar, on 9/10 .....  | <i>E. aborianus</i>  |
| Genital markings pre- and post- clitellar, on<br>10/11-12/13, 18/19-21/22 .....             | <i>E. callosus</i>   |
| 21. Spermathecal pores at <i>ab</i> .....   | <i>E. nicholsoni</i> |
| Spermathecal pores at <i>bc</i> .....   | 22                   |
| 22. Spermathecae bidiverticulate; genital markings<br>pre-, intra- and post clitellar ..... | <i>E. waltoni</i>    |
| Spermathecae polydiverticulate; genital<br>markings post-clitellar or absent .....          | <i>E. kempii</i>     |
- 

\*The description of *E. assamensis* is based on immature types, possibly of two species (Gates, 1938a, 1972), and characterization of the vestibular region is still uncertain. In order to include *assamensis* in the key, it is grouped with both avestibulate and vestibulate species until clitellate specimens are studied from the type locality.

## 26. *Eutyphoeus aborianus* Stephenson

1914. *Eutyphoeus aborianus* Stephenson, *Rec. Indian Mus.*, 8: 406.

1923. *Eutyphoeus aborianus*, Stephenson, *Fauna Br. India, Oligochaeta*: 428.

1972. *Eutyphoeus aborianus*, Gates, *Trans. Am. phil. Soc.*, 62: 286.

Length 210 mm, diameter 6 mm. First dorsal pore 11/12 (?). Clitellum 2/3 xiii-xvii. Setae *aa* = 1.3 *ab* = 0.9 *bc* = 1.3 *cd* = 0.09 *dd* on xii, *aa* = 3.1 *ab* = 1.5 *bc* = 2*cd* = 0.12 *dd* on xxi. Male pores discharge into small paired vestibula (bivestibulate) opening onto the surface through large apertures with centres at *b*, penes annular. Female pore single, on the left side, slightly anterior to *a*. Spermathecal pores transverse slits, just lateral to *b*. Genital markings paired, on 9/10, at *ab*.

Lateral intestinal caeca absent; median ventral intestinal caeca and supra-intestinal glands (?). Dorsal vessel aborted anterior to vii (?). Metandric, testis sac ventral, seminal vesicles in xii extending posteriorly to xiv. Penial setae, sparsely ornamented with short transverse rows of fine spines, tip slightly S-shaped, 3.3 mm long, 32  $\mu$  diameter. Each spermatheca with a median and a lateral ental diverticula which are directed posteriorly and bound together by a connective tissue, duct very short. Genital marking glands absent.

*Type locality* : Kobo, Abor Hills, Arunachal Pradesh, India.

*Type specimens* : In ZSCI, ZEV 6068/7.

*Material examined* : 0-0-1, holotype, in ZSIC, ZEV 6068/7.

*Distribution* : So far known from the type locality.

*Remarks* : Stephenson (1923) discussed close relationship of *E. aborianus* with *E. gammiei* (Beddard), but stated that these might be united after further studies. Gates (1938a, 1972) treated *E. aborianus* as a distinct species, clearly distinguishing it from *E. gammiei* (Beddard), *E. orientalis* (Beddard) and *E. callosus* Gates on the basis of the shape of vestibulum and location of genital markings. The holotype of *E. aborianus* in National Zoological Collections, Zoological Survey of India, Calcutta is in a poor state of preservation and the intestine is ruptured, and the location of supra-intestinal glands, intestinal caeca and typhlosole cannot be ascertained. The exact status of this inadequately described species can only be determined when more material from the type locality is available for study.

## 27. *Eutyphoeus annandalei* Michaelsen

1907. *Eutyphoeus annandalei* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 174.

1923. *Eutyphoeus annandalei*, Stephenson, *Fauna Br. India, Oligochaeta*: 430.

1938. *Eutyphoeus annandalei*, Gates, *Rec. Indian Mus.*, 40: 64.

Length 65 mm, diameter 1.7-2.3 mm, 91 segments. Prostomium indistinctly tanylobic. First dorsal pore (?). Clitellum xiii-xvii. Setae

$aa = 2$   $ab = 0.8$   $bc = 1.3$   $cd$  on postclitellate segments. Avestibulate, male pores on paired, oval porophores, each pore in a transverse fissure, at or near  $a$ , penes absent (?). Female pores paired, slightly within  $aa$ , anterior to the setal ring. Spermathecal pores transverse slits, at lateral portion of  $bc$ . Genital markings paired at  $ab$ , on 13/14 and 14/15.

Dorsal vessel complete (?) with lateral commissures in v and vi (?). Holandric, testis sacs (?), seminal vesicles in ix and xii, those of xii extending posteriorly to xviii. Penial setae, length (?),  $c. 20 \mu$  diameter. Each spermatheca with a median and a lateral ental diverticula, duct short. Genital marking glands (?).

*Type locality* : Bhim Tal, Kumaon Hills, Uttar Pradesh, India.

*Type specimens* : In ZMUH, 3040.

*Distribution* : So far known from the type locality.

*Remarks* : The original description of this species provides no information about several important taxonomic characteristics viz., vestibulum, penes, intestinal caeca, supra-intestinal glands, dorsal vessel, testis sacs, etc. Its relationship with other species can only be determined after studying more material from the type locality.

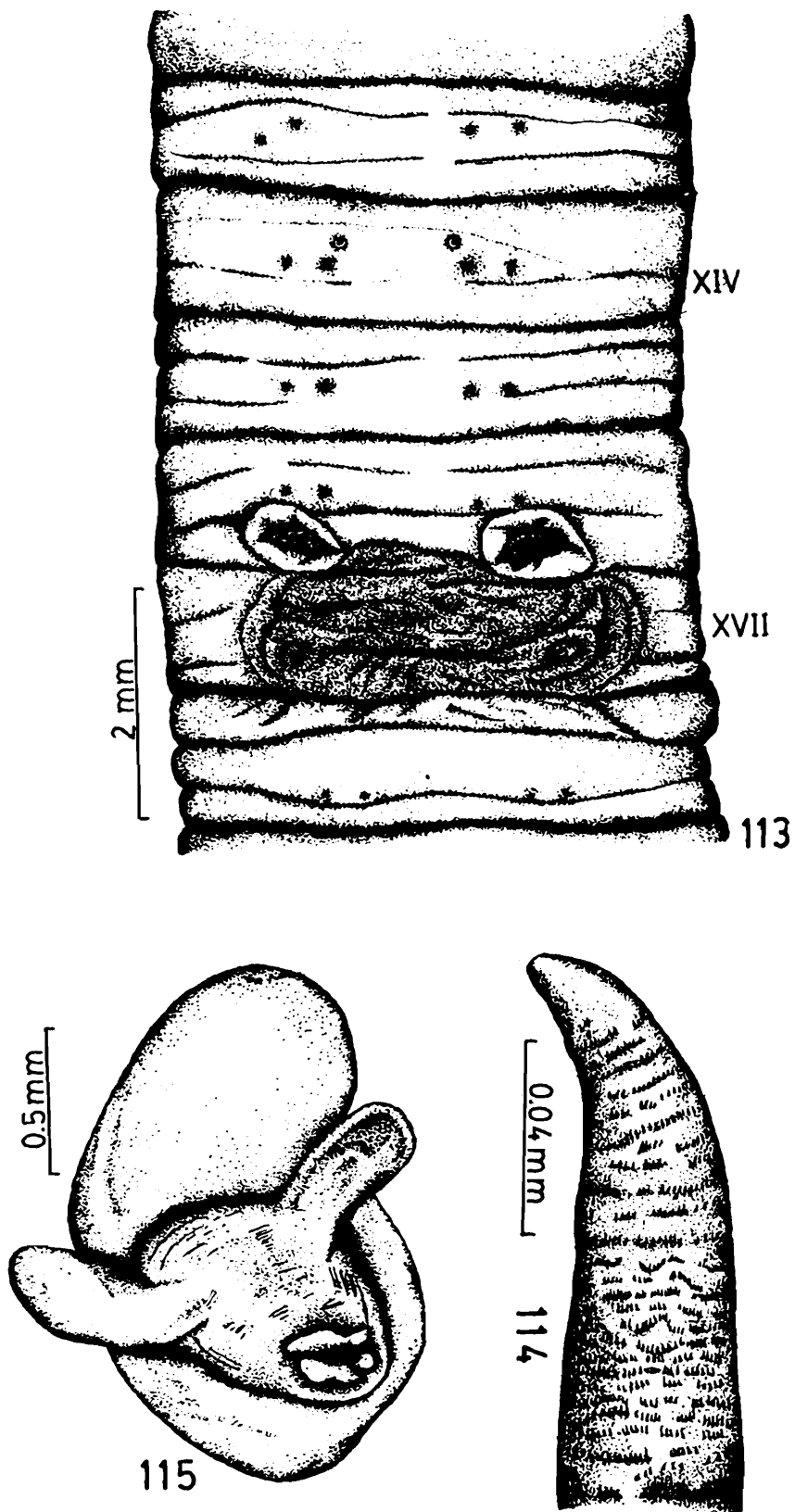
## 28. *Eutyphoeus assamensis* Stephenson

(Figs. 113-115)

1926. *Eutyphoeus assamensis* Stephenson, *Rec. Indian Mus.*, **28**: 262.

1972. *Eutyphoeus assamensis*, Gates, *Trans. Am. phil. Soc.*, **62**: 288.

Length 185-245 mm, diameter 4 mm, 255 segments. Prostomium pro/analytic. First dorsal pore 11/12. Clitellum  $\frac{1}{2}$ xiii-xvii. Setae  $aa = 3$   $ab = 0.9$   $bc = 1.5$   $cd = 0.17$   $dd$  on xii,  $aa = 4.7$   $ab = 1.1$   $bc = 2.4$   $cd = 0.18$   $dd$  on xxiv. Avestibulate (?) or bivestibulate but apenile (?), male pores (?). Female pores paired, presetal, within  $a$  lines. Spermathecal pores small, transverse slits, at or just lateral to  $b$ . Genital markings paired, postsetal on xvi, at  $ab$ .



FIGS. 113-115. *Eutyphoeus assamensis* Stephenson. 113. genital region, 114. penial seta, 115. spermatheca (all drawn from a syntype).

Lateral intestinal caeca absent, median ventral intestinal caeca 10-11 in xxxvi-xlvi, supra-intestinal glands 4-6 pairs in ciii-cxii, typhlosole begins in xxvii. Dorsal vessel extends anterior to gizzard, at least to 4/5. Metandric, testis sac annular, seminal vesicles in xii. Penial setae ornamented with irregular circles of fine spines, tip bluntly rounded or with a bluntly rounded terminal spine, 2 mm long, 40  $\mu$  diameter. Each spermatheca with a median and a lateral ental diverticula, duct more than 1 mm long. Genital marking glands absent.

*Type locality* : Katlicherra, S. Cachar, Assam, India.

*Type specimens* : In ZSIC, W 1951/1; BMNH, 1933: 2: 23: 510-1.

*Material examined* : 0-17-0, syntypes, W 1951/1, in ZSIC.

*Distribution* : So far known from the type locality.

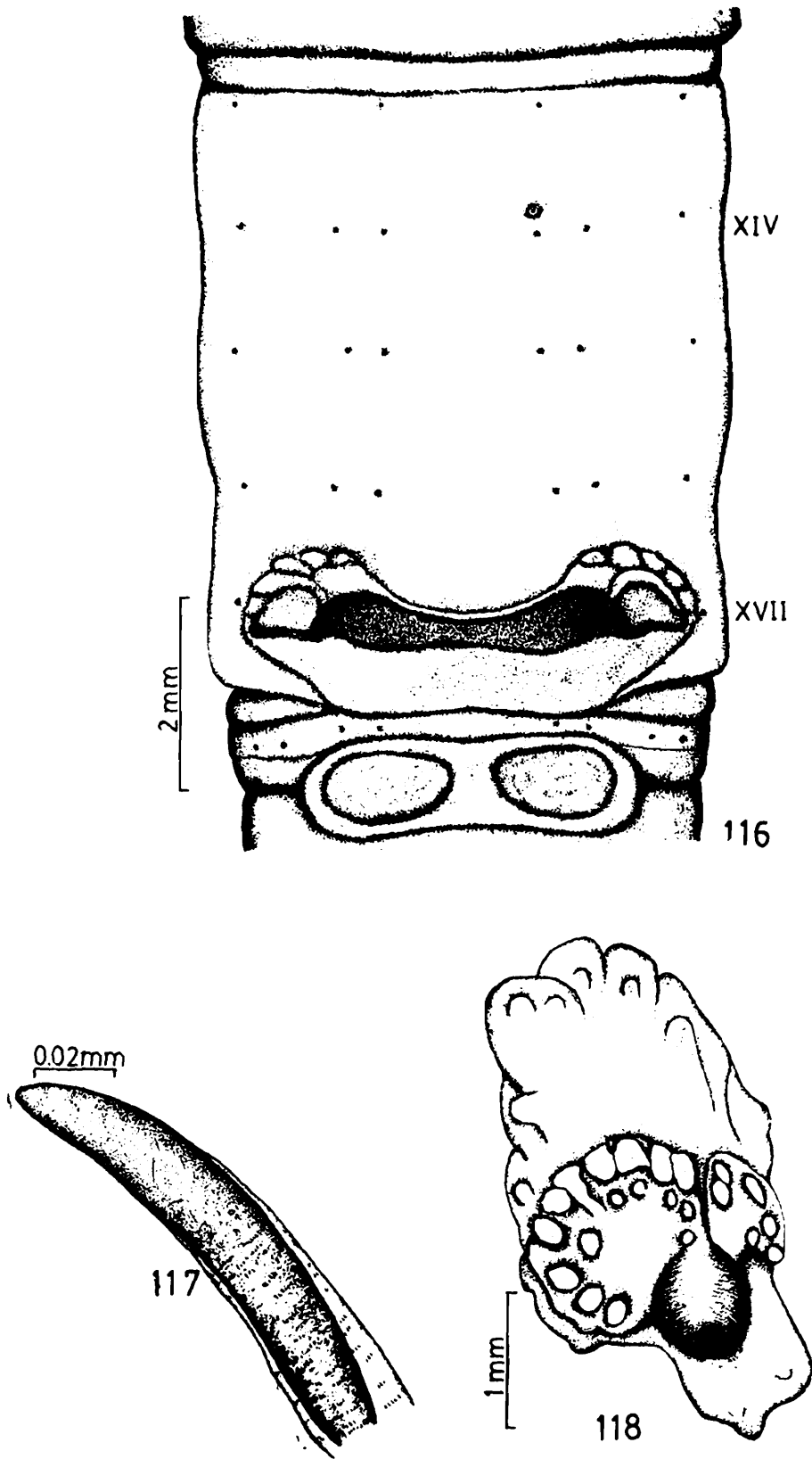
*Remarks* : The description of this species is not adequate, as it is based on acitellate types in which the male genitalia has not fully developed. The types probably belong to two species (Gates, 1938a).

## 29. *Eutyphoeus callosus* Gates

(Figs. 116-118)

1938. *Eutyphoeus callosus* Gates, *Rec. Indian Mus.*, 40: 67.

Length 247-320 mm, diameter 7-8 mm, 216 segments. Prostomium tanylobic. First dorsal pore 11/12. Clitellum 2/3 xiii-xvii. Setae  $aa = 2.8$   $ab = 1.2$   $bc = 1.7$   $cd = 0.14$   $dd$  on xii,  $aa = 3.1$   $ab = 1.1$   $bc = 2.3$   $cd = 0.14$   $dd$  on xxiv. Male pores discharge into paired vestibula (bivestibulate) opening onto the surface through large oval apertures, penes annular. Female pore (functional) on left side. Spermathecal pores, slightly lateral to *b*. Genital markings paired, circular, at *a*—mid*bc*, on 10/11-12/13, rectangular, closely paired, margins united at mid-ventral line, on 18/19-21/22.



FIGS. 116-118. *Eutyphoeus callosus* Gates. 116. genital region, 117. penial seta, 118. spermatheca (all drawn from a syntype).

Lateral intestinal caeca absent, median ventral intestinal caeca 12-30, in xxxvii-lxvi, supra-intestinal glands 5-6 pairs, in xciv-ci. Dorsal vessel terminates posterior to gizzard in vii. Metandric, testis sac ventral, seminal vesicles in xii, extending posteriorly to xiv. Penial setae ornamented with irregularly interrupted circles of fine spines, tip spoon-shaped, 2-2.5 mm long, 30-40  $\mu$  diameter. Each spermatheca with a median and a lateral ental diverticula which may be in contact or united with each other posteriorly, duct short. Genital marking glands absent.

*Type locality* : Dumpep, Khasi Hills, Meghalaya, India.

*Type specimens* : In ZSIC, W 3325/1.

*Material examined* : 0-2-3, syntypes, W 3325/1, in ZSIC.

*Distribution* : So far known from the type locality.

### 30. *Eutyphoeus comillahnus* Michaelsen

1907. *Eutyphoeus comillahnus* (? in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 187 (? excluding an acitellate specimen with spermathecal pores in mid *bc* and supra-intestinal glands in cxxvi-cxxx).

1923. *Eutyphoeus comillahnus* (? in part), Stephenson, *Fauna Br. India, Oligochaeta*: 432.

1972. *Eutyphoeus comillahnus*, Gates, *Trans. Am. phil. Soc.*, 62: 289.

Length 65-90 mm, diameter 3-4 mm, *c.* 240 segments. Prostomium tanylobic First dorsal pore 11/12. Clitellum xiv-xvii. Setae  $aa = 3ab = 0.9 bc = 1.7 cd = 0.15 dd$  on xii,  $aa = 3 ab = 0.75 bc = cd$  on xviii. Avestibulate, male pores discharge onto the body surface in fissures, on small, paired porophores, at *ab*, penes absent. Female pores paired, presetal, at *c. a* (as indicated in Figure by Michaelsen, 1909a). Spermathecal pores at or slightly lateral to *a*. Genital markings unpaired, median, postsetal, on xii and xiii, at *bb*.

Lateral intestinal caeca absent, median ventral, intestinal caeca (?), supra-intestinal glands 4 pairs in xxxv-xxxviii, typhlosole (?). Dorsal vessel extends anterior to gizzard, at least into v. Metandric, testis sac ventral, seminal vesicles in xii, extending posteriorly to xiv.

Penial setae ornamented with irregular transverse rows or circles of triangular teeth, tip broadened and hollowed on one side, 2 mm long, 40  $\mu$  diameter. Each spermatheca with a median and a lateral ental diverticula, duct short. Genital marking glands absent.

*Type locality* : Comillah, Bangla Desh.

*Type specimens* : In ZSIC, ZEV 2837/7; ZMUH, 2292.

*Distribution* : So far known from the type locality.

### 31. *Eutyphoeus festivus* Gates

(Figs. 119-121)

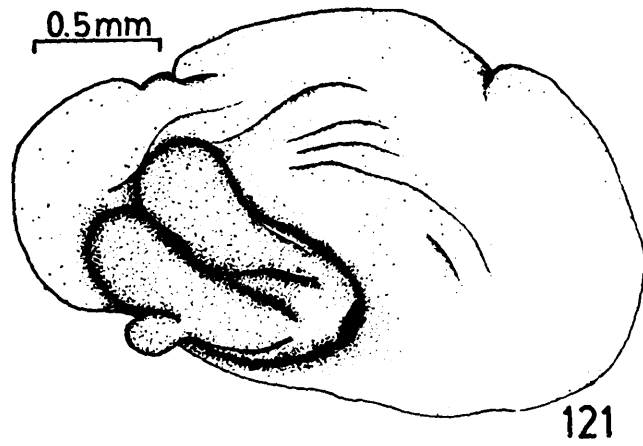
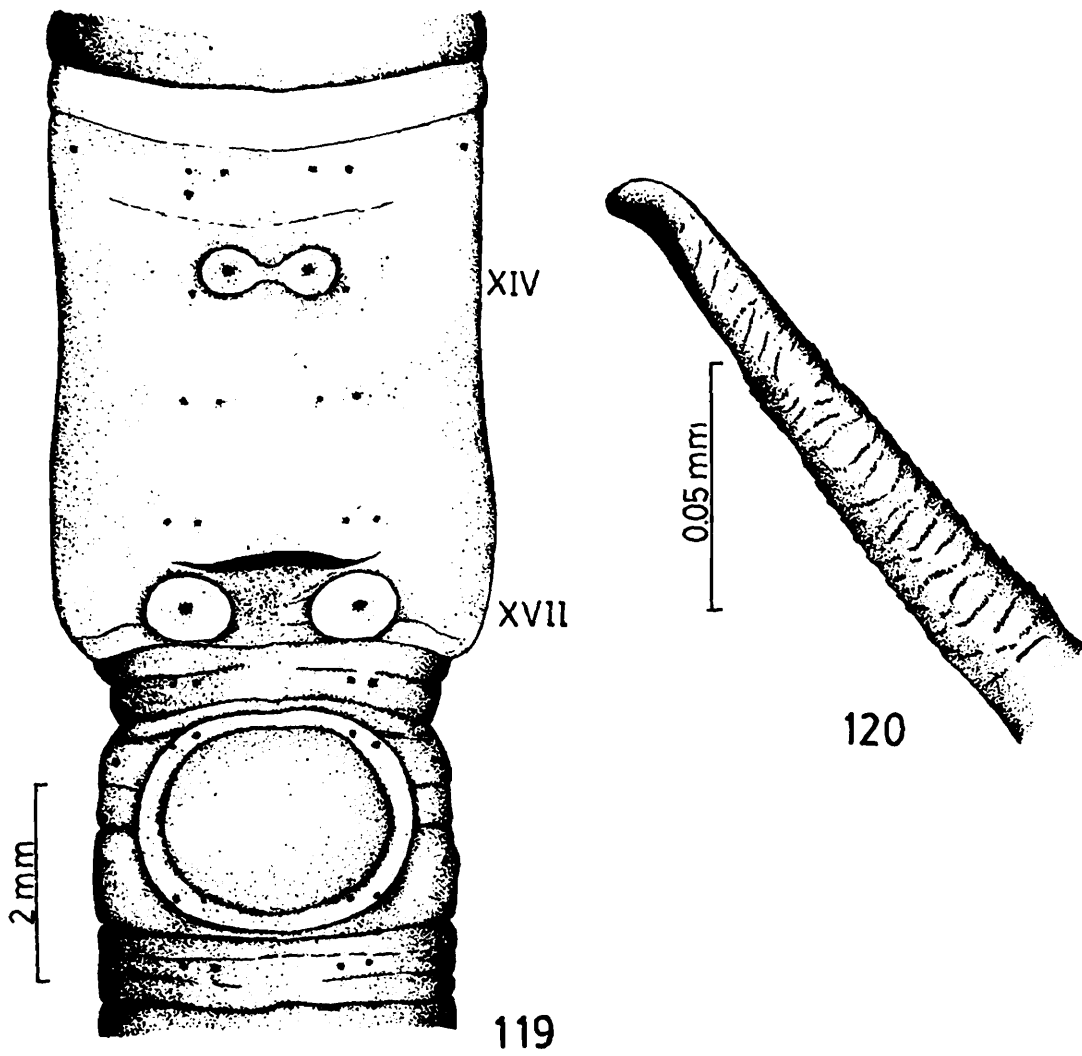
1938. *Eutyphoeus festivus* Gates, *Rec. Indian Mus.*, 40: 71.

Length 85-235 mm, diameter 4-6 mm, 124-271 segments. Prostomium prolobic. First dorsal pore 11/12, sometimes 10/11. Clitellum xiii,  $\frac{1}{2}$ xiii-xvii, xviii. Setae *aa* = 2.6-3.5 *ab* = 0.8-0.9 *bc* = 1.2-1.7 *cd* = 0.15 *dd* on xii, *aa* = 3.6-5.7 *ab* = 1.2-1.5 *bc* = 1.6-2.1 *cd* = 0.18-0.21 *dd* on xxiv. Avestibulate, male pores discharge onto the body surface in fissures on small, paired porophores, at *ab*, penes absent. Female pores paired slightly within *a* lines and anterior to the setal ring. Spermathecal pores small, transverse slits, at *ab*. Genital markings unpaired, median, on 19/20, at *bb*, sometimes on 18/19, 20/21, 22/23/24, at *aa* or *bb*.

Lateral intestinal caeca absent, median ventral intestinal caeca 4-6 in xxxvi-xliii, supra-intestinal glands 3-4 pairs in lxxxii-xcv, typhlosole begins in xxiv or xxv. Dorsal vessel complete, extends anterior to gizzard into iii. Metandric, testis sac ventral, seminal vesicles in xii, extending posteriorly to xiv. Penial setae ornamented with irregularly broken circles of fine spines, tip spoon-shaped, 1.05-1.32 mm long, 20-35  $\mu$  diameter. Each spermatheca with a median and a lateral posteriorly directed ental diverticula, duct short. Genital marking glands sessile, circular.

*Type locality* : Dumpep, Khasi Hills, Meghalaya, India.

*Type specimens* : In ZSIC, W 3324/1.



FIGS. 119-121. *Eutyphoeus festivus* Gates. 119. genital region, 120. penial seta, 121. spermatheca.

*Material examined* : In ZSIC: 0-0-1, holotype, W 3324/1. In HAZFS, ZSI, Solan - coll. N. Mazumdar: 0-0-1 Umshling, Garo Hills, 10 Sept 1969, An 488; coll. J.M. Julka 1977: 0-0-1 Sumer near Shillong, 11 July, An 487, 2-3-7 Cherrapunji, 12 July, An 486, 0-0-2 Dumpep, 12 July, An 484, 7-9-21 Shillong, 12, 14 July, An 483, 7-2-6 Mawphlang, 13 July, An 485.

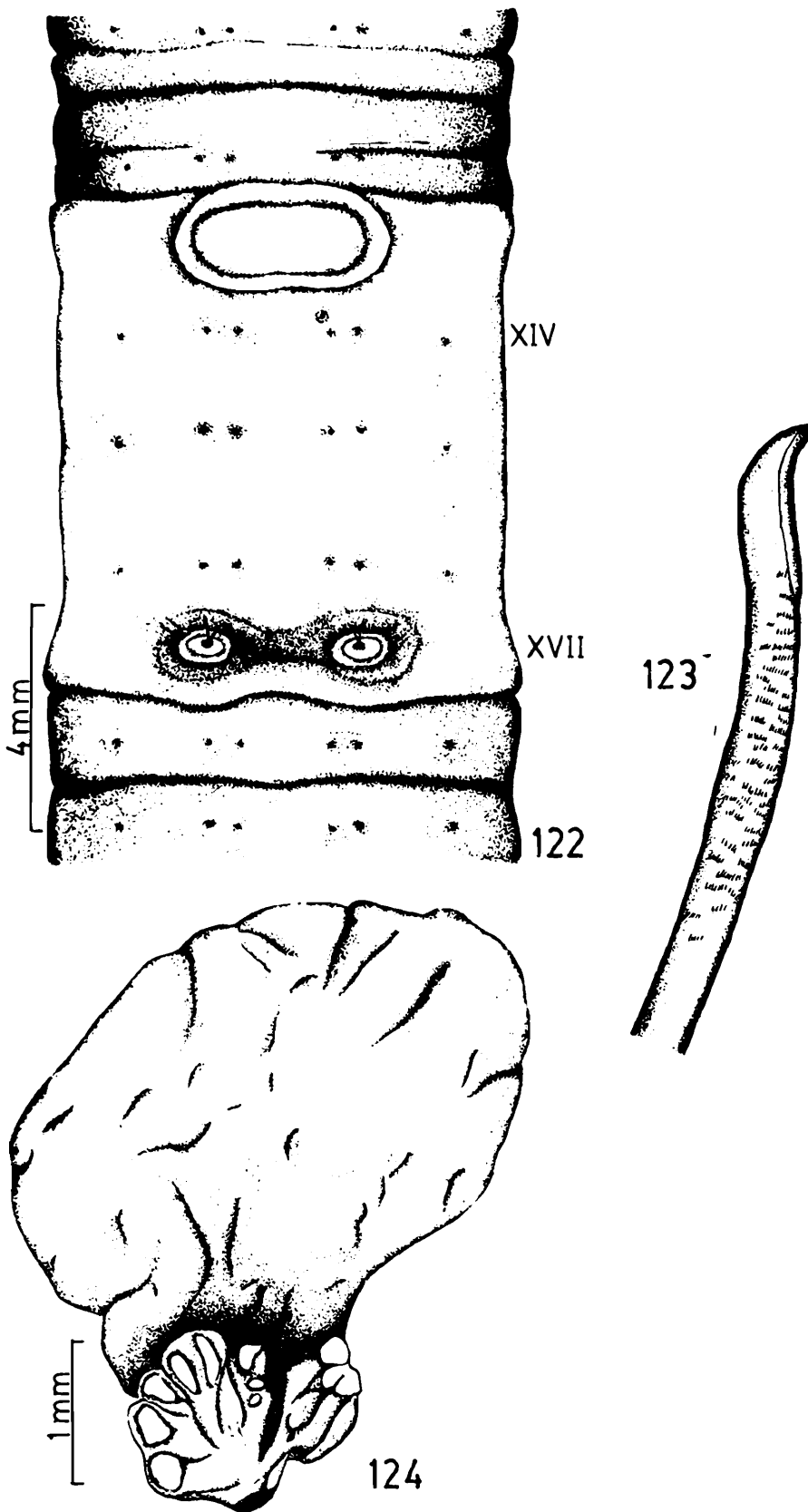
*Distribution* : India: *Meghalaya*: Dumpep, Umsing, Sumer near Shillong, Cherrapunji, Shillong, Mawphlang in Khasi Hills, Umshling in Garo Hills.

### 32. *Eutyphoeus gammiei* (Beddard)

(Figs. 122-124)

1888. *Typhaeus gammii* Beddard, *Q. Jl microsc. Sci.*, **29**: 111.  
 1900. *Eutyphoeus gammiei*, Michaelsen, *Tierreich*, **10**: 323.  
 1901. *Typhoeus gammiei*, Beddard, *Proc. zool. Soc. Lond.*, **1901**: 205.  
 1907. *Eutyphoeus chittagongianus* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 181.  
 1914. *Eutyphoeus koboensis* Stephenson, *Rec. Indian Mus.*, **8**: 404.  
 1914. *Eutyphoeus magnus* Stephenson, *Rec. Indian Mus.*, **8**: 408.  
 1923. *Eutyphoeus gammiei* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 434.  
 1938. *Eutyphoeus gammiei*, Gates, *Rec. Indian Mus.*, **40**: 72.  
 1972. *Eutyphoeus gammiei*, Gates, *Trans. Am. phil. Soc.*, **62**: 293.

Length 182-405 mm, diameter 5-10 mm, 195-282 segments. Prostomium prolobic. First dorsal pore 11/12, sometimes 10/11. Clitellum ½xiii-xvii. Setae *aa* = 2-2.6 *ab* = 0.9-1.2 *bc* = 1.5-1.9 *cd* = 0.13-0.14 *dd* on xii, *aa* = 3.5-4.2 *ab* = 1.4-1.7 *bc* = 2.5-3.4 *cd* = 0.15-0.17 *dd* on xxiv. Male pores discharge into an unpaired, median, vestibulum (univestibulate) opening onto the surface through a transverse aperture, anterior margin of the vestibular aperture lobed and posterior margin straight, penes annular. Female pore single, on the left side, presetal, at or just median to *a*. Spermathecal pores small, transverse slits, at or slightly lateral to *b*.



FIGS. 122-124. *Eutyphoeus gammiei* (Beddard). 122. genital region, 123. penial seta (redrawn, after Stephenson 1923), 124. spermatheca.

Genital markings unpaired and median or closely paired with margins united, on 13/14, 19/20/21, sometimes on 9/10-12/13, 21/22-23/24, at *bb*.

Lateral intestinal caeca absent, median ventral intestinal caeca 32-75 in xxv-xcix, supra-intestinal glands 4-6 pairs in xcvi-cxl, typhlosole begins in xxix-xxx. Dorsal vessel terminates posterior to gizzard in vii. Metandric, testis sac ventral, seminal vesicles in xii, extending posteriorly to xiv. Penial setae ornamented with closely crowded circles of fine spines, tip spoon-shaped, 2-5 mm long, 20-40  $\mu$  diameter. Each spermatheca with a median and a lateral posteriorly directed ental diverticula, sometimes bound together by a connective tissue to form a semi-circle of seminal chambers, duct short. Genital marking glands absent.

*Type locality* : Darjiling, W Bengal, India.

*Type specimens* : *Typhaeus gammii*: In BMNH, 1904: 10: 5: 2: 263. *Eutyphoeus chittagongianus*: In ZSIC, ZEV 2839/7; ZMUH, 7157. *Eutyphoeus koboensis*: In ZSIC, ZEV 5152/7. *Eutyphoeus magnus*: In ZSIC, ZEV 5383/7.

*Material examined* : 0-2-4 Tura, Garo Hills, Meghalaya, 17 July 1977, coll. J.M. Julka, An 477, HAZFS, ZSI, Solan.

*Distribution* : India: *West Bengal*: Darjiling, Sureil, Nam Ting Pokri, Sukiapokri; *Assam*: Katlicherra, Amingaon; *Meghalaya*: Tura, Siju Cave; *Arunachal Pradesh*: Upper Rotung, Kobo, Lokra in Balipara Frontier Tract.

Outside India: Bangla Desh: Comillah.

*Biology* : The species is found in sandy loam soil usually in the forests. It has also been recorded from caves and an island in a lake.

### 33. *Eutyphoeus gigas* Stephenson

(Figs. 125-127)

1917. *Eutyphoeus gigas* Stephenson, *Rec. Indian Mus.*, 13: 408.

1923. *Eutyphoeus gigas*, Stephenson, *Fauna Br. India, Oligochaeta*: 436.

1930. *Eutyphoeus longiseta* var. *typica* Gates, *Rec. Indian Mus.*, 32: 332.

1930. *Eutyphoeus longiseta* var. *postremus* Gates, *Rec. Indian Mus.*, 32: 336.

1972. *Eutyphoeus gigas*, Gates, *Trans. Am. Phil. Soc.*, 62: 294.

Length 160-290 mm, diameter 7-11 mm, 155-212 segments. Prostomium tiny, prolobic. First dorsal pore 11/12. Clitellum  $\frac{1}{2}$ xiii-xvii. Setae  $aa = 2$   $ab = 0.9$   $bc = 1.4$   $cd = 0.12$   $dd$  on xii,  $aa = 4$   $ab = 1.4$   $bc = 2$   $cd = 0.17$   $dd$  on xxiv. Avestibulate, male pores discharge on the body surface on posterior retractile flap-like lobes of annular penes, each at the centre of a slightly depressed or folded, circular to longitudinally oval porophore. Female pore single, on the left side, presetal, at or median or lateral to *a*. Spermathecal pores small, transverse slits, slightly lateral to *b*, sometimes extending into *ab*. Genital markings paired, presetal or postsetal on some of segments viii-xvi, xviii-xx, 18/19-21/22, at *aa* or *ab* or *bc*, unpaired, median on some of 11/12-15/16, 18/19-21/22.

Lateral intestinal caeca digitiform, usually ventrally directed, in xxviii, median ventral intestinal caeca 24-29 in xxxii-lxi, supra-intestinal glands 4-7 pairs in lxxxii-xcv, typhlosole begins in xxvii-xxviii. Dorsal vessel terminates posterior to gizzard in vii. Metandric, testis sac ventral, seminal vesicles in xii, extending posteriorly to xiii-xiv. Penial setae ornamented with numerous, short, crowded, transverse rows of spine-like teeth, tip pointed to a spine, 5-8.5 mm long 52-61  $\mu$  diameter. Each spermatheca with a median and a lateral, stalked ental diverticula, duct 1-2 mm long. Genital marking glands sessile.

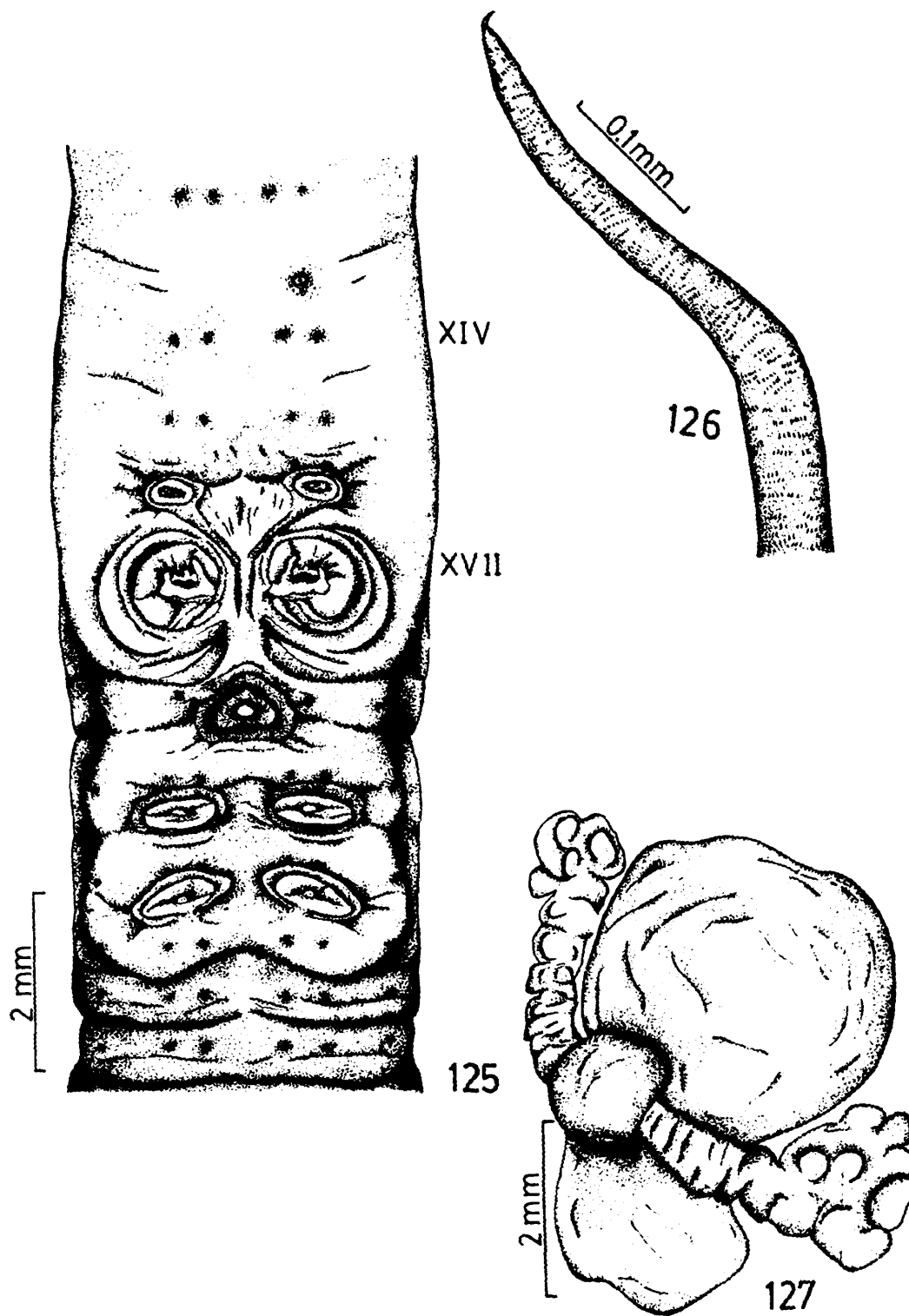
*Type locality* : Rangamati, Chittagong Hill Tracts, Bangla Desh.

*Type specimens* : In ZSIC, W 73/1.

*Material examined* : 0-0-1, type, W 73/1, in ZSIC; 0-0-1 Bhungtilang, 16 km from Aijal, Mizoram, 19 Oct 1960, coll. T.G. Vazirani, An 489, HAZFS, ZSI, Solan.

*Distribution* : India: *Mizoram*: Bhungtilang, c. 16 km from Aijal.

Outside India: Bangla Desh, Burma.



FIGS. 125-127. *Eutyphoeus gigas* Stephenson. 125. genital region, 126. penial seta, 127. spermatheca.

**Biology** : Elongate gregarines and nematodes have been observed to parasitize in its coelomic cavity (Gates, 1972).

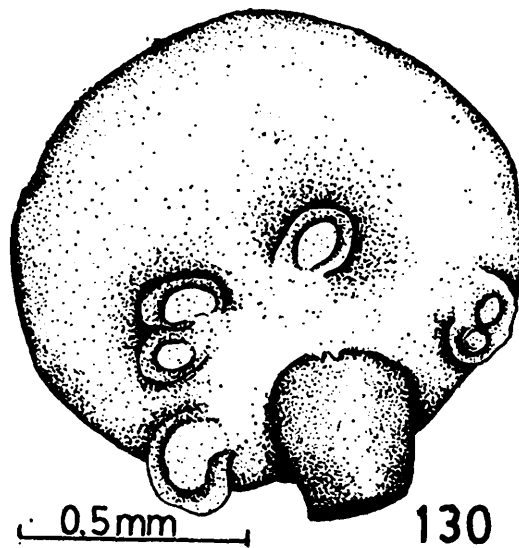
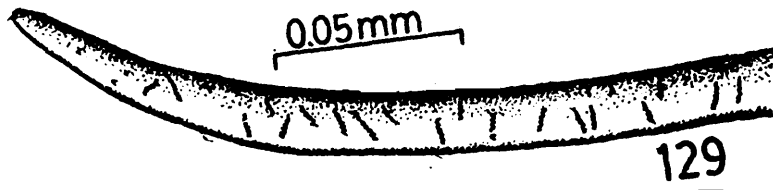
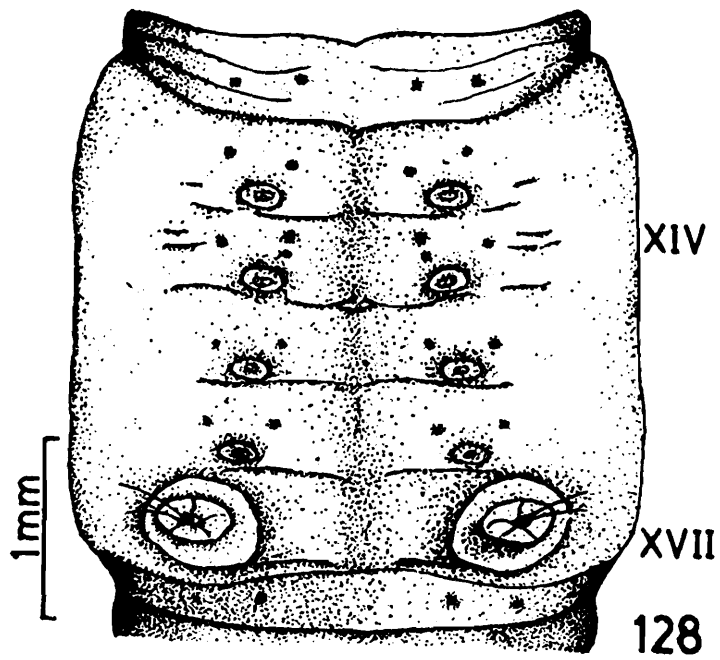
### 34. *Eutyphoeus incommodus* (Beddard)

(Figs. 128-130)

1901. *Typhoeus incommodus* Beddard, *Proc. zool. Soc. Lond.*, 1901: 200.
1903. *Eutyphoeus incommodus*, Michaelsen, *Die geographische Verbreitung der Oligochaeten*: 109.
1914. *Eutyphoeus mohammedi* Stephenson, *Rec. Indian Mus.*, 10: 350.
1916. *Eutyphoeus annandalei* var. *fulgidus* Stephenson, *Rec. Indian Mus.*, 12: 342.
1923. *Eutyphoeus incommodus*, Stephenson, *Fauna Br. India, Oligochaeta*: 438.
1923. *Eutyphoeus incommodus* var. *fulgidus*, Stephenson, *Fauna Br. India, Oligochaeta*: 439.
1923. *Eutyphoeus mohammedi*, Stephenson, *Fauna Br. India, Oligochaeta*: 443.
1938. *Eutyphoeus incommodus*, Gates, *Rec. Indian Mus.*, 40: 83.

Length 25-147 mm, diameter 2.5-6 mm, 92-189 segments. Prostomium combined pro/epilobic or pro/tanylobic. First dorsal pore 11/12, sometimes 10/11 or 12/13. Clitellum xiii,  $\frac{1}{2}$ xiii-xvii, xviii. Setae  $aa = 1.8-2.5$   $ab = 0.9$   $bc = 1.3-1.4$   $cd = 0.14$   $dd$  on xii,  $aa = 2.3-3.2$   $ab = 1.4$   $bc = 2-2.5$   $cd = 0.2$   $dd$  on xxiv. Avestibulate, male pores discharge on body surface in fissures on low, circular, paired porophores at or close to *b*, penes absent. Female pores paired, presetal, at or slightly median to *a*. Spermathecal pores transverse slits, slightly lateral to *b*. Genital markings paired, postsetal, usually on xiii-xvi at *ab* (one of the paired markings occasionally absent), sometimes on xii, rarely all markings absent.

Lateral intestinal caeca absent, median ventral intestinal caeca 3-9 in xxvii-xxxvi, supra-intestinal glands 3-6 pairs in lxii-lxxv. Dorsal vessel extends anterior to gizzard into iii. Holandric, testes and male funnels in annular sacs, seminal vesicles in ix and xii, those of xii extending posteriorly to xiii. Penial setae sparsely



FIGS. 128-130. *Eutyphoeus incommodus* (Beddard). 128. genital region, 129. penial seta, 130. spermatheca.

ornamented with widely separated rows or circles of fine spines, tip bluntly rounded or with a terminal spine, 0.5-1.4 mm long, 15-17  $\mu$  diameter. Each spermatheca with 2 median and 2 lateral, shortly stalked, ental diverticula or in the form of a circle of 10-18 seminal chambers with 4-6 openings into a short duct. Genital marking glands absent.

*Type locality* : Calcutta, West Bengal, India.

*Type specimens* : *Typhoeus incommodus*: probably do not exist. *Eutyphoeus mohammedi*: in BMNH, 1925: 5: 12: 106. *Eutyphoeus annandalei* var. *fulgides*: in ZSIC, ZEV 6571/7.

*Material examined* : In HAZFS, ZSI, Solan - *Uttar Pradesh*-coll. B.N. Chopra: 1-0-2 Dehra Dun, 1930, An 474; coll. German Expedition: 9-8-10 Varanasi Cantt., 21, 22 Oct 1956, An 475-476. *Himachal Pradesh* - coll. K.K. Mahajan 1972, Bilaspur district: 0-1-4 Kandhar, 18 Aug, an 470, 0-0-166 Goalthui, 30 Aug, An 452-453, 0-0-1 Maijpur, 25 Aug, An 471; coll. M. Chandra, 1973, Kangra district: 0-2-0 Jaritika, near Dehra, 19 July, An 472, 0-0-1 Dehra, 20 July, An 467; Bilaspur district: 0-1-1 Bherighat, 1 Aug 1973, An 469; coll. H.P. Agarwal, Sirmour district: 0-0-1 Paonta, 20 Sept 1973, An 473; coll. J.M. Julka 1978, Kangra district: 0-2-24 Nurpur, 8, 9 Aug, An 455-458, 1-1-17 Jasoor, 10 Aug, An 464-465, 0-2-15 Gangwal c. 20 km from Nurpur, 10 Aug, An 459, Chamba district: 3-3-4 Rajpura c. 10 km from Chamba, 15 Aug, An 463, 7-8-16 Chamba, 16 Aug, An 461, Mandi district: 0-0-2 Hara Bagh c. 10 km from Sundar Nagar, 29 Aug, An 462, 1-1-18 Sundar Nagar, 28 Aug, An 466, 0-6-23 Ner Chowk, 27 Aug, An 460. *Punjab* - coll. K.K. Mahajan: 0-0-107 Nangal, 29 Aug 1972, An 454. *Jammu & Kashmir* - coll. M. Chandra and R.N. Mukherjee: 0-1-0 Changram, Kathua district, 15 Dec 1977, An 468.

*Distribution* : India: *Punjab*: Basi Muda in Hoshiarpur district, Nangal; *Jammu & Kashmir*: Changram in Kathua district; *Haryana*: Ambala; *Himachal Pradesh*: Kasauli in Solan district, Kandhar, Maijpur, Goalthui, Bherighat in Bilaspur district, Jaritika, Dehra,

Nurpur, Jasoor, Gangwal in Kangra district, Paonta in Sirmour district, Rajpura, Chamba in Chamba district, Harabagh, Ner Chowk, Sundar Nagar in Mandi district; *Chandigarh*; *Uttar Pradesh*: Agra, Rurki, Allahabad, Anwargunj, Tanda Falls, Sohagi, Chakia, Ahraura, Varanasi, Chunar, Mirzapur, Madho Singh, Zafarabad, Jaunpur, Janghai, Jhusi, Bhita, Ghoorpur, Pratabgarh, Sultanpur, Fyzabad, Fatehpur, Rae Bareli, Lucknow, Bara Banki, Lakhaoti, Gorakhpur, Saharanpur, Dehra Dun, Robertsganj; *Rajasthan*: Bharatpur; *Madhya Pradesh*: Rewa, Nowgong; *Bihar*: Patna, Pusa, Rajmehal; *W. Bengal*: Calcutta.

#### Outside India Pakistan

*Biology* : It inhabits alluvial soil with a pH range of 7.2-7.6 in agricultural fields, plant nurseries, gardens, orchards, grasslands, under stones on the banks of ponds and streams in the plains to an altitude of c. 1830 m. Activity is restricted to the rainy season from July to September. Reproduction is biparental and breeding occurs in August-October. Vermicelliform casts are deposited on the soil surface in the form of small towers. Bioluminescence has been reported in this species (Gates, 1944). Mukherjee (1980) has recorded a ciliate parasite, *Anoplophrya marylandensis*, from its gut contents.

### 35. *Eutyphoeus kherai* Julka

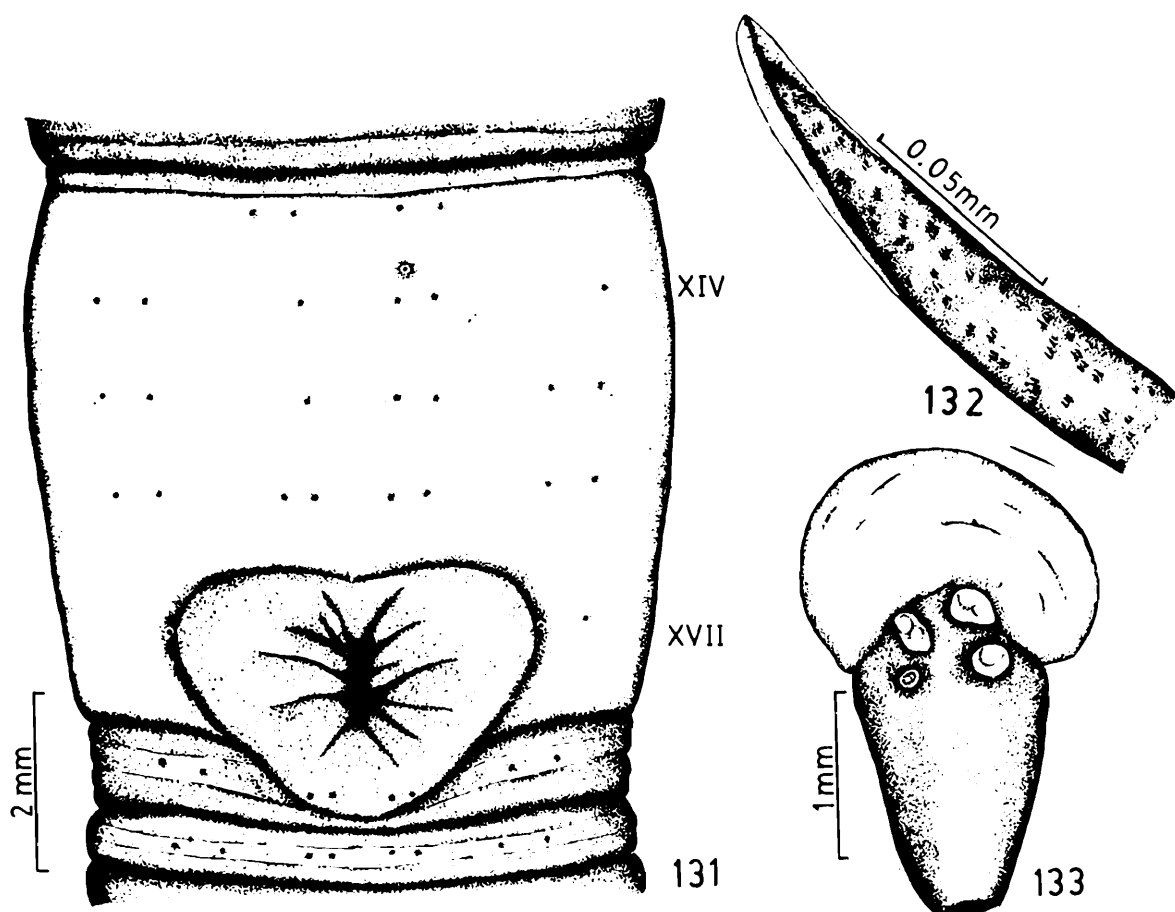
(Figs. 131-133)

1978. *Eutyphoeus kherai* Julka, *Mitt. zool. Mus. Berlin*, 54: 191.

Length 90-222 mm, diameter 4-7 mm, 137-214 segments. Prostomium prolobic. First dorsal pore 11/12. Clitellum  $\frac{1}{2}$ xiii-xvii. Setae  $aa = 1.9$   $ab = 0.6$   $bc = 1.4$   $cd = 0.1$   $dd$  on xii,  $aa = 2.9$   $ab = 1.2$   $bc = 2.7$   $cd = 0.11$   $dd$  on xxiv. Male pores discharge into a median deep vestibulum (univestibulate) opening onto the body surface through a circular to transversely oval aperture, at  $bb$ , penes short and conical. Female pore single on the left side, presetal, at or slightly lateral to  $a$ . Spermathecal pores small, transverse slits, at  $ab$ . Genital markings paired, usually on 19/20-22/23, sometimes

on 18/19 and 23/24/25; one of the paired markings may occasionally be absent.

Lateral intestinal caeca absent, median ventral intestinal caeca 25-26 in xxxiv-lix, supra-intestinal glands 4-5 pairs in lxxxi-lxxxvii, typhlosole begins in xxvii-xxviii. Dorsal vessel terminates posterior to gizzard in vii, sometimes extending anterior to gizzard in vi. Metandric, testis sac ventral, seminal vesicles in xii, extending to xiv. Penial setae ornamented with 3-4 spines in each of 2-3 rows, tip spoon-shaped, 1.6-1.7 mm long, 21-30  $\mu$  diameter. Each spermatheca with ental diverticula in the form of 4-5 seminal chambers on posterior surface of duct, opening into the duct lumen through 2 apertures. Genital marking glands sessile, oval.



FIGS. 131-133. *Eutyphoeus kherai* Julka. 131. genital region, 132. penial seta, 133. spermatheca. (all drawn from the holotype).

*Type locality* : Bisoi, Mayurbhanj district, Orissa, India.

*Type specimens* : In ZSIC: Holotype, An 305/1; 31 paratypes, An 306/1.

*Distribution* : So far known from the type locality.

### 36. *Eutyphoeus lippus* Gates

(Figs. 134-139)

1934. *Eutyphoeus lippus* Gates, *Rec. Indian Mus.*, **36**: 273.

1938. *Eutyphoeus lippus*, Gates, *Rec. Indian Mus.*, **40**: 88.

Length 112-129 mm, diameter 4-6 mm, 176-184 segments. Prostomium tanylobic. First dorsal pore 10/11, sometimes 7/8-9/10. Clitellum xiii-xvi,  $\frac{1}{2}$ xvii. Setae  $aa = 2.3$   $ab = 1.1$   $bc = 1.5$   $cd = 0.16$   $dd$  on xii,  $aa = 3.5$   $ab = 1.9$   $bc = 2.1$   $cd = 0.18$   $dd$  on xxiv. Avestibulate, male pores discharge on the body surface in fissures at or close to *b*, penes absent. Female pores paired, presetal, slightly within setal lines *aa*. Spermathecal pores large, transverse slits, at *ac*. Genital markings paired, postsetal on x, pre- or post-setal on xvii, at *c. ab*.

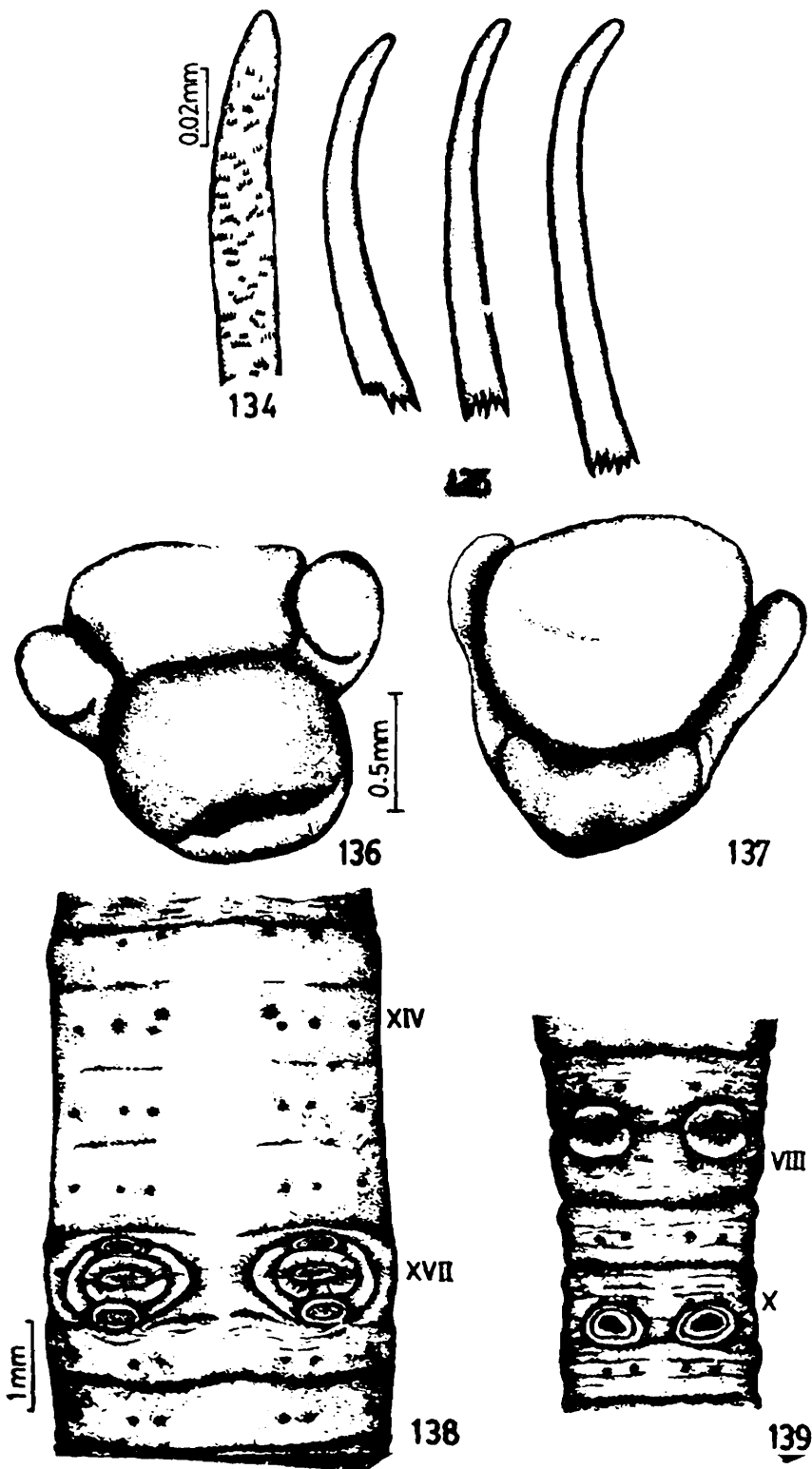
Lateral intestinal caeca dorsally directed flaps with rounded tips in xxiv, median ventral intestinal caeca 4-7 in xxx-xxxvii, supra-intestinal glands 3-5 pairs in lxvi-lxx. Dorsal vessel extends anterior to gizzard into iii. Metandric, testis sac annular or horse-shoe-shaped, seminal vesicles in xii, extending to xiv. Penial setae ornamented with short transverse rows of fine spines, tip bluntly rounded, 0.74 mm long, 18  $\mu$  diameter. Each spermatheca with a median and a lateral digitiform ental diverticula, duct short. Genital marking glands sessile, oval.

*Type locality* : Gurjung, Khare and Phoktey villages, Remechap district, Nepal.

*Type specimens* : In ZSIC, W 3045/1.

*Material examined* : 0-0-2, syntypes, W 3045/1, ZSIC.

*Distribution* : Nepal.



FIGS. 134-139. *Eutyphoeus lippus* Gates. 134. penial seta, , 135. penial setae (redrawn, after Gates 1934), 136-137. spermatheca, posteroventral view (136), antero-dorsal view (137), 138. genital region, 139. spermathecal pore region (all drawn from a syntype).

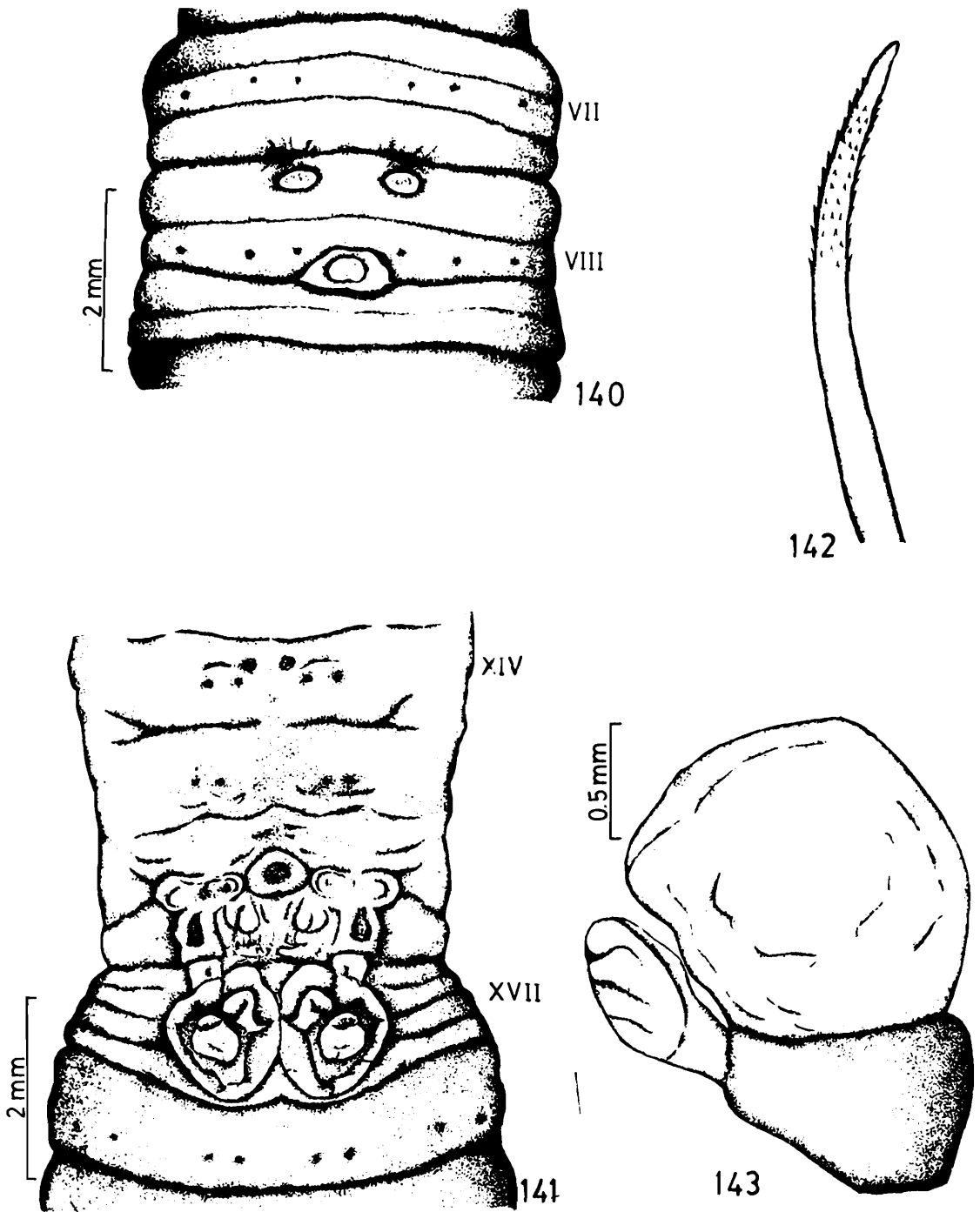
*Biology* : Found in dark brown soil intermixed with rocks and stones, thin layer of mud on rocks covered with lichens at an elevation of 1220 m to 4575 m (?). Sporozoan parasites have been reported in the coelom of post-prostatic region (Gates, 1934).

**37. *Eutyphoeus manipurensis manipurensis* Stephenson**  
(Figs. 140-143)

1921. *Eutyphoeus manipurensis* Stephenson, *Rec. Indian Mus.*, 22: 763.  
 1923. *Eutyphoeus manipurensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 441.  
 1938. *Eutyphoeus manipurensis*, Gates, *Rec. Indian Mus.*, 40: 89.  
 1958. *Eutyphoeus manipurensis manipurensis*, Gates, *Rec. Indian Mus.*, 53: 110.

Length 120 mm, diameter 5 mm, 162 segments. Prostomium tanylobic. First dorsal pore 10/11. Clitellum 2/3 xiii-2/3 xvii. Setae  $aa = 2.2$   $ab = 0.9$   $bc = cd = 0.12$   $dd$  on xii,  $aa = 3.2$   $ab = 1.2$   $bc = 1.6$   $cd = 0.14$   $dd$  on xxiv. Avestibulate, male pores discharge on the body surface on paired porophores, at *ac*, penes absent. Female pores paired, presetal, slightly median to *a* lines. Spermathecal pores transverse slits, at *ab*. Genital markings unpaired and median, on setal annuli on viii and ix, pre- or postsetal on xvi, paired, on setal annulus or presetal on viii, pre- or postsetal on xvi, at *ab*, presetal on xvi and xvii at *aa*; 4 postsetal markings in a transverse row on xvi.

Lateral intestinal caeca digitiform, ventrally directed in xxvii, median ventral intestinal caeca 23-24 in xxxii-lvi, supra-intestinal glands 3-5 pairs in lxxiii-lxxviii, typhlosole begins in xxvii. Dorsal vessel extends anterior to gizzard into iii. Holandric, testis sacs annular, seminal vesicles in ix and xii, those of xii extending to xiv. Penial setae ornamented with fine triangular teeth, tip bluntly rounded, 1.5 mm long, 45 $\mu$  diameter. Each spermatheca with a shortly stalked, lateral, ental diverticulum, duct short and stout. Genital marking glands sessile, each with a strong but transparent capsule.



FIGS. 140-143. *Eutyphoeus manipurensis manipurensis* Stephenson. 140. spermathecal pore region, 141. genital region, 142. penial seta, (redrawn, after Stephenson 1923), 143. spermatheca (all drawn from a syntype).

*Type locality* : Thonga Island, Loktak Lake, Manipur, India.

*Type specimens* : In ZSIC, W 555/1; BMNH, 1933: 5: 25: 1344.

*Material examined* : 0-0-2, syntypes, W 555/1, in ZSIC.

*Distribution* : So far known from the type locality.

### 38. *Eutyphoeus nainianus* Michaelsen

(Figs. 144-145)

1907. *Eutyphoeus nainianus* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 177.

1923. *Eutyphoeus nainianus*, Stephenson, *Fauna Br. India, Oligochaeta*: 444.

1938. *Eutyphoeus nainianus*, Gates, *Rec. Indian Mus.*, **40**: 91.

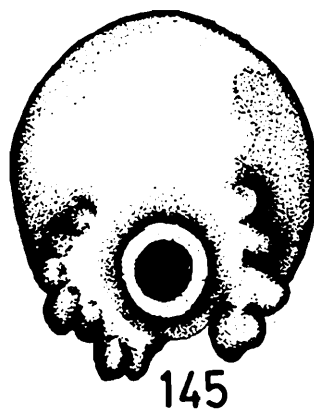
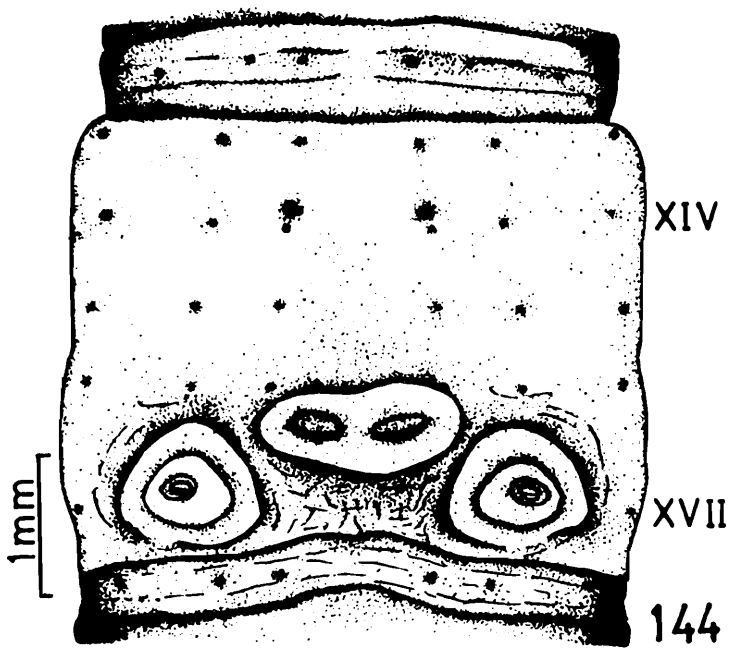
Length 60 mm, diameter 3-4.5 mm, 138 segments. Prostomium tanylobic. Clitellum xiii-xvii. Setae  $aa = 2$   $ab = 0.8$   $bc = 1.1$   $cd = 0.14$   $dd$  on xii,  $aa = 2.2$   $ab = 1.3$   $bc = 1.4$   $cd = 0.14$   $dd$  on xxiv. Avestibulate, male pores discharge on the body surface in fissures on oval porophores, at *b*, penes absent. Female pores paired, presetal, slightly median to *a*. Spermathecal pores transverse slits, at *bc*. Genital markings closely paired with median margins united, postsetal, on xvi, at *aa*.

Lateral intestinal caeca digitiform, dorsally directed in xxiii or xxiv (?), median ventral intestinal caeca 5 in xxv-xxix, supra-intestinal glands 4 pairs in lxvi-lxix. Dorsal vessel extends anterior to gizzard at least into v. Metandric, testis sac annular, seminal vesicles in xii, extending to xx. Penial setae absent (?). Each spermatheca with ental diverticula in the form of an interrupted circle of *c*. 6-7 seminal chambers around short duct, opening into the duct lumen individually. Genital marking glands sessile.

*Type locality* : Naini Tal, Kumaon Hills, Uttar Pradesh, India.

*Type specimens* : In ZSIC, ZEV 2842/7.

*Material examined* : 0-0-1, holotype, ZEV 2842/7, in ZSIC.



FIGS. 144-145. *Eutyphoeus nainianus* Michaelsen. 144. genital region (based on holotype), 145. spermatheca (redrawn, after Stephenson 1923).

*Distribution* : So far known from the type locality.

*Remarks* : Penial setae are stated to be absent in *E. nainianus*. It is probable that they are very small and deeply embedded in the body wall.

### 39. *Eutyphoeus nepalensis* Michaelsen

(Figs. 146-148)

1907. *Eutyphoeus nepalensis* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 176.

1923. *Eutyphoeus nepalensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 445.

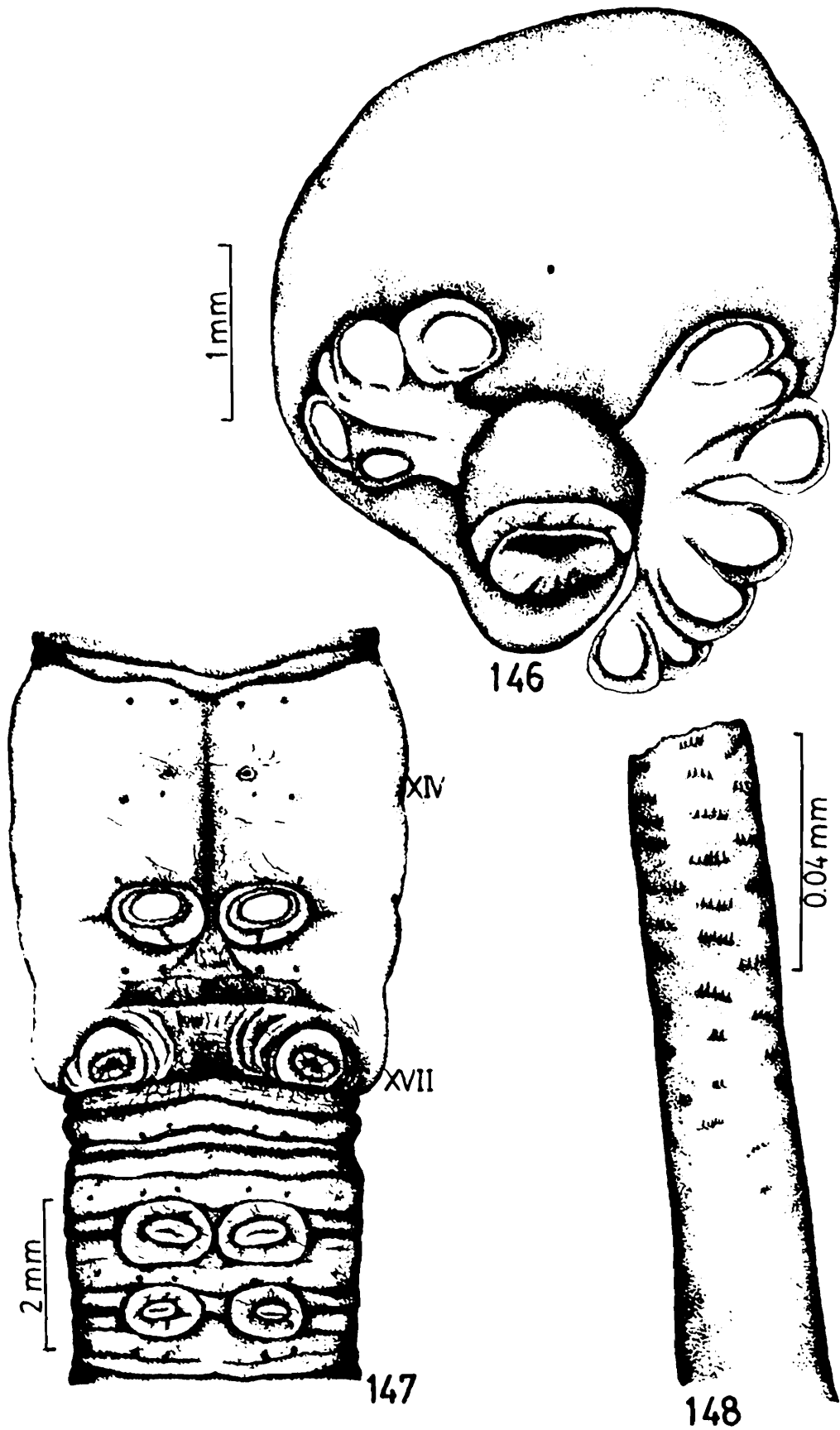
1938. *Eutyphoeus nepalensis*, Gates, *Rec. Indian Mus.*, 40: 92.

Length 110-140 mm, diameter 6 mm, 150-180 segments. Prostomium tanylobic. First dorsal pore 10/11. Clitellum xiii-xvii. Setae  $aa = 1.7-1.9$   $ab = 1.1-1.2$   $bc = 1.3-1.4$   $cd = 0.16$   $dd$  on xii,  $aa = 2.8-3$   $ab = 1.5-2.1$   $bc = 1.5-2.3$   $cd = 0.17$   $dd$  on xxiv. Avestibulate, male pores discharge on body surface in fissures, on oval porophores, at or just lateral to *b*, penes absent. Female pores paired, presetal, slightly median to *a*. Spermathecal pores large, transverse slits with centres at *c*. Genital markings closely paired, postsetal on xiv, xv, intersegmental on 18/19-21/22, at *ab*.

Lateral intestinal caeca small, conical, dorsally directed in xxiv, median ventral intestinal caeca 5 in xxxi-xxxvi, supra-intestinal glands 4 pairs in lxxvii-lxxx. Dorsal vessel extends anterior to gizzard into iii. Metandric, testis sac annular, seminal vesicles in xii, extending to xiv. Penial setae deeply embedded in the body wall, ornamented with transverse rows of fine spines, length and diameter (?). Each spermatheca with median and lateral rows of ental seminal chambers on a short duct, opening into the duct lumen at least through 2 apertures on each side. Genital marking glands sessile.

*Type locality* : Chitlong, Nepal.

*Type specimens* : In ZSIC, ZEV 2880/7; ZMUH, 7131.



FIGS. 146-148. *Eutyphoeus nepalensis* Michaelsen, 146. spermatheca, 147. genital region, 148. penial seta, tip broken (all drawn from a syntype).

*Material examined* : 0-0-3, syntypes, ZEV 2880/7, in ZSIC.

*Distribution* : So far known from the type locality.

*Remarks* : The location of the ventral intestinal caeca needs confirmation as it was determined from a softened syntype in the National Zoological Collections, Zoological Survey of India, Calcutta.

#### 40. *Eutyphoeus nicholsoni* (Beddard)

(Figs. 149-152)

1901. *Typhoeus nicholsoni* Beddard, *Proc. zool. Soc. Lond.*, 1901: 206.

1907. *Eutyphoeus khani* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 182.

1909. *Eutyphoeus provincialis (lapsus)*, Michaelsen, *Mem. Indian Mus.*, 1: 219.

1909. *Eutyphoeus waltoni* (in part), Michaelsen, *Mem. Indian Mus.*, 1: 229.

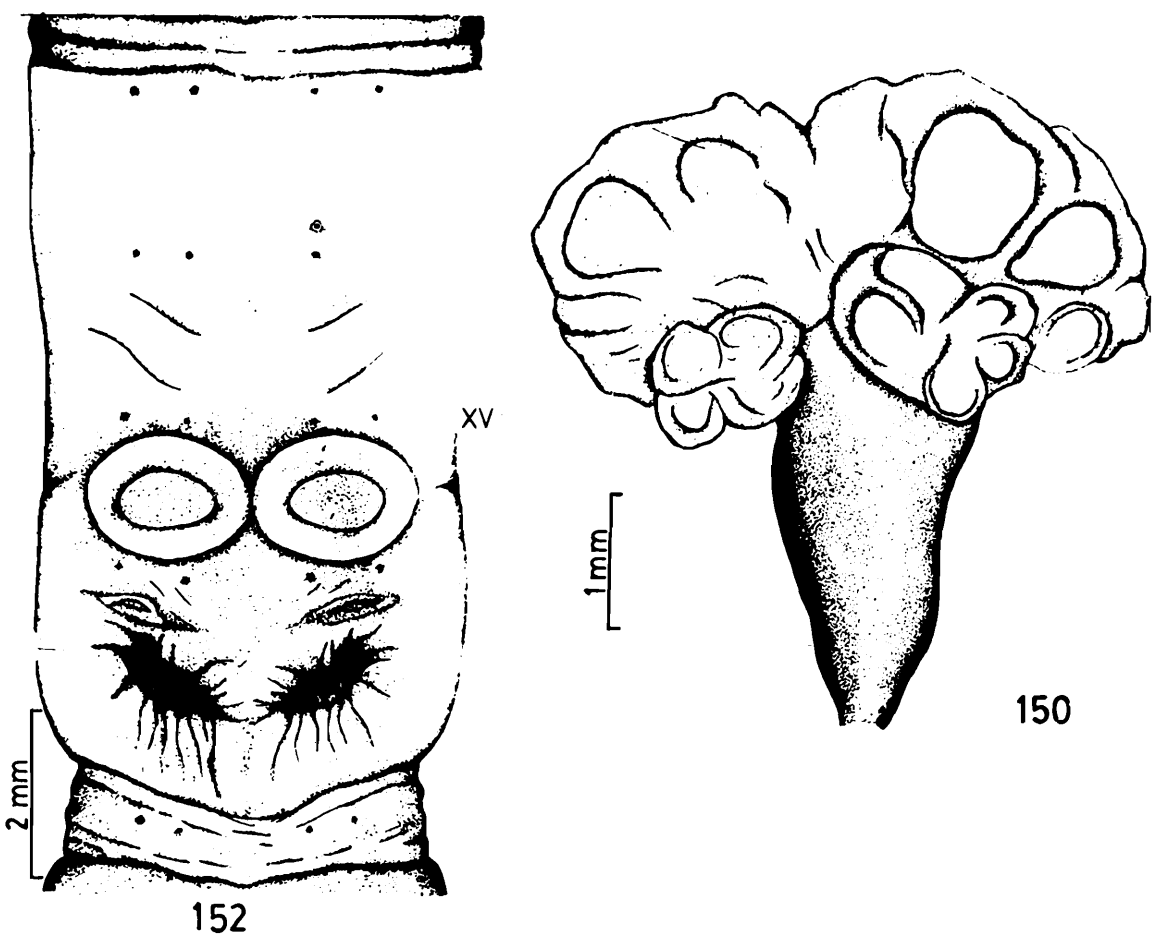
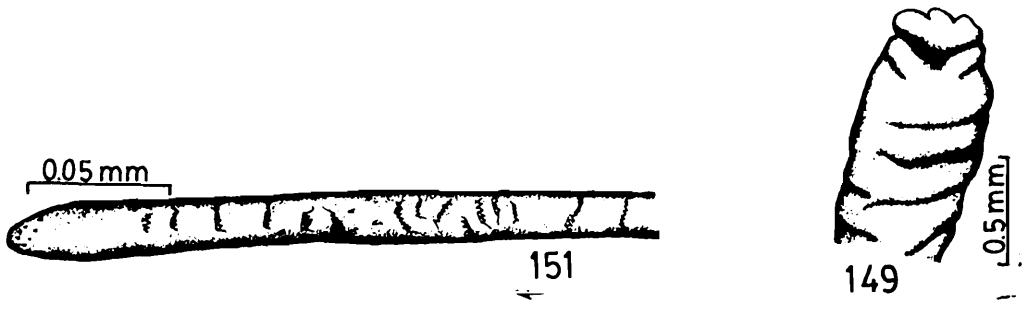
1923. *Eutyphoeus nicholsoni*, Stephenson, *Fauna Br. India, Oligochaeta*: 446.

1927. *Eutyphoeus gigas*, Bahl, *Q. Jl microsc. Sci.*, 71: 485.

1938. *Eutyphoeus nicholsoni*, Gates, *Rec. Indian Mus.*, 40: 94.

Length 141-270 mm, diameter 5-10 mm, 172-225 segments. Prostomium prolobic or pro/tanylobic. First dorsal pore 11/12, sometimes 12/13. Clitellum xiii-xvii. Setae  $aa = 1.9-2.3$   $ab = 0.9-1$   $bc = 1.4-1.6$   $cd = 0.11-0.12$   $dd$  on xii,  $aa = 2.7-3$   $ab = 1.4-1.5$   $bc = 2.3-2.5$   $cd = 0.14-0.15$   $dd$  on xxiv. Male pores discharge into paired, deep, well-like vestibula (bivestibulate) opening onto the surface through slit-like apertures at  $c$ .  $ab$ , penes elongate, tubular, 1.25-1.5 mm long, each with a slit-like to crescentic aperture at the tip. Female pore single, on the left side, presetal, at  $a$ . Spermathecal pores small, transverse slits, at or slightly lateral to  $a$ . Genital markings closely paired, margins in contact or united at mid-ventral line, extending laterally into  $bc$ , on 15/16, sometimes an additional marking, either on left or right side, on 14/15, 16/17 and 18/19.

Lateral intestinal caeca absent, median ventral intestinal caeca 24-30 in xxxv-lxix, supra-intestinal glands 4-7 pairs in lxxx-lxxxix, typhlosole begins in xxviii-xxix. Dorsal vessel terminates posterior



FIGS. 149-152. *Eutyphoeus nicholsoni* (Beddard). 149. posterior view of penis, 150. spermatheca, 151. penial seta, 152. genital region.

to gizzard in vii, rarely extending anteriorly to vi. Metandric, testis sac ventral, seminal vesicles in xii, extending to xiv. Penial setae ornamented with sparse, shallow pits, tip bluntly rounded, 3.6-4.4 mm long, 26-33  $\mu$  diameter. Each spermatheca with ental diverticula in the form of one or two fan-shaped clusters or a semicircle row of 5-11 digitiform seminal chambers on posterior face of duct, opening into the duct lumen through 2 (?), 4-6 apertures, duct comparatively long (usually more than 2 mm). Genital marking glands sessile, protuberant into the body cavity.

*Type locality* : Calcutta, West Bengal, India.

*Type specimens* *Typhoeus nicholsoni*: Typus amissus; *Eutyphoeus khani*: In ZSIC, ZEV 2841/7; ZMUH, 7162.

*Material examined* In HAZFS, ZSI, Solan - *Uttar Pradesh* -coll. M.N. Dutta & Raghunath: 0-1-8 Benaras Cantt., 10 Oct 1944, An 494; coll. Raghunath: 0-0-36 Benaras Cantt., 15, 26 Aug 1946, An 493, An 492; coll. Raj Tilak: 0-0-10 Mohund Rao Mohund, Saharanpur district, 26 Sept 1973, An 496; coll. A. Husain: 0-0-1 Lakhimpur district, 5 Nov 1973, An 497. *Himachal Pradesh* - coll. H.P. Agarwal: 0-0-2 Paonta, Sirmour district, 17, 20 Sept 1973, An 499, An 500.

*Distribution* : India: *West Bengal*: Calcutta; *Bihar*: Rajmahal; *Uttar Pradesh*: Kotwari Bazar, Buzru Kurme, Mowaie, Bara Banki, Saharanpur, Lucknow, Cawnpore, Fyzabad, Allahabad, Ahraura, Moghul Serai, Varanasi, Chunar, Mirzapur, Madho Singh, Zafarabad, Jaunpur, Jhusi, Janghai, Bhita, Ghoorpur, Pratabgarh, Sultanpur, Fatehpur, Rae Bareli, Tanda Falls, Manikpur Junction, Chakia, Gorakhpur, Robertsganj, Sohagi, Doon Valley, Mohund Rao Mohund; *Madhya Pradesh*: Mauganj, Satna, Nowgong, Rewa; *Himachal Pradesh*: Paonta; *Chandigarh*.

*Biology* : *E. nicholsoni* inhabits alluvial soil in the paddy fields and pastures. It has also been recorded from the flower pots and manure heaps. Soota (1970) reported it from soils with 7.5-8 pH, 27.07% moisture and 2.06% organic matter. Its altitudinal range is from plains to an elevation of c. 150-300 m.

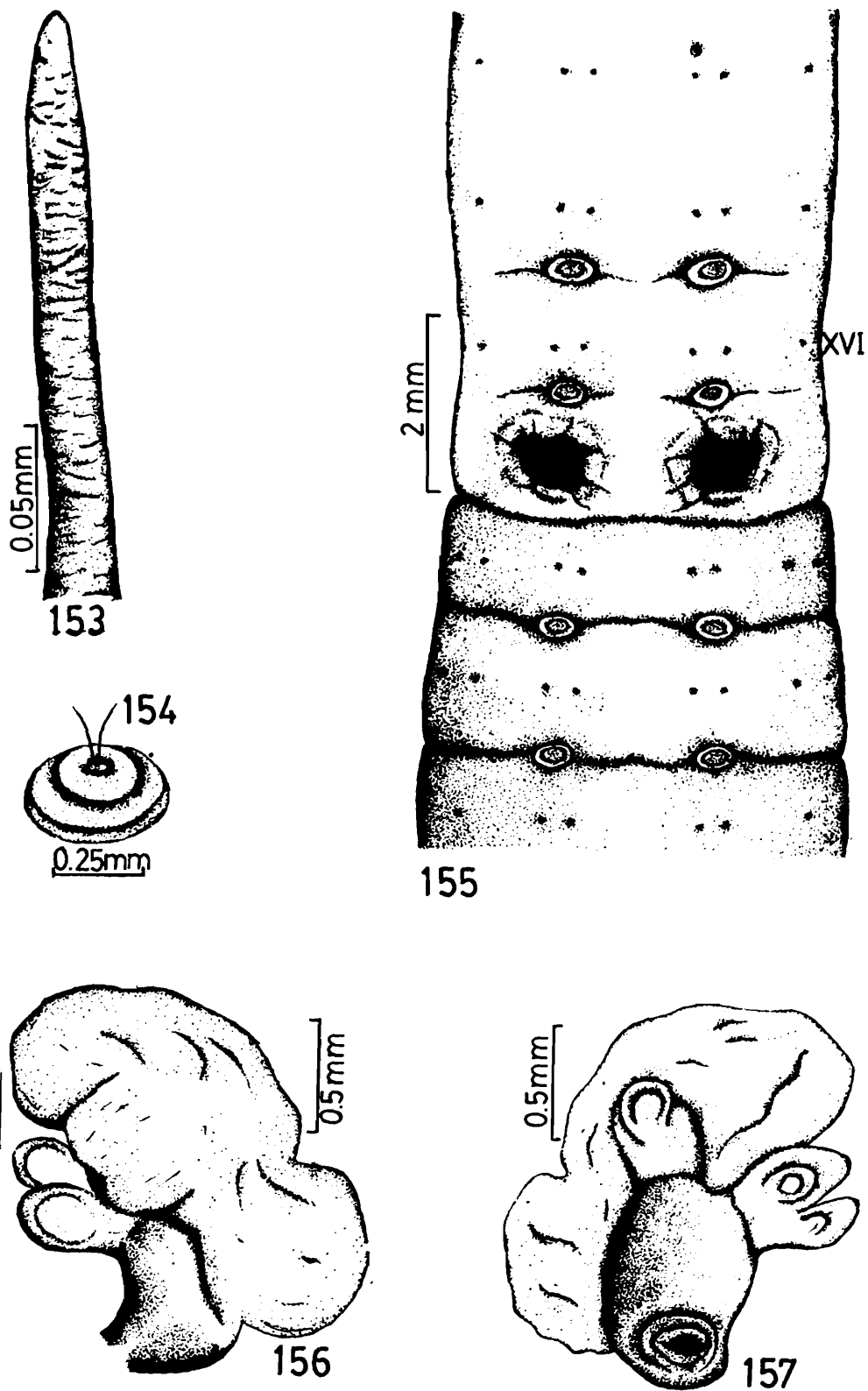
Activity in this species is possible from May-June to October in Pakistan (Bhatti, 1962b) and from July to December (Gates, 1945c) in the Gangetic Plains. It undergoes diapause in November at c. 30 cm depth of soil in the Doon Valley (Soota, 1970). It is usually found crawling aimlessly in large numbers on the soil surface at the end of the rainy season in October-November (Gates, 1945c). Copulation takes place above the soil surface in July-August (Menon *et al.*, 1968) and from late August to November (Gates, 1945c). Vermicelliform tower-like casts are deposited on the soil surface. Gates (1944) records bioluminescence in this species.

Monocystid protozoan parasites have been reported from its coelomic cavity by Gates (1938a).

#### 41. *Eutyphoeus orientalis* (Beddard)

(Figs. 153-157)

1883. *Typhoeus orientalis* Beddard, *Ann. Mag. nat. Hist. (ser. 5)*, **12**: 219.  
 1888. *Typhaeus orientalis*, Beddard, *Q. Jl microsc. Sci.*, **29**: 117.  
 1889. *Typhaeus masoni* Bourne, *J. Asiat. Soc. Beng.*, **58**: 112.  
 1900. *Eutyphoeus orientalis*, Michaelsen, *Tierreich*, **10**: 322.  
 1900. *Eutyphoeus masoni*, Michaelsen, *Tierreich*, **10**: 323.  
 1901. *Typhoeus masoni*, Beddard, *Proc. zool. Soc. Lond.*, **1901**: 202.  
 1907. *Eutyphoeus paivai* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 178.  
 1907. *Eutyphoeus bastianus* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 183.  
 1907. *Eutyphoeus andersoni* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 185.  
 1914. *Eutyphoeus bishambari* Stephenson, *Rec. Indian Mus.*, **10**: 355.  
 1916. *Eutyphoeus waltoni* (in part), Stephenson, *Rec. Indian Mus.*, **12**: 342.  
 1923. *Eutyphoeus bishambari*, Stephenson, *Fauna Br. India, Oligochaeta*: 431.  
 1923. *Eutyphoeus masoni*, Stephenson, *Fauna Br. India, Oligochaeta*: 442.  
 1923. *Eutyphoeus orientalis*, Stephenson, *Fauna Br. India, Oligochaeta*: 448.  
 1923. *Eutyphoeus paivai*, Stephenson, *Fauna Br. India, Oligochaeta*: 449.  
 1923. *Eutyphoeus waltoni* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 455.



FIGS. 153-157. *Eutyphoeus orientalis* (Beddard). 153. penial seta, 154. penis, 155. genital region, 156-157. spermatheca, lateral view (156), ventral view (157).

1938. *Eutyphoeus orientalis*, Gates, *Rec. Indian Mus.*, 40: 98.

Length 130-250 mm, diameter 4.5-10 mm, 130-217 segments. Prostomium pro/tanylobic. First dorsal pore 11/12. Clitellum xiii, 1/2-1/3 xiii-xvii. Setae  $aa = 1.8-2.2$   $ab-bc = 1.6-1.8$   $cd = 0.12-0.13$   $dd$  on xii,  $aa = 2.4$   $ab = 1.1$   $bc = 1.8$   $cd = 0.13$   $dd$  on xxiv. Male pores discharge into paired vestibula (bivestibulate) opening onto the body surface through circular to oval or slit-like apertures at  $a$ -mid  $bc$ , penes annular. Female pore single, on the left side, presetal at  $a$ . Spermathecal pores small, transverse slits, at  $bc$ . Genital markings paired, segmental, postsetal, usually on xv and xvi, sometimes on ix-x, xii-xiv, intersegmental usually on 18/19/20/21, sometimes on 21/22-26/27, at  $ab$ .

Lateral intestinal caeca absent, median ventral intestinal caeca 31-34 in xxiv-lxvii, supra-intestinal glands 4-7 pairs in lxxxvi-xcvi, typhlosole begins in xxviii. Dorsal vessel terminates posterior to gizzard in vii. Metandric, testis sac ventral, seminal vesicles in xii, extending to xiv-xvi. Penial setae ornamented with closely crowded circles of spines, tip simple or spoon-shaped, 4-5 mm long, 32-36  $\mu$  diameter. Each spermatheca with a median and a lateral ental diverticula, usually directed posteriorly, duct 0.8-1.5 mm long. Genital marking glands sessile, slightly protuberant into the body cavity.

*Type locality* : Calcutta, West Bengal, India.

*Type specimens* : *Typhoeus orientalis*: (?). *Typhaeus masoni*: In ZMUH, 7154. *Eutyphoeus paivai*: In ZSIC, ZEV 2836/7. *Eutyphoeus bastianus*: In ZSIC, ZEV 2850-51/7; ZMUH, 713. *Eutyphoeus andersoni*: In ZSIC, ZEV 2840/7. *Eutyphoeus bishambari*: In ZSIC, W 22/1.

*Material examined* : 5-3-1 Dehra Dun, 1930, coll. B.N. Chopra, An 490, in HAZFS, ZSI, Solan.

*Distribution* : India: *West Bengal*: Calcutta; *Bihar*: Sirsiah, Saripur, Pusa; *Uttar Pradesh*: Katwari Bazar, Buzru Kurme, Mowaie, Dehra Dun, Chhitauni.

**Biology :** It has been recorded from a pasture soil with 6.0 pH, 2.06% organic matter and 27.07% moisture (Soota, 1970). Its altitudinal range is from plains to an elevation of c. 610 m (Gates, 1938a). Its maximum population was recorded in the Doon Valley from June to September, juveniles occurring in June-July and sexually matured worms in August-September (Soota, 1970). It undergoes aestivation during the summer drought and winter cold. It deposits vermicelliform tower-like casts on the soil surface.

Monocystid protozoan parasite, *Aikinetocystis* sp., has been recorded from the lateral wall of the gut and also in the coelomic cavities of xii-xiv (Gates, 1938a).

#### 42. *Eutyphoeus kemp* Stephenson

(Figs. 158-159)

1914. *Eutyphoeus kemp* Stephenson, *Rec. Indian Mus.*, 8: 401.

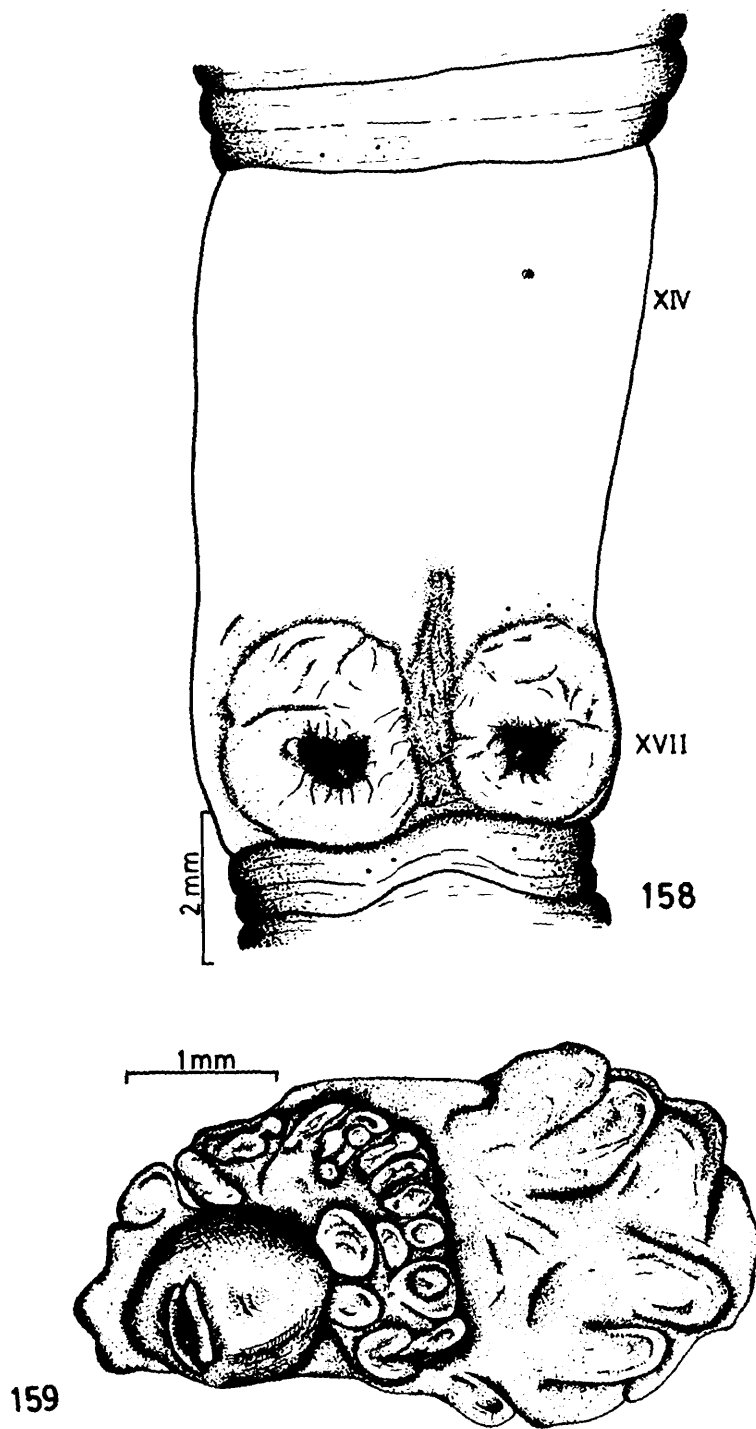
1923. *Eutyphoeus gammiei* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 434.

1938. *Eutyphoeus kemp*, Gates, *Rec. Indian Mus.*, 40: 87.

1972. *Eutyphoeus kemp*, Gates, *Trans. Am. phil. Soc.*, 62: 295.

Length 230 mm, diameter 6 mm, 254 segments. Prostomium prolobic. First dorsal pore 11/12. Clitellum 1/3 xiii-xvii. Setae *aa* = 1.7 *ab* = *bc* = 1.5 *cd* = 0.17 *dd* on xii, *aa* = 3.1 *ab* = 1.2 *bc* = 2.1 *cd* = 0.18 *dd* on xxiv. Male pores discharge into paired, deep, vestibula (bivestibulate), at *ab*, penes elongate, tubular. Female pore single, on the left side, presetal, just lateral to *a*. Spermathecal pores paired, small transverse slits, at median part of *bc*. Genital markings unpaired and median (?), on 21/22, 22/23 (?).

Lateral intestinal caeca absent, median ventral intestinal caeca (?), supra-intestinal glands 6 pairs in cxiii-cxviii. Dorsal vessel terminates posterior to gizzard in vii. Metandric, testis sac ventral, seminal vesicles in xii, extending to xiii. Penial setae ornamented with interrupted circles of very fine teeth, tip slightly spoon-shaped, 2.3-2.9 mm long, 34  $\mu$  diameter. Each spermatheca with numerous



FIGS. 158-159. *Eutyphoeus kempii* Stephenson 158. genital region, 159. spermatheca.

ental diverticula arranged in a semicircle on posterior face of a short duct, opening into the duct lumen through two groups of 5-6 apertures. Genital marking glands absent.

*Type locality* : Kobo, Abor Hills, Arunachal Pradesh, India.

*Type specimens* : In ZSIC, ZEV 5150/7; BMNH, 1933: 5: 25: 262.

*Material examined* : 0-0-1, syntype, ZEV 5150/7, in ZSIC.

*Distribution* : So far known from the type locality.

### 43. *Eutyphoeus pharpingianus* Michaelsen

(Figs. 160-162)

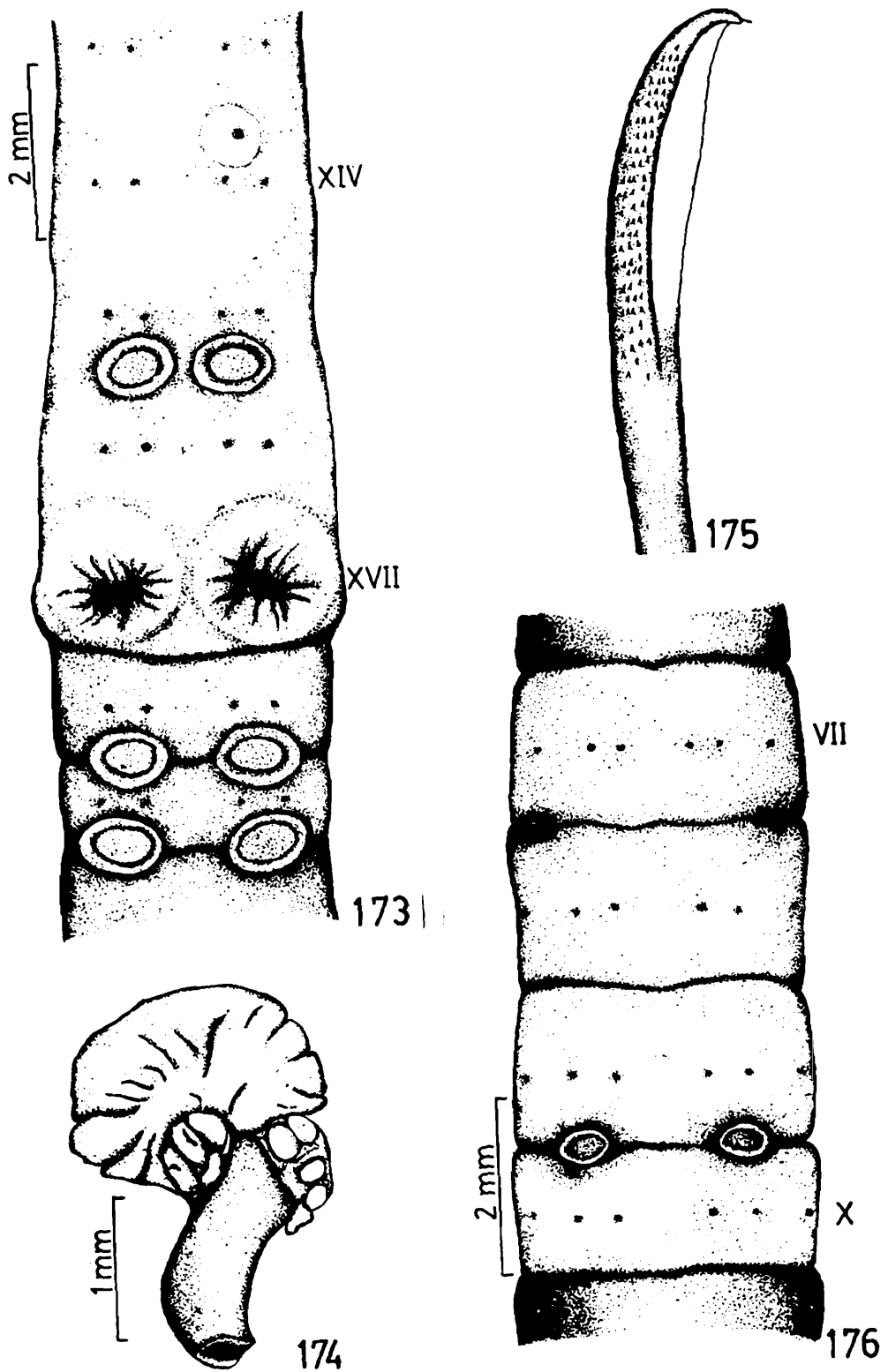
1907. *Eutyphoeus pharpingianus* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 177.

1923. *Eutyphoeus pharpingianus*, Stephenson, *Fauna Br. India, Oligochaeta*: 450.

1938. *Eutyphoeus pharpingianus*, Gates, *Rec. Indian Mus.*, 40: 104.

Length 130 mm, diameter 4.5 mm, 118 segments. Prostomium tanylobic. First dorsal pore 11/12. Clitellum xiii-xvii. Setae  $aa = 1.8$   $ab = 0.7$   $bc = cd = 0.09$   $dd$  on xii,  $aa = 2.6$   $ab = 1.5$   $bc = 1.5$   $cd = 0.11$   $dd$  on xxiv. Avestibulate, male pores discharge on body surface in fissures on somewhat circular porophores, at or close to *b*, penes absent. Female pores paired, presetal, at *a*. Spermathecal pores small, transverse slits, centres at *b*. Genital markings paired, postsetal, on xiii-xvi, at *ab*.

Lateral intestinal caeca absent, median ventral intestinal caeca 6 in xxviii-xxxiii, supra-intestinal glands 4 pairs in lxviii-lxxi. Dorsal vessel extends anterior to gizzard. Metandric, with male funnels in x, testis sac annular (?), seminal vesicles in xii, extending to xxxiii. Penial setae ornamented with sparse, small, irregularly toothed ridges or rows of short teeth, tip bluntly rounded, *c.* 1.66 mm long, 24  $\mu$  diameter. Each spermatheca with ental diverticula in the form of an interrupted circle of seminal chambers with more than 2 (?) openings into a very short duct. Genital marking glands (?).



FIGS. 160-162. *Eutyphoeus pharpius* Michaelsen. 160. penial seta, 161. spermatheca, 162. genital region (160 and 161 redrawn, after Stephenson 1923; others drawn from syntypes).

*Type locality* : Pharping, nr. Kathmandu, Nepal.

*Type specimens* : In ZSIC, ZEV 2863/7.

*Distribution* : So far known from the type locality.

*Remarks* : A dissected clitellate specimen in the Zoological Survey of India, Calcutta is macerated. The location of the ventral intestinal caeca and condition of the dorsal vessel, andry and testis sac need confirmation.

#### 44. *Eutyphoeus quadripapillatus* Michaelsen

(Figs. 163-165)

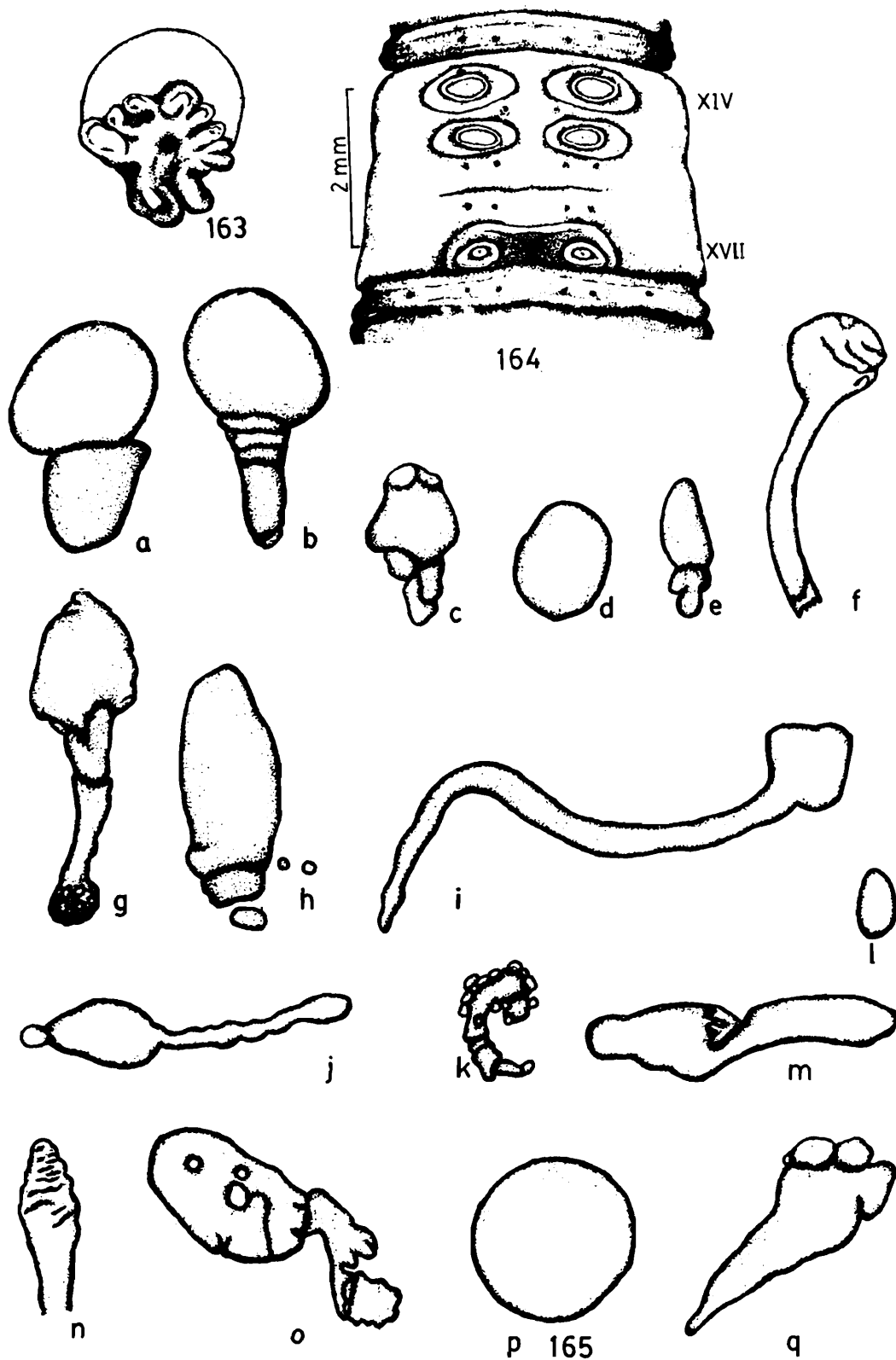
1907. *Eutyphoeus quadripapillatus* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 175.

1923. *Eutyphoeus quadripapillatus*, Stephenson, *Fauna Br. India, Oligochaeta*: 451.

1938. *Eutyphoeus quadripapillatus*, Gates, *Rec. Indian Mus.*, 40: 106.

Length 60-110 mm, diameter 3-4 mm, 120-168 segments. Prostomium tanylobic. First dorsal pore 11/12, sometimes 10/11 or 12/13. Clitellum xiii-xvii. Setae  $aa = 2-2.5$   $ab = 0.8$   $bc = 1.2-1.7$   $cd = 0.14$   $dd$  on xii,  $aa = 2.8-3.7$   $ab = 1-1.1$   $bc = 1.4-2.1$   $cd = 0.15$   $dd$  on xxiv. Avestibulate, male pores discharge on body surface on oval porophores, at or close to *b*, penes absent. Female pores paired, presetal, at or slightly median to *a*. Spermathecal pores small, transverse slits, at *ab*. Genital markings paired, postsetal, on xiii-xiv, sometimes on xv, at *ab*, occasionally absent.

Lateral intestinal caeca absent, median ventral intestinal caeca 4-9 in xxvii-xxxv, supra-intestinal glands 3-4 pairs in lxii-lxxi. Dorsal vessel extends anterior to gizzard into iii. Holandric, testis sacs annular (?), seminal vesicles in ix and xii, those of xii extend to xxvi-xxx, sometimes to lxxiii. Penial setae usually absent but penisetal follicles present, each follicle with 'fragments' of setae of various shapes, sometimes with unornamented 'normal' setae of 0.25-0.49 mm length. Each spermatheca with ental diverticula in the form of a circle of seminal chambers with 4 openings into a short duct. Genital marking glands absent.



FIGS. 163-165. *Eutyphoeus quadripapillatus* Michaelsen. 163. spermatheca, 164. genital region, 165. penial setae (163 redrawn, after Stephenson 1923; 164 based on a syntype; 165 redrawn, after Gates 1947).

*Type locality* : Saraghat, West Bengal, India.

*Type specimens* : In ZSIC, ZEV 2845-2846/7; MNHU, 7260; ZMUH, 7135, 7153.

*Material examined* : 0-1-3, syntypes, ZEV 2846/7, 0-0-2, syntypes, ZEV 2845/7, in ZSIC.

*Distribution* : India: *West Bengal*: Saraghat, Calcutta; *Bihar*: Sirsiah; *Uttar Pradesh*: Chhitauni, Gorakhpur.

*Remarks* : A dissected clitellate specimen in the Zoological Survey of India, Calcutta is macerated. The location of the ventral intestinal caeca and condition of the dorsal vessel, andry and testis sac need confirmation.

#### 45. *Eutyphoeus scutarius* Michaelsen

(Figs. 166-168)

1907. *Eutyphoeus scutarius* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 186.

1907. ?*Eutyphoeus comillahnus* (in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 187 (aclitellate specimens with spermathecal pores at mid *bc* and supra-intestinal glands in cxxvi-cxxx).

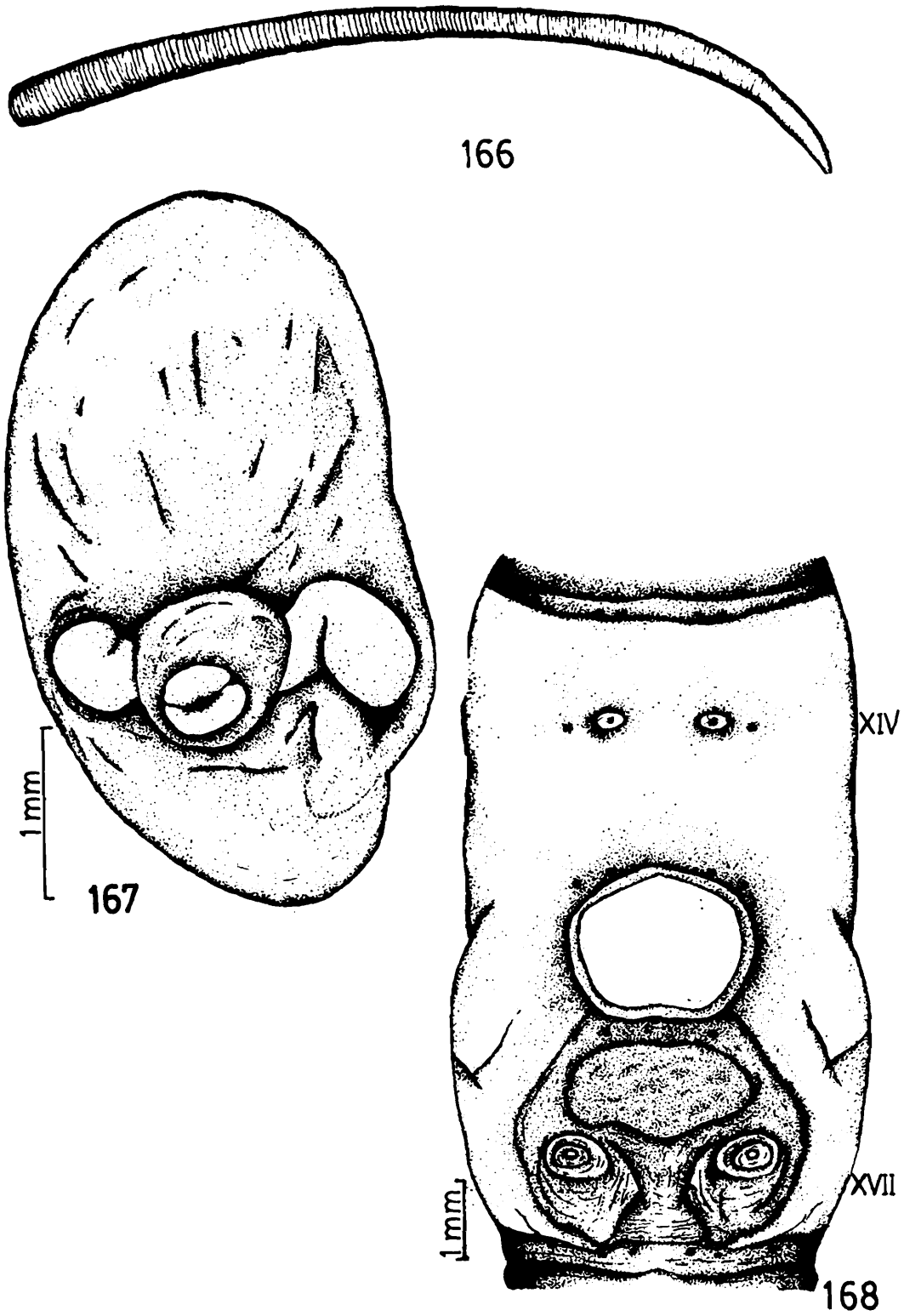
1923. ?*Eutyphoeus comillahnus* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 432.

1923. *Eutyphoeus scutarius*, Stephenson, *Fauna Br. India, Oligochaeta*: 452.

1938. *Eutyphoeus scutarius*, Gates, *Rec. Indian Mus.*, 40: 108.

Length 140-180 mm, diameter 5 mm, *c.* 290 segments. Prostomium tanylobic. First dorsal pore 11/12. Clitellum ½xiii-xvii. Setae *aa* = 2.5 *ab* = 1.1 *bc* = 2.1 *cd* = 0.2 *dd* on xii, *aa* = 3.4 *ab* = 1.2 *bc* = 1.7 *cd* = 0.21 *dd* on xxiv. Avestibulate, male pores discharge on body surface in fissures on oval porophores, at or close to *b*, penes absent. Female pores paired, presetal, slightly within setal lines *aa*. Spermathecal pores small, transverse slits, at mid *bc*. Genital marking single, median on 15/16, at *bb*.

Lateral intestinal caeca absent, median ventral intestinal caeca (?), supra-intestinal glands 5 pairs in cxxvi-cxxx (?) or cxxxiii-cxxxvii. Dorsal vessel extends anterior to gizzard, at least into v.



FIGS. 166-168. *Eutyphoeus scutarius* Michaelsen. 166. penial seta, 167. spermatheca, 168. genital region (166 redrawn, after Stephenson 1923; 167-168 based on a syntype).

Metandric, testis sac annular (?), seminal vesicles in xii, extending to xv. Penial setae ornamented with closely crowded circles of fine spines, tip pointed, c. 2 mm long, 80-95  $\mu$  diameter. Each spermatheca with a median and a lateral, sessile, ental diverticula, duct more than 1 mm long. Genital marking glands absent.

*Type locality* : Comillah, Chittagong district, Bangla Desh.

*Type specimens* : In ZSIC, ZEV 2844/7; ZMUH, 7132.

*Material examined* : 0-0-1, syntype, ZEV 2844/7, in ZSIC.

*Distribution* : So far known from the type locality.

*Remarks* : The syntype in Zoological Survey of India, Calcutta is broken into two pieces and parts of its intestine are ruptured. Hence, the location of ventral intestinal caeca and supra-intestinal glands is tentative.

#### 46. *Eutyphoeus turaensis* Stephenson

(Figs. 169-172)

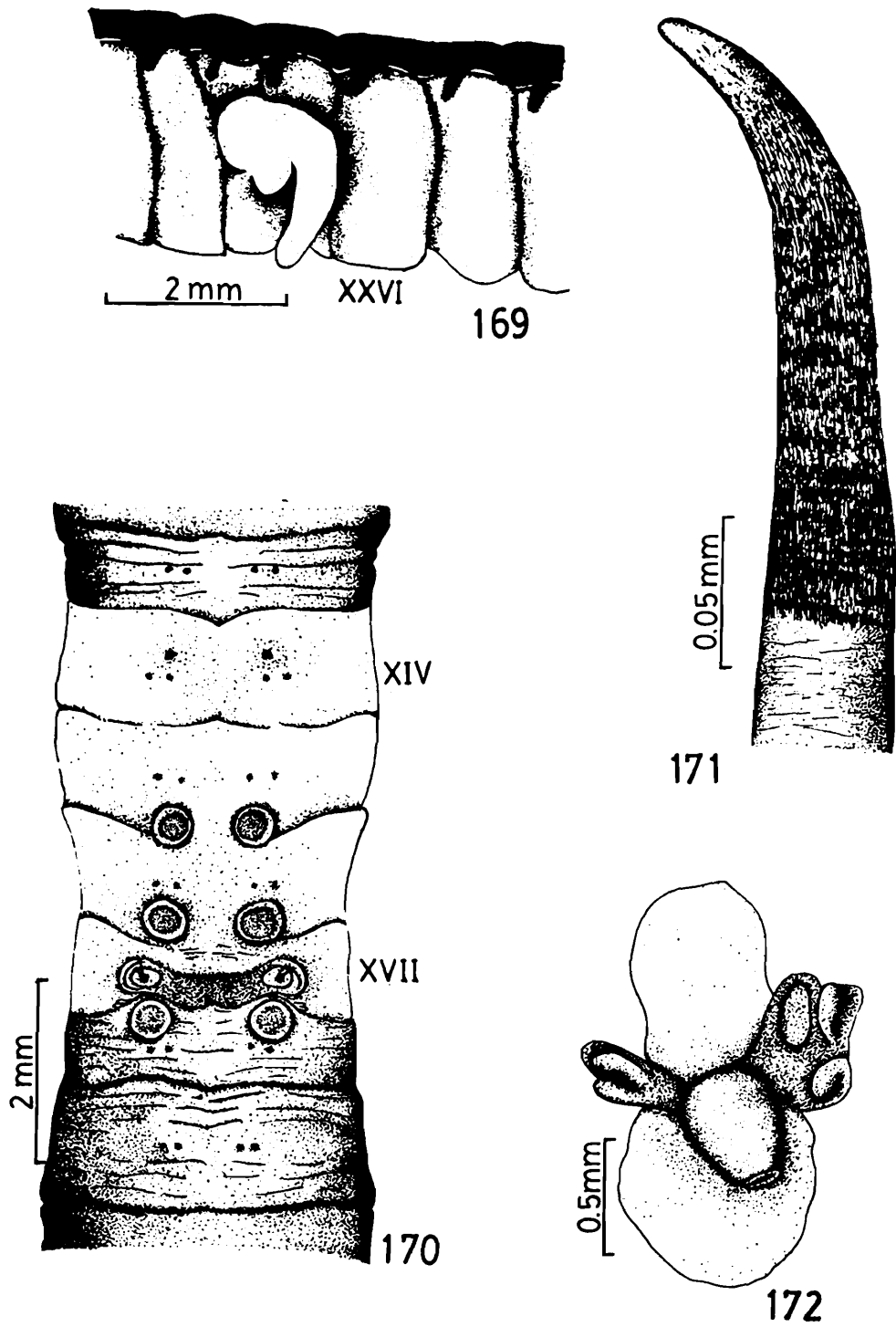
1920. *Eutyphoeus turaensis* Stephenson, *Mem. Indian Mus.*, 7: 244.

1923. *Eutyphoeus turaensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 453.

1972. *Eutyphoeus turaensis*, Gates, *Trans. Am. phil. Soc.*, 62: 305.

Length 100-177 mm, diameter 3.5 mm, 171-174 segments. Prostomium pro- or pro/tanylobic. First dorsal pore 11/12. Clitellum (?). Setae  $aa = 2.6-3.5$   $ab = 0.8-0.9$   $bc = 1.2-1.7$   $cd = 0.15$   $dd$  on xii,  $aa = 3.6-5.8$   $ab = 1.2-1.5$   $bc = 1.6-2.1$   $cd = 0.18-0.21$   $dd$  on xxiv. Avestibulate, male pores discharge on body surface in slight depressions, penes annular. Female pores paired, presetal, at *a*. Spermathecal pores small, transverse slits, slightly lateral to *b*. Genital markings paired at *ab*; postsetal, on xv-xvi, sometimes on xiv; presetal, sometimes on xviii.

Lateral intestinal caeca ventrally directed, digitiform, in xxviii, median ventral intestinal caeca 14-18 in xxxii-xlix, supra-intestinal glands 3-7 pairs in lxxv-lxxi, typhlosome begins in xxvii-xxviii. Dorsal vessel terminates anterior to gizzard in vi, sometimes in v.



FIGS. 169-172. *Eutyphoeus turaensis* Stephenson. 169. lateral view of intestine showing lateral intestinal caecum, 170. genital region, 171. penial seta, 172. spermatheca.

Metandric, testis sac ventral, seminal vesicles in xii, extending to xiv. Penial setae ornamented with circles of closely crowded fine spines especially towards the ectal end, tip bluntly pointed, 1.5-1.8 mm long, 35-43  $\mu$  diameter. Each spermatheca with a median and a lateral, shortly stalked, ental diverticula, duct short. Genital marking glands abseni.

*Type locality* : Tura, Garo Hills, Meghalaya, India.

*Type specimens* : In ZSIC, W 178/1, W 181/1; BMNH, 1933: 5: 25: 280.

*Material examined* : 3-4-0, syntypes, W 178/1, W 181/1, in ZSIC; 2-4-0 Tura, 16 July 1977, coll. J.M. Julka, An 491, in HAZFS, ZSI, Solan.

*Distribution* : So far known from the type locality.

*Remarks* : In a revisionary work on the genus, Gates (1938a) could not trace the lateral intestinal caeca in slightly softened immature syntypes of *E. turaensis* in the Indian Museum, now in Zoological Survey of India, Calcutta (W 178/1, W 182/1). On a careful examination of these syntypes and fresh material from the type locality, it is found that the lateral intestinal caeca are present in this species. These are ventrally directed in xxviii and their tips reach beneath the intestine.

*Biology* : It inhabits dark loam soil, under bark and in rotten wood at an altitude between 1075-1200 m. Monocystid protozoan parasites (*Aikinetocystis* sp.) have been reported from its coelomic cavity (Gates, 1938a, 1972).

#### 47. *Eutyphoeus waltoni* Michaelsen

(Figs. 173-176)

1907. *Eutyphoeus waltoni* (in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 179.

1907. *Eutyphoeus bengalensis* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 183.

1914. *Eutyphoeus ibrahimi* Stephenson, *Rec. Indian Mus.*, 10: 357.

1923. *Eutyphoeus ibrahimi*, Stephenson, *Fauna Br. India, Oligochaeta*: 438.

1923. *Eutyphoeus waltoni*, Stephenson, *Fauna Br. India, Oligochaeta*: 455.

1932. ? *Eutyphoeus* sp., Thapar, *Curr. Sci.*, 1: 129.

1938. *Eutyphoeus waltoni*, Gates, *Rec. Indian Mus.*, 40: 112.

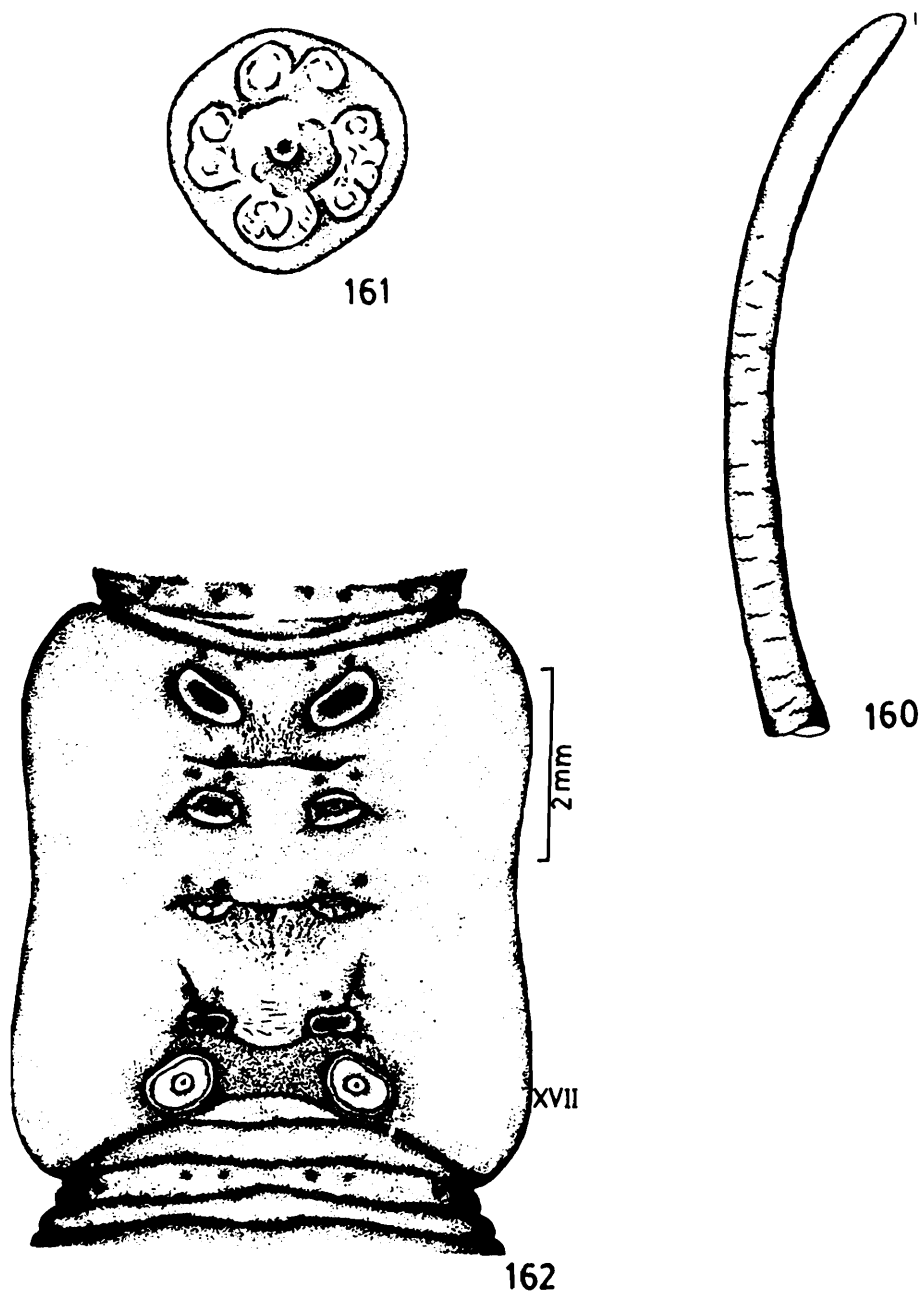
Length 53-230 mm, diameter 4-8 mm, 115-201 segments. Prostomium pro- or tanylobic. First dorsal pore 11/12. Clitellum xiii, ½xiii-xvii. Setae  $aa = 1.7-2.4$   $ab = 1-1.2$   $bc = 1.4-1.9$   $cd = 0.12-0.14$   $dd$  on xii,  $aa = 2.4-3.2$   $ab = 1.2-1.7$   $bc = 2.1-2.8$   $cd = 0.15$   $dd$  on xxiv. Male pores discharge into deep, well-like paired vestibula (bivestibulate) opening onto the body surface through circular apertures or transverse slits, at  $ac$ ; penes elongate, tubular, 1 mm long. Female pore single on the left side, presetal, slightly lateral to  $a$ . Spermathecal pores small, transverse slits, the centres at or slightly median to  $c$ . Genital markings paired (sometimes one of the pair absent), postsetal one ix, sometimes on viii, x, intersegmental on 14/15/16, 18/19, occasionally on 13/14, 16/17, 19/20-22/23.

Lateral intestinal caeca absent, median ventral intestinal caeca 24-29 in xxxiii-lxii, supra-intestinal glands 4-5 pairs in lxxvi-lxxxvi, typhlosole begins in xxvii-xxviii. Dorsal vessel terminates posterior to gizzard, in vii. Metandric, testis sac ventral, seminal vesicles in xii, extending to xiii-xiv. Penial setae ornamented with fairly closely crowded circles of small, fine teeth, tip spoon-shaped, 4-5 mm long, 20-30  $\mu$  diameter. Each spermatheca with a median and a lateral ental diverticula, often directed posteriorly, sometimes bound together in a connective tissue, duct slender, comparatively long,  $c$ . 2 mm in length. Genital marking glands sessile.

*Type locality* : Mainpuri, Uttar Pradesh, India.

*Type specimens* : *Eutyphoeus waltoni*: in ZSIC, ZEV 2849/7; MNHU, 7340; MZUT, 101; ZMUH, 7163-5. *Eutyphoeus bengalensis*: in ZSIC, ZEV 2843/7; *Eutyphoeus ibrahimi*: in ZSIC, W 21/1; BMNH, 1933: 5: 25: 275.

*Material examined* : In HAZFS, ZSI, Solan - Uttar Pradesh -coll. B.N. Chopra: 0-0-2 Dehra Dun, 1930, An 502; coll. M.N.



FIGS. 173-176. *Eutyphoeus waltoni* Michaelsen. 173. genital region, 174. spermatheca, 175. penial seta (redrawn, after Stephenson 1923), 176. spermathecal pore region.

Dutta & Raghunath: 0-0-27 Benaras Cantt., 10 Sept 1944, 15 Aug 1946, An 531, An 529; coll. K.P. Singh: 0-0-1 Badshahi Bag, Saharanpur district, 21 Sept 1972, An 527; coll. Asket Singh: 0-0-3 Dehra Dun, 25 Aug 1973, An 532; coll. J.C. Tripathi: 0-0-1 East Hope Town Tea Estate, Dehra Dun, 9 Aug 1974, An 526, 0-0-1 Pauri (Kandholia), alt. 1800 m, 27 Sept 1975, An 524, 0-0-10 Chamdhar (Srinagar), Pauri district, alt. 600 m, 28 Sept 1975, An 528, 0-0-5 Budhana (Srinagar), Pauri district, alt. 550 m, 29 Sept 1975, An 523, 0-0-6 Ranikhet, Tehri district, alt. 500 m, 1 Oct 1975, An 525, 0-0-3 Guthain (Kirtinagar), Tehri district, alt 500 m, 2 Oct 1975, An 522; coll. R.N. Chopra 1975: 0-0-1 Dhikala-Saraduli road, Pauri district, 7 Aug, An 521, 0-0-9 Dhikala-Machan, Pauri district, 13 Aug, An 520; coll. R.N. Bharghava: 0-0-1 Kandholi forest, Dehra Dun district, 17 Oct, An 530. *Himachal Pradesh* - coll. K.K. Mahajan 1972: 0-0-1 Swarghat, Bilaspur district, 19 Aug, An 507, 0-0-1 Una, 23 Aug, An 535; coll. M. Chandra 1973: 0-0-2 Dehra, Kangra district, 18 July, An 518, 0-0-5 Bilaspur, 1 Aug, An 506; coll. H.P. Agarwal 1973: 0-0-2 Gisani vill. near Banethi, Sirmour district, 5, 15 Sept, An 534, An 501, 0-0-11 Paonta, 17, 18, 20 Sept, An 503, An 504, An 505; coll. J.M. Julka 1978, Kangra district: 0-6-12 Nurpur, 8, 9 Aug, An 510-512, 0-0-2 Gangwal c. 20 km from Nurpur, 10 Aug, An 519, 0-4-24 Jasoor, alt. 400 m, 10 Aug, An 508-509, Chamba district: 0-0-11 Rajpura, c. 10 km from Chamba, alt. 950 m, 15 Aug, An 513-514, Mandi district: 0-0-12 Ner Chowk, c. 12 km from Sundar Nagar, 27 Aug, An 516, 0-0-8 Sundar Nagar, 28 Aug, An 515. *Jammu & Kashmir* - 0-0-1 Parel vill. near Samba, Jammu district, 30 Sept 1978, coll. H. Khajuria, An 533; 0-0-3 c. 10 km west of Mansar, Jammu district, 9 Oct 1978, H. Khajuria & M. Chandra, An 517.

*Distribution* : India: *West Bengal*: Calcutta, Baranagore, Tribeni, Saraghat; *Bihar*: Rajmehal, Siripur, Pusa, Patna, Giridih; *Uttar Pradesh*: Mainpuri, Fyzabad, Lucknow, Agra, Cawnpore, Dehra Dun, Allahabad, Ahraura, Moghul Serai, Varanasi, Chunar, Mirzapur, Tanda Falls, Madho Singh, Zafarabad, Jaunpur,

Janghai, Jhusi, Bhita, Ghoorpur, Pratabgarh, Sultanpur, Fatehpur, Rae Bareli, Bara Banki, Chhitauni, Gorakhpur, Badshahi Bag, Dhikala-Saraduli Road, Pauri, Chamdhar, Budhana, Ranikhet, Guthain, Kandholi forest, Dhikala Machan; *Madhya Pradesh*: Satna, Rewa, Gwalior (?); *Rajasthan*: Udaipur; *Gujarat*: Baroda, Navali (?); Ahmedabad (?); *Delhi*; *Chandigarh*; *Punjab*: Basi Muda, Hoshiarpur, Kapurthala; *Himachal Pradesh*: Swarghat, Una, Dehra, Bilaspur, Gisani vill. near Banethi, Paonta, Nurpur, Gangwal, Jasoor, Rajpura near Chamba, Ner Chowk, Sundar Nagar; *Jammu & Kashmir*: Parel vill. near Samba, Mansar.

Outside India: Pakistan (Lahore).

*Biology* : Its habitats include alluvial soils with pH range of 7.5-8.6, cultivated fields, plant nurseries, gardens, flower pots, manure heaps and banks of a tank. It is found in plains to an elevation of c. 610 m.

This species is mainly active from July to October in the Indo-Gangetic Plains. Breeding is restricted to August-October (Gates, 1945c, 1961b; Bhatti, 1962b; Khan, 1966), and aestivation is probably imposed during the summer drought and winter cold. It wanders aimlessly in large numbers on the soil surface towards the end of the rainy season in October-November, which also results in heavy mortality of the individuals due to heat (Gates, 1945c). Feeding, copulation and cast deposition occur above the soil surface. Bioluminescence has been reported in this species.

#### Genus 10. *Hoplochaetella* Michaelsen, 1900

1886. *Perichaeta* (in part), Bourne, *Proc. zool. Soc. Lond.*, 1886: 667.  
 1890. *Hoplochaeta* Beddard, *Proc. zool. Soc. Lond.*, 1890: 57 (non Rondani, 1856, *Dipt. ital. Prodr.*, 1: 113).  
 1900. *Hoplochaetella* Michaelsen, *Tierreich*, 10: 321.  
 1915. *Erythraeodrilus* Stephenson, *Mem. Indian Mus.*, 6: 100.  
 1923. *Erythraeodrilus*, Stephenson, *Fauna Br. India, Oligochaeta*: 457.  
 1923. *Hoplochaetella*, Stephenson, *Fauna Br. India, Oligochaeta*: 467.

1940. *Hoplochaetella*, Gates, *Rec. Indian Mus.*, 42: 207.

**Diagnosis :** Perichaetine. Combined male and prostatic pores 2 pairs on xvii or 17/18 and xix or 18/19, rarely one pair on xvii; seminal grooves absent. Oesophagus with a single gizzard in vi (sometimes in vii) and 4 pairs of discrete extramural calciferous glands in x-xiii, supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate; paired, enteronephric tufts in iv and v; numerous exonephric on the body wall in iv and posteriad segments. Paired, stomate, enteronephric megameronephridia in each segment from xii-xiv to the caudal end.

**Type species :** *Perichaeta stuarti* Perrier, 1886.

**Description :** Setae perichaetine throughout the body, some of the ventralmost setae in the spermathecal region modified as copulatory, internally associated with tubular glands. Combined male and prostatic pores 2 pairs on small porophores, on xvii or 17/18 and xix or 18/19, rarely one pair on xvii. Female pore single, median, presetal, on xiv. Spermathecal pores paired, segmental, between vii and x. Genital markings present or absent, when present with or without central apertures. Nephridiopores not recognized.

A large oesophageal gizzard in vi, rarely vii. Discrete calciferous glands 4 pairs in x-xiii, reniform, opening through short stalks directly into oesophagus ventro-laterally. Intestine begins in xvi, supra-intestinal glands absent, caeca occasionally present, typhlosole low, simple, lamelliform. Dorsal blood vessel single and complete; extra-oesophageal vessels paired, each receiving a vessel in xiii, formed by the union in xiv of a latero-parietal vessel and a commissure from the dorsal vessel; subneural vessel present or absent, when present united in xiv with the latero-parietal vessel; lateral hearts with connectives to the dorsal and supra-oesophageal vessels in x-xii, xiii. Unpaired lymph glands present or absent. Holandric; testis sacs present. Vasa deferentia, in species with 2 pairs of prostates, open separately into prostatic ducts, one vas deferens on each side turns anteriorly in xviii to join the anterior

prostatic duct, while the other vas deferens joins the posterior prostatic duct. In species with one pair of prostates, vasa deferentia on each side join with each other in xiv-xvi, the combined duct passing laterally to prostatic duct extends to xviii where it turns anteriorly to open into the prostatic duct in xvii. Spermathecae paired. Ovisacs paired, in xiv. Micromeronephridia, astomate, paired tufts, small, ? exonephric in ii and iii, large enteronephric in iv and v, numerous exonephric on the body wall in iv and posterior segments; paired stomate megameronephridia, in xii-xiv and posterior segments, discharging into a pair of lateral, parietal, longitudinal excretory canals, which open separately into rectum; each megameronephridium with a large functional funnel and several vestigeal secondary funnels, close to the nerve cord.

*Distribution* : Western coastal plains and western Ghats in Maharashtra, Goa and Karnataka, Shevaroy Hills in Tamil Nadu, and Nandi Hills in Karnataka.

#### Key to the species of *Hoplochaetella*

1. Combined male and prostatic pores 2 pairs ..... 2  
     Combined male and prostatic pores one pair ..... *H. kinneari*
2. All spermathecal pores on segment viii ..... 3  
     All spermathecal pores not on segment viii ..... 13
3. Last pair of hearts in xii ..... *H. righii*  
     Last pair of hearts in xiii ..... 4
4. Genital markings absent ..... *H. inornata*  
     Genital markings present ..... 5
5. Genital markings with central apertures, associated internally with tubular and sausage-shaped glands ..... 6  
     Genital markings without central apertures associated internally with sessile glands ..... 9

- |  |   |
|--|---|
| 6. Genital markings unpaired and median .....  | 7   |
| Genital markings paired .....  | 8   |
| 7. Genital marking on xix .....  | <i>H. khandalaensis</i><br><i>khandalaensis</i> |
| Genital markings on xvi and xix .....  | <i>H. khandalaensis</i><br><i>dichordarius</i>  |
| 8. Genital markings intersegmental, on 16/17,<br>19/20-20/21 .....   | <i>H. powelli</i>                               |
| Genital markings segmental, on xiii-xv .....   | <i>H. panchganiensis</i>                        |
| 9. Genital markings in part paired; spermathecal-<br>diverticula in a complete circle .....  | <i>H. suctoria</i>                              |
| Genital markings unpaired; spermathecal<br>diverticula in two groups or an incomplete<br>circle around duct .....  | 10  |
| 10. Genital markings median .....  | 11  |
| Genital markings with centres on or close to<br>male pore lines .....  | 12  |
| 11. Genital markings on xvii and xix .....   | <i>H. affinis</i>                               |
| Genital markings on 16/17 and xx .....   | <i>H. bifoveata</i>                             |
| 12. Genital markings presetal on xvi or 16/17<br>(usually on right side), presetal on xx or 19/20<br>(usually on left side); copulatory setae on ix<br>present ..... | <i>H. kempfi</i>                                |
| Genital markings on right side of xviii-xix,<br>sometimes xvii; copulatory setae on ix absent ...  | <i>H. kurmagarensis</i>                         |
| 13. Spermathecal pores on vii and ciii .....   | <i>H. stuarti</i>                               |
| Spermathecal pores not so located .....  | 14  |
| 14. Spermathecal pores on viii and ix .....  | 15  |
| Spermathecal pores on viii and x .....   | <i>H. londensis</i>                             |
| 15. Last pair of hearts in xii .....   | 16  |
| Last pair of hearts in xiii .....  | <i>H. mullani</i>                               |
| 16. Copulatory setae on viii present .....   | 17  |
| Copulatory setae on viii absent .....  | <i>H. karnatakensis</i>                         |

17. Septum 6/7 present; spermathecal pores on viii just in front of setal arc; parietal glands lateral to ectal ends of prostatic ducts..... *H. sanvordemensis*

Septum 6/7 absent; spermathecal pores on viii equidistant between setal arc and 7/8; parietal glands median and lateral to ectal ends of prostatic ducts..... *H. anomala*

#### 48. *Hoplochaetella affinis* Stephenson

(Figs. 177-180)

1917. *Hoplochaetella affinis* (in part) Stephenson, *Rec. Indian Mus.*, 13: 399 (excluding specimens from Vareeg Islet).

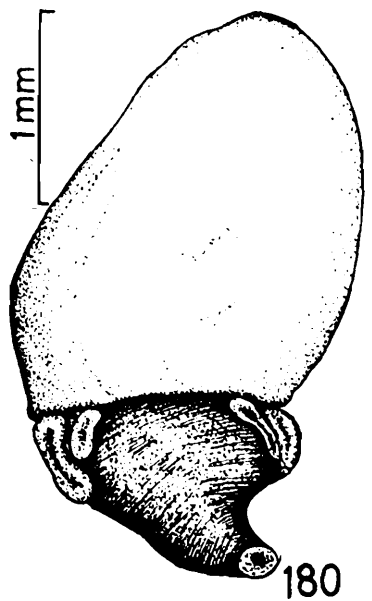
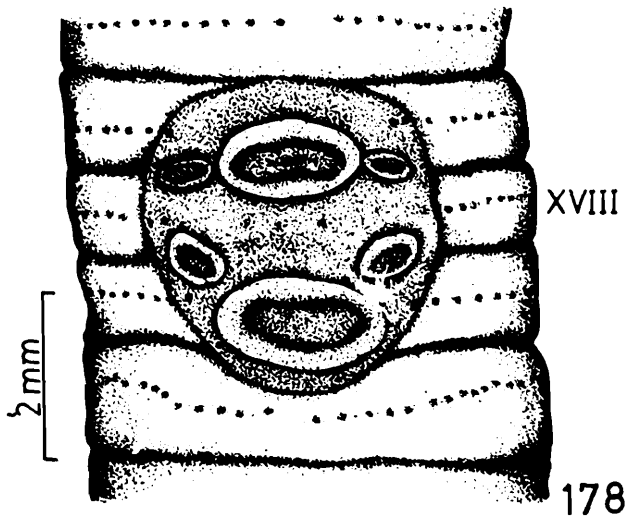
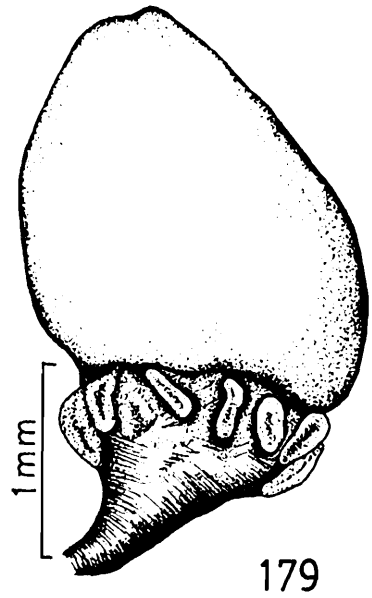
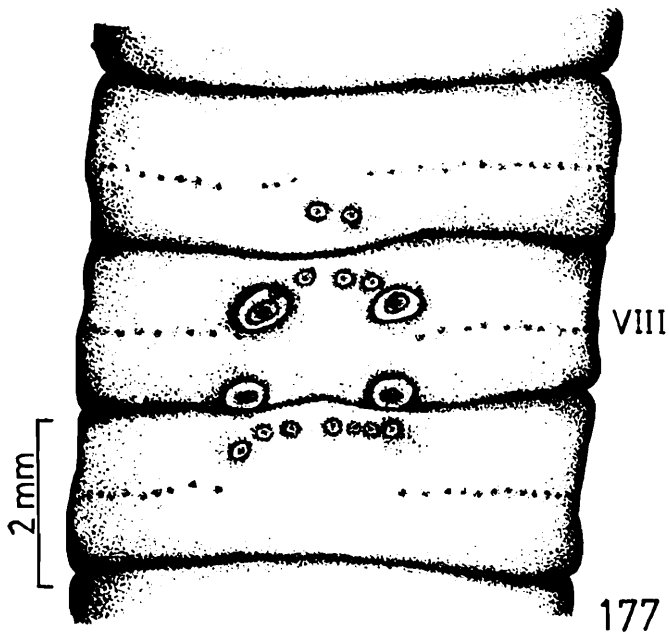
1923. *Erythraeodrilus suctorius* var. *affinis* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 466.

1940. *Hoplochaetella affinis*, Gates, *Rec. Indian Mus.*, 42: 209.

1940. *Hoplochaetella affinis*, Chapman, *Rec. Indian Mus.*, 42: 375.

Length 140 mm, diameter 7 mm, 130 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum (?). Setae  $aa = 2ab = 2bc = 2.3yz = zz$  on xii; 72 on v, 80 on ix, 74 on xii, 65 on xix; setae *a* on vii, some or all of *a-d* on viii and ix copulatory. Combined male and prostatic pores minute, at about centres of slightly depressed porophores on xvii (slightly anterior to 17/18) and xix (slightly posterior to 18/19), at *ce*, 0.13 body circumference apart. Spermathecal pores minute, 2 pairs, on viii at *cd*, 0.08 body circumference apart, anterior pair slightly in front of the setal arc, posterior pair slightly anterior to 8/9. Genital markings oval without central apertures, unpaired and median, postsetal, on xvii and xix.

Septa 4/5 muscular, 5/6/7 delicate, 7/8/9 slightly muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxiii to (?). Supraoesophageal vessel single, ix-xiii. Subneural vessel (?), last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix and xii. Vasa deferentia slightly enlarged into ejaculatory bulbs before



FIGS. 177-180. *Hoplochaetella affinis* Stephenson. 177. spermathecal pore region, 178. genital region, 179-180. spermatheca, anterior view (179), posterior view (180) (all drawn from a syntype).

opening into the prostatic ducts. Penial setae (?). Spermathecae 2 pairs in viii, each with an incomplete circle of 9-12 ventrally directed, adherent to the duct, sinuous, digitiform ental diverticula. Copulatory setae ornamented with spirally arranged rows of teeth, 0.48-0.66 mm long, 23-32  $\mu$  diameter. Copulatory setal glands 1-2 mm long, in paired coelomic sacs, in viii and ix. Parietal glands (?). Genital marking glands sessile.

*Type locality* : Mormugao Bay, Goa, India.

*Type specimens* : In ZSIC, W 128/1; BMNH, 1925: 5: 12: 49.

*Material examined* : 0-5-0, syntypes, W 128/1, in ZSIC.

*Distribution* : So far known from the type locality.

#### 49. *Hoplochaetella anomala* Stephenson

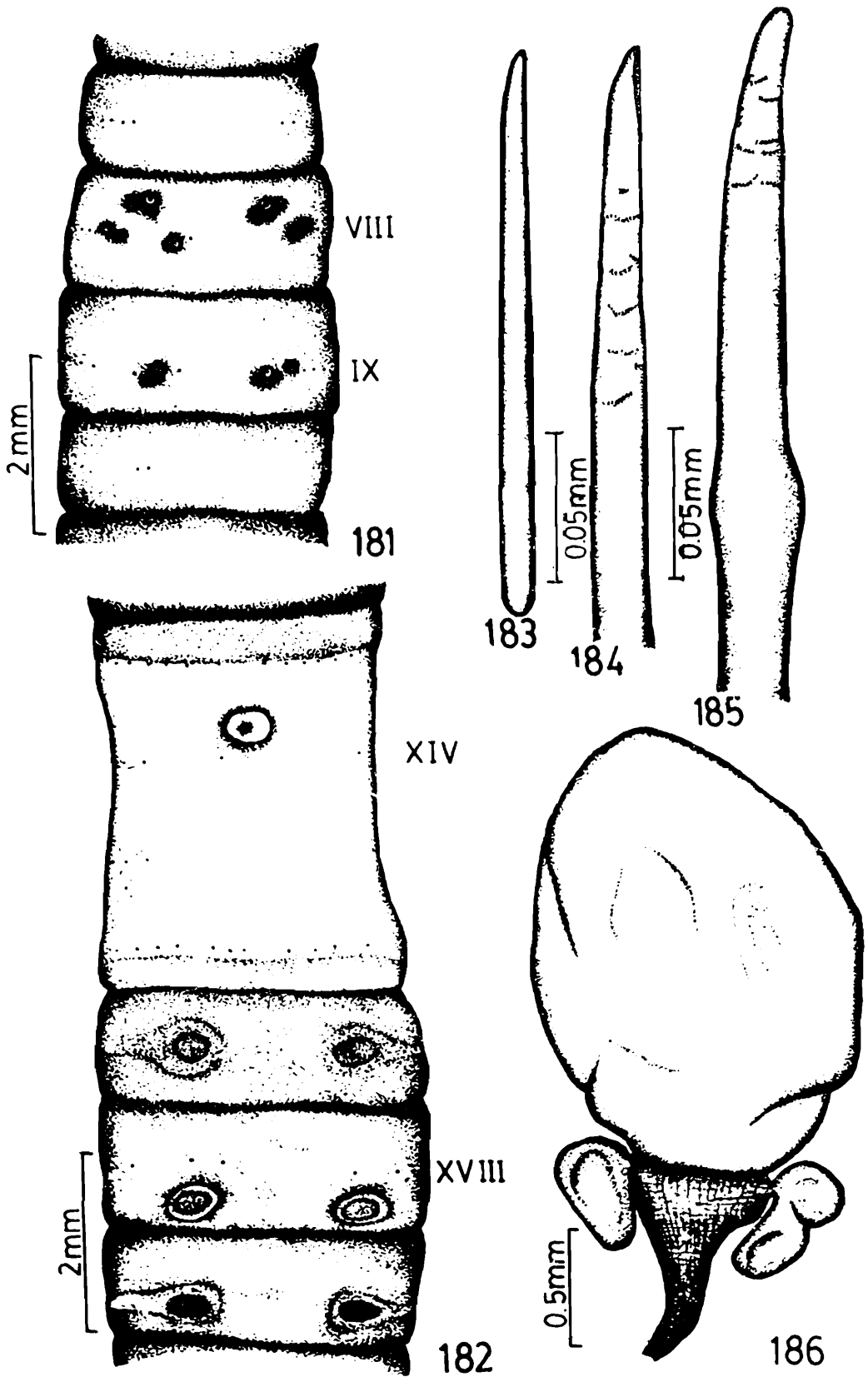
(Figs. 181-186)

1920. *Hoplochaetella anomala* Stephenson, *Mem. Indian Mus.*, 7: 223.

1923. *Erythraeodrilus anomalus*, Stephenson, *Fauna Br. India, Oligochaeta*: 458.

1940. *Hoplochaetella anomala*, Gates, *Rec. Indian Mus.*, 42: 212.

Length 48-139 mm, diameter 2.5-4 mm, 66-117 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvi. Setae *aa* = 1.3-1.8 *ab* = 1.5-2 *bc* = 1.5-3.2 *yz* = 0.4-0.6 *zz* on xii, *aa* = 2-2.4 *ab* = 2.1-2.3 *bc* = 2.8-3.5 *yz* = 0.5-0.7 *zz* on xxiv; 15-24 on ii, 31-44 on vii, 33-46 on xii, 34-46 on xx; some or all of setae *b-f* on viii and ix copulatory and shifted around spermathecal pores. Combined male and prostatic pores minute, at about centres of slightly depressed porophores on setal arcs of xvii and xix, at *cd*, 0.10-0.15 body circumference apart. Spermathecal pores paired, minute, on viii and ix at or close to *c*. 0.11-0.15 body circumference apart, those on viii presetal, about equidistant from the setal arc and 7/8, those on ix in or slightly posterior to the setal arc. Genital markings present or absent, if present, oval without central apertures, paired (occasionally one of the pair wanting), on or



FIGS. 181-186. *Hoplochaetella anomala* Stephenson. 181. spermathecal pore region, 182. genital region, 183. penial seta, 184. copulatory seta, 185. seta *a* on xviii, 186. spermatheca.

slightly lateral to male pore lines, usually on xviii (presetal or postsetal), sometimes on 15/16, xix (presetal), xx (postsetal).

Septa 4/5, 9/10-12/13 slightly muscular, 5/6, 7/8/9 delicate, 6/7 absent. Gizzard in a space between septa 5/6 and 7/8, belonging to segment vii as the lateral commissural blood vessels of vi and vii are anterior and posterior to the gizzard respectively. Intestinal caeca absent; typhlosole xxii-xxiv to lx-xciii. Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xii. Lymph glands absent. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x rudimentary. Vasa deferentia slightly enlarged into ejaculatory bulbs before opening into the prostatic ducts. Penial setae associated with each prostatic duct, unornamented, 0.12-0.22 mm long, 7-13  $\mu$  diameter. Spermathecae paired in viii and ix, each with a median and a lateral, uni- to multiloculate, shortly stalked, ventrally directed ental diverticula. Copulatory setae ornamented with short transverse rows of small teeth, 0.61-0.78 mm long, 19-27  $\mu$  diameter. Copulatory setal glands 1-2.2 mm long, in paired coelomic sacs in viii and ix, 2-5 in each sac. Parietal glands paired in xvii and xix, lateral and median to the ectal ends of prostatic ducts. Genital marking glands sessile, oval.

*Type locality* : Belgaum, Karnataka, India.

*Type specimens* In ZSIC, W 290/1, BMNH, 1933: 5: 25: 863-4.

*Material examined* : 0-2-5, syntypes, W 290/1, in ZSIC; coll. K.K. Tiwari: 0-1-4 Panchgani, 9, 20, 21, 28 Aug 1964, HAZFS, ZSI, Solan, An 640, An 639, An 638, An 641, coll. J.M. Julka, 1979: 1-3-57 Panchgani, 25, 26 Aug, An 636, An 637, 0-0-28 Belgaum, 29 Aug, An 642, 0-2-22 Tirthahalli, 5 Sept, An 643, 0-0-14 Somwarpet, 11 Sept, An 644, all in HAZFS, ZSI, Solan.

*Distribution* : India: *Maharashtra*: Panchgani; *Karnataka*: Belgaum, Somwarpet, Tirthahalli.

**Biology :** Found under dried cow dung; in red sandy loam soil around roots of grasses. It deposits castings on the surface of the soil. When handled, it produces serpentine movements and the posterior end is autotomized.

### 50. *Hoplochaetella bifoveata* Stephenson

1917. *Hoplochaetella bifoveata* Stephenson, *Rec. Indian Mus.*, 13: 398.  
 1922. *Erythraeodrilus kempfi* var. *bifoveatus*, Stephenson, *Rec. Indian Mus.*, 24: 437.  
 1923. *Erythraeodrilus kempfi* var. *bifoveatus*, Stephenson, *Fauna Br. India, Oligochaeta*: 462.  
 1940. *Hoplochaetella bifoveata*, Gates, *Rec. Indian Mus.*, 42: 218.

Length 82 mm, diameter 5.5 mm, 62(+) segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum ½xiii-xvi. Setae  $aa = 2 ab = 1.6 bc = 1.1 yz = 0.2 zz$  on xii,  $aa = 2 ab = 1.8 bc = yz = 0.3 zz$  on xxiv; 44-50 on ii, 72-83 on vii, 60-86 on xii, 63-75 on xx; some or all of setae *b-d* on viii, *c* or *d* on ix, sometimes *a-c* on vii copulatory. Combined male and prostatic pores minute, at about centres of small oval porophores, on xvii slightly anterior to 17/18 and on xix slightly posterior to 18/19, 0.03 body circumference apart. Spermathecal pores minute, 2 pairs on viii, at *bc*, 0.03 body circumference apart, anterior pair presetal, *c* equidistant from setal arc and 7/8, posterior pair postsetal, slightly anterior to 8/9. Genital markings oval, without central apertures, unpaired, median, on 16/17, presetal on xx.

Septa 4/5 slightly muscular, 5/6-8/9 delicate, 9/10-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxii to (?). Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of the septa 9/10/11/12; seminal vesicles in ix and xii. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae (?). Spermathecae 2 pairs in viii, each with a median

and a lateral group of 1-2 (sometimes a circle of 7-8 with a posterior gap around the duct), ventrally directed, sinuous, digitiform ental diverticula. Copulatory setae ornamented with a few short transverse rows of small spines 0.4-0.44 mm long, 19-22  $\mu$  diameter. Copulatory setal glands 1.4-2 mm long, in paired coelomic sacs in viii and ix, sometimes in vii, 1-4 in each sac. Parietal glands paired in the form of complete or incomplete annular collars around the ectal ends of the prostatic ducts in xvii and xix. Genital marking glands sessile, oval.

*Type locality* : Talewadi, nr. Castle Rock, Karnataka, India.

*Type specimens* : In ZSIC, W 129/1.

*Material examined* 0-0-1, type, W 129/1, in ZSIC.

*Distribution* : India: *Karnataka*: Talewadi, nr. Castle Rock; *Maharashtra*: Bombay.

### 51. *Hoplochaetella inornata* Stephenson

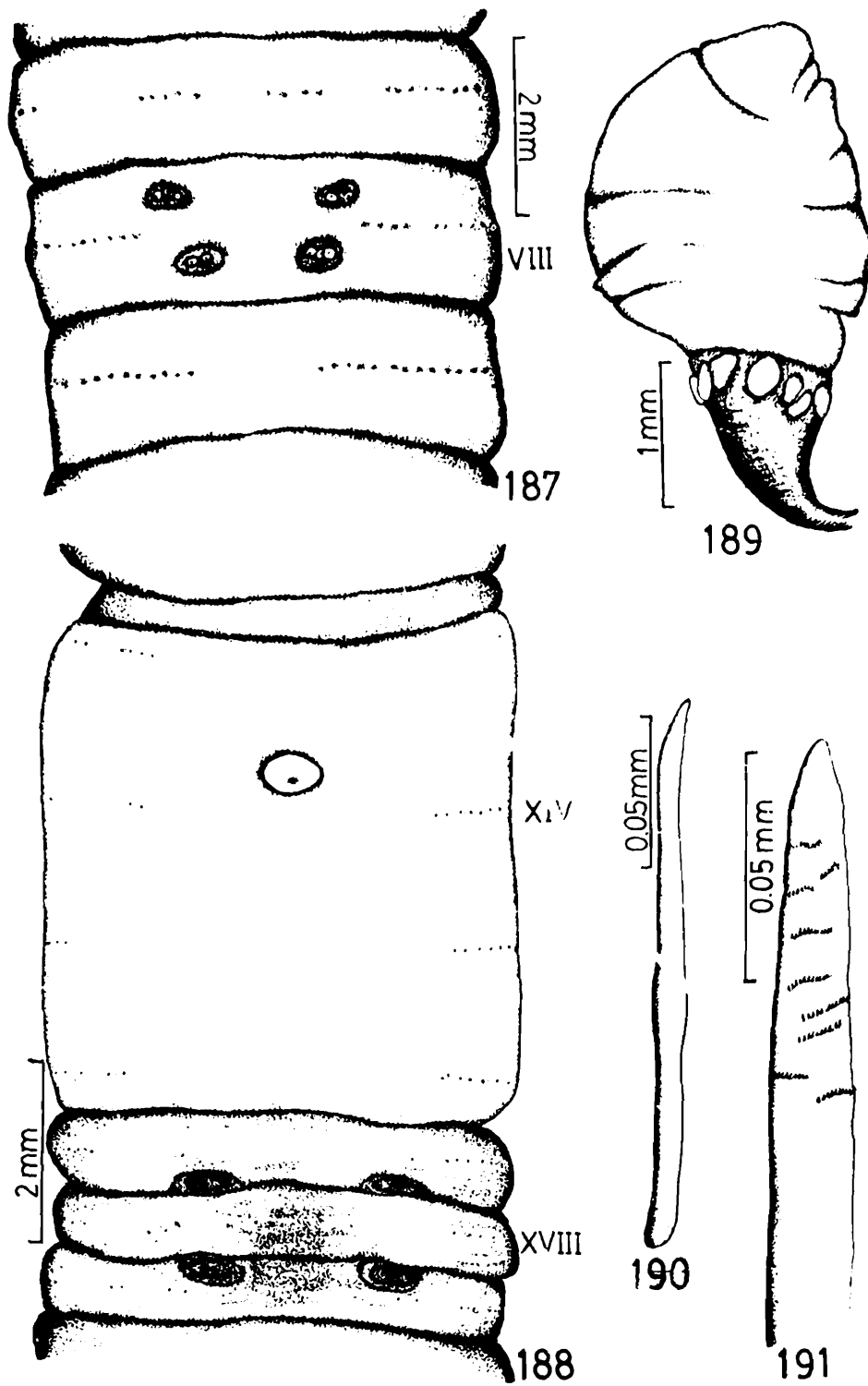
(Figs. 187-191)

1917. *Hoplochaetella inornata* Stephenson, *Rec. Indian Mus.*, 13: 395.

1923. *Erythraeodrilus inornatus*, Stephenson, *Fauna Br. India, Oligochaeta*: 459.

1940. *Hoplochaetella inornata*, Gates, *Rec. Indian Mus.*, 42: 219.

Length 101-128 mm, diameter 6 mm, 79 (?) -122 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum  $\frac{1}{2}$ xiii-xvi. Setae  $aa = 2$   $ab = 2-2.3$   $bc = 2.1-2.2$   $yz = 1.2$   $zz$  on xii,  $aa = 2-2.6$   $ab = 2.2-2.9$   $bc = 1.8-2.3$   $yz = 0.8-0.9$   $zz$  on xxiv; 35-48 on ii, 63-73 on vii, 66-84 on xii, 63-85 on xx; setae  $a-c$ , sometimes  $d$  or  $e$  on viii copulatory, shifted towards both anterior and posterior pairs of spermathecal pores. Combined male and prostatic pores minute, at about centres of depressed oval porophores, on posterior margin of xvii and anterior margin of xix at  $ce$ , 0.09-0.11 body circumference apart. Spermathecal pores minute, 2 pairs on viii at  $bd$ , equidistant from the setal arc and intersegmental furrows, anterior



FIGS. 187-191. *Hoplochaetella inornata* Stepnenson. 187. spermathecal pore region, 188. genital region, 189. spermatheca, 190. penial seta, 191. copulatory seta.

pair 0.11-0.12 body circumference apart, posterior pair 0.06-0.09 body circumference apart. Genital markings absent.

Septa 4/5 slightly muscular, 5/6-8/9 delicate, 9/10-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxiii to lxxxvii. Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x rudimentary. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae associated with each prostatic duct, unornamented, 0.13 mm long, 11  $\mu$  diameter. Spermathecae 2 pairs in viii, each with a circle of c. 12 ventrally directed, sinuous, digitiform ental diverticula adherent around the duct. Copulatory setae ornamented with a few transverse rows of small spines, 0.54-0.63 mm long, 20-24  $\mu$  diameter. Copulatory setal glands 2.07-2.44 mm long in a pair of coelomic sacs in viii, 3-5 in each sac. Parietal glands paired, median to the ectal ends of the prostatic ducts in xvii, xviii and xix.

*Type locality* : Talewadi, nr. Castle Rock, Karnataka, India.

*Type specimens* : In ZSIC, W 130/1.

*Material examined* : 0-0-6 Castle Rock, 28 Aug 1979, coll. J.M. Julka, An 630, HAZFS, ZSI, Solan.

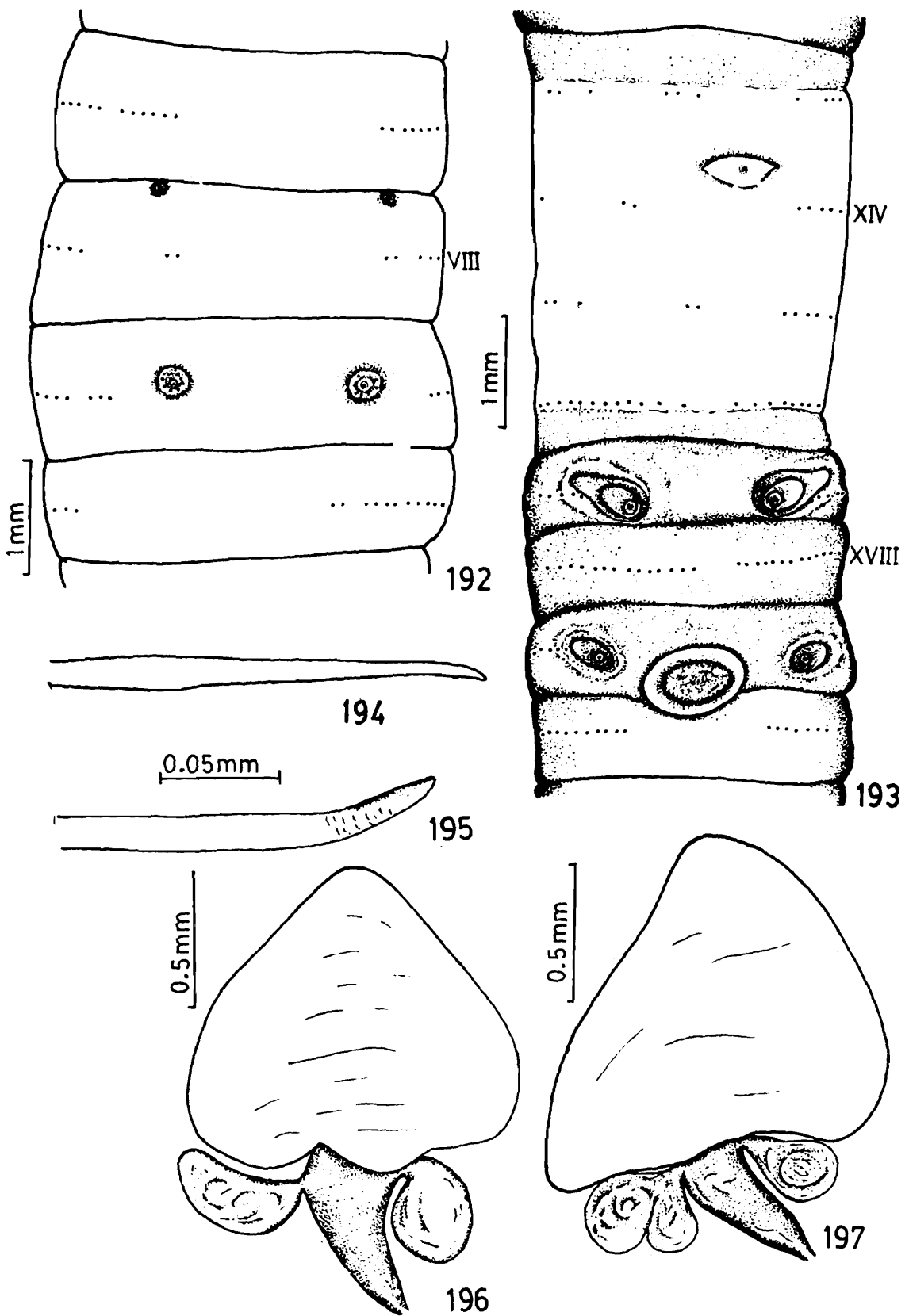
*Distribution* : India: *Karnataka*: Talewadi, Castle Rock.

*Biology* : It inhabits top 7.5-10 cm layer of red loam soil and usually crawls on the soil surface in early morning during the rainy season. It readily responds to thigmotactic stimuli in the form of serpentine movements and also autotomizes the tail portion.

## 52. *Hoplochaetella karnatakensis* sp. nov.

(Figs. 192-197)

Length 64-82 mm, diameter 2.5-3 mm, 103-106 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum



FIGS. 192-197. *Hoplochaetella karnatakensis* sp. nov. 192. spermathecal pore region, 193. genital region, 194. penial seta, 195. copulatory seta, 196-197. spermathecae.

annular,  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvi. Setae  $aa = 1.6-2$   $ab = 1.7-2.5$   $bc = 1.2-2.2$   $yz = 0.2-0.3$   $zz$  on xii,  $aa = 2.4-2.8$   $ab = 2.4-3.3$   $bc = 1.8-2.2$   $yz = 0.3$   $zz$  on xxiv; 13-17 on ii, 38-44 on vii, 36-38 on xii, 40-51 on xx; setae  $c-g$ , sometimes  $b$  and  $h$  on ix copulatory, arranged in a circle around each spermathecal pore. Combined male and prostatic pores minute, at centres of depressed oval porophores, on or a little posterior to the setal arcs of xvii and xix at  $fg$ , 0.13-0.21 body circumference apart. Spermathecal pores, paired, minute, on viii and ix at  $fh$ , those on viii presetal, closer to  $\frac{7}{8}$  than to the setal ring (0.18-0.20 body circumference apart), those on ix, on or a little anterior to the setal ring (0.15-0.17 body circumference apart). Genital markings usually present, oval, without central apertures, unpaired, postsetal, slightly lateral to mid-ventral line, on xix.

Septa 4/5, 8/9/10 slightly muscular, 5/6/7/8 delicate, 10/11/12/13 muscular. Gizzard in vii. Intestinal caeca absent; typhlosole xviii to lxxxv-lxxxvii. Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xii. Lymph glands absent. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xii, those of ix and xii extending to the dorsal line. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae 2, associated with each prostatic duct, unornamented, 0.22-0.26 mm long, 11  $\mu$  diameter. Spermathecae paired in viii and ix, each with a median and a lateral, free, clavate, ental diverticula. Copulatory setae ornamented with a few short transverse serrated ridges, 0.52-0.58 mm long, 24-30  $\mu$  diameter. Copulatory setal glands 1.5-2.2 mm long, in a pair of coelomic sacs in ix, 5-6 in each sac. Parietal glands paired in xvii and xix, lateral to the ectal ends of prostatic ducts. Genital marking glands sessile, oval.

*Material examined* 0-0-3 grassland, soil red loam, Kemmengundi, 13.48 N, 75.69 E, altitude *c.* 1480 m, 9 Sept 1979, coll. J.M. Julka (holotype and one paratype in ZSIC. An 1816/1, An 1817/1, one paratype in HAZFS, ZSI, Solan, An 724).

*Distribution* : India: Kemmengundi, Karnataka, S. India.

*Etymology* : Derived from the area 'Karnataka', in which the type locality of the species is located.

*Remarks* : *Hoplochaetella karnatakensis* sp. nov. belongs to a group of species with 2 pairs of male pores, paired spermathecal pores on viii and ix, last pair of hearts in xii and without lateral intestinal caeca. It can be distinguished from the other two species of this group, *H. anomala* Stephenson, 1920 and *H. sunvordemensis* sp. nov. (described elsewhere in this work) by the characteristics as given in Table 5 (on page 195).

### 53. *Hoplochaetella kemp*i Stephenson

(Figs. 198-202)

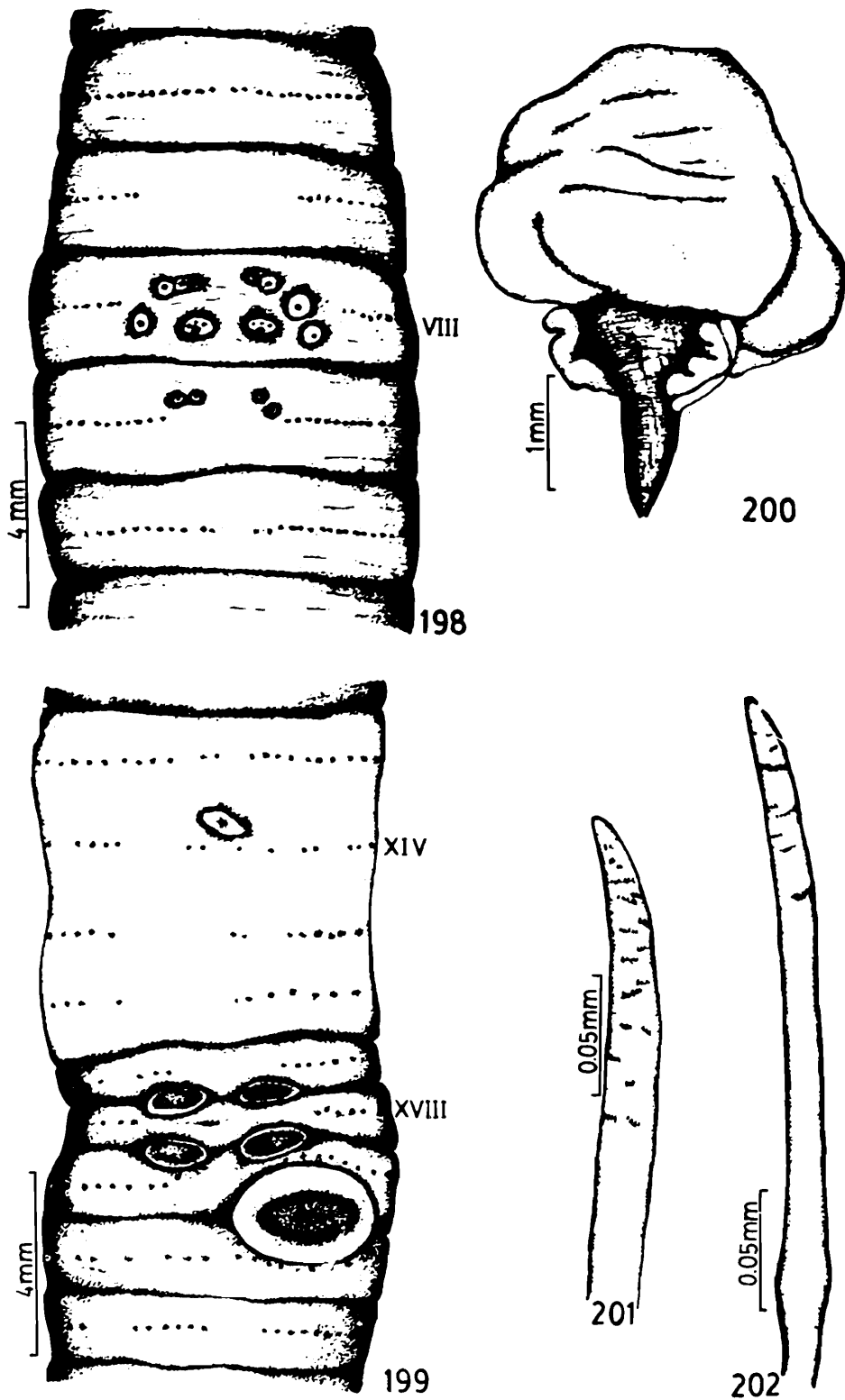
1917. *Hoplochaetella kemp*i Stephenson, *Rec. Indian Mus.*, 13: 392.

1923. *Erythraeodrilus kemp*i (in part). Stephenson, *Fauna Br. India, Oligochaeta*: 460 (excluding var. *bifoveatus*).

1940. *Hoplochaetella kemp*i, Gates, *Rec. Indian Mus.*, 42: 221.

1940. *Hoplochaetella kemp*i, Chapman, *Rec. Indian Mus.*, 42: 376.

Length 70-197 mm, diameter 4-6.5 mm, 106-120 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum xiii-xvi. Setae  $aa = 2$   $ab = 2$   $bc = 1.6$   $yz = 0.4$   $zz$  on xii,  $aa = 2$   $ab = 2.1$   $bc = 2.5$   $yz = 0.5$   $zz$  on xxiv; 34-41 on ii, 54-63 on vii, 75-79 on xii, 45-70 on xx; some of ventral setae on viii and ix, sometimes on vii copulatory. Combined male and prostatic pores minute, at about centres of small oval porophores, on or slightly anterior to 17/18 and slightly posterior to 18/19, at  $ac$ , 0.06 body circumference apart. Spermathecal pores minute, 2 pairs on viii at  $ac$ , 0.06 body circumference apart, anterior pair slightly anterior to the setal arc, posterior pair postsetal, slightly nearer to 8/9 than to the setal arc. Genital markings oval without central apertures, unpaired, centres usually on or lateral to the male pore lines, two



FIGS. 198-202. *Hoplochaetella kempii* Stephenson. 198. spermathecal pore region, 199. genital region, 200. spermatheca, 201. copulatory seta, 202. penial seta.

markings usually present, anterior marking presetal on xvii or on 16/17 usually on right side, posterior marking on xx or on 19/20 on left side.

TABLE 5. Comparison of *H. karnatakensis* and *H. sanvordemensis* spp. nov. with *H. anomala*.

Character	<i>H. karnatakensis</i>	<i>H. sanvordemensis</i>	<i>H. anomala</i>
Setae on xii	36-38	43-54	33-46
Spermathecal pores on viii	just behind 7/8	just in front of setal arc	equidistant from setal arc and 7/8
Copulatory setae on viii	absent	present	present
Copulatory setal glands	in paired coelomic sacs, in ix	free, in viii rarely in ix	in paired coelomic sacs, in viii and ix
Septum 6/7	present	present	absent
Parietal glands in xvii and xix	lateral to ectal ends of prostatic ducts	lateral to ectal ends of prostatic ducts	median and lateral to ectal ends of prostatic ducts

Septa 4/5, 7/8-11/12 slightly muscular, 5/6/7 delicate, 12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxii to lxxv-xcix. Supra-oesophageal vessel single, ix-xiii; subneural vessel present, but not recognised anterior to xiii; last pair of hearts in xiii. Lymph glands unpaired in xv and posterior segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix and xii. Vasa deferentia enlarged into ejaculatory bulbs before opening into the prostatic ducts. Penial setae associated with each prostatic duct, ornamented with a few short transverse serrated ridges, 0.3-0.52 mm long, 19-22  $\mu$  diameter. Spermathecae 2 pairs in viii, each with a median and a lateral group of 1-3 ventrally directed, adherent to the duct, sinuous, digitiform ental diverticula. Copulatory setae ornamented with a few short transverse or spirally

arranged rows of small, fine teeth, 0.52-0.78 mm long, 22-30  $\mu$  diameter. Copulatory setal glands 2.31-3 mm long, in paired coelomic sacs in viii and ix, sometimes in vii. Parietal glands paired, half collar-shaped, median to the ectal ends of the prostatic ducts with a small lobe on the lateral face, in xvii and xix. Genital marking glands sessile, oval.

*Type locality* : Talewadi nr. Castle Rock, Karnataka, India.

*Type specimens* : In ZSIC, W 68/1; BMNH, 1925: 5: 12: 41.

*Material examined* : 0-0-8, syntypes, W 68/1, in ZSIC; 0-0-2 Moodabidri, 15 Sept 1978, coll. B.R. Rao, An 623, in HAZFS, ZSI, Solan.

*Distribution* : India: *Karnataka*: Talewadi nr. Castle Rock, Moodabidri.

#### 54. *Hoplochaetella khandalaensis* (Stephenson)

#### *Hoplochaetella khandalaensis khandalaensis* (Stephenson)

(Figs. 203-207)

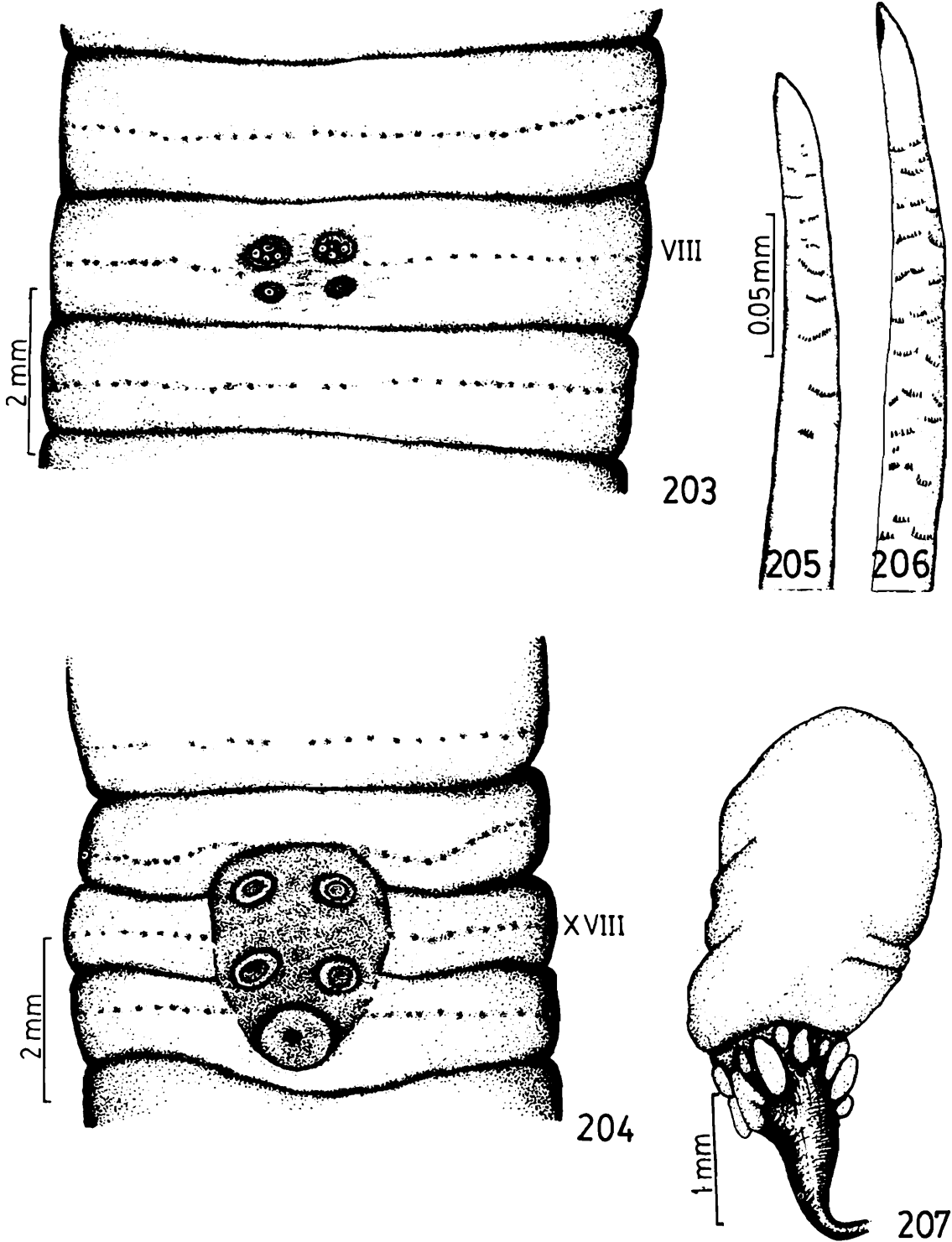
1924. *Erythraeodrilus khandalaensis* Stephenson, *Rec. Indian Mus.*, 26: 350.

1926. *Hoplochaetella khandalaensis*, Stephenson, *Rec. Indian Mus.*, 28: 265.

1940. *Hoplochaetella khandalaensis*, Gates, *Rec. Indian Mus.*, 42: 225.

1940. *Hoplochaetella khandalaensis*, Chapman, *Rec. Indian Mus.*, 42: 377.

Length 85-210 mm, diameter 4-7 mm, 90-138 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5, sometimes 5/6 or 6/7. Clitellum xiii,  $\frac{1}{2}$ xiii-xvi. Setae  $aa = 2-2.1$   $ab = 1.9-2$   $bc = 1.1-1.4$   $yz = 0.4-0.5$   $zz$  on xii,  $aa = 2.1-2.2$   $ab = 2.1-2.2$   $bc = 1.2-1.5$   $yz = 0.3-0.4$   $zz$  on xxiv; 28-41 on ii, 44-59 on vii, 48-66 on xii, 43-68 on xx; setae  $a-c$  on viii copulatory, usually shifted around anterior pair of spermathecal pores. Combined male and prostatic pores minute, at about centres of oval porophores, on or close to sites of 17/18 and 18/19, at  $bc$ , 0.06-0.07 body circumference apart. Spermathecal pores minute, 2 pairs, on viii, at  $ac$ , 0.06-0.07 body circumference apart, slightly near to the setal arc



FIGS. 203-207. *Hoplochaetella khandalaensis khandalaensis* (Stephenson). 203. spermathecal pore region, 204. genital region, 205. penial seta, 206. copulatory seta, 207. spermatheca.

than to the intersegmental furrows. Genital markings oval with central tiny slit-like apertures, unpaired, median postsetal on xix.

Septa 4/5 slightly muscular, 5/6/7/8 delicate, 8/9-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxiv-xxv to cviii. Supra-oesophageal vessel single, ix-xiii; subneural vessel present, but not recognised anterior to xiii-xiv; last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of the septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x rudimentary. Vasa deferentia enlarged into ejaculatory bulbs before opening into the prostatic ducts. Penial setae ornamented with a few short serrated ridges, 0.29-0.44 mm long, 16-30  $\mu$  diameter. Spermathecae 2 pairs in viii, each with a circle of 8-17 ventrally directed, adherent to the duct, sinuous, digitiform ental diverticula. Copulatory setae ornamented with short transverse rows of small teeth, 0.62-0.74 mm long, 23-30  $\mu$  diameter. Copulatory setal glands 3-5 mm long, in paired coelomic sacs in viii, 3 in each sac. Parietal glands paired, median to the ectal ends of the prostatic ducts, in xvii, xviii and xix. Genital marking glands tubular, sausage-shaped, 4.5-13 mm long.

*Type locality* : Khandala, Maharashtra, India.

*Type specimens* : In ZSIC, W 1137/1; BMNH, 1925: 5: 12: 122.

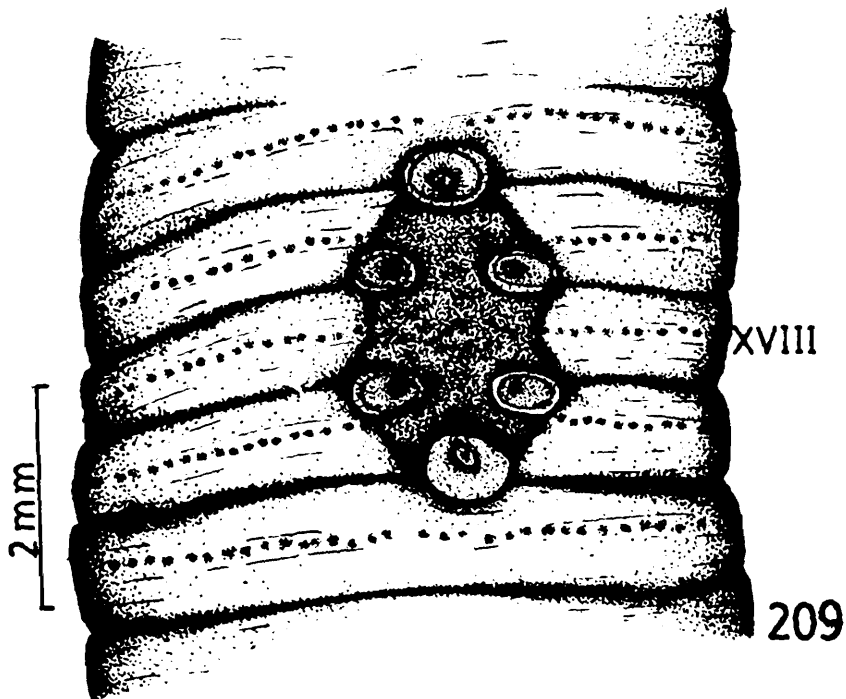
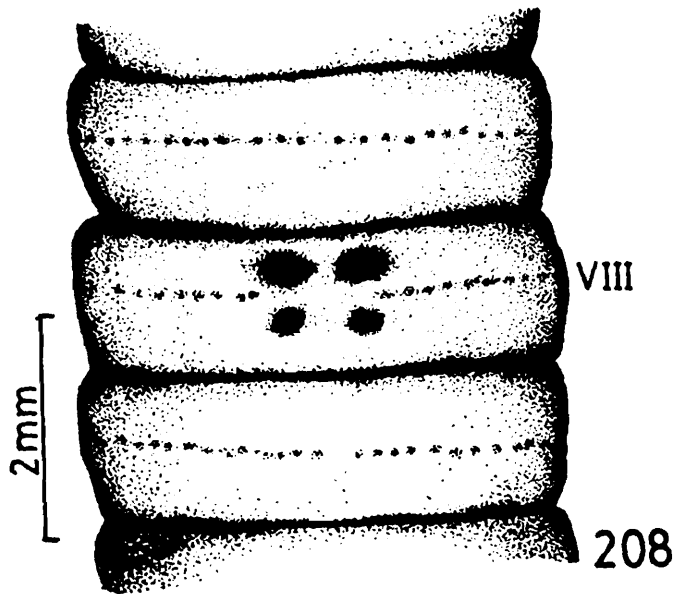
*Material examined* : 0-3-8 Khapoli, 27, 28, 29 Sept, 1 Oct 1964, coll. K.K. Tiwari, HAZFS, ZSI, Solan, An 649-652; 8-9-0 Khandala, 24 Aug 1979, coll. J.M. Julka, HAZFS, ZSI, Solan, An 647-648.

*Distribution* : India: *Maharashtra*: Bombay, Andheri, Lonavala, Khandala, Khapoli; *Madhya Pradesh*: Baraila.

## 55. *Hoplochaetella khandalaensis dichordarius* (Stephenson)

(Figs. 208-209)

1924. *Erythraeodrilus khandalaensis* f. *dichordarius* Stephenson, *Rec. Indian Mus.*, 26: 352.



FIGS. 208-209. *Hoplochaetella khandalaensis dichordarius* (Stephenson). 208. spermathecal pore region, 209. genital region.

1926. *Hoplochaetella khandalaensis* f. *dichordarius*, Stephenson, *Rec. Indian Mus.*, 28: 265.

1940. *Hoplochaetella khandalaensis* f. *dichordarius*, Gates, *Rec. Indian Mus.*, 42: 232.

Description as for *H. khandalaensis khandalaensis* except as follows:

First dorsal pore 4/5. Setae  $aa = 2.3-2.4$   $ab = 2-2.4$   $bc = 1.33$   $yz = 0.6$   $zz$  on xii,  $aa = 2.3-2.4$   $ab = 2-2.4$   $bc = 1.2$   $yz = 0.4$   $zz$  on xxiv; 43-48 on ii, 64-77 on vii, 62-86 on xii, 69-76 on xx; setae *a*, *b*, sometimes *c* copulatory, shifted around anterior pair of spermathecal pores. Combined male and prostatic pores 0.05-0.06 body circumference apart. Spermathecal pores 0.04-0.05 body circumference apart. Genital markings unpaired, median, postsetal, on xvi and xix.

*Type locality* Bombay, Maharashtra, India.

*Type specimens* : Typus amissus.

*Material examined* : In HAZFS, ZSI, Solan: 1-0-0 Panchgani, 23 Aug 1964, K.K. Tiwari, An 645; 1-0-0 Khandala, 24 Aug 1979, J.M. Julka, An 646.

*Distribution* : India: *Maharashtra*: Bombay, Andheri, Mahabaleshwar, Panchgani, Khandala.

### 56. *Hoplochaetella kinneari* (Stephenson)

1915. *Erythraeodrilus kinneari* (in part) Stephenson, *Mem. Indian Mus.*, 7: 100 (excluding specimen with widely paired spermathecal pores on vii and viii, genital marking on 16/17).

1923. *Erythraeodrilus kinneari* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 463.

1940. *Hoplochaetella kinneari*, Gates, *Rec. Indian Mus.*, 42: 249.

Length 120 mm, diameter 3.5 mm, 116-133 segments (aclitellate specimens). Prostomium epilobic, tongue open. First dorsal pore 3/4. Clitellum  $\frac{1}{2}$ xiii- $\frac{2}{3}$ xvi. Setae  $aa = 1.85$   $ab = 2.4$   $bc = 2.4$   $yz = 0.86$   $zz$  on xii,  $aa = 2.3$   $ab = 2.5$   $bc = 2.33$   $yz = 0.87$   $zz$  on xxiv;

38-40 on ii, 49-57 on vii, 45-53 on xii, 46-50 on xx; setae *c-d* on viii copulatory, a little dislocated from the setal ring, surrounded by slight circular depressions. Combined male and prostatic pores large transverse slits, at the centres of protuberant circular porophores, postsetal, on xvii, at *c*. Spermathecal pores minute, 2 pairs on viii, just anterior and posterior to the setal arc, at *cd*. Genital markings, when present, somewhat circular, postsetal, on xviii, more or less in line with the male porophores.

Septa 4/5 slightly muscular, 5/6/7/8/9 delicate, 9/10-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxii to lxxxv-xcix (acelitellate specimens). Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xii. Lymph glands absent. Testes and male funnels enclosed in unpaired sub-oesophageal sacs, in x and xi; seminal vesicles in ix, x and xii. Vasa deferentia enlarged into ejaculatory bulbs before opening into the prostatic ducts. Penial setae (?). Spermathecae 2 pairs, in viii, each with a median and lateral disc-shaped ental diverticula. Copulatory setae ornamented. Copulatory setal glands short, 2-3 on each side of viii (in coelomic sacs ?). Parietal glands (?). Genital marking glands sessile.

*Type locality* : Castle Rock, Karnataka, India.

*Type specimens* : In ZSIC, W 26/1.

*Material examined* : In HAZFS, ZSI, Solan: 17-2-0 Castle Rock, 28 Aug 1979, coil. J.M. Julka, An 762.

*Distribution* : So far known from the type locality.

*Remarks* : Gates (1940b) excluded a syntype (W 26/1 in ZSIC) and Kemp's specimen (Stephenson, 1917a) with spermathecal pores widely paired on vii and viii from *Hoplochaetella kinneari*, and he described these specimens as distinct *Hoplochaetella* spp. He did not name these species since the specimens were in poor state of preservation; hence these are not included in this work.

### 57. *Hoplochaetella kurmagarensis* Gates

1945. *Hoplochaetella kurmagarensis* (?) Gates, *Jl. R. Asiat. Soc. Beng.*, 11(1): 88.

Length 70-110 mm, diameter 4-5 mm. Prostomium epilobic, tongue open. Setae *a-d* on viii copulatory, shifted towards anterior and posterior spermathecal pores. Combined male and prostatic pores at about centres of small, oval, porophores on or near 17/18 and 18/19. Spermathecal pores 2 pairs on viii at *ac*, about equidistant from the setal arc and intersegmental furrows. Genital markings circular to oval, without central apertures, unpaired, on the right side in line with or slightly lateral or median to the male porophores, on xviii, xix, sometimes xvii.

Septa present from 4/5 posteriorly. Gizzard in vi. Intestinal caeca absent. Supra-oesophageal vessel single, ix-xiii; last pair of hearts in xiii. Lymph glands absent (?). Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix and xii. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae ornamented with irregular rows of fine teeth. Spermathecae 2 pairs in viii, each with a median and a lateral group of (number ?) ventrally directed digitiform diverticula. Copulatory setae ornamented with 10-16 interrupted, irregular circles of fine spines, 2(+) mm long. Copulatory setal glands 2(+) mm long, in a pair of coelomic sacs in viii. Parietal glands paired, collar-shaped, surrounding the ectal ends of the prostatic ducts, in xvii and xix. Genital marking glands sessile.

*Type locality* : Kurmagar Island, Karwar Harbour, Karnataka, India.

*Type specimens* : Typus pereditus.

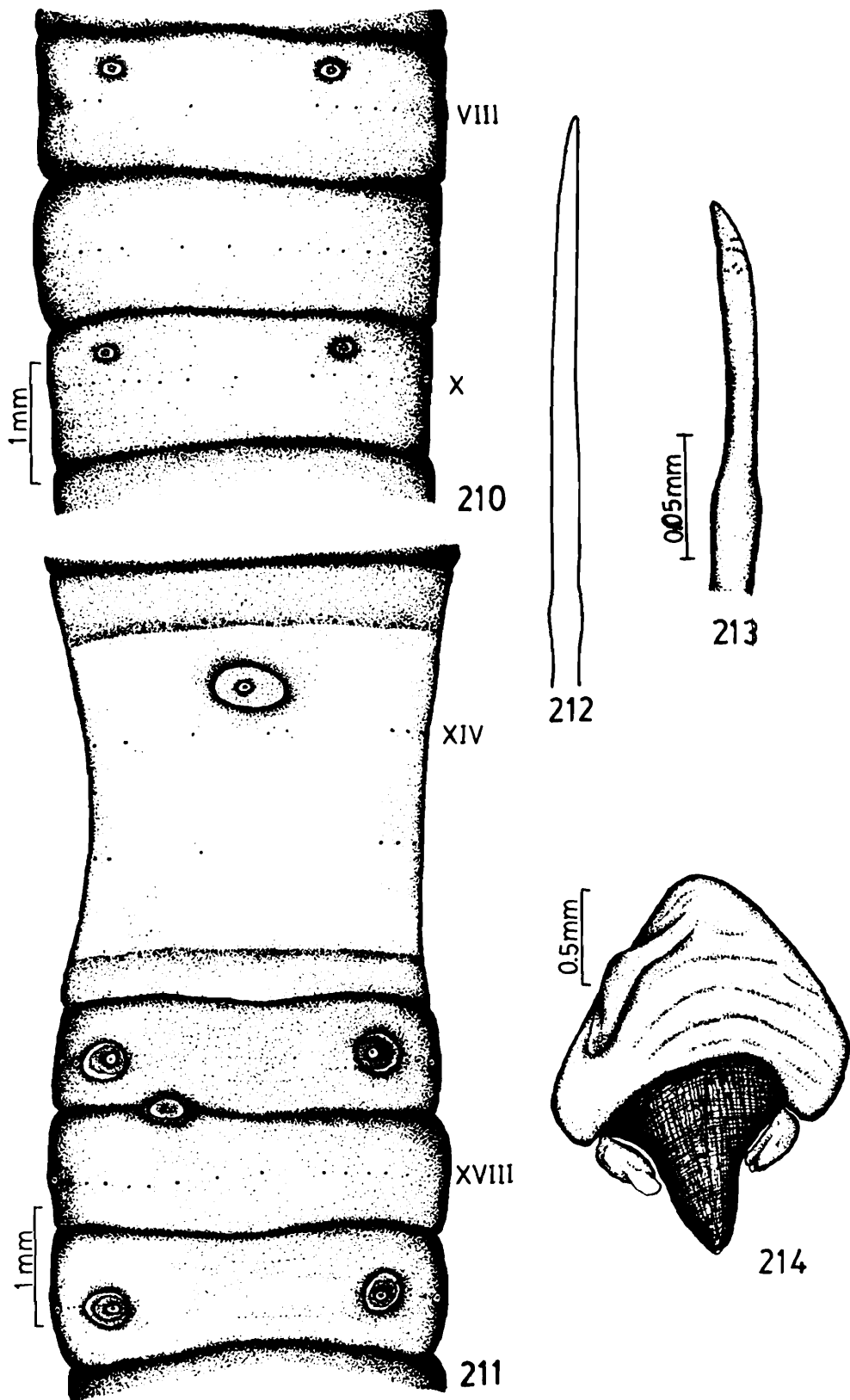
*Distribution* : So far known from the type locality.

**58. *Hoplochaetella londensis* sp. nov.**

(Figs. 210-214)

Length 101-115 mm, diameter 3-3.2 mm, 109-125 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum annular,  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvi. Setae  $aa = 1.5-1.6$   $ab = 1.7-2$   $bc = 1.5-1.7$   $yz = 0.4-0.5$   $zz$  on xii,  $aa = 1.7$   $ab = 1.7-2.5$   $bc = 1.9-2.2$   $yz = 0.4-0.7$   $zz$  on xxiv; 11-17 on ii, 35-38 on vii, 32-39 on xii, 35-40 on xx,  $a$ ,  $b$  on viii sigmoid with a middle nodule, slightly enlarged and ornamented. Combined male and prostatic pores minute, near centres of slightly depressed, somewhat circular porophores, on setal arcs of xvii and xix, at  $ef$ , 0.17-0.22 body circumference apart. Spermathecal pores paired, minute, presetal, equidistant from setal arcs and intersegmental furrows, on viii and x, at  $de$  or  $ef$ , 0.17-0.19 body circumference apart. Genital markings sometimes present, oval, unpaired, on right side, a little ventral to the male pore line, at 17/18.

Septa 4/5-8/9 delicate, 6/7 aborted ventrally, 9/10-11/12 slightly muscular. Gizzard in vii. Intestinal caeca absent; typhlosole xxiii-xxiv to xcii-xcvi. Supra-oesophageal vessel ix-xiii, single in ix-xi, double in xii-xiii; subneural vessel absent; last pair of hearts in xii. Lymph glands absent. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xi, those of ix and xii extending to the dorsal line. Vasa deferentia enlarged into ejaculatory bulbs before opening into prostatic ducts. Penial setae 2 associated with each prostatic duct, unornamented, 0.29 mm long, 11  $\mu$  diameter. Spermathecae paired in viii and x, each with a median and a lateral, multiloculate, free, ental diverticula. Copulatory setae and glands associated with them absent. Parietal glands paired, slightly median to the ectal ends of the prostatic ducts, in xvii and xix; small collar-shaped paired glands on the body wall, slightly lateral to the ectal ends of the prostatic ducts in xvii and xix. Genital marking glands sessile, circular.



FIGS. 210-214. *Hoplochaetella londensis* sp. nov. 210. spermathecal pore region, 211. genital region, 212. penial seta, 213. seta *b* on viii, 214. spermatheca.

*Material examined* : 0-1-3 soil black clay around the base of a tree, *Mangifera indica* in a grassland, Londa, 15.60 N, 74.50 E, 29 Aug 1979, coll. J.M. Julka (holotype and one paratype in ZSIC, An 1818/1, An 1819/1, 2 paratypes in HAZFS, ZSI, Solan, An 729).

*Distribution* : India: *Karnataka*: Londa.

*Etymology* : Derived from the type locality 'Londa'

*Remarks* : *Hoplochaetella londensis* sp. nov. is distinguishable from all the known species of the genus by the location of the spermathecal pores on viii and x.

*Biology* : It deposits casts on the surface of the soil in the form of oval pellets arranged in small mounds. When handled, it produces quick jerky movements.

### 59. *Hoplochaetella mullani* (Stephenson)

(Figs. 215-219)

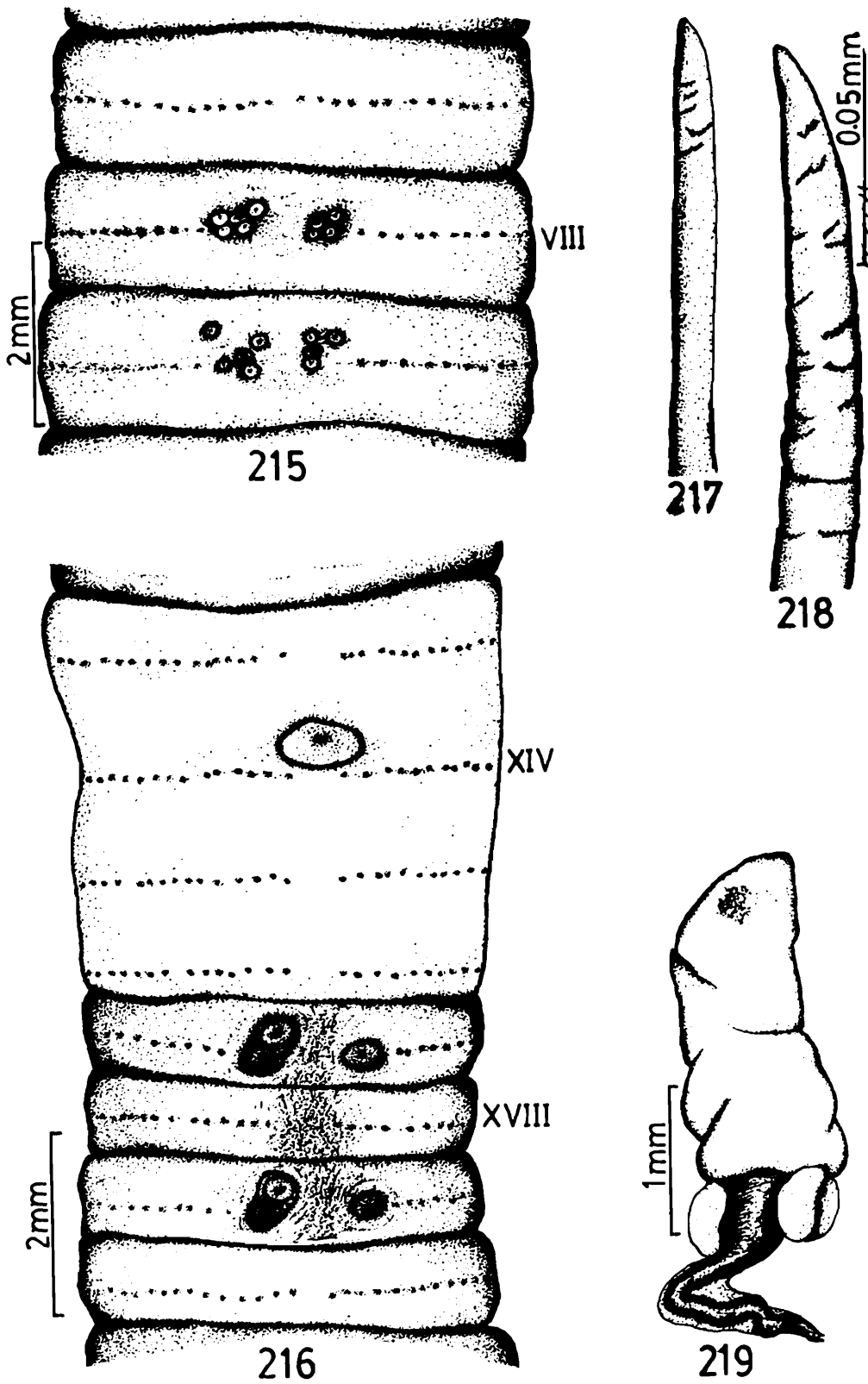
1924. *Erythraeodrius mullani* Stephenson, *Rec. Indian Mus.*, 26: 348.

1926. *Hoplochaetella mullani*, Stephenson, *Rec. Indian Mus.*, 28: 265.

1940. *Hoplochaetella mullani*, Gates, *Rec. Indian Mus.*, 42: 233.

1940. *Hoplochaetella mullani*, Chapman, *Rec. Indian Mus.*, 42: 378.

Length 110-123 mm, diameter 3.5-7 mm, 111-122 segments. Prostomium epilobic, tongue open. Clitellum, ½xiii-xvi. Setae *aa* = 1.8-2 *ab* = 1.7-1.8 *bc* = 2 *yz* = 0.4-0.7 *zz* on xii, *aa* = 1.8-2 *ab* = 1.8 *bc* = 2 *yz* = 0.6 *zz* on xxiv; 28-36 on ii, 41-58 on vii, 46-76 on xii, 42-56 on xx; setae *a-d*, sometimes *e* or *f* on viii and ix copulatory, arranged in a more or less regular circle around each spermathecal pore. Combined male and prostatic pores minute, at about centres of oval porophores on the setal arcs of xvii and xix, 0.06-0.08 body circumference apart. Spermathecal pores paired, minute, on or close to setal arcs of viii and ix, at *ac*, 0.05-0.06 body circumference apart. Genital markings oval with tiny slit-like central apertures, unpaired, asymmetrical, with centres on or slightly ventral or slightly lateral to the male pore lines, presetal or postsetal, usually on xix, sometimes on xvi, xvii and xviii.



FIGS. 215-219. *Hoplochaeteila mullani* (Stephenson). 215. spermathecal pore region, 216. genital region, 217. penial seta, 218. copulatory seta, 219. spermatheca.

Septa 4/5 slightly muscular, 5/6/7/8/9 delicate, 9/10-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxii to cxiv. Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xiii. Lymph glands in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of the septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x rudimentary. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae ornamented with a few to several transverse serrated ridges, 0.28-0.37 mm long, 14  $\mu$  diameter. Spermathecae paired, in viii and ix, each usually with a median and a lateral group of ventrally directed, adherent to the duct, oval, ental diverticula, 2-7 in each group. Copulatory setae ornamented with transverse serrated ridges, 0.48-0.8 mm long, 20-26  $\mu$  diameter. Copulatory setal glands c. 1.5 mm long, in paired coelomic sacs in viii and ix, 4-6 in each sac. Parietal glands paired, half-collar-shaped, median to the ectal ends of the prostatic ducts, in xvii and xix. Genital marking glands tubular, sausage-shaped, 3-6 mm long.

*Type locality* : Matheran, Maharashtra, India.

*Type specimens* : In ZSIC, W 1136/1; BMNH, 1925: 5: 12: 78.

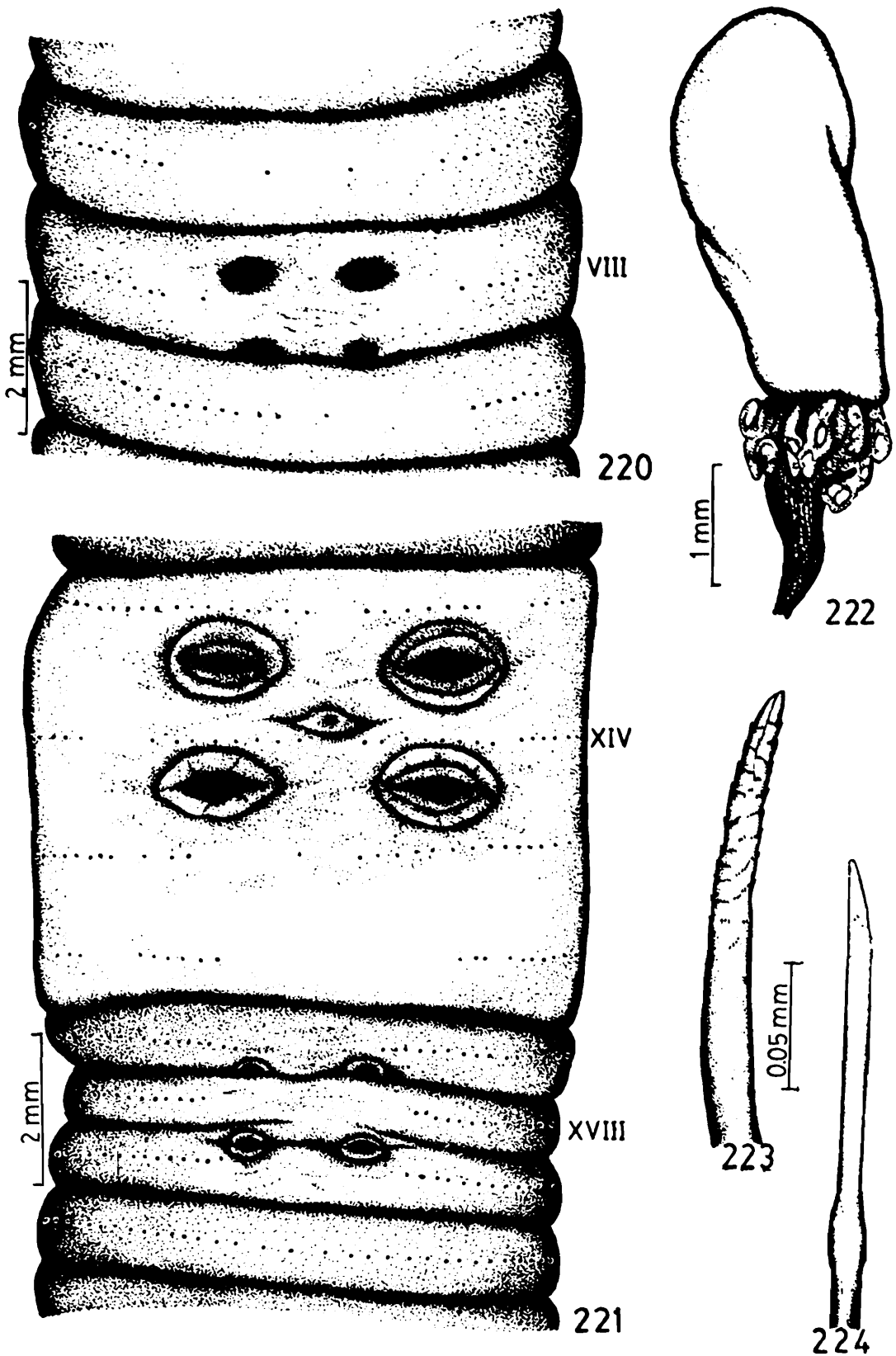
*Material examined* : 0-0-7, syntypes, in ZSIC, W 1136/1; 0-4-10 Satara, 1, 2 Oct 1964, coll. K.K. Tiwari, HAZFS, ZSI, Solan, An 624-625.

*Distribution* : India: *Maharashtra*: Matheran, Lonavala, Satara.

### 60. *Hoplochaetella panchganiensis* sp. nov.

(Figs. 220-224)

Length 145 mm, diameter 7 mm, 126 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum annular, xiii-xvi. Setae  $aa = 2.2-2.5$   $ab = 2.9-3$   $bc = 1.7-2.1$   $yz = 0.5-0.7$   $zz$  on xii,  $aa = 2.5-3$   $ab = 2.4-2.5$   $bc = 2.1-2.5$   $yz = 0.5-0.8$   $zz$  on xxiv; 38-51 on ii, 65-69 on vii, 74-79 on xii, 70-75 on xx; setae  $a-c$ , sometimes  $d$  on viii copulatory, shifted towards anterior pair of



FIGS. 220-224. *Hoplochaetella panchganiensis* sp. nov. 220. spermathecal pore region, 221. genital region, 222. spermatheca, 223. copulatory seta, 224. penial seta.

spermathecal pores. Combined male and prostatic pores minute, at centres of slightly depressed oval porophores, at *bc*, on xvii and xix, 0.06-0.07 body circumference apart, those on xvii postsetal, slightly anterior to 17/18, those on xix presetal, slightly posterior to 18/19. Spermathecal pores minute, 2 pairs on viii at *bc*, 0.06-0.07 body circumference apart, anterior pair presetal, equidistant from setal arc and 7/8, posterior pair postsetal, slightly anterior to 8/9. Genital markings paired (sometimes one of the pair wanting), oval, slightly depressed, each with a minute central aperture in a transverse groove, postsetal, on xiii-xv.

Septa 4/5, 9/10-11/12 muscular, 5/6/7 delicate, 7/8/9 slightly muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxiii-xxiv to cx. Supra-oesophageal vessel single, ix-xiii; subneural vessel present, but not recognized anterior to xiv; last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x smaller than those of ix and xii. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae 2 associated with each prostatic duct, ornamented with a few transverse rows of short spines, 0.25 mm long, 16  $\mu$  diameter. Spermathecae 2 pairs in viii, each with a median and a lateral group of 3-5 small ventrally directed, adherent to the duct, sinuous, digitiform ental diverticula, sometimes 8-10 diverticula in a circle around the duct but with a posterior gap. Copulatory setae ornamented with a few transverse rows of short spines, 0.57-0.6 mm long, 22-27  $\mu$  diameter. Copulatory setal glands 1.7-3.6 mm long, in a pair of coelomic sacs in viii, 2-4 in each sac. Parietal glands paired, slightly median to the ectal ends of the prostatic ducts, in xvii, xviii and xix, those of xviii larger than those of xvii and xix. Genital marking glands sausage-shaped, 1.3-3.1 mm long.

*Material examined* : 0-1-2 grassland, soil red loam, Panchgani, 17.58 N, 73.43 E, altitude 1380 m, 26 Aug 1979, coll. J.M. Julka

(holotype in ZSIC, An 1820/1, 2 paratypes in HAZFS, ZSI, Solan, An 730); 0-0-1 from a tree trunk, Panchgani, 18 Aug 1964, coll. K.K. Tiwari, in HAZFS, ZSI, Solan, An 731).

*Distribution* : India: *Maharashtra*: Panchgani.

*Etymology* : Derived from the type locality 'Panchgani'

*Remarks* : *Hoplochaetella panchganiensis* sp. nov. belongs to a group of species with 2 pairs of male pores, all spermathecal pores on viii, parietal glands median to prostatic ducts in xvii, xviii and xix, and with genital markings. It is readily distinguishable from other members of the group, *H. khandalaensis*, *H. powelli* and *H. righii* (described elsewhere in this work) by the characteristics as given in Table 6.

TABLE 6. Comparison of *H. panchganiensis* and *H. righii* spp. nov. with related species.

Character	<i>H. khandalaensis</i>	<i>H. panchganiensis</i>	<i>H. powelli</i>	<i>H. righii</i>
Length (mm)	85-210	145	102-187	65-120
Segments	90-138	126	125-139	90-133
Setae on vii	44-59	65-69	53-86	25-37
Genital markings	with central apertures; unpaired and median, postsetal on xix or xvi and xix	with central apertures; paired, postsetal on xiii-xv	with central apertures; paired, 16/17, 19/20-21/22, unpaired near mV line on 16/17	without central apertures; paired on 16/17, 19/20-22/23 rarely unpaired and median on 19/20
Last pair of hearts	xiii	xiii	xiii	xii
GM glands	tubular	tubular	tubular	sessile oval

**61. Hoplochaetella powelli** (Stephenson)

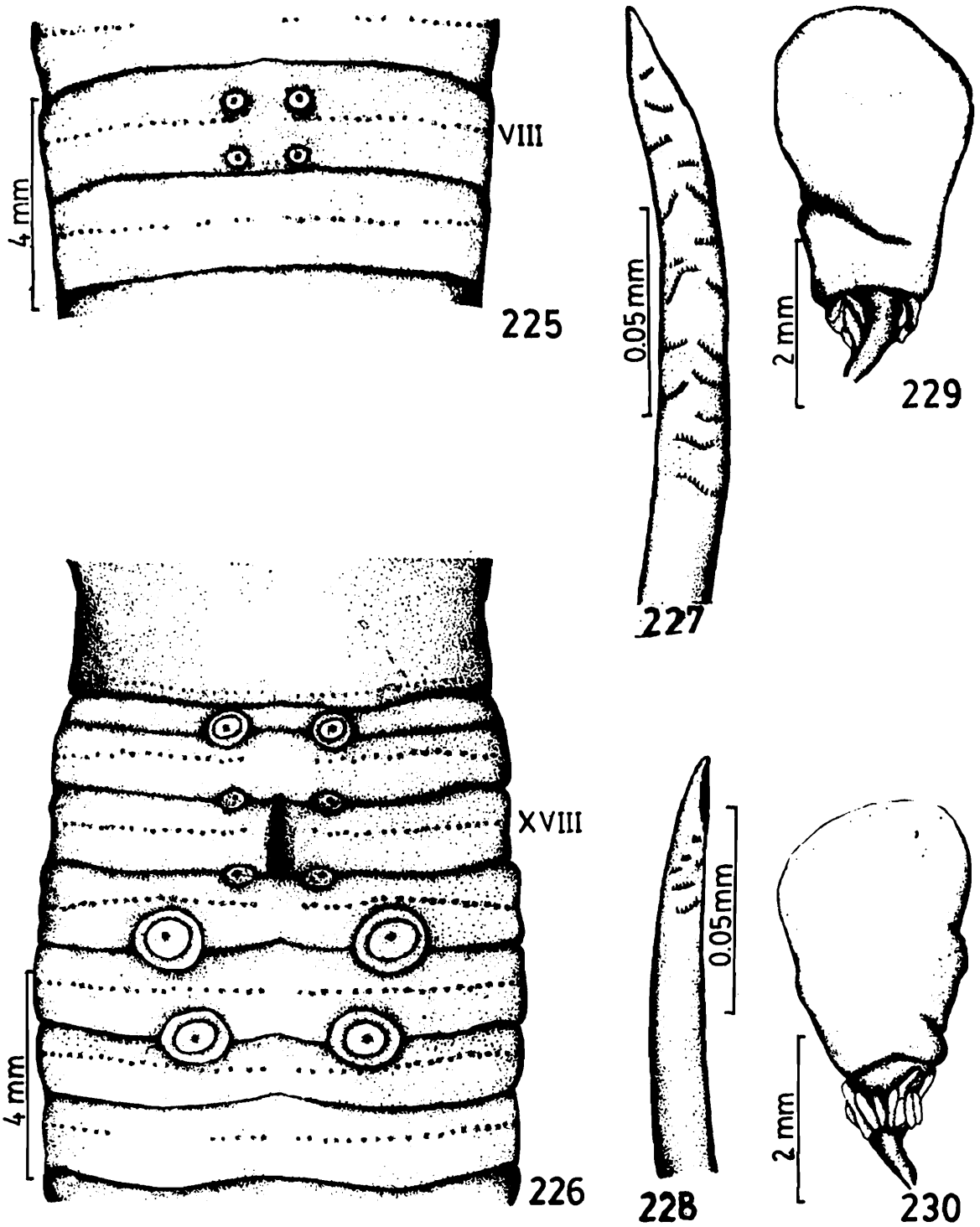
(Figs. 225-230)

1925. *Erythraeodrilus powelli* Stephenson, *Proc. zool. Soc. Lond.*, 1925: 898.

1940. *Hoplochaetella powelli*, Gates, *Rec. Indian Mus.*, 42: 236.

Length 102-187 mm, diameter 5-8 mm, 125-139 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum xiii-2/3xvi, xvi. Setae  $aa = 2.1$   $ab = 2.1$   $bc = 2$   $yz = 0.6$   $zz$  on xii,  $aa = 1.7$   $ab = 2.4$   $bc = 2.3$   $yz = 0.8$   $zz$  on xxiv;  $zz$  on xii,  $aa = 1.7$   $ab = 2.4$   $bc = 2.3$   $yz = 0.8$   $zz$  on xxiv; 36-46 on ii, 53-86 on vii, 52-96 on xii, 48-88 on xx; some or all of setae *a-c* or *d* on viii copulatory and shifted anteriorly. Combined male and prostatic pores minute, at about centres of oval porophores, on or close to 17/18 and 18/19 at *bd*, 0.06-0.07 body circumference apart. Spermathecal pores minute, 2 pairs on viii at *bc*, 0.05-0.07 body circumference apart, anterior pair slightly in front of the setal arc, posterior pair slightly anterior to 8/9. Genital markings oval with tiny central apertures; paired, on or just lateral to male pore lines, on 19/20-20/21, sometimes on 16/17, 21/22 (one of pair usually wanting); occasionally unpaired, slightly towards left or right side of the mid-ventral line on 16/17.

Septa 4/5 slightly muscular, 5/6/7/8/9 delicate, 9/10-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xxiv-xxv to cv-cxxiv. Supra-oesophageal vessel single, ix-xiii; subneural vessel present, but not recognized anterior to xiv; last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of the septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x rudimentary. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae ornamented with a few short transverse rows of small teeth, 0.33-0.44 mm long, 15-19  $\mu$  diameter. Spermathecae 2 pairs in viii, each with an incomplete circle of 10-12 ventrally directed, adherent to



FIGS. 225-230. *Hoplochaetella powelli* (Stephenson). 225. spermathecal pore region, 226. genital region, 227. copulatory seta, 228. penial seta, 229-230. spermatheca, posterior view (229), anterior view (230).

the duct, digitiform ental diverticula. Copulatory setae ornamented with short transverse rows of fine teeth, 0.57-0.62 mm long, 22  $\mu$  diameter. Copulatory setal glands *c.* 2 mm long, in paired coelomic sacs in viii, 3-4 in each sac. Parietal glands paired, median to the ectal ends of the prostatic ducts in xvii, xviii and xix. Genital marking glands tubular, sausage-shaped, 1-4 mm long.

*Type locality* : Bombay, Maharashtra, India.

*Type specimens* : In BMNH, 1924: 2: 14: 13-8.

*Material examined* : 0-2-3 Panchgani, 20-23 Aug 1964, coll. K.K. Tiwari, HAZFS, ZSI, Solan, An 632, An 633, An 634, 0-4-7 grassland by the side of a small stream, soil red loam, Panchgani, 26 Aug 1979, coll. J.M. Julka, HAZFS, ZSI, Solan, An 635.

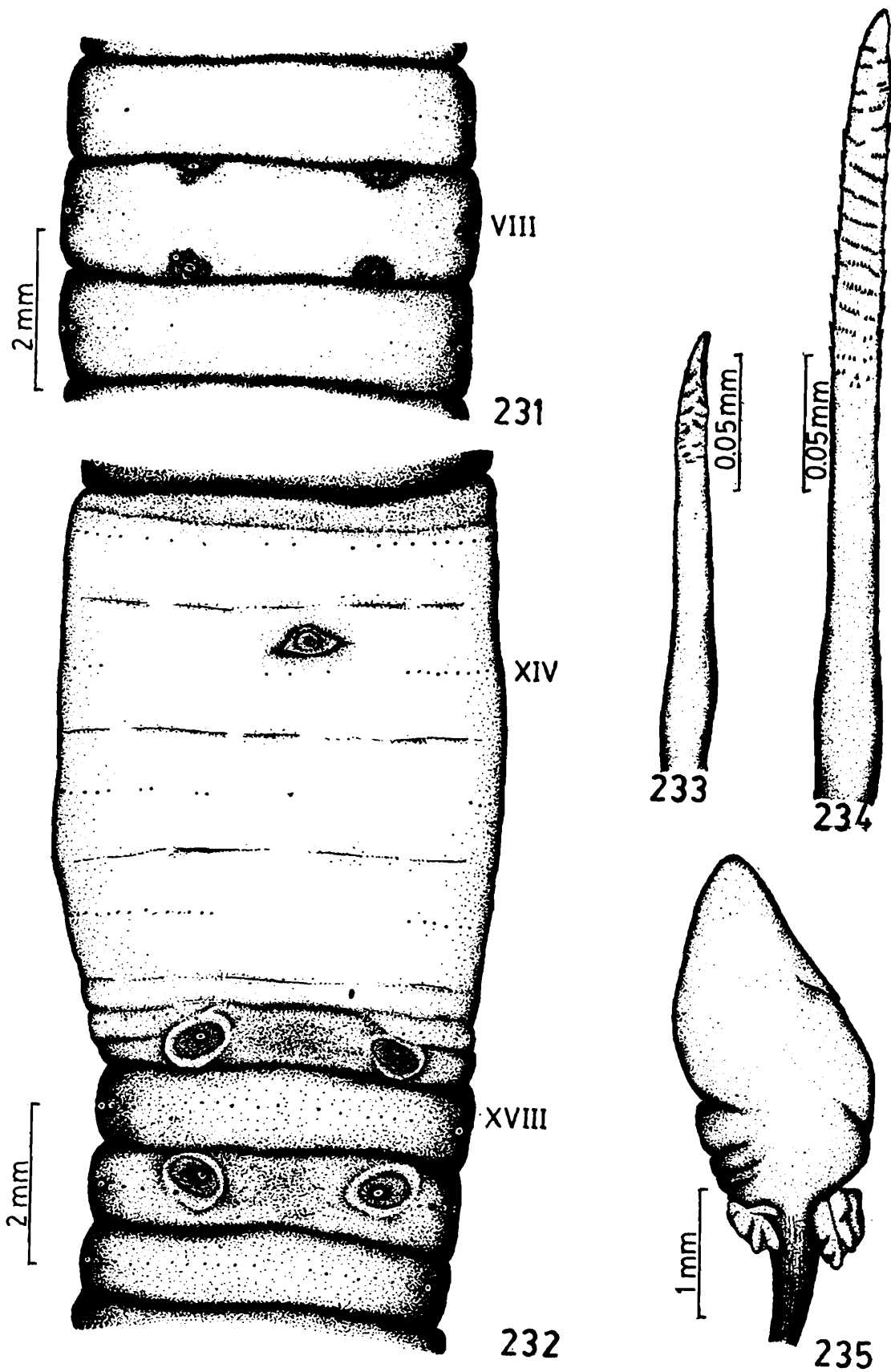
*Distribution* : India: *Maharashtra*: Bombay, Panchgani.

*Biology* : This species deposits casts on the soil surface in the form of short strings of oval pellets. When handled, it produces serpentine movements.

## 62. *Hoplochaetella righii* sp. nov.

(Figs. 231-235)

Length 65-120 mm, diameter 3-5 mm, 90-131 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum annular,  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvi, xvi. Setae *aa* = 1.3-1.6 *ab* = 1.5-1.7 *bc* = 1.4-1.6 *yz* = 0.2-1 *zz* on xii, *aa* = 1.7-1.9 *ab* = 1.9-2.2 *bc* = 1.7-3.2 *yz* = 0.2-0.4 *zz* on xxiv; 8-30 on ii, 25-37 on vii, 25-46 on xii, 24-48 on xx; setae *c-e* on viii copulatory, shifted towards spermathecal pores. Combined male and prostatic pores minute, at *c.* centres of slightly depressed oval porophores, on xvii and xix, at *ef*, 0.11-0.15 body circumference apart, those on xvii postsetal, those on xix presetal. Spermathecal pores minute, 2 pairs on viii, at *de*, 0.12-0.15 body circumference apart, anterior pair presetal, slightly posterior to 7/8, posterior pair postsetal just anterior to 8/9. Genital markings, if present, oval, without central apertures, usually paired (occasionally one of the pair wanting), on or slightly ventral to male pore lines, on 16/17, 19/20-22/23, rarely unpaired, median, on 19/20.



FIGS. 231-235. *Hoplochaetella righii* sp. nov. 231. spermathecal pore region, 232. genital region, 233. penial seta, 234. copulatory seta, 235. spermatheca, anterior view.

Septa 4/5 slightly muscular, 5/6/7/8/9 delicate, 9/10-12/13 muscular. Gizzard in vi. Intestinal caeca absent; typhlosole xx-xxiii to lxxvi-cvi. Supra-oesophageal vessel in ix-xiii, bifurcates in x or xi or xii, the two branches connected with each other by a transverse vessel in each segment; subneural vessel present, but not recognised anterior to septa 7/8-9/10; last pair of hearts in xii. Lymph glands unpaired in xv and posterior segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xii, those of ix and xii extending to the dorsal line. Vasa deferentia enlarged into ejaculatory bulbs before joining the prostatic ducts. Penial setae 2-3 associated with each prostatic duct, ornamented with a few transverse serrated ridges, 0.34 mm long, 19  $\mu$  diameter. Spermathecae 2 pairs in viii, each usually with a median and a lateral group of 2-6 small ventrally directed, adherent to the duct, sinuous, digitiform ental diverticula, sometimes 8-10 diverticula in a circle around the duct but with a posterior gap. Copulatory setae ornamented with 16-20 transverse rows of fine spines, 0.41-0.48 mm long, 24-26  $\mu$  diameter. Copulatory setal glands 1-2 mm long, in a pair of coelomic sacs in viii, 2-4 in each sac. Parietal glands paired, slightly median to the ectal ends of the prostatic ducts, in xvii, xviii and xix, those of xvii small. Genital marking glands sessile, oval.

*Material examined* : coll. J.M. Julka: 3-4-13 under a log, grassland, soil black sandy loam, Kotegehar, 13.16 N, 75.15 E, altitude 650 m, 7 Sept 1979 (holotype and 2 paratypes in ZSIC, An 1821/1, An 1822/1, 17 paratypes in HAZFS, ZSI, Solan, An 725); 0-5-6 Tirthahalli, 5 Sept 1979, HAZFS, ZSI, Solan, An 726. coll. G. Ramakrishna and B. Sinha: 0-0-12 under stones on the right bank of the river Hemavati, Sakleshpur, 5 and 8 Sept 1969, HAZFS, ZSI, Solan, An 727-728.

*Distribution* : India: *Karnataka*: Kotegehar, Tirthahalli, Sakleshpur.

**Etymology** : The species is named after Dr. Gilberto Righi, Universidade de Sao Paulo, Brazil in appreciation of his work on South American earthworms.

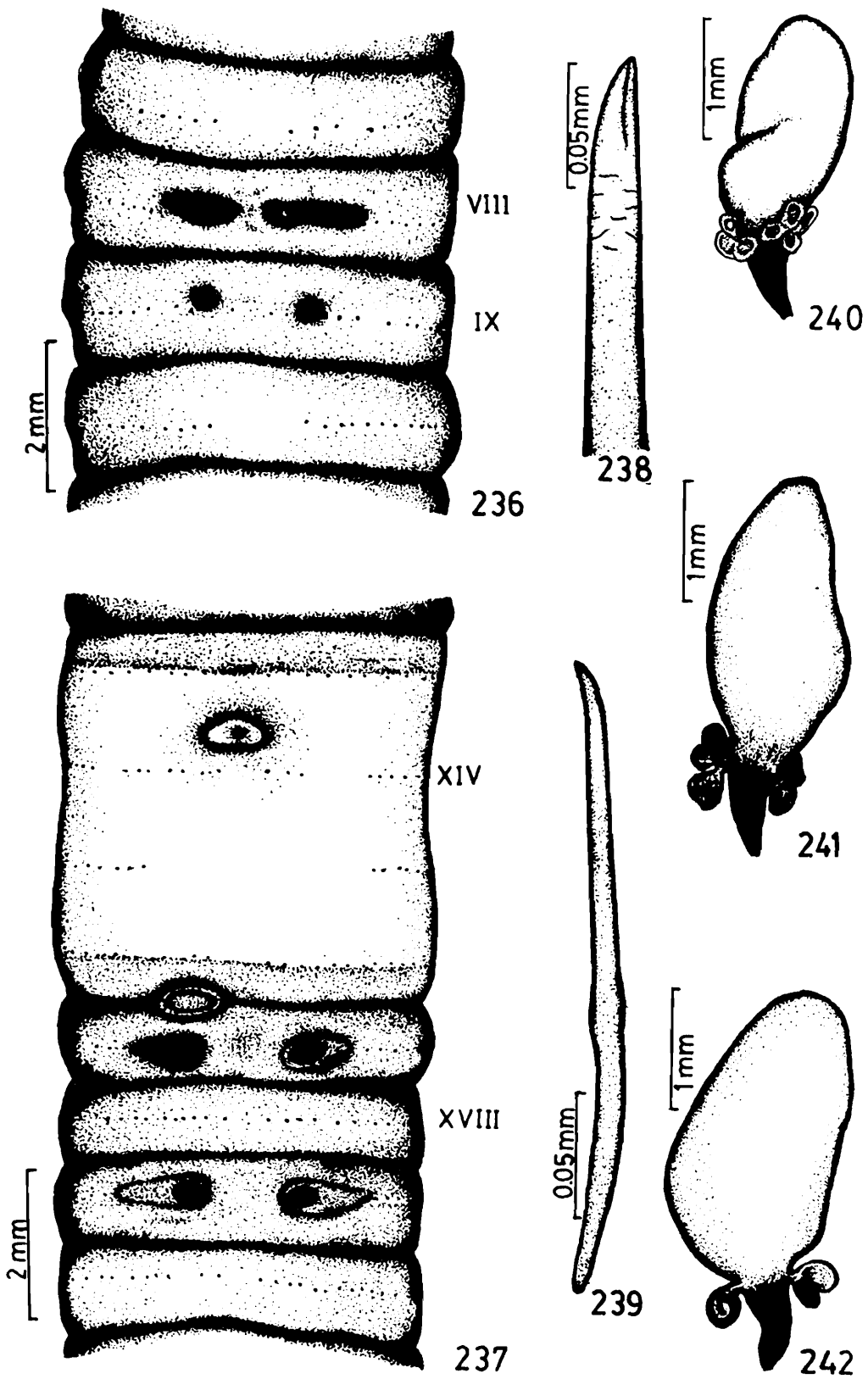
**Remarks** : *Hoplochaetella righii* sp. nov. belongs to a group of species with 2 pairs of male pores, all spermathecal pores on viii, parietal glands median to prostatic ducts in xvii, xviii and xix, and with genital markings. It can be distinguished from other species of the group, *H. khandalaensis khandalaensis* (Stephenson), *H. khandalaensis dichordarius* (Stephenson), *H. powelli* (Stephenson) and *H. panchganiensis* sp. nov. (described elsewhere in this work) by the characteristics as given in Table 6.

### 63. *Hoplochaetella sanvordemensis* sp. nov.

(Figs. 236-242)

Length 77-182 mm, diameter 3-5 mm, 105-134 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum annular, ½xiii-½xvi. Setae  $aa = 1.6-2.1$   $ab = 1.7-2.3$   $bc = 1.5-2.3$   $yz = 0.3-0.5$   $zz$  on xii,  $aa = 1.9-2.4$   $ab = 2-2.8$   $bc = 2.3-2.8$   $yz = 0.4-0.6$   $zz$  on xxiv; 16-26 on ii, 40-53 on vii, 43-56 on xii, 40-56 on xx; setae *a-d* and sometimes *e-g* on viii and rarely on ix copulatory. Combined male and prostatic pores paired, minute, at centres of slightly depressed oval porophores on setal arcs of xvii and xix, at *bc*, 0.08-0.11 body circumference apart. Spermathecal pores paired, minute, slightly anterior to setal arcs on viii and ix, at *bc*, sometimes at *ab* or *cd*, 0.04-0.12 body circumference apart. Genital markings sometimes present, oval, without central apertures, depressed on or slightly ventral to male pore lines, paired, at any of 15/16-17/18, 21/22/23 (one of the pair occasionally wanting), unpaired, median, at 16/17.

Septa 4/5-7/8 delicate, 8/9 slightly muscular, 9/10-12/13 muscular. Gizzard in vii. Intestinal caeca absent; typhlosole xxiii-xxiv to xcvi-ciii. Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xii. Lymph glands absent. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by



FIGS. 236-242. *Hoplochaetella sanvordemensis* sp. nov. 236. spermathecal pore region, 237. genital region, 238. copulatory seta, 239. penial seta, 240-242 spermathecae (anterior views)

the peripheral union of septa 9/10/11/12; seminal vesicles in ix, x and xii, those of xii smaller than those of ix and x. Vasa deferentia enlarged into ejaculatory bulbs before opening into prostatic ducts. Penial setae 2 associated with each prostatic duct, unornamented, 0.25 mm long, 12  $\mu$  diameter. Spermathecae paired in viii and ix, each with a median and a lateral, shortly stalked, free, uniloculate to multiloculate, ental diverticula. Copulatory setae ornamented with a few short transverse serrated ridges, 0.69-0.75 mm long, 27-31  $\mu$  diameter. Copulatory setal glands 1.86-3.04 mm long, free (not enclosed in coelomic sacs), 4-6 on each side in viii, rarely 2-4 in ix. Parietal glands paired, sessile, lateral to the ectal end of each prostatic duct, on xvii and xix. Genital marking glands sessile, oval, beneath the longitudinal muscle layer, sometimes slightly protuberant into coelom.

*Material examined* : coll. J.M. Julka 1979: 1-0-12 under decaying leaves, soil reddish sandy loam, Sanvordem, Goa, 15.27 N, 74.11 E, 31 Aug (holotype and 2 paratypes in ZSIC, An 1823/1, An 1824/1, 10 paratypes in HAZFS, ZSI, Solan, An 732); 0-0-3 soil laterite, Castle Rock, Karnataka, 28 Aug, in HAZFS, ZSI, Solan, An 733; 0-2-8 under stones, soil around roots of bushes along the sea shore, Marmugao, Goa, 30 Aug, in HAZFS, ZSI, Solan, An 734).

*Distribution* : India: Goa: Sanvordem, Marmugao; Karnataka: Castle Rock.

*Etymology* : Derived from the type locality 'Sanvordem'.

*Biology* : It inhabits under stones and prefers top soil surface. Casts are deposited on the surface of the soil. It responds to thigmotactic stimuli in the form of serpentine movements of the body.

*Remarks* : *Hoplochaetella sanvordemensis* sp. nov. belongs to *anomala* group of species with 2 pairs of male pores, paired spermathecal pores on viii and ix, last pair of hearts in xii and without intestinal caeca. It can be distinguished from other species of this group, *H. anomala* and *H. karnatakensis* sp. nov. (described

elsewhere in this work) by the characteristics as given in Table 5

#### 64. *Hoplochaetella stuarti* (Bourne)

(Figs. 243-247)

1886. *Perichaeta stuarti* Bourne, *Proc. zool. Soc. Lond.*, 1886: 667.

1890. *Hoplochaeta stuarti*, Beddard, *Proc. zool. Soc. Lond.*, 1890: 57

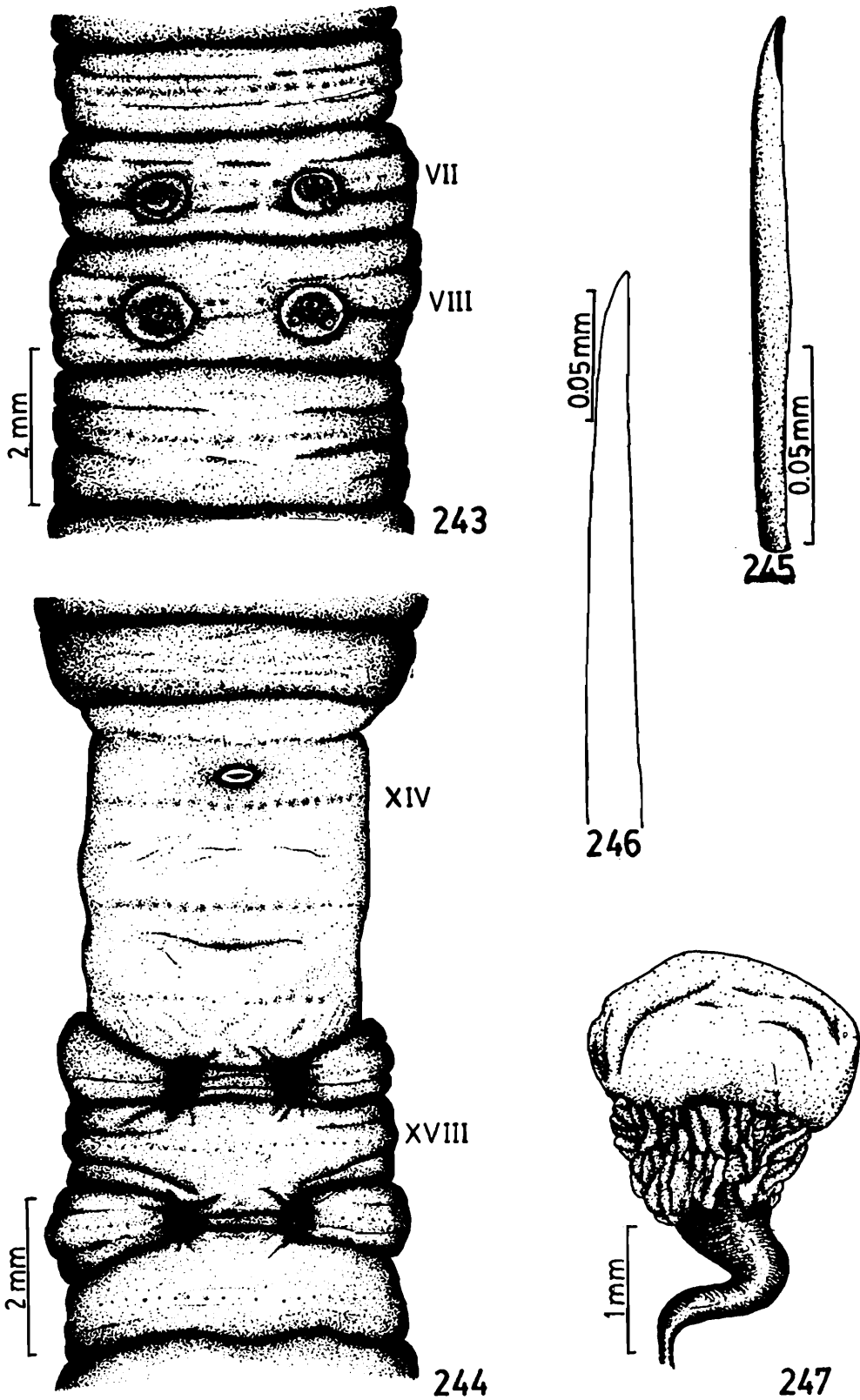
1900. *Hoplochaetella stuarti*, Michaelsen, *Tierreich*, 10: 322.

1923. *Hoplochaetella stuarti*, Stephenson, *Fauna Br. India, Oligochaeta*: 468.

1940. *Hoplochaetella stuarti*, Gates, *Rec. Indian Mus.*, 42: 239.

Length 111-162 mm, diameter 3.5-5 mm, 110-120 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5, sometimes 3/4. Clitellum ½xiii-xvi. Setae  $aa = 1.8$   $ab = 1.9$   $bc = 1.8$   $yz = 0.4$   $zz$  on xii,  $aa = 2$   $ab = 2.3$   $bc = 1.8$   $yz = 0.5$   $zz$  on xxiv; 22-28 on ii, 34-40 on vii, 46-52 on xii, 46-56 on xx; setae *c-e*, sometimes *f* and *g* on vii and viii copulatory, shifted towards spermathecal pores. Combined male and prostatic pores minute, at about centres of somewhat circular and depressed porophores on setal arcs of xvii and xix, at *cf*, 0.11 body circumference apart. Spermathecal pores paired, minute, slightly posterior to setal arcs, on vii and viii, at *df*, 0.13-0.17 body circumference apart. Genital markings absent.

Septa 4/5, 9/10/11/12 slightly muscular, 5/6 delicate, 6/7/8/9 absent. Gizzard in a space between septa 5/6 and 9/10, belonging to segment vii (as the lateral commissural blood vessels of segments vii, viii and ix are posterior to the gizzard and anterior to the septum 9/10, and those of segment vi are anterior to the gizzard). Intestinal caeca present, 4 pairs, dorsolateral, in xxv (rudimentary), xxvi-xxviii; typhlosole xxiv-xxv to lxxxiv-lxxxvi. Supra-oesophageal vessel single, ix-xiii; subneural vessel absent; last pair of hearts in xiii. Lymph glands absent. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of the septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x small. Vasa deferentia not enlarged into ejaculatory bulbs



FIGS. 243-247. *Hoplochaetella stuarti* (Bourne). 243. spermathecal pore region, 244. genital region, 245. penial seta, 246. copulatory seta, 247. spermatheca.

ectally. Penial setae unornamented, 0.14-0.34 mm long, 9-11  $\mu$  diameter. Spermathecae paired, in vii and viii, each with a circle of 15-22 doubly glove-shaped diverticula, each diverticulum with 6-12 irregularly digitiform seminal chambers, part of which are directed ectally and part entally. Copulatory setae unornamented, 0.88-1.23 mm long, 24-27  $\mu$  diameter. Copulatory setal glands 1.5-2.5 mm long, in paired coelomic sacs in vii and viii. Parietal glands paired in xvii and xix, lateral and median to the ectal ends of the prostatic ducts.

*Type locality* : Yercaud, Tamil Nadu, India.

*Type specimens* : In ZMUH, 9673.

*Material examined* : 2-9-32 under decaying leaves, soil black sandy, Nandi Hills, c. 16 km from Bangalore, 23 Sept 1979, coll. J.M. Julka, HAZFS, ZSI, Solan, An 629.

*Distribution* : India: *Tamil Nadu*: Yercaud; *Karnataka*: Nandi Hills.

### 65. *Hoplochaetella suctoria* Stephenson

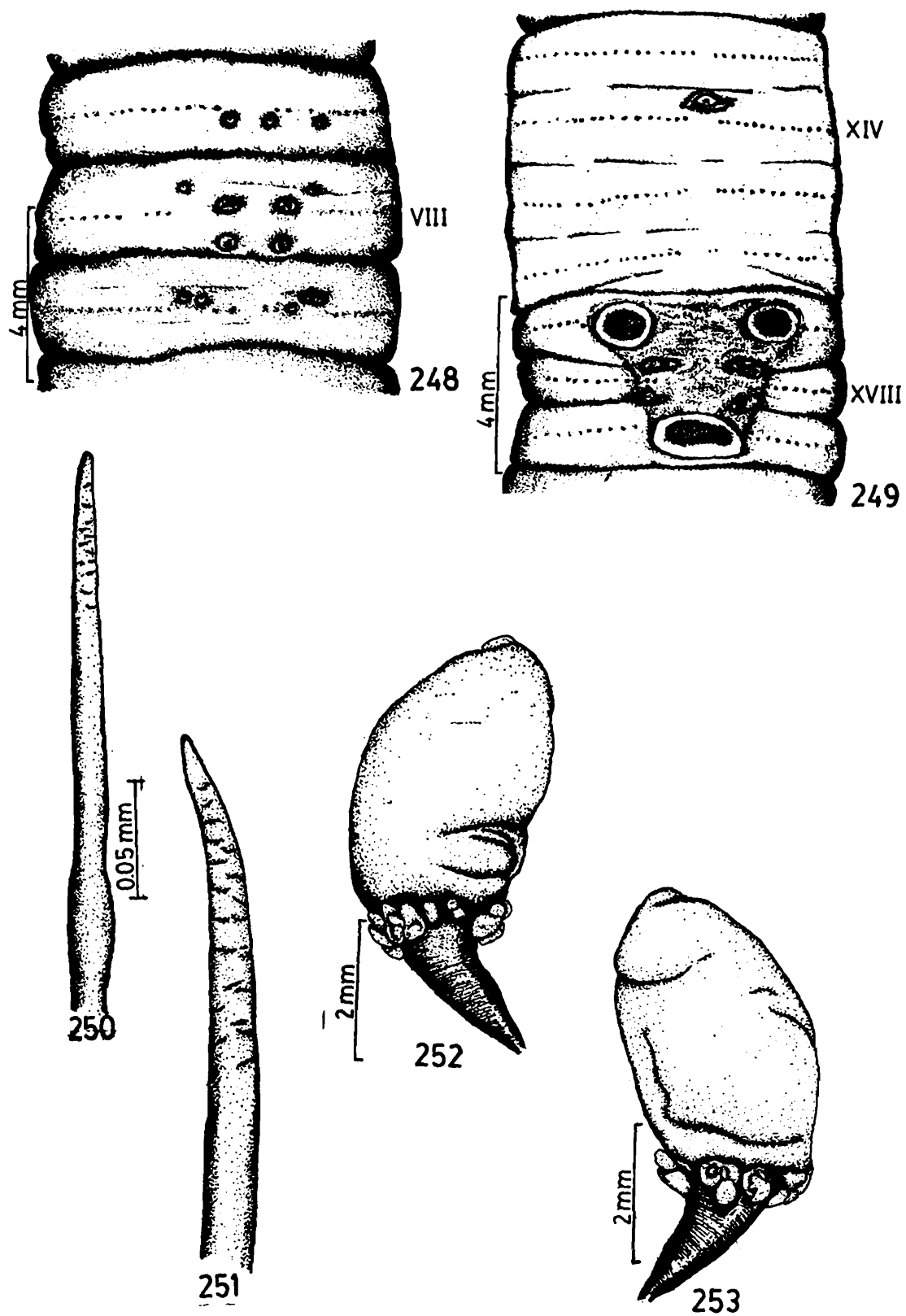
(Figs. 248-253)

1917. *Hoplochaetella suctoria* Stephenson, *Rec. Indian Mus.*, 13: 388.

1923. *Erythraeodrilus suctorius* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 464 (excluding var. *affinis*).

1940. *Hoplochaetella suctoria*, Gates, *Rec. Indian Mus.*, 42: 244.

Length 140-187 mm, diameter 6-8 mm, 114-145 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum xiii-xvi. Setae  $aa = 2$   $ab = 2$   $bc = 1.4$   $yz = 0.5$   $zz$  on xii,  $aa = 2$   $ab = 2$   $bc = 1.3$   $yz = 0.4$   $zz$  on xxiv; 51 on ii, 67 on vii, 63-68 on xii, 63 on xx; setae *a* on vii, some or all of *a-e* on viii and ix copulatory, those on vii shifted slightly posterior to the setal arc, those on viii and ix shifted anterior to the setal arcs. Combined male and prostatic pores minute, at about centres of somewhat oval porophores on or near to 17/18 and 18/19, at *bc* or *cd*, 0.07 body circumference apart. Spermathecal pores minute, 2 pairs on viii, at or slightly lateral to



FIGS. 248-253. *Hoplochaetella suctoriamorphus* Stephenson. 248. spermathecal pore region, 249. genital region, 250. penial seta, 251. copulatory seta, 252-253. spermatheca, posterior (252) and anterior (253) views.

*bc*, 0.05 body circumference apart, anterior pair slightly anterior to setal arc, posterior pair just in front of 8/9. Genital markings without central apertures, oval to circular, on xvii and on region between setal arcs of xix and xx, paired in one (or both ?) of these regions, centres of paired markings on or lateral to male pore lines.

Septa 4/5, 8/9-11/12 slightly muscular, 5/6/7/8 delicate. Gizzard in vi. Intestinal caeca absent; typhlosole xxii-xxiv to cxviii. Supra-oesophageal vessel single, ix-xiii; subneural vessel present, but not recognized anterior to xii; last pair of hearts in xiii. Lymph glands unpaired in xv and posteriad segments. Testes and male funnels in x and xi, enclosed in unpaired sacs, formed by the peripheral union of the septa 9/10/11/12; seminal vesicles in ix, x and xii, those of x rudimentary. Vasa deferentia enlarged into ejaculatory bulbs before opening into the prostatic ducts. Penial setae ornamented with a few, short, serrated ridges, 0.2-0.39 mm long, 10-16  $\mu$  diameter. Spermathecae 2 pairs in viii, each with a circle of 15-20 ventrally directed, adherent to the duct, digitiform diverticula. Copulatory setae ornamented with short transverse rows of small fine teeth, 0.49-0.63 mm long, 24-27  $\mu$  diameter. Copulatory setal glands c. 1-2.4 mm long, in paired coelomic sacs in vii, viii and ix. Parietal glands paired, half collar-shaped, median to the ectal ends of the prostatic ducts, in xvii and xix. Genital marking glands sessile, oval.

*Type locality* : Sanvordem, Goa, India.

*Type specimens* : In ZSIC, W 67/1; BMNH, 1933: 5: 25: 857-62.

*Material examined* : 1-4-0, syntypes, W 67/1, in ZSIC; 0-0-2 Moodabidri, 5 Oct 1978, coll. B.R. Rao, An 626, HAZFS, ZSI, Solan; coll. J.M. Julka 1979: 12-6-0 Castle Rock, 28 Aug, An 627, 0-6-0 Londa, 29 Aug, An 628, all in HAZFS, ZSI, Solan.

*Distribution* : India: *Goa*: Sanvordem; *Karnataka*. Castle Rock, Londa, Moodabidri.

### Genus 11. **Karmiella** Julka, 1983

1983. *Karmiella* Julka, *Geobios New Reports*, 2: 48.

**Diagnosis** : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in v and one pair of discrete, extramural calciferous glands, each gland bilobed, one lobe in xv and the other in xvi, both lobes opening into gut through a common duct close to the attachment of septum 15/16; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate, exonephric, paired tufts on the body wall in ii-iv, few scattered on the body wall in v and posteriad segments. Paired, stomate, enteronephric megameronephridia in each segment from c. middle of body to posterior end.

**Type species** : *Karmiella karnatakensis* Julka, 1983.

**Description** : As for the only species, *karnatakensis*.

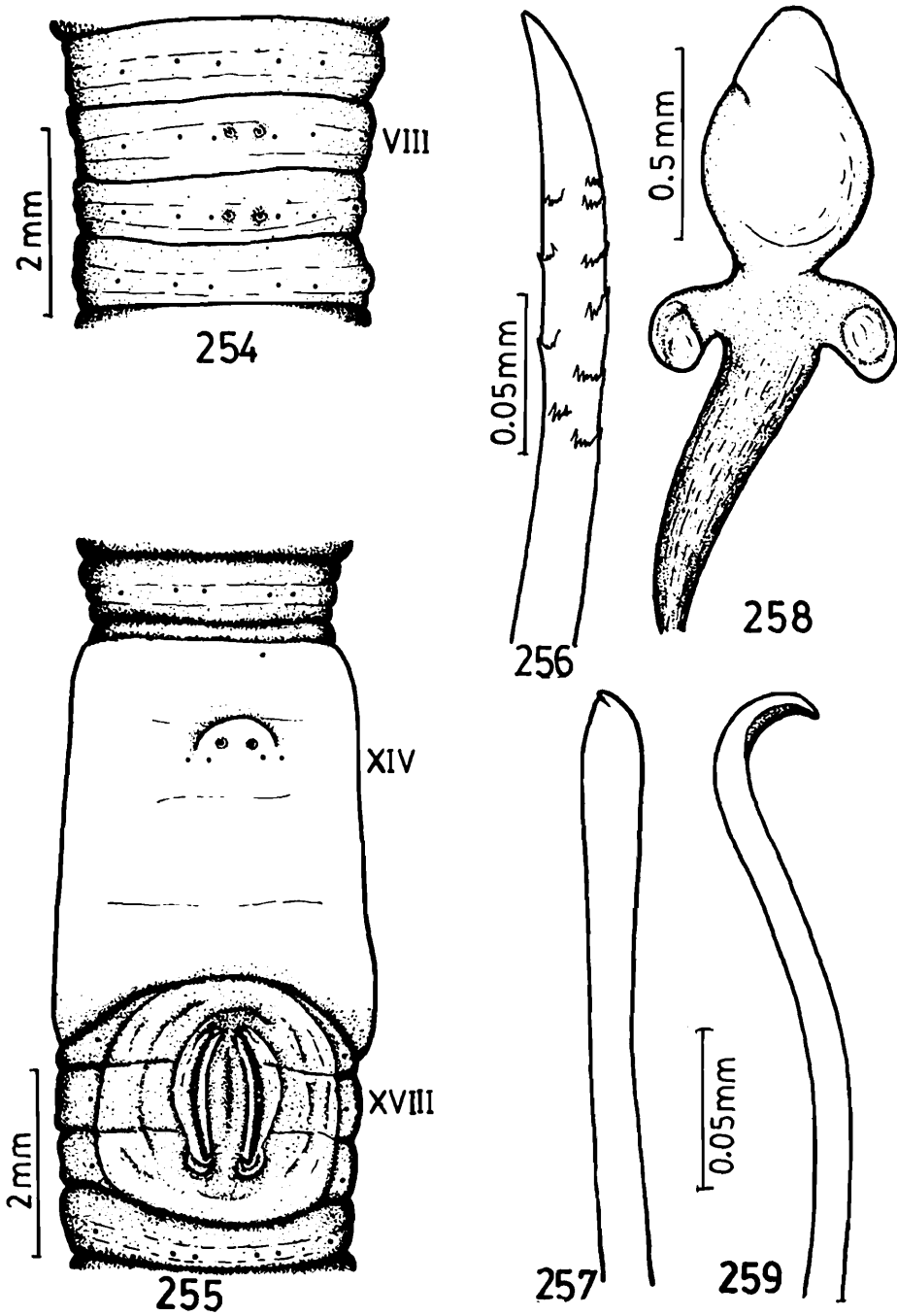
**Distribution** : Karnataka, S. India.

### 66. **Karmiella karnatakensis** Julka

(Figs. 254-259)

1983. *Karmiella karnatakensis* Julka, *Geobios New Reports*, 2: 48.

Length 64-87 mm, diameter 2.5-3 mm, 125-157 segments. Prostomium tanylobic. First dorsal pore 5/6. Clitellum annular, xiii,  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvii, xvii. Setae lumbricine,  $aa = 1.7-2$   $ab = 0.7-0.9$   $bc = 0.9-1$   $cd = 0.11-0.15$   $dd$  on xii,  $aa = 2.5-3$   $ab = 0.8-1$   $bc = 1.1-1.4$   $cd = 2.5-3$   $ab = 0.8-1$   $bc = 1.1-1.4$   $cd = 0.12-0.16$   $dd$  on xxiv,  $a$  or  $b$  on viii sometimes copulatory. Male pores paired, minute, in seminal grooves, on the setal arc of xviii, slightly lateral to  $a$ ; prostatic pores paired, minute, at the ends of seminal grooves, on xvii and xix, at  $a$ ; seminal grooves concave, between setal arcs of xvii and xix. Female pores paired, antero-median to  $a$ , on xiv. Spermathecal pores paired, minute, on or slightly anterior to setal arcs, on viii and ix, just median to  $a$ . Genital markings absent. Nephridiopores not recognized.



FIGS. 254-259. *Karmiella karnatakensis* Julka. 254. spermathecal pore region, 255. genital region, 256. copulatory seta, 257, 259. penial seta, dorsal (257) and lateral (259) views, 258. spermatheca.

Septa 4/5, 7/8-11/12 muscular, 5/6/7 delicate. Gizzard large, in v. A pair of discrete, extramural, symmetrical, reniform calciferous glands, each gland bilobed, one lobe in xv and the other in xvi, both the lobes opening into oesophagus through a common short duct close to the attachment of septum 15/16. Intestine begins in xviii; caeca and supra-intestinal glands absent; typhlosole lamelliform, simple, xxvii-xxix to cxiv-cxix. Dorsal vessel single and complete; supra-oesophageal vessel single, vii-xv; extra-oesophageal vessels paired, v-xv; latero-parietal vessels paired, joining the supra-oesophageal vessel in xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xiii. Holandric, testes and male funnels enclosed in annular sacs, in x and xi; seminal vesicles in ix and xii. Prostates paired, in xvii and xix. Penial setae unornamented, 1.1-2 mm long, 14-16  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a median and a lateral ental diverticula (one of the pair sometimes absent). Copulatory setae, when present, ornamented, 0.66-0.67 mm long, 24-30  $\mu$  diameter. Ovaries paired, fan-shaped, in xiii; ovisacs absent. Micromeronephridia astomate, exonephric, paired tufts on the body wall, in ii-iv, few scattered on the body wall in v and posteriad segments, numerous in clitellar segments; paired, stomate megameronephridia in lvi-lx and posteriad segments, funnels close to the nerve cord, loops extending laterally, discharging into posterior part of rectum through a pair of longitudinal excretory canals, one on each side of mid-dorsal line.

*Type locality* : Tirthahalli, Karnataka, India.

*Type specimens* : In HAZFS, ZSI, Solan - Holotype, An 395; 0-1-5 paratypes, An 396.

*Distribution* : India: *Karnataka*: Tirthahalli, Kotegehar, Moodabidri, Bhagamandala, Sakleshpur.

## Genus 12. *Konkadrilus* gen nov.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves,

on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in v and calciferous lamellae in xvi, xvi-½xvii; discrete calciferous glands and supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate, exonephric, few, on the body wall in ii and posteriad segments. Paired, stomate, exonephric megameronephridia in each of caudal segments.

*Type species : Howascolex stephensoni* Soota and Julka, 1972.

*Description* : Setae lumbricine throughout the body. Clitellum annular. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Female pore(s) single and median, or paired, presetal, on xiv. Spermathecal pores paired. Genital markings present. Nephridiopores not recognized.

Septa present from 4/5. Oesophagus with a single gizzard in v and calciferous lamellae in xvi, xvi-½xvii; discrete calciferous glands, intestinal caeca and supra-intestinal glands absent; typhlosole lamelliform, simple. Dorsal blood vessel single, complete; supra-oesophageal vessel single or partly doubled in some segments but the two branches reunite anterior to septa, in vii-xiii; extra-oesophageal vessels paired, v-x; latero-parietal vessels paired, joining the supra-oesophageal vessel in xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii, xiii. Holandric; seminal vesicles in xi and xii. Prostates paired, in xvii and xix, extending posteriorly to 1-3 segments. Penial setae present. Spermathecae paired, in viii and ix. Ovisacs paired, in xiv. Micromeronephridia astomate, exonephric, few, on the body wall in ii and posteriad segments, tufted micromeronephridia absent; paired, stomate, exonephric megameronephridia in each of posteriormost segments, funnels close to the nerve cord, loops extending laterally close to the mid-dorsal line.

*Distribution* : Goa and western Karnataka, India.

*Etymology* : *Konkadrilus*, gender masculine, derived from the vernacular word 'Konkan' denoting the area in which it is commonly found, and the Greek word 'drilos' meaning the worm.

*Remarks* : On the basis of the presence of paired enteronephric megameronephridia alongwith astomate exonephric micromeronephridia in each of the caudal segments, the Indian species *Howascolex corethrurus* Michaelsen, 1922 (possibly also *H. bidens* and *H. merkaraiensis* both of Michaelsen, 1922) has been assigned to *Wahoscolex* gen. nov. (described elsewhere in this work). As a result, *Howascolex* is restricted to include the Malagasian type species *madagascariensis*, which is defined by the presence of holonephridia in the anterior region and meronephridia in the posterior region of the body (see under remarks of *Wahoscolex* gen. nov. in this work). A re-examination of the excretory system in the types of 2 other Indian species in the Zoological Survey of India, Calcutta, viz., *Howascolex bahli* and *H. stephensoni* described by Soota and Julka (1972) from Goa reveals - "few, astomate, exonephric micromeronephridia in ii and posteriad segments; paired, stomate, exonephric megameronephridia in each of the caudal segments" These species, therefore, form a distinct assemblage distinguishable from *Howascolex* s.s. Michaelsen, 1901 by the presence of meronephridia throughout the body and absence of holonephridia, and from *Wahoscolex* gen. nov. (other Indian species of *Howascolex* and described elsewhere in the work) by the exonephric condition of the caudal megameronephridia. Accordingly, they are assigned to new genus *Konkadrilus*, which can be easily distinguished from related genera by the characters shown in Table 7.

### Key to the species of *Konkadrilus*

1. Spermathecal pores intersegmental, in 7/8/ 9;  
female pores paired ..... *K. bahli*
- Spermathecal pores segmental, on viii and ix;  
female pore single, median ..... 2

2. Last pair of hearts in xii ..... *K. zicsii*  
 Last pair of hearts in xiii ..... 3
3. Genital markings present on preclitellar  
 segments ..... *K. tirthahalliensis*  
 Genital markings absent on preclitellar  
 segments ..... *K. stephensoni*

### 67. *Konkadrilus bahli* (Soota and Julka)

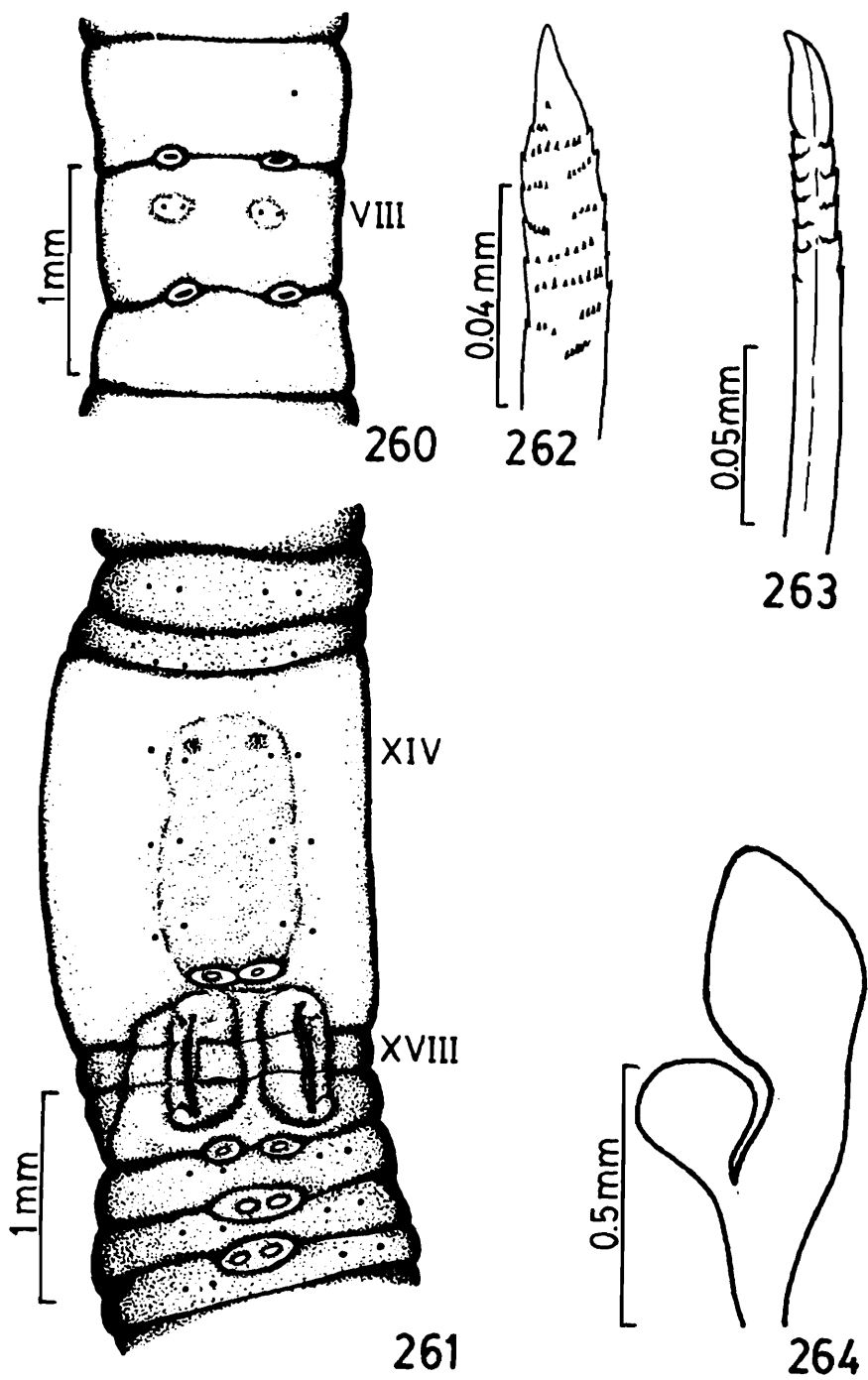
(Figs. 260-264)

1972. *Howascolex bahli* Soota and Julka, *Zool. Anz., Leipzig*, **189**: 402.

Length 32-43 mm, diameter 1-1.5 mm, 87-117 segments. Prostomium epilobic, tongue closed. First dorsal pore 10/11, sometimes 9/10. Clitellum ½xiii-xvii. Setae  $aa = 2.6$   $ab = 0.75$   $bc = 1.64$   $cd = 0.20$   $dd$  on xii,  $aa = 3$   $ab = bc = 2.4$   $cd = 0.25$   $dd$  on xxiv,  $a, b$  on viii copulatory, being surrounded by indistinct tumescences, slightly shifted anteriorly from the setal arc. Male pores minute, at or slightly median to  $b$ ; prostatic pores minute, at or slightly lateral to  $a$ ; seminal grooves almost straight or slightly concave, between setal arcs of xvii and xix. Female pores paired, anteromedian to  $a$ . Spermathecal pores large, transverse slits, in 7/8/9, at  $ab$ . Genital markings oval, paired, in 15/16/17, 19/20-23/24, at  $aa$  (one of the pair sometimes absent).

Septa 4/5-11/12 delicate. Intestine begins in xix, typhlosole in xx-xxi to lxxxv. Last pair of hearts in xiii. Testes and male funnels free, in x and xi. Penial setae ornamented with a few transverse rows of fine spines or teeth, tip pointed,  $c$ . 0.47-0.52 mm long, 16  $\mu$  diameter. Each spermatheca with a shortly stalked, spheroidal, ental diverticulum, duct longer than ampulla. Copulatory setae ornamented with scale-like spines on the margins, tip slightly claw-shaped, 0.42-0.44 mm long, 14-16  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Satpalli village,  $c$ . 4 km from Mollem, Goa, India.



FIGS. 260-264. *Konkadrilus bahli* (Soota and Julka). 260. spermathecal pore region, 261. genital region, 262. tip of penial seta, 263. copulatory seta, 264. spermatheca (all drawn from a paratype).

TABLE 7. Comparison of *Konkadrilus* gen. nov. and *Wahoscolex* gen. nov. with related genera.

Character	<i>Howoscolex</i> sensu stricto	<i>Wahoscolex</i>	<i>Konkadrilus</i>	<i>Ramiella</i>	<i>Mallehulla</i>	<i>Celeriella</i>
Setae	lumbricine	lumbricine or perichaetine in posterior segments	lumbricine	lumbricine	perichaetine	perichaetine
Male terminalia	acanthodriline	acanthodriline to microscolecine	acanthodriline	acanthodriline	acanthodriline	megascolecine
Calciferous lamellae	xvi	xvi, ½xv-xvi, xvi-½xvii	xvi, xvi-½xvii	viii-xi	xiv-xv	xiii-xiv
Typhlosole	absent	present	present	present	present	absent
Excretory system	partly holo- and partly meronephric	meronephric	meronephric	meronephric	meronephric	meronephric
Megameronephridia	absent	present enteronephric	present exonephric	present exonephric	present exonephric	present enteronephric
Micromeronephridia	astomate	astomate	astomate	astomate	astomate	stomate at least in caudal segments
Prostates	short, in 2-3 segments	short, in 2-3 segments	short, in 2-3 segments	short, in 2-3 segments	short, in 2-3 segments	very long, in several segments
Penial setae	present	present	present	present	present	absent

*Type specimens* : In ZSIC: Holotype, An 154/1; 0-1-2 paratypes, An 155/1.

*Material examined* : In ZSIC: holotype and 3 paratypes, An 154/1, An 155/1; 0-0-2 Yella village, 9 Dec 1970, coll. T.D. Soota, An 156/1. In HAZFS, ZSI, Solan: 0-0-2 Castle Rock, 28 Aug 1979, coll. J.M. Julka, An 736

*Distribution* : India: *Goa*: Stapalli village c. 4 km from Mollem, Yella village; *Karnataka*: Castle Rock.

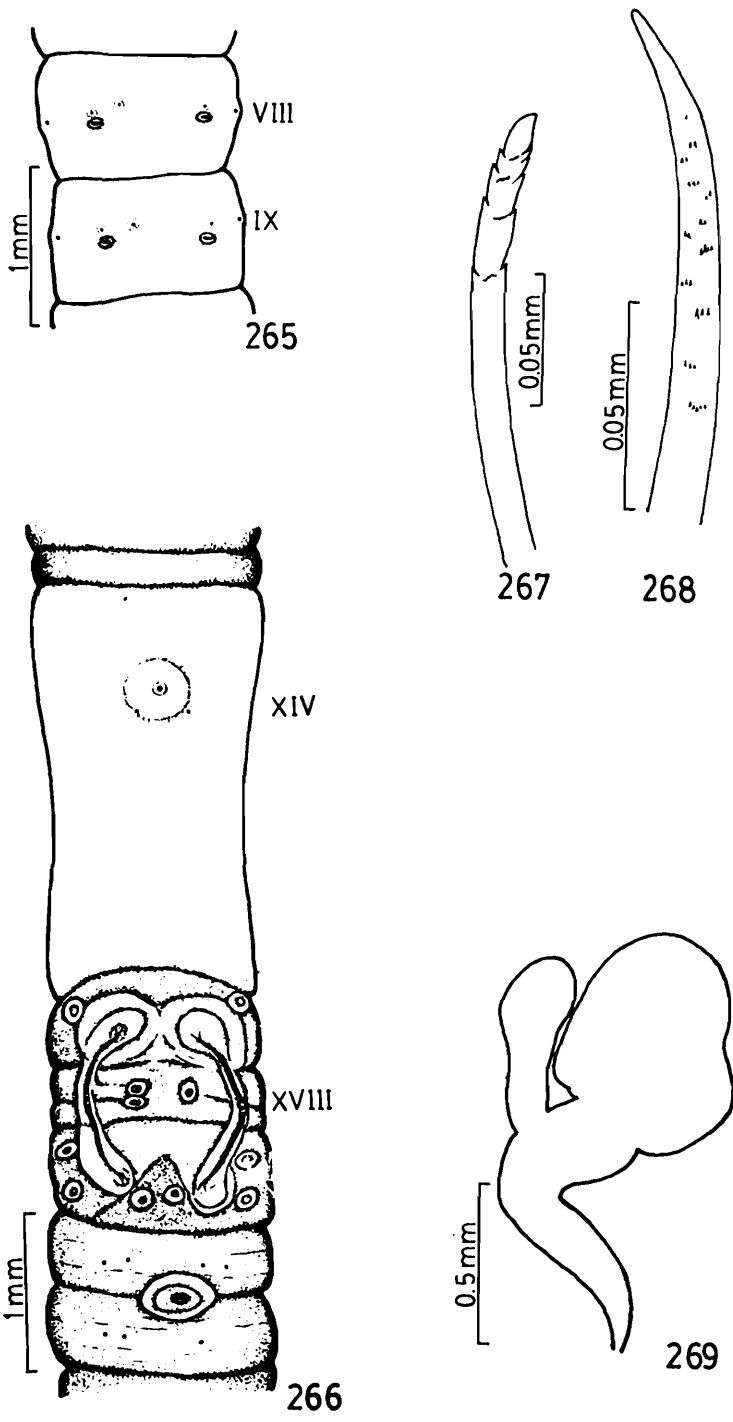
### 68. *Konkadrilus stephensoni* (Soota and Julka)

(Figs. 265-269)

1972. *Howascolex stephensoni* Soota and Julka, *Zool. Anz., Leipzig*, **189**: 401.

Length 31-91 mm, diameter 1.5-2.5 mm, 83-141 segments. Prostomium epilobic, tongue closed. First dorsal pore in region of 9/10-12/13. Clitellum  $\frac{1}{2}$ xiii-xvi. Setae *aa* = 2.4-3.3 *ab* = 1.1-1.4 *bc* = 1.3-1.7 *cd* = 0.21-0.27 *dd* on xii, *aa* = 2.6-3.2 *ab* = 1.4-1.8 *bc* = 1.6-2.4 *cd* = 0.22-0.32 *dd* on xxiv, *a*, *b* on viii and ix, sometimes x, xi copulatory, being surrounded by tumescences. Male pores minute, at *b*; prostatic pores minute, just lateral to *a* lines; seminal grooves concave between setal arcs of xvii and xix. Female pore single and median. Spermathecal pores small, transverse slits, surrounded by oval tumescences, on viii and ix, slightly anterior or posterior to the setal arcs, sometimes slightly posterior to intersegmental furrows 7/8/9, at *b*. Genital markings small, oval; paired: presetal or postsetal on xv-xvi at *aa* or *ab*, xvii-xix at *aa* or *ab* or *bc*, presetal on xx, 14/15-23/24 at *aa*, xx-xxii at *ab*; unpaired and median: presetal on xvii-xix, 16/17, with 4/5 central areas on 14/15; 3-4 markings in a transverse row; postsetal on xvi, xix, presetal on xvii, at *aa* or *ab*.

Septa 4/5/6 delicate, 6/7 slightly muscular, 7/8-11/12 muscular. Intestine begins in xix; typhlosole xx-xxi to lxxi-xcvii. Last pair of hearts in xiii. Testes and male funnels free, in x and xi. Penial setae ornamented with short 5-11 transverse rows of a few



FIGS. 265-269. *Konkadrilus stephensoni* (Soota and Julka). 265. spermathecal pore region, 266. genital region, 267. copulatory seta, 268. penial seta, 269. spermatheca (all drawn from a paratype).

fine teeth or spines, tip pointed, 0.55-1.07 mm long, 12-23  $\mu$  diameter. Each spermatheca with a tubular to clavate ental diverticulum (rarely with 2 diverticula), distal end of the diverticulum sometimes bifid to quadrifid, duct as long as or slightly longer than ampulla. Copulatory setae ornamented with scale-like spines on the margins, tip claw-shaped, 0.34-0.45 mm long, 12-18  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Valpoi, Goa, India.

*Type specimens* : In ZSIC: holotype, An 152/1; 0-9-8 paratypes, An 153/1.

*Material examined* : In ZSIC: holotype and 17 paratypes, An 152/1, An 153/1. In HAZFS, ZSI, Solan, coll. J.M. Julka 1979: *Karnataka*: 6-15-26 Castle Rock, 28 Aug, An 739, 11-5-31 Londa, 29 Aug, An 740, 0-0-4 Tirthahalli, 5 Sept, An 742, 0-20-48 Kotegehar, 7 Sept, An 743; *Goa*: 0-3-29 Sanvordem, 31 Aug 1979, An 741.

*Distribution* : India: *Goa*: Valpoi, Sanvordem; *Karnataka*: Castle Rock, Londa, Tirthahalli, Kotegehar.

*Abnormality* : One specimen from Londa with clitellum  $\frac{1}{2}$ xii-xv, female pore on xiii, male pores on xvii and prostatic pores on xvi and xviii. One specimen from Castle Rock with spermathecal pores on vi and vii, clitellum  $\frac{1}{2}$ xi-xiv, female pore xiii, male pores on xvi, prostatic pores on xv and xvii; in another specimen from Castle Rock left spermatheca in viii absent, though associated copulatory setae present, spermathecae in ix bidiverticulate. One specimen from Sanvordem with an additional female pore on xv. Another specimen from Sanvordem with well-developed spermathecal pores on vii, viii and a rudimentary thecal pore on the left side of vi, clitellum xii-xiv, female pore on xii, male pores on xvi, prostatic pores on xv and xvii, testes and male funnels in viii and ix, seminal vesicles in ix and x, last pair of hearts in xi, ovaries in xi, intestine begins in xvii.

**69. Konkadrilus tirthahalliensis sp. nov.**

(Figs. 270-274)

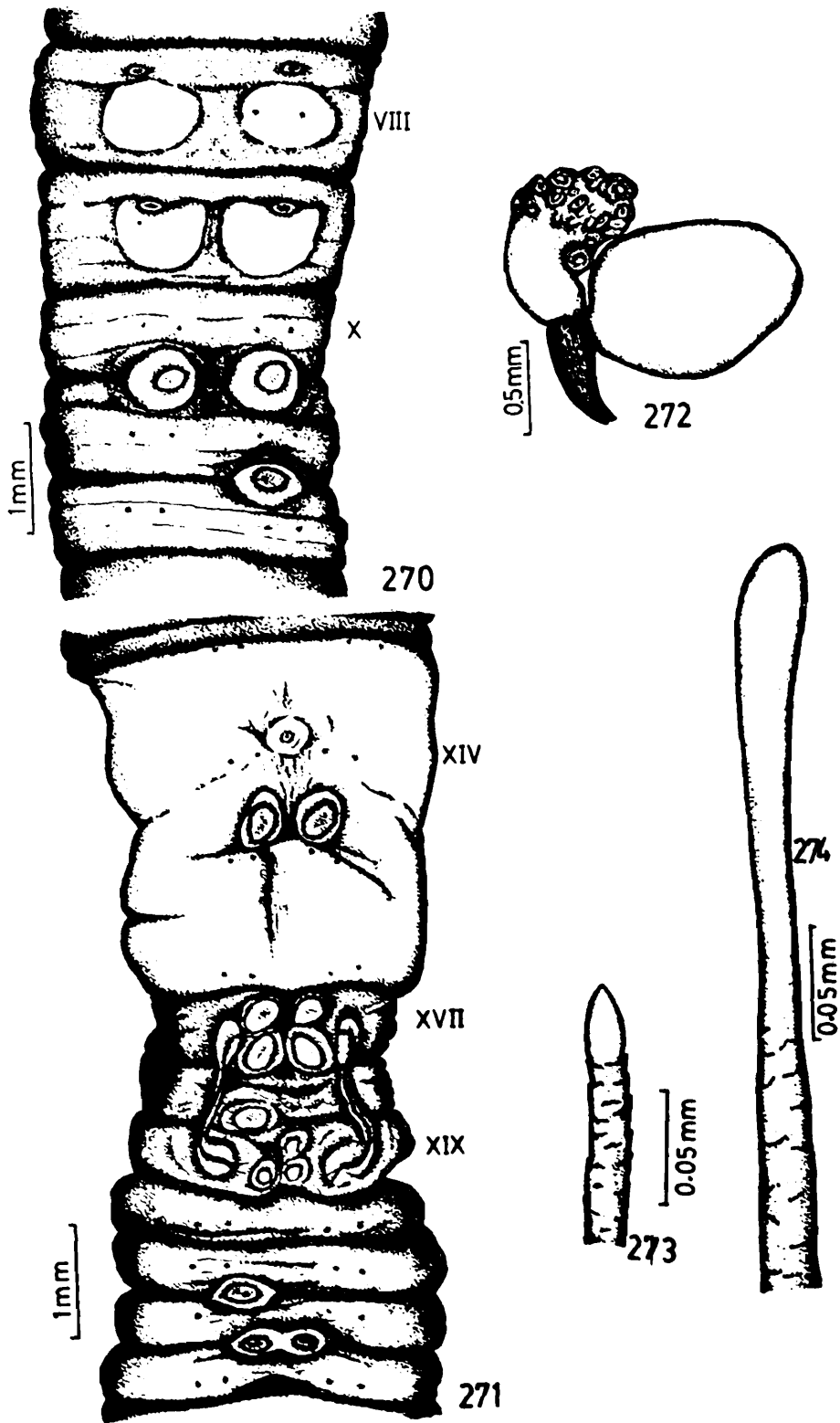
Length 54-97 mm, diameter 2-3 mm, 130-157 segments. Prostomium proepilobic. First dorsal pore 11/12, sometimes 10/11. Clitellum  $\frac{1}{2}$ - $\frac{2}{3}$  xiii-xvi. Setae  $aa = 2.5-3.4$   $ab = 1.3$   $bc = 1.4-1.8$   $cd = 0.18-0.21$   $dd$  on xii,  $aa = 2.6-3.7$   $ab = 1.4-1.5$   $bc = 1.9-2.4$   $cd = 0.19$   $dd$  on xxiv,  $a$  and  $b$  on viii, ix copulatory, being surrounded by tumescences. Male pores minute, slightly median to  $b$ ; prostatic pores minute, slightly lateral to  $a$ ; seminal grooves almost concave, slightly diverging posteriorly, between the setal arcs of xvii and xix. Female pore single and median. Spermathecal pores small, transverse slits, surrounded by oval tumescences, presetal, on viii and ix, close to intersegmental furrows or setal arcs or equidistant from intersegmental furrows and setal arcs, at or just median to  $b$ . Genital markings circular to oval; paired at  $ab$ : on 10/11/12, 14/15, sometimes 9/10, 12/13, 15/16, presetal on xvii; paired at  $aa$ : presetal or postsetal on xvii-xix, 21/22, sometimes 17/18-20/21, 22/23-29/30; rarely unpaired and median, presetal, on xvii.

Septa 4/5 delicate, 5/6 slightly muscular, 6/7-12/13 muscular. Intestine begins in  $\frac{1}{2}$ xix; typhlosole xx to cxi-cxiii. Last pair of hearts in xiii. Testes and male funnels free, in x and xi. Penial setae ornamented with 8-10 rows of small, fine teeth, tip spatulate, 2.86-3.23 mm long, 15-16  $\mu$  diameter. Each spermatheca with a dorsally directed ental diverticulum, about half as long as combined length of duct and ampulla, duct shorter than ampulla. Copulatory setae ornamented with a few serrated ridges, tip bluntly pointed, 0.36-0.4 mm long, 16  $\mu$  diameter. Genital marking glands absent.

*Material examined* : 0-13-15 Tirthahalli, 13.7 N, 75.21 E, 5 Sept 1979, coll. J.M. Julka (holotype and 2 paratypes in ZSIC, An 1827/1, An 1828/1, 25 paratypes in HAZFS, ZSI, Solan, An 737).

*Distribution* : India: *Karnataka*: Tirthahalli.

*Etymology* : Derived from the type locality.



FIGS. 270-274. *Konkadrilus tirthahalliensis* sp. nov. 270. spermathecal pore area, 271. genital region, 272. spermatheca, 273. tip of copulatory seta, 274. penial seta.

**Remarks :** *Konkadrilus tirthahalliensis* sp. nov. belongs to a group of species with segmental location of spermathecal pores on viii and ix, and a single median female pore. It can be distinguished from the other species of the group, *K. stephensoni* (Soota and Julka, 1972) and *K. zicsii* sp. nov. (described elsewhere in this work) by the characters shown in Table 8.

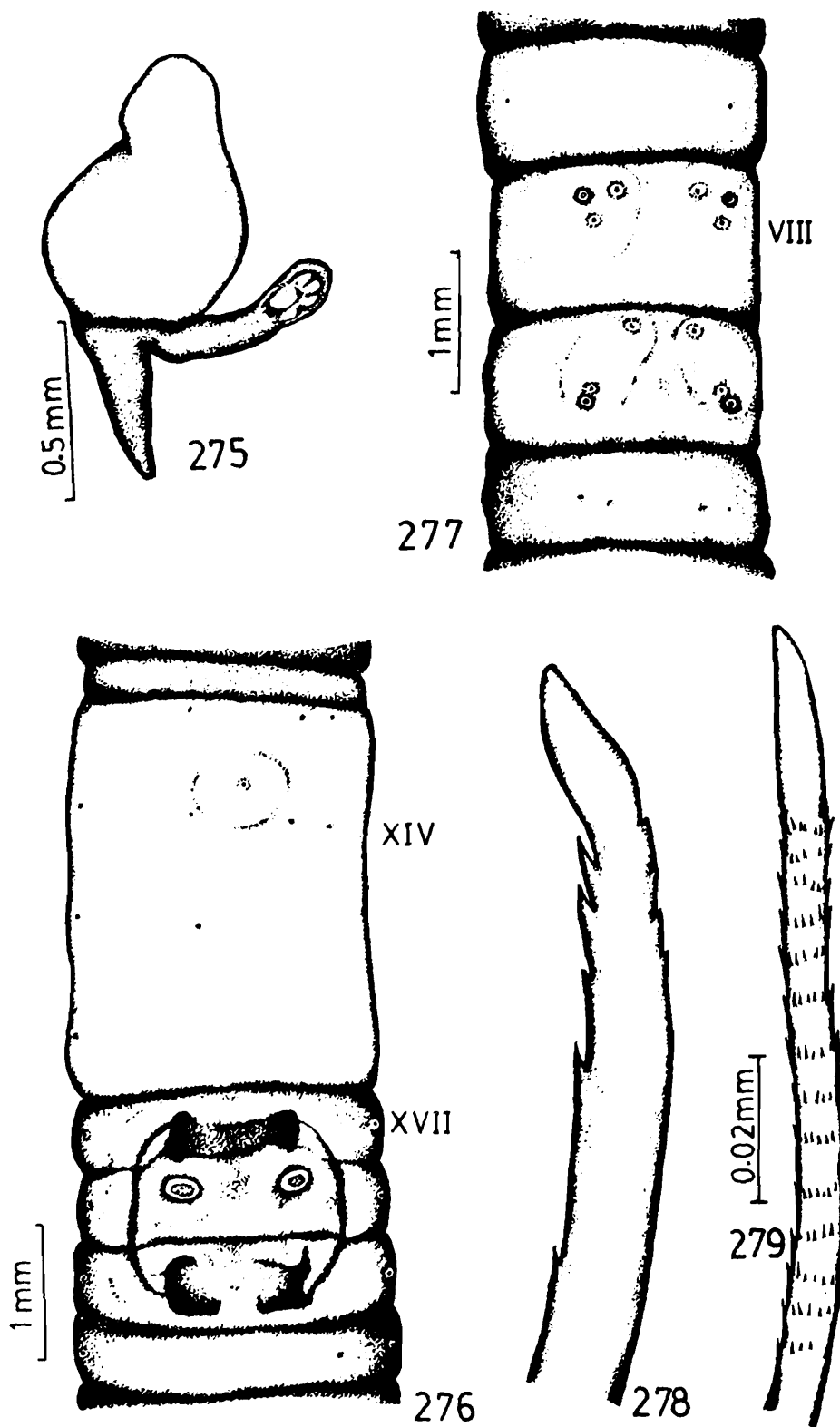
**70. *Konkadrilus zicsii* sp. nov.**

(Figs. 275-279)

Length 55-85 mm, diameter 1.8-2.5 mm, 106-129 segments. Prostomium epilobic, tongue closed. First dorsal pore 10/11, sometimes 9/10, 11/12. Clitellum annular,  $\frac{1}{2}$ - $\frac{2}{3}$  xiii-xvi. Setae *aa* = 2.9-3.3 *ab* = 1.2-1.3 *bc* = 1.5-1.6 *cd* = 0.23-0.30 *dd* on xii, *aa* = 2.4-2.8 *ab* = 1.3-1.5 *bc* = 1.7-1.8 *cd* = 0.25-0.30 *dd* on xxiv, *a*, *b* on viii and ix copulatory, being surrounded by indistinct tumescences, those on viii shifted from the setal arc anteriorly to the spermathecal pores, on ix *a* setae shifted anteriorly towards intersegmental furrow 8/9. Male pores minute, at *b*; prostatic pores minute, slightly lateral to *a*; seminal grooves concave, between setal arcs of xvii and xix. Female pore single and median. Spermathecal pores minute, on viii and ix, at *b*, those on viii about equidistant from setal arc and 7/8, those on ix slightly posterior to the setal arc. Genital markings, when present, oval, paired, presetal or on setal arc, on xviii, presetal on xix, at *ab* (one of the pair sometimes absent).

Septa 4/5/6 delicate, 6/7 slightly muscular, 7/8-12/13 muscular. Intestine begins in  $\frac{1}{2}$ xix; typhlosole xxi-xxii to xci-xciii. Last pair of hearts in xii. Testes and male funnels free, in x and xi. Penial setae slightly sinuous ectally, ornamented with 12-14 circles of fine spines, 0.83-0.96 mm long, 8-11  $\mu$  diameter, tip bluntly pointed. Each spermatheca with a digitiform ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with a few spines on the margins, 0.34-0.37 mm long, 12-14  $\mu$  diameter, tip slightly claw-shaped. Genital marking glands absent.

**Material examined :** 0-0-6 Castle Rock, Karnataka, 15.43 N, 74.37 E, 28Aug 1979, coll. J.M. Julka (holotype and 2 paratypes in



FIGS. 275-279. *Konkadrilus zicsii* sp. nov. 275. spermatheca, 276. genital region, 277. spermathecal pore region, 278. copulatory seta, 279. penial seta.

ZSIC, An 1825/1, An 1826/1 paratypes in HAZFS, ZSI, Solan, An 735).

*Distribution* : India: *Karnataka*: Castle Rock.

*Remarks* : *Konkadrilus zicsii* sp. nov. belongs to a group of species with paired spermathecal pores on viii and ix, and a single median female pore. It is distinguishable from other species of the group *K. stephensoni* (Soota and Julka, 1972) and *K. tirthahalliensis* sp. nov. (described elsewhere in this work) by the characters given in Table 8.

TABLE 8. A comparison of *K. tirthahalliensis* and *K. zicsii* spp. nov. with related species.

Character	<i>K. tirthahalliensis</i>	<i>K. stephensoni</i>	<i>K. zicsii</i>
Length (mm)	54-97	31-91	55-85
Segments	130-157	83-141	106-129
Prostomium	proepilobic	epilobic	epilobic
Preclitellar genital markings	present	absent	absent
Typhlosole	xx to cxi-cxiii	xx-xxi to lxxi-xcviii	xxi-xxii to xci-xciii
Last pair of hearts	xiii	xiii	xii
Penial setae, Tip	spatulate	pointed	pointed
Length (mm)	2.83-3.23	0.55-1.07	-.83-0.96

### Genus 13. *Kotegeharia* gen. nov.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in v and one pair of discrete extramural calciferous glands in xv; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate, exonephric, several on the body wall in i and posteriad segments. Paired, stomate, exonephric megameronephridia in each segment from about middle of body to posterior end.

*Type species* : *Kotegeharia gatesi* sp. nov.

*Description* : As for the only species, *gatesi*.

*Distribution* : Kotegehar, Karnataka, S. India.

*Etymology* : *Kotegeharia*, gender feminine, derived from the locality Kotegehar.

*Remarks* : *Kotegeharia* gen. nov. belongs to a group of octochaetid genera with a single oesophageal gizzard, discrete extramural calciferous glands and stomate exonephric megamero-nephridia in caudal segments. It can be distinguished from other members of the group, *Priodochaeta* Gates, 1940 and *Calebiella* Gates, 1945, by the characters shown in Table 9.

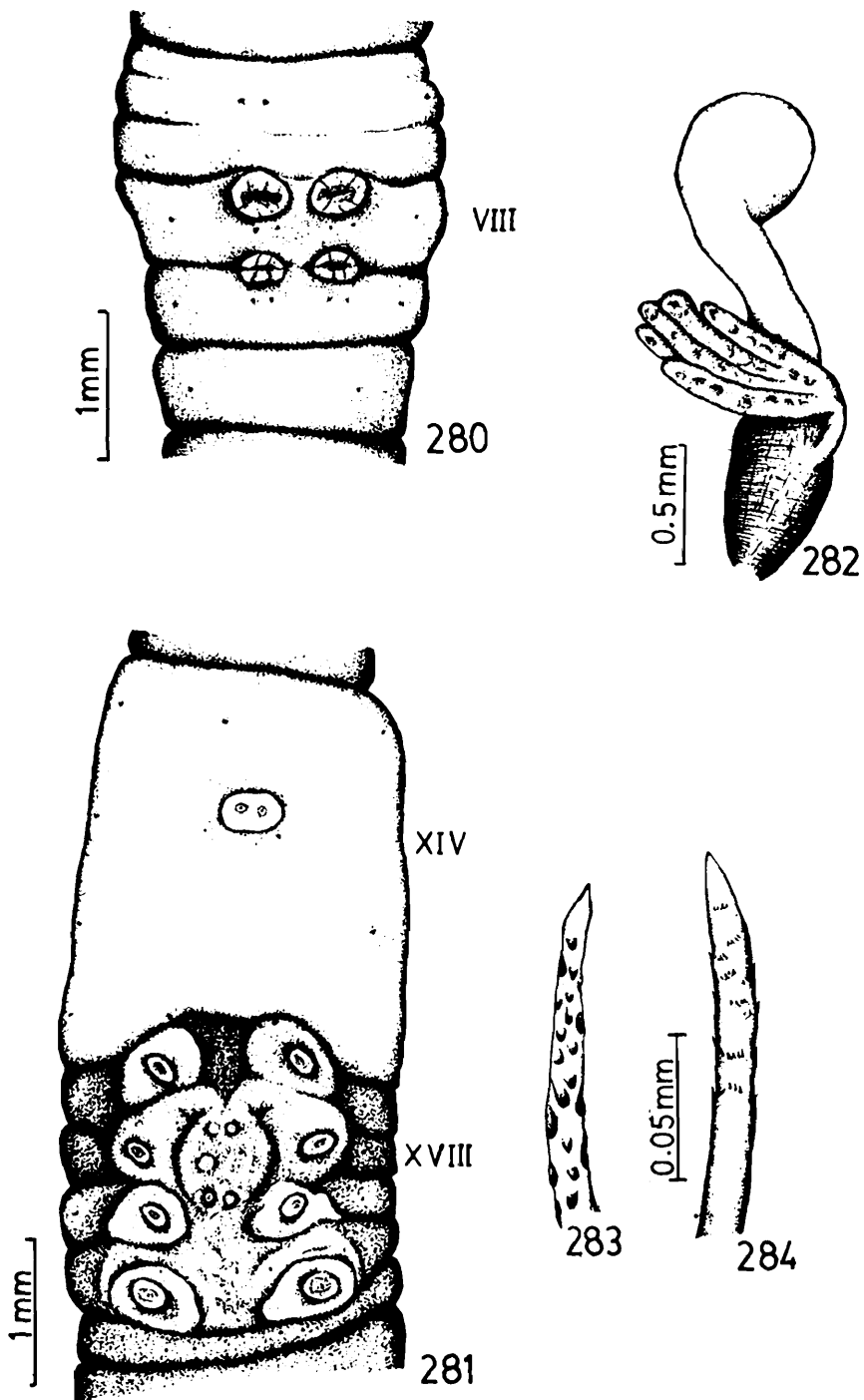
TABLE 9. Comparison of *Kotegeharia* gen nov with related genera.

Character	<i>Kotegeharia</i>	<i>Calebiella</i>	<i>Priodochaeta</i>
Setae	lumbricine	lumbricine	perichaetine
Male terminalia	acanthodriline	acanthodriline	megascolecine
Gizzard	v	vi	v
Calciferous glands	one pair, in xv	4 pairs, in x-xiii	3 pairs, in xiv-xvi
Typhlosole	lamelliform, simple	lamelliform, bifid ventrally	rudimentary, a low ridge
Penial setae	present	present	absent

### 71. *Kotegeharia gatesi* sp. nov.

(Figs. 280-284)

Length 42-71 mm, diameter 1.5-2 mm, 132-140 segments. Prostomium epilobic, tongue open. First dorsal pore 4/5. Clitellum annular, xiii-xvi. Setae lumbricine,  $aa = 3.7-3.9$   $ab = 0.7-0.8$   $bc = 1.9-2.1$   $cd = 0.14-0.16$   $dd$  on xii,  $aa = 3.7-4$   $ab = 1.2-1.3$   $bc = 2.6-2.8$   $cd = 0.18-0.19$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix, sometimes vii copulatory. Male genital field tumescent, slightly depressed at the middle, between 16/17 and 19/20. Male pores paired, minute, in seminal grooves, on xviii, just lateral to  $a$ ; prostatic pores paired,



FIGS. 280-284. *Kotegeharia gatesi* gen. et sp. nov. 280. spermathecal pore region, 281. genital region, 282. spermatheca, 283. copulatory seta, 284. penial seta.

minute, at the ends of seminal grooves, on xvii and xix, at *a*; seminal grooves concave, between setal arcs of xvii and xix. Female pores paired, presetal, within *a* lines, on xiv. Spermathecal pores paired, large transverse slits, presetal on viii and in 8/9, at *ab*. Genital markings paired, large, oval, presetal or postsetal on xvi-xvii, xix-xxii, setal arcs of xvii-xix, 20/21, extending from *a* to mid *bc*; paired, small, circular, presetal on xvii, xix, postsetal on xvii, setal arc of xviii, at *aa*. Nephridiopores not recognized.

Septa 4/5/6 delicate, 6/7-8/9 slightly muscular, 9/10-12/13 muscular. Gizzard large, in v; one pair of discrete, extramural, sessile, bean-shaped calciferous glands, in xv, opening directly into oesophagus through small pores dorso-laterally; intestinal caeca and supra-intestinal glands absent; intestine begins in xviii; typhlosole lamelliform, simple, xxi to cxi-cxv. Dorsal vessel single and complete; supra-oesophageal vessel single, vii-xiii; extra-oesophageal vessels paired, not recognized posterior to x; latero-parietal vessels paired, ending on the ventrolateral surfaces of oesophagus in xiii; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel, in x-xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles racemose, in ix and xii. Prostates paired, in xvii and xix. Penial setae ornamented with short, transverse rows of small teeth, tip bluntly pointed, 0.66-0.73 mm long, 16-19  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a fan-shaped, shortly stalked ental diverticulum, duct as long as or slightly longer than ampulla. Copulatory setae ornamented with longitudinal rows of gouges, tip slightly claw-shaped, 0.41-0.47 mm long, 14  $\mu$  diameter. Ovaries paired, fan-shaped, in xiii; ovisacs paired, in xiv. Micromeronephridia astomate, exonephric, 6-7 on the body wall in i-iv, arranged in 2 ranks on each side, in v and posteriad segments, median rank of 3-5 at *ab*, lateral rank of one at *d* lines; stomate, exonephric, paired, megameronephridia in each segment from *c*. middle of body to posterior end, increasing in size with loops reaching to mid-dorsal line in caudal segments, funnels close to the nerve cord. Genital marking glands absent.

**Material examined :** 1-7-17 Kotegehar, Karnataka, 75.15 N, 13.48 E, altitude 650 m, 7 Sept 1979, coll. J.M. Julka (Holotype and 4 paratypes in ZSIC, An 1829/1, An 1830/1, 20 paratypes in HAZFS, ZSI, Solan, An 738).

**Distribution :** India: Karnataka: Kotegehar.

**Etymology :** The species is named after Dr. G.E. Gates for his highly significant contributions on oligochaete taxonomy during the last sixty years.

#### Genus 14. **Lennogaster** Gates, 1939

1920. *Eudichogaster* (in part), Stephenson, *Mem. Indian Mus.*, 7: 246.

1923. *Eudichogaster* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 402.

1939. *Lennogaster* Gates, *Rec. Indian Mus.*, 41: 183.

1972. *Lennogaster*, Gates, *Trans. Am. phil. Soc.*, 62: 305.

**Diagnosis :** Lumbricine. Male pores paired, in seminal grooves on xviii or 17/18; prostatic pores 2 pairs, at the ends of seminal grooves, on xvii and xix, or one pair on xvii. Oesophagus with 2 gizzards, in v-vi and 3 pairs of discrete extramural calciferous glands in x-xii; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate; paired enteronephric tufts in iii; few, exonephric on the body wall in iv and posteriad segments. Paired, stomate, exonephric megameronephridia in each of few posteriormost segments.

**Type species :** *Eudichogaster yeicus* Stephenson, 1931.

**Description :** Setae lumbricine throughout the body. Clitellum annular. Male pores paired, in seminal grooves on xviii and paired prostatic pores at the ends of seminal grooves on xvii and xix or male pores at the posterior ends of seminal grooves in 17/18 and one pair of prostatic pores at the anterior ends of seminal grooves on xvii. Female pores paired, minute, presetal, within *a* lines on xiv. Spermathecal pores paired on viii or viii-ix. Nephridiopores not recognized.

Septa all present from 4/5. Oesophagus with 2 gizzards in v-vi. Discrete extramural glands 3 pairs in x-xii, vertically ovoidal, opening through dorsal poles without distinct stalks into longitudinal grooves in lateral walls of the oesophagus. Intestine begins in xv; supra-intestinal glands and intestinal caeca absent; typhlosole simple, lamelliform. Dorsal vessel single and complete; supra-oesophageal vessel single in x-xiii; extra-oesophageal vessels paired, connected with each other by transverse vessels in v and vi, passing posteriorly to the oesophageal wall within ridges covering the apertures to calciferous glands; latero-parietal vessels paired, passing to oesophagus in xiii; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric or proandric or metandric; testes and male funnels free, some-times in paired sacs, seminal vesicles present or absent. Prostates paired. Spermathecae paired, diverticulate. Ovisacs paired, in xiv. Micromeronephridia astomate; enteronephric paired tufts in iii; few, exonephric on the body wall in iv and posterior segments, arranged in 3-5 longitudinal rows on each side in postclitellate segments. Paired stomate exonephric megameronephridia in caudal segments, funnels close to the nerve cord.

*Distribution* : India (from Burma border through the Gangetic plain and into the northern part of the peninsula, and lower western Himalayas), Burma, Bangla Desh.

#### Key to the species of *Lennogaster*

1. Spermathecal pores two pairs, on viii-ix; prostatic pores on xvii and xix ..... 2
  - Spermathecal pores one pair, on viii; prostatic pores one pair on xvii ..... 5
2. Male genital field restricted to xvii-xix ..... 3
  - Male genital field extends posteriorly at least to 20/21 ..... *L. elongatus*

- |  |                           |
|--|---------------------------|
| 3. Holandric.....  | 4                         |
| Proandric.....   | <i>L. yeicus</i>          |
| 4. Setae <i>a</i> and <i>b</i> on viii and ix copulatory ..... | <i>L. trichochaetus</i>   |
| Setae <i>a</i> on vii copulatory .....                         | <i>L. falcifer</i>        |
| 5. Setae <i>a</i> on viii copulatory .....                     | <i>L. chittagongensis</i> |
| No setae copulatory .....                                      | <i>L. pusillus</i>        |

## 72. *Lennogaster chittagongensis* (Stephenson)

(Figs. 285-289)

1917. *Eudichogaster chittagongensis* Stephenson, *Rec. Indian Mus.*, 13: 411.

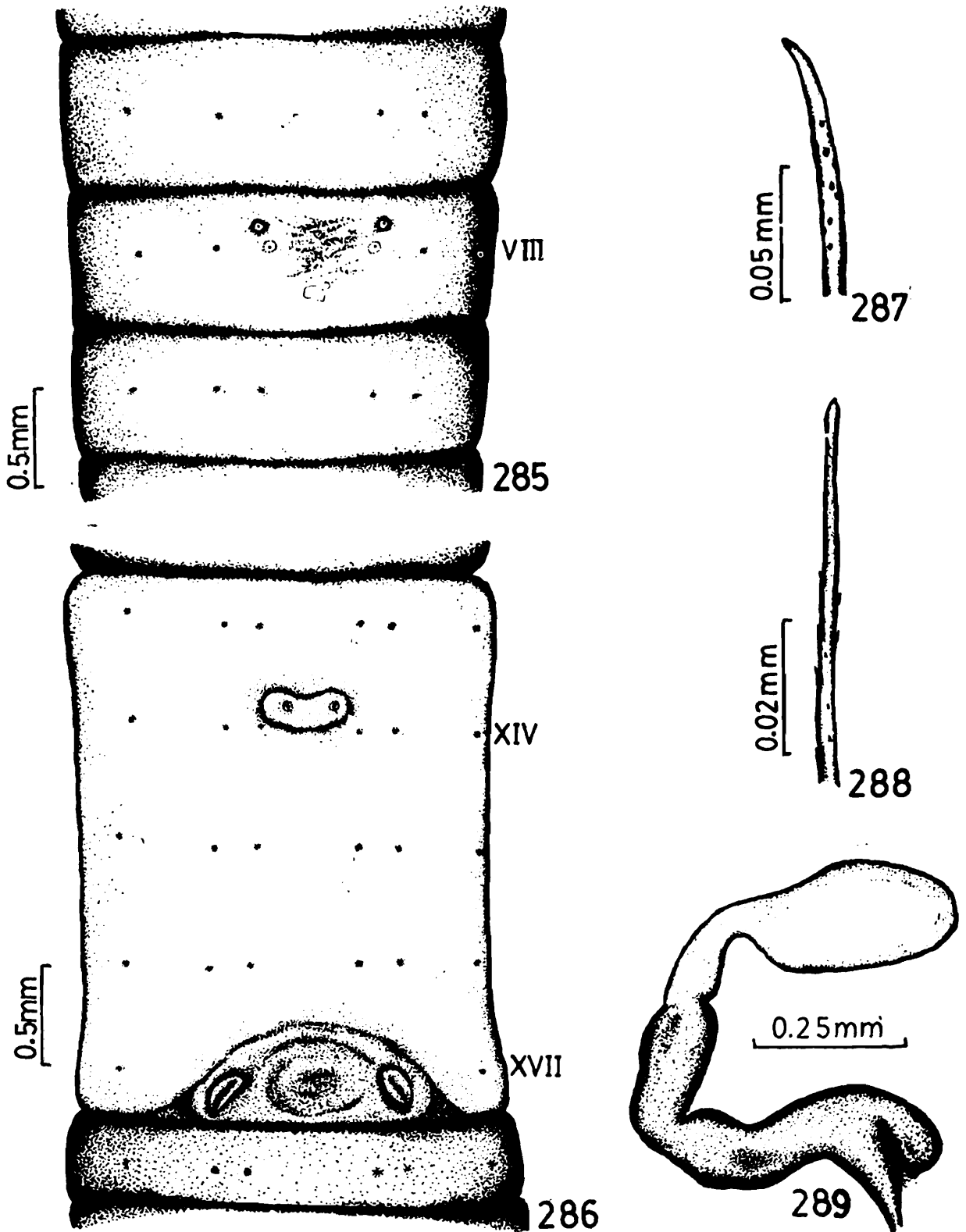
1923. *Eudichogaster chittagongensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 411.

1939. *Lennogaster chittagongensis*, Gates, *Rec. Indian Mus.*, 41: 192.

1972. *Lennogaster chittagongensis*, Gates, *Trans. Am. phil. Soc.*, 62: 306.

Length 24-78 mm, diameter 1-2.5 mm, 79-138 segments. Prostomium epilobic, tongue closed. First dorsal pore 11/12. Clitellum xiii-xvii. Setae *aa* = 2.4-2.7 *ab* = 1.1 *bc* = 1.4-1.5 *cd* = 0.15-0.17 *dd* on xii, *aa* = 2.8-3.3 *ab* = 1.1-1.2 *bc* = 1.7-2 *cd* = 0.16-0.18 *dd* on xxiv, *a* on viii copulatory being surrounded by tumescences. Male genital field transverse, on xvii, often rather spindle-shaped. Male pores minute at posterior ends of seminal grooves on xvii, just anterior to 17/18, at *b*; prostatic pores minute at anterior ends of seminal grooves on setal arc of xvii, at *a*; seminal grooves diagonally placed on oval porophores, at *ab*. Spermathecal pores minute on or slightly anterior to the setal arc of viii, just lateral to *a*. Genital markings absent.

Septa 4/5-7/8 delicate, 8/9-12/13 slightly muscular. Typhlosole in xvii-xviii to lxxii-lxxviii. Proandric but also with male funnels in xi, testes and male funnels in x enclosed in paired sacs; seminal vesicles absent. Prostates one pair, in xvii. Penial setae ornamented with 12-17 circles of fine spines, tip truncate or narrowed to a short spine, 0.5-0.64 mm long, 3-6  $\mu$  diameter. Spermathecae one pair, in viii, each with an ental, pendant, shortly



FIGS. 285-289. *Lennogaster chittagongensis* (Stephenson). 285. spermathecal pore region, 286. genital region, 287. copulatory seta, 288. penial seta, 289. spermatheca.

digitiform diverticulum. Copulatory setae ornamented with scattered triangular teeth or longitudinal rows of gouges, 0.22-0.28 mm long, 11-14  $\mu$  diameter.

*Type locality* : Rangamati, Chittagong Hill Tracts, Bangla Desh.

*Type specimens* : In ZSIC, W 71/1; BMNH 1933: 5: 25: 344-5.

*Material examined* : In HAZFS, ZSI, Solan - *Himachal Pradesh* - coll. H.P. Agarwal, Sirmour district: 0-1-4 Gaura, 5 Aug 1971, An 672, 0-0-1 Kulchet nr. Benethi, 13 Sept 1973, An 674, 0-0-1 Gisani nr. Banethi, 15 Sept 1973, An 678, 0-0-1 Renuka Lake, 22 Sept 1973, An 676, 0-0-1 Lal Khud nr. Dadahu, 24 Sept 1973, An 673, Solan district: 0-0-1 Dharampur 10 Aug 1971, An 677, 0-0-1 Kunihar, 7 Sept 1971, An 675; coll. M. Chandra: 0-0-1 Sarahan, Sirmour district, 28 July 1972, An 671; coll. J.M. Julka 1978, Kangra district: 0-2-27 Nurpur, 8,9 Aug, An 657, An 664, 0-0-35 Jasur, 10 Aug, An 660, 0-0-5 Joginder Nagar, 22 Aug, An 665, 0-0-13 Baijnath, 23 Aug, An 658, 0-0-5 Mohan Ghatti c. 15 km from Joginder Nagar, 23 Aug, An 659, 0-0-5 Dak Bagda c. 10 km from Joginder Nagar, 25 Aug, An 669, Chamba district: 1-2-14 Sundla, 13 Aug, An 655, 0-0-24 Rajpura, 15 Aug, An 656, 0-0-18 Rakh, 16 Aug, An 668, 0-0-10 Chamba, 16 Aug, An 662, Mandi district: 0-0-15 Ner Chowk, 22 Aug, An 661, 0-0-14 Sunder Nagar, 28 Aug, An 666, 0-0-11 Hara Bagh, An 663, 0-2-19 Tata Pani, 31 Aug, An 667. *Jammu & Kashmir* - coll. H. Khajuria: 0-0-1 Mansar Lake, Jammu district, 6 Oct 1978, An 670.

*Distribution* : India: *Himachal Pradesh*: Chamba, Baijnath, Sarahan, Dharampur, Gisani village and Kulchet nr. Banethi, Renuka, Lal Khud nr. Dadahu, Kunihar, Gaura, Nurpur, Rajpura, Sundla, Jasur, Rakh, Mohan Ghatti, Joginder Nagar, Tata Pani, Ner Chowk, Sunder Nagar, Hara Bagh, Dak Bagda; *Jammu & Kashmir*: Mansar Lake.

Outside India: Bangla Desh: Rangamati; Burma.

*Biology* : It inhabits sandy to sandy loam and black clay soils with pH 7.2-7.6 in grasslands, under stones and decaying leaves, and among roots of ferns and mosses growing on rocks.

### 73. *Lenogaster elongatus* Gates

(Figs. 290-291)

1945. *Lenogaster elongatus* Gates, *Proc. Indian Acad. Sci.*, (B) 21: 248.

Length 120 mm, diameter 3.5 mm, *c.* 185 segments. Prostomium proepilobic, tongue closed. First dorsal pore 12/13. Clitellum xiii-xvii. Setae *aa* = 2.2 *ab* = *bc* = 1.8 *cd* = 0.13 *dd* on xii, *aa* = 3 *ab* = 1.5 *bc* = 2 *cd* = 0.16 *dd* on xxiv, no setae copulatory. Male genital field almost rectangular, longitudinally placed, extending from 16/17 to the setal arc on xxi. Male pores minute, in seminal grooves on xviii, just lateral to *a*; prostatic pores minute, in seminal grooves on the setal arcs of xvii and xix, at about *a*; seminal grooves almost straight extending from the setal arc on xvii to 20/21. Spermathecal pores minute, presetal, on viii and ix, at about *a*. Genital markings absent.

Septa 4/5-7/8 muscular, 8/9 thickly muscular. Typhlosole in xx-xxi to cxvi. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Prostates two pairs, in xvii and xix, extending posteriorly to a few segments. Penial setae sparsely ornamented with small, rather triangular teeth, tip chisel-shaped, sharply pointed or with a short sharp spine, 0.47-0.56 mm long, 10-12  $\mu$  diameter. Spermathecae two pairs, in viii-ix, each with an ental, ventrally directed, digitiform diverticulum.

*Type locality* : Nowgong, Madhya Pradesh, India.

*Type specimens* : In ZSIC, W 3631/1.

*Material examined* : 0-0-1, holotype, W 3631/1, ZSIC.

*Distribution* : India: *Madhya Pradesh*: Nowgong; *Uttar Pradesh*: Robertsganj, Sohagi.

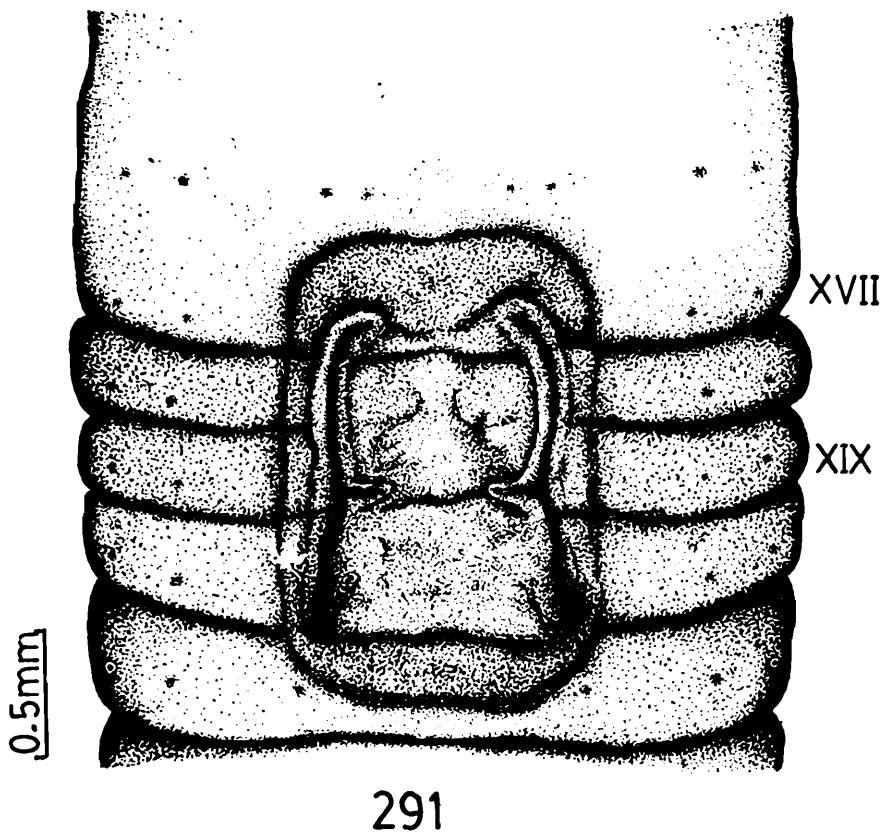
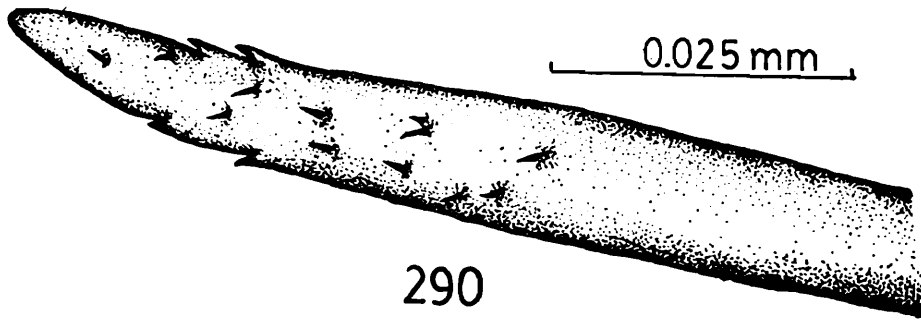
### 74. *Lenogaster falcifer* (Stephenson)

(Figs. 292-296)

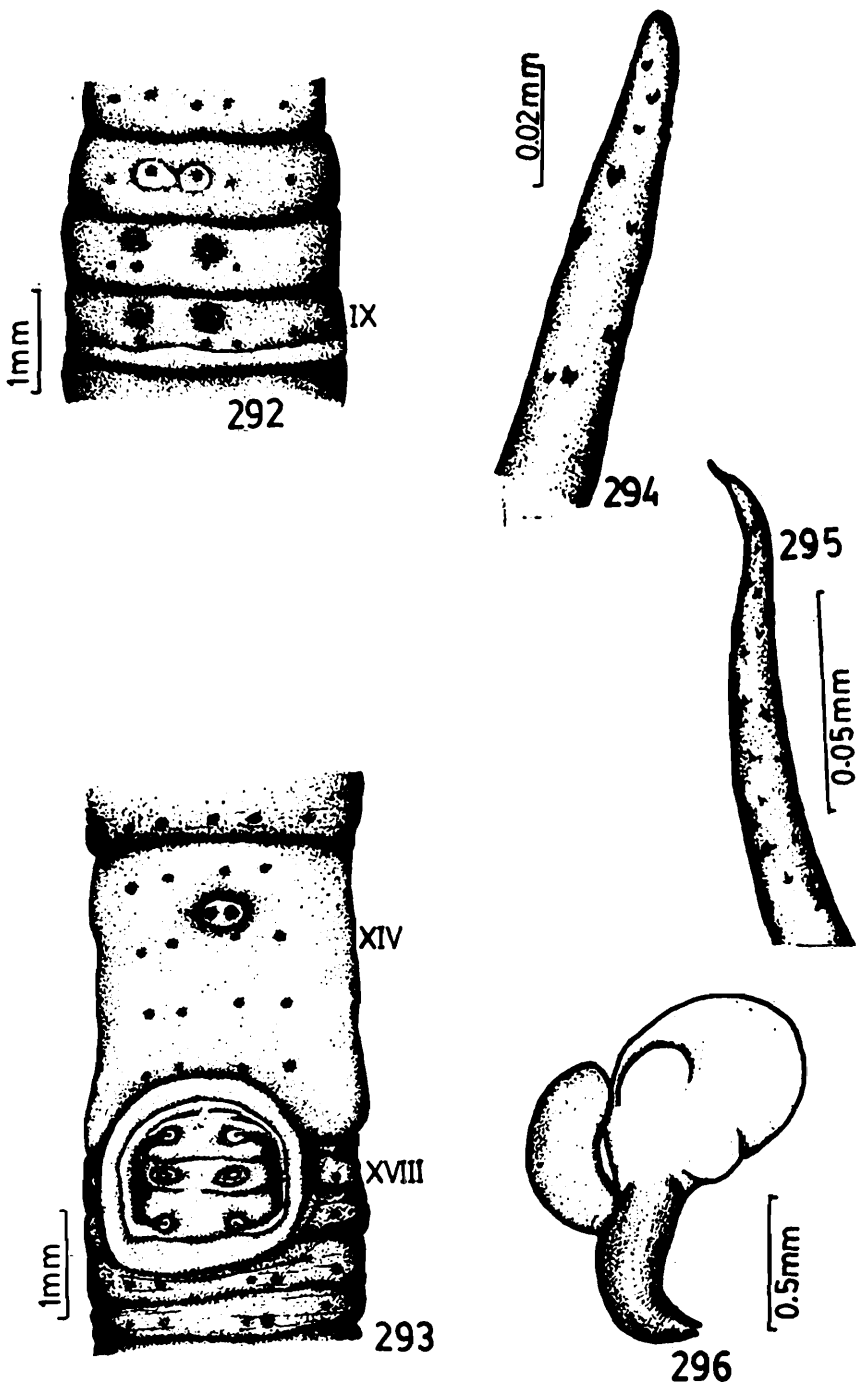
1920. *Eudichogaster falcifer* Stephenson, *Mem. Indian Mus.*, 7: 252.

1923. *Eudichogaster falcifer*, Stephenson, *Fauna Br. India, Oligochaeta*: 412.

1939. *Lenogaster falcifer*, Gates, *Rec. Indian Mus.*, 41: 184.



FIGS. 290-291. *Lennogaster elongatus* Gates. 290. penial seta, 291. genital region (both drawn from holotype).



FIGS. 292-296. *Lennogaster falcifer* (Stephenson). 292. spermathecal pore region, 293. genital region, 294. copulatory seta, 295. penial seta, 296. spermatheca.

Length 40-70 mm, diameter 2-3 mm, 142-151 segments. Prostomium proepilobic, tongue closed. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 2$   $ab = 1.1$   $bc = 1.3-1.4$   $cd = 0.14$   $dd$  on xii,  $aa = 2.3-2.5$   $ab = 1-1.1$   $bc = 1.4-1.8$   $cd = 0.15$   $dd$  on xxiv,  $a$  on vii copulatory, being surrounded by tumescences. Male genital field shortly oval, between 16/17 and 19/20. Male pores minute, in seminal grooves on the setal arc of xviii, at or a little median to  $b$ ; prostatic pores minute, at the ends of seminal grooves on the setal arcs of xvii and xix, at  $a$ ; seminal grooves concave, extending from the setal arc on xvii to the setal arc on xix, at  $ab$ . Spermathecal pores minute, on circular tumescent areas, presetal on viii and ix, at or slightly lateral to  $a$ . Genital markings oval, at  $aa$ , usually paired on xviii, sometimes unpaired and median areas of tumescence on 20/21.

Septa 4/5/6/7 delicate, 7/8 slightly muscular, 8/9-12/13 muscular. Typhlosole in xix-xx to lx-lxxxiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles acinous, in ix and xii. Prostates two pairs, in xvii and xix. Penial setae ornamented with marginal indentations or numerous fairly large triangular spines, tip chisel-shaped, membranous or bifid or pointed with a short hair or spine, 0.3-0.96 mm long, 8-16  $\mu$  diameter. Spermathecae 2 pairs, in viii-ix, each with a digitiform, usually dorsally directed, ental diverticulum, duct slightly shorter than ampulla. Copulatory setae ornamented with a few scattered gouges or unornamented (Gates, 1945b), tip rounded, 0.44-0.48 mm long, 14-16  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Jubbulpore, Madhya Pradesh, India.

*Type specimens* : In ZSIC, W 297/1; BMNH, 1925: 5: 12: 94:

*Material examined* : In ZSIC: 12-0-0, syntypes, W 297/1; 0-1-0 Saugor, W 298/1; 1-5-0 Bheraghat, W 299/1; 0-0-18, Jubbulpore, W 3657/1.

*Distribution* : India: *Madhya Pradesh*: Jubbulpore, Saugor, Baraila, Bheraghat, Safraha, Gaurighat.

75. *Lenogaster pusillus* (Stephenson)

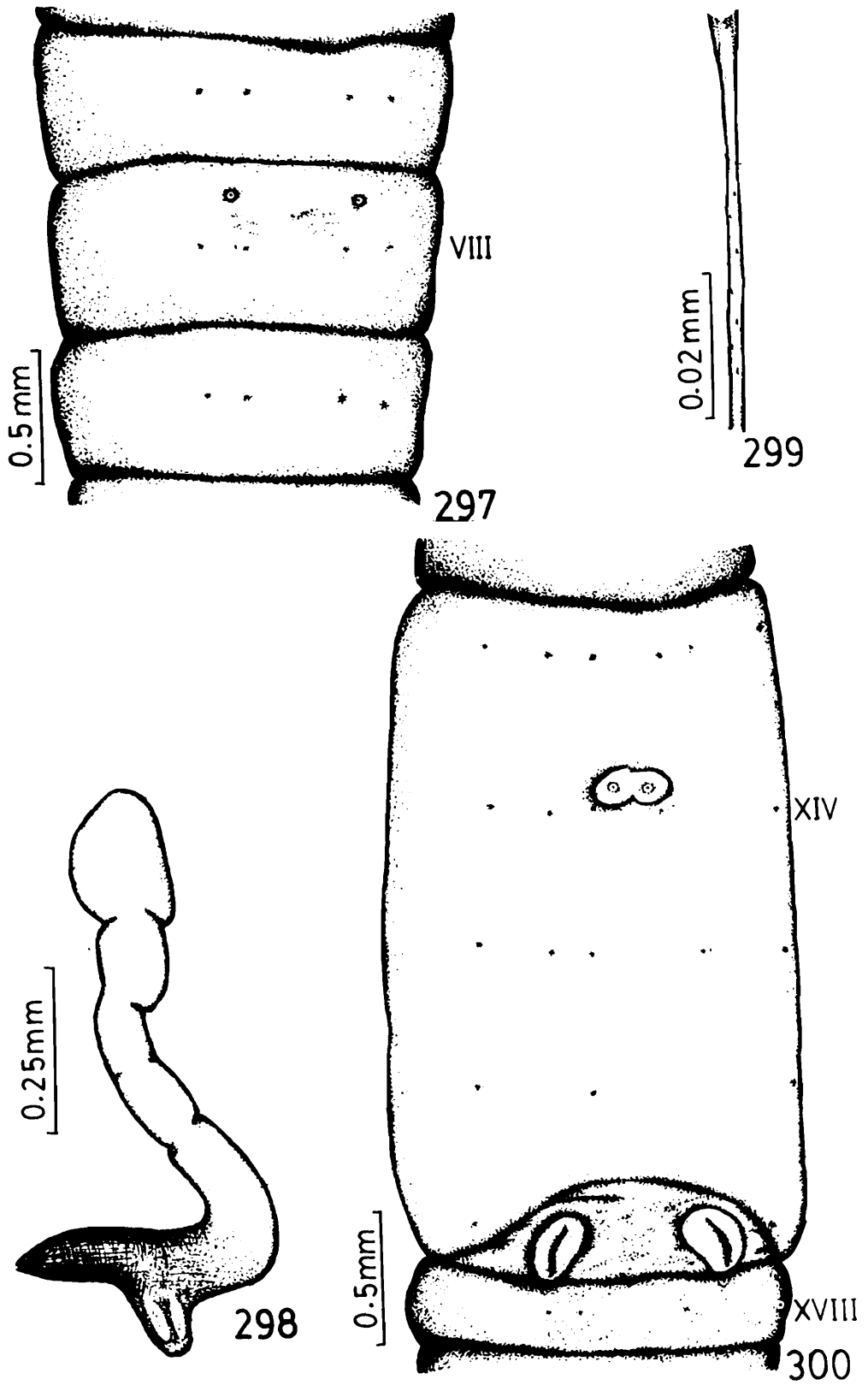
(Figs. 297-300)

1920. *Eudichogaster pusillus* Stephenson, *Mem. Indian Mus.*, 7: 253.  
 1921. *Eudichogaster barkudensis* Stephenson, *Rec. Indian Mus.*, 22: 765.  
 1923. *Eudichogaster barkudensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 408.  
 1923. *Eudichogaster pusillus*, Stephenson, *Fauna Br. India, Oligochaeta*: 418.  
 1939. *Lenogaster barkudensis*, Gates, *Rec. Indian Mus.*, 41: 191.  
 1939. *Lenogaster pusillus*, Gates, *Rec. Indian Mus.*, 41: 199.  
 1978. *Lenogaster pusillus*, Julka, *Mitt. zool. Mus. Berlin*, 54: 192.

Length 20-68 mm, diameter 1-2.5 mm, 105-132 segments. Prostomium proepilobic, tongue closed. First dorsal pore 11/12, sometimes 12/13. Clitellum xiii-xvii. Setae  $aa = 1.6-1.7$   $ab = 0.9$   $bc = 1-1.1$   $cd = 0.12-0.13$   $dd$  on xii,  $aa = 2.4-2.5$   $ab = 1.3$   $bc = 1.5-1.7$   $cd = 0.14-0.17$   $dd$  on xxiv, no setae copulatory. Male genital field transverse, on xvii. Male pores minute, in or near 17/18 at posterior ends of seminal grooves, at  $b$ ; prostatic pores minute, on the setal arc of xvii at anterior ends of seminal grooves, at  $a$ , seminal grooves crescentic, diagonally placed on oval poropores, extending from the setal arc on xvii to 17/18, at  $ab$ . Spermathecal pores minute, presetal, on viii, at about  $a$ . Genital markings absent.

Septa 4/5-7/8 delicate, 8/9-12/13 slightly muscular. Typhlosole in xvii-xviii to lxx-lxxvi. Proandric but also with male funnels in xi, testes and male funnels in x enclosed in paired sacs; seminal vesicles absent. Prostates one pair, in xvii. Penial setae ornamented with scattered small triangular teeth, tip almost membranous, slightly widened with ectal end straight or jagged or concave or deeply indented, 0.53-0.65 mm long, 4-5  $\mu$  diameter. Spermathecae one pair, in viii, each with a sessile, spheroidal to tubular ental diverticulum, ampulla longer than the duct, at right angle to the latter.

*Type locality* : Saugor, Madhya Pradesh, India.



FIGS. 297-300. *Lennogaster pusillus* (Stephenson). 297. spermathecal pore region, 298. spermatheca, 299. penial seta, 300. genital region.

*Type specimens* : *E. barkudensis*: In ZSIC, W 564/1; BMNH, 1925: 5: 12: 11. *E. pusillus*: In BMNH, 1933: 5: 25: 346-7.

*Material examined* : In HAZFS, ZSI, Solan - *Himachal Pradesh*: coll. J.M. Julka 1978, Kangra district: 0-0-1 Nurpur, 9 Aug, An 746, 0-0-1 Rakh, near Chamba, 16 Aug, An 747, 0-0-1 Dak Bagda c. 8 km from Joginder Nagar, 25 Aug, An 745; *Karnataka*: 0-0-18 Belgaum, 29 Aug 1979, coll. J.M. Julka, An 744.

*Distribution* : India: *Uttar Pradesh*: Allahabad, Naini, Varanasi, Chunar, Fyzabad, Tanda Falls, Manikpur Junction, Robertsganj; *Madhya Pradesh*: Saugor, Rewa, Nowgong, Jubbulpore, Baraïla, Safraha, Gaurighat; *Orissa*: Baripada, Bisoi, Antrakaryari nr. Balugaoni, Sundargarh, Jharsuguda, Godbhaga, Ladukhai, Burla; *Himachal Pradesh*: Dak Bagda, Nurpur, Rakh nr. Chamba; *Karnataka*: Belgaum.

*Biology* : It is litter dwelling and remains within top 5 cm layer of sandy loam soil with 7-8 pH and high organic matter (> 10%). It also inhabits kitchen waste, compost pits near cow sheds, in roofs of thatched houses, under stones and amongst roots of mosses and ferns growing on rocks.

Activity is restricted to 2-3 months from late June to October. Maximum population density of 600/m<sup>2</sup> has been observed around a compost pit. Diapause during unfavourable period is passed in immature stage. Cocoons are small, round with ornamentations, initially pale lemon gradually changing to greenish-reddish-brown. Incubation period is about 12-18 days. Usually a single worm hatches from each cocoon. Clitellum degenerates during the post-reproductive period. Activity may continue throughout the year where adequate moisture (15-20 g%) and organic matter are available. Casts are deposited on the soil surface in the form of small towers with central openings.

**76. *Lennogaster trichochaetus* (Stephenson)**

(Figs. 301-306)

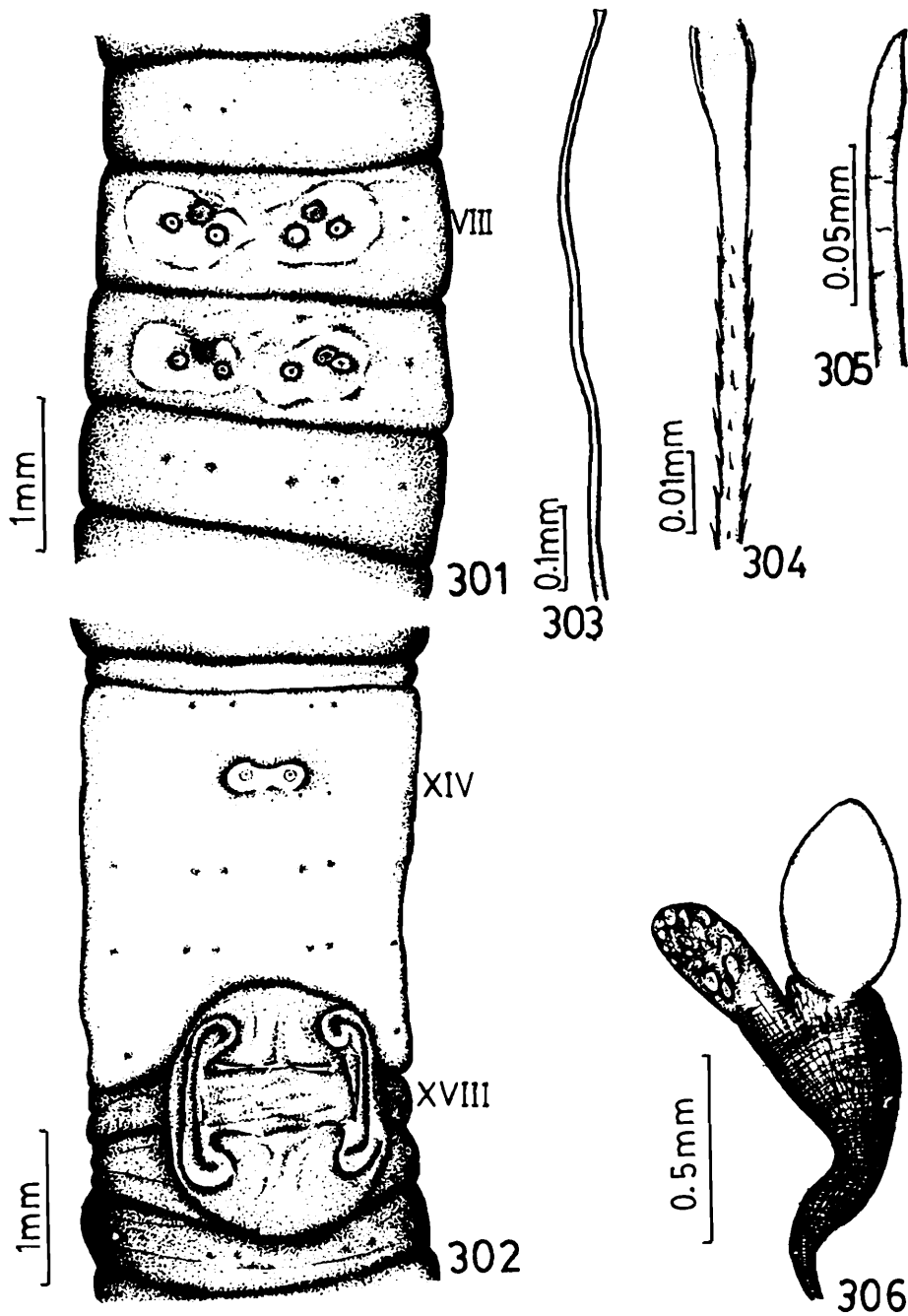
1920. *Eudichogaster trichochaetus* Stephenson, *Mem. Indian Mus.*, 7: 249.1923. *Eudichogaster trichochaetus*, Stephenson, *Fauna Br. India, Oligochaeta*: 419.1939. *Lennogaster trichochaetus*, Gates, *Rec. Indian Mus.*, 41: 185.

Length 32-45 mm, diameter 1.75-2.25 mm, 103-128 segments. Prostomium proepilobic, tongue closed. First dorsal pore 12/13. Clitellum xiii-½xvii. Setae  $aa = 2 ab = 0.9 bc = 1.5 cd = 0.15 dd$  on xii,  $aa = 2.8 ab = 1.2 bc = 1.7 cd = 0.16 dd$  on xxiv,  $a$  and  $b$  on viii and ix copulatory, being surrounded by epidermal tumescences. Male genital field somewhat rectangular, longitudinally placed, extending from 16/17 to 19/20. Male pores minute, in seminal grooves on xviii, at  $b$ ; prostatic pores minute, at the ends of seminal grooves on the setal arcs of xvii and xix, at or a little lateral to  $a$ ; seminal grooves bracket-shaped, extending from the setal arc of xvii to the setal arc of xix, at  $ab$ . Spermathecal pores minute, on circular tumescent areas, on or just posterior to the setal arcs of viii and ix, at  $ab$ . Genital markings absent.

Septa 4/5-7/8 delicate, 8/9/10 muscular. Typhlosole in xix-xx to lxxvi-lxxx. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Prostates 2 pairs, in xvii and xix, extending posteriorly to a few segments. Penial setae slightly undulating, ornamented with a few longitudinal rows of triangular teeth, tip widened, membranous, margins curved, rather spoon to scoop-shaped, 1.94-1.99 mm long, 5-7  $\mu$  diameter. Spermathecae 2 pairs, in viii-ix, each with a digitiform, dorsally directed, ental diverticulum, duct longer than ampulla. Copulatory setae ornamented with short transverse serrated ridges, tip slightly claw-shaped, 0.26-0.35 mm long, 9-11  $\mu$  diameter.

*Type locality* : Palchar, Maharashtra, India.

*Type specimens* : In ZSIC, W 277/1; BMNH, 1925: 5: 12: 111.



FIGS. 301-306. *Lennogaster trichochaetus* (Stephenson). 301. spermathecal pore region, 302. genital region, 303. penial seta, 304. enlarged tip of penial seta, 305. copulatory seta, 306. spermatheca.

*Material examined* : 0-5-1 Marmugao, Goa, 30 Aug 1978, coll. J.M. Julka, An 748, in HAZFS, ZSI, Solan.

*Distribution* : India: *Maharashtra*: Palchar, Bombay, Andheri; *Goa*: Marmugoa.

*Biology* : Found in soil around roots of grasses in a cultivated field.

### 77. *Lennogaster yeicus* (Stephenson)

(Figs. 307-311)

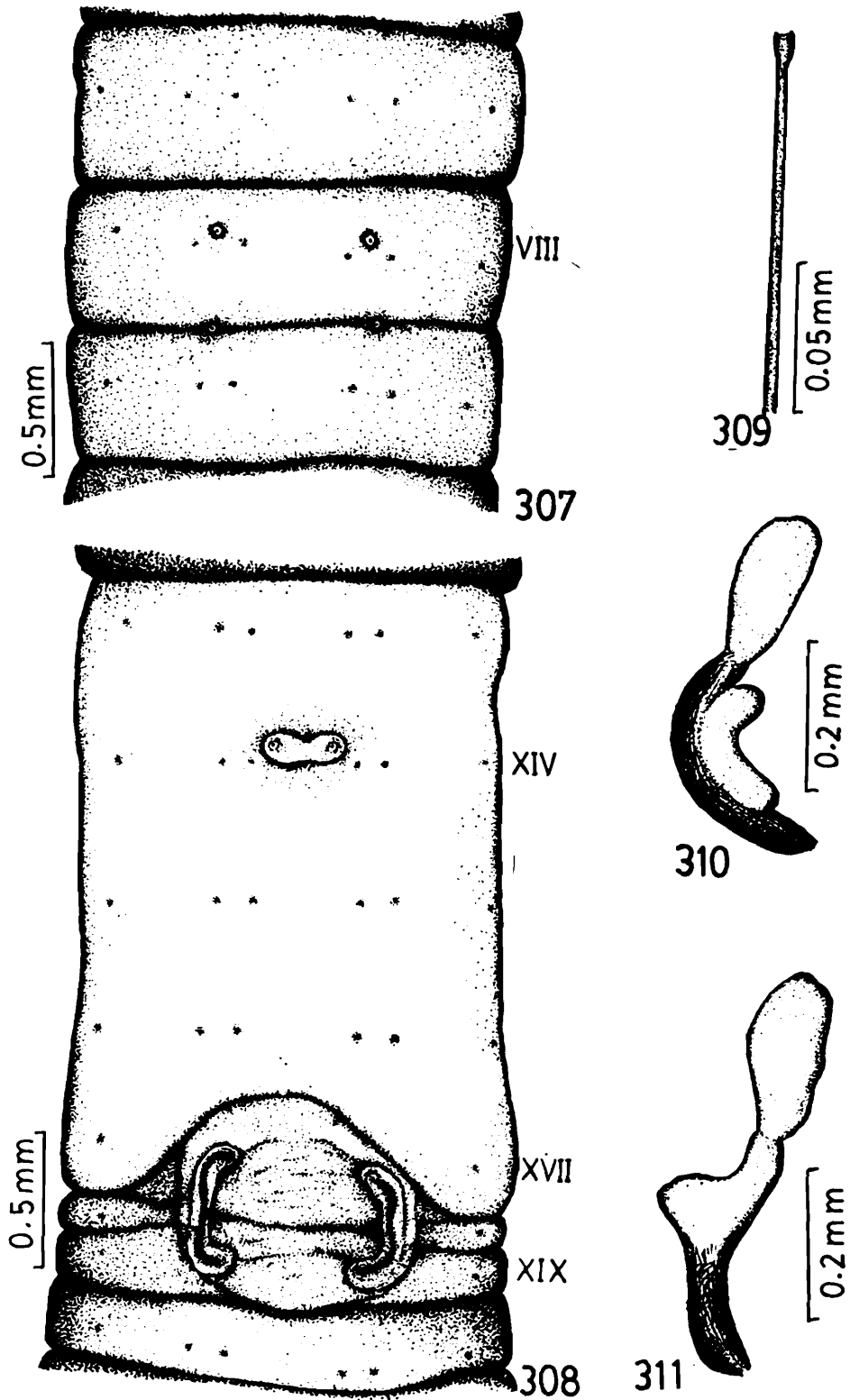
1931. *Eudichogaster yeicus* Stephenson, *Rec. Indian Mus.*, 33: 193.

1939. *Lennogaster yeicus*, Gates, *Rec. Indian Mus.*, 41: 186.

1972. *Lennogaster yeicus*, Gates, *Trans. Am. phil. Soc.*, 62: 307.

Length 25-45 mm, diameter 1.25-2 mm, 91-120 segments. Prostomium proepilobic, tongue closed. First dorsal pore 11/12. Clitellum xiii-xvii. Setae  $aa = 2.1-2.3$   $ab = 1-1.1$   $bc = 1.1-1.4$   $cd = 0.14-0.17$   $dd$  on xii,  $aa = 2.6-2.7$   $ab = 1.1-1.3$   $bc = 1.4-1.5$   $cd = 0.16$   $dd$  on xxiv, no setae copulatory. Male genital field slightly raised, extending from 16/17 to 19/20. Male pores minute, in seminal grooves on xviii, at *b*; prostatic pores minute, at the angles of seminal grooves on the setal arcs of xvii and xix, at *b*; seminal grooves bracket-shaped, extending from the setal arc of xvii to the setal arc of xix, at *b*. Spermathecal pores minute, surrounded by circular tumescences, on or slightly anterior to the setal arc of viii and in or just posterior to the intersegmental furrow 8/9, at about mid *ab*. Genital markings absent.

Septa 4/5/6 slightly muscular, 6/7 delicate, 7/8-13/14 muscular. Typhlosole in xvii-xviii to lxiii-lxxviii. Proandric but also with male funnels in xi, testes and male funnels of x in paired sacs; seminal vesicles absent. Prostates 2 pairs, in xvii and xix. Penial setae unornamented or ornamented with slight marginal serrations, tip widened or bifid with a web between the prongs or tapering or truncate, 0.3-0.46 mm long, 3-5  $\mu$  diameter. Spermathecae 2 pairs, in viii-ix, each with a digitiform or slightly



FIGS. 307-311. *Lennogaster yeicus* (Stephenson). 307. spermathecal pore region, 308. genital region, 309. penial seta, 310-311. spermathecae.

protuberant, ventrally directed ental diverticulum, duct longer than ampulla.

*Type locality* : Chaungson, Amherst district, Burma.

*Type specimens* : In BMNH, 1930: 12: 27: 36-7.

*Material examined* : In HAZFS, ZSI, Solan - *Himachal Pradesh*: coll. J.M. Julka 1978, Kangra district: 0-0-4 Mohan Ghatti c. 15 km from Joginder Nagar, 23 Aug, An 679, 0-0-1 Dak Bagda c. 8 km from Joginder Nagar, 25 Aug, An 680.

*Distribution* : India: *Himachal Pradesh*: Mohan Ghatti and Dak Bagda nr. Joginder Nagar.

Outside India: Burma.

### Genus 15. *Mallehulla* Julka and Rao, 1982

1982. *Mallehulla* Julka and Rao, *J. Soil Biol. Ecol.*, 2(2): 67.

*Diagnosis* : Perichaetine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard, in v and lacking discrete calciferous glands but with calciferous lamellae, in xiv-xv; supra-intestinal glands absent; typhlosole in the form of a low ridge. Micromeronephridia astomate; paired enteronephric tufts in iv; numerous, exonephric on the body wall in iii and posteriad segments. Paired, stomate, exonephric megameronephridia in vi and posteriad segments.

*Type species* : *Mallehulla indica* Julka and Rao, 1982.

*Description* : As for the only species, *indica*.

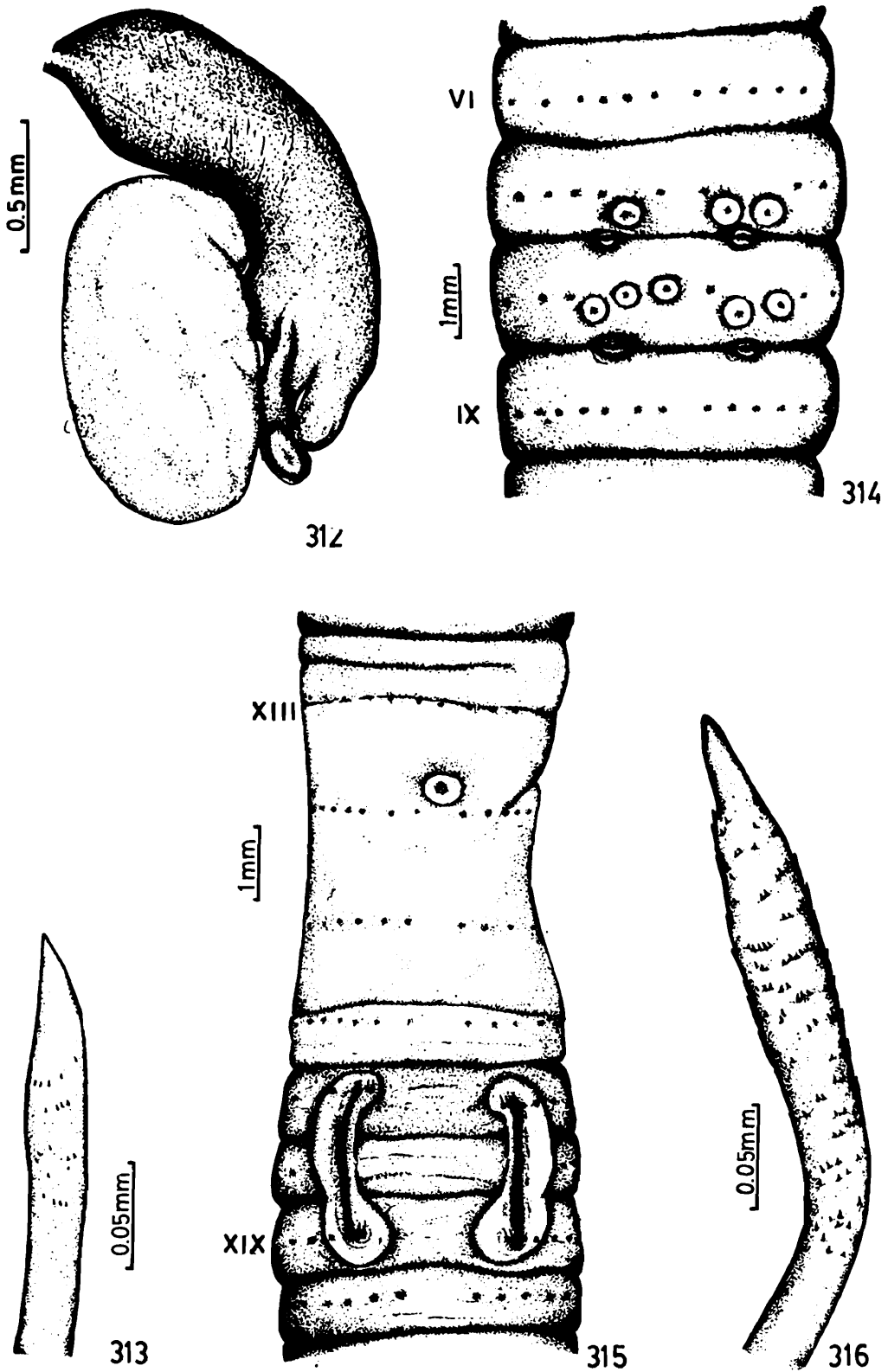
*Distribution* : Karnataka, S. India.

### 78. *Mallehulla indica* Julka and Rao

(Figs. 312-316)

1982. *Mallehulla indica* Julka and Rao, *J. Soil Biol. Ecol.*, 2(2): 70.

Length 47-133 mm, diameter 2-4 mm, 73-112 segments.



FIGS. 312-316. *Mallehulla indica* Julka and Rao. 312. spermatheca, 313. copulatory seta, 314. spermathecal pore region, 315. genital region, 316. penial seta.

Prostomium epilobic or combined pro/epilobic, tongue open or closed. First dorsal pore 4/5. Clitellum annular,  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvi. Setae perichaetine,  $aa = 1.5-2.2$   $ab = 1.8-2.4$   $bc = 2-3.2$   $yz = 1-1.6$   $zz$  on xii,  $aa = 2-2.7$   $ab = 2-2.7$   $bc = 2.5-3.7$   $yz = 1.2-1.9$   $zz$  on xx, 12-18 on ii, 23-28 on vii, 34-42 on xx,  $a$ ,  $b$  and sometimes  $c$  ornamented and enlarged throughout the body, on vii and viii copulatory, being surrounded by circular tumescences. Male pores paired, minute, in seminal grooves, on xviii, at  $bc$ , 0.16-0.19 body circumference apart; prostatic pores paired, minute, at the ends of seminal grooves, on xvii and xix, at  $bc$ ; seminal grooves straight or slightly concave, between setal arcs of xvii and xix. Female pore single and median, presetal, on xiv. Spermathecal pores paired, small transverse slits, in 7/8/9, at  $bc$ , 0.10-0.13 body circumference apart. Genital markings absent. Nephridiopores not recognized.

Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 delicate. Gizzard large, in v. Oesophagus enlarged and with calciferous lamellae, in xiv-xv; discrete calciferous glands absent. Intestine begins in xvii; caeca and supra-intestinal glands absent; typhlosole in the form of a low ridge, xxviii-xxx to xliv-liv. Dorsal vessel single and complete; supra-oesophageal vessel single, viii-xiii; extra-oesophageal vessels paired, v-xii; latero-parietal vessels paired, joining the supra-oesophageal vessel in xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xiii. Holandric, testes and male funnels in unpaired ventral sacs, in x and xi; seminal vesicles racemose, in ix and xii, pseudoseminal vesicles rudimentary, in xiii. Prostates paired, in xvii and xix, extending posteriorly to 2 segments. Penial setae ornamented, 3.46-6.51 mm long, 35-58  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a small ental diverticulum. Copulatory setae ornamented, 1.20-1.42 mm long, 38-50  $\mu$  diameter. Ovisacs paired, in xiv. Micromeronephridia astomate; paired, ? exonephric tufts in iii, larger, paired enteronephric tufts in iv, numerous, exonephric on the body wall in iii and posteriad segments; paired, stomate, exonephric megamero-

nephridia in vi and posterior segments, funnels close to the nerve cord, loops extending laterally.

*Type locality* : Moodabidri, Karnataka, India.

*Type specimens* : In ZSIC: Holotype, An 1507/1; 0-0-2 paratypes, An 1508/1. In HAZFS, ZSI, Solan: 0-0-4 paratypes, An 323.

*Distribution* : India: *Karnataka*: Moodabidri, Tirthahalli, Kotegehar, Bhagamandala, Mercara, Ajjekar, Venoor, Abashrame, Udipi.

*Biology* : It inhabits laterite soil with pH 6 under decaying leaves of *Mangifera indica* and *Colocasia* sp. near paddy and turmeric cultivation.

#### Genus 16. *Octochaetoides* Michaelsen, 1922

1900. *Octochaetus* (in part), Michaelsen, *Tierreich*, 10: 319.

1922. *Octochaetus* (*Octochaetoides*) (in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 37.

1923. *Octochaetus* (*Octochaetoides*) (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 371.

1962. *Octochaetoides*, Gates, *Ann. Mag. nat. Hist. Soc. (ser. 13)*, 5: 209.

*Diagnosis* : Lumbricine. Male pores paired, on xviii (in seminal grooves?); prostatic pores paired (at the ends of seminal grooves?), on xvii and xix. Oesophagus with 2 gizzards in vii-viii (?) and one or 2 pairs of discrete, extramural calciferous glands in region of xiv-xv (?); supra-intestinal glands and typhlosole absent. Micro-and megameronephridia (?).

*Type species* : *Benhamia aitkeni* Fedarb, 1898.

*Description* : As for the only species, *aitkeni*.

*Distribution* : Kerala, S. India.

*Remarks* Gates (1962b) re-examined the sectioned type of *O. aitkeni* in the British Museum, and defined the genus *Octochaetoides* as bigiceriate. Its relationships with other octochaetid genera are not clear for lack of information on the excretory system, exact location of gizzards and calciferous glands, and other characteristics.

### 79. *Octochaetoides aitkeni* (Fedarb)

1898. *Benhamia aitkeni* Fedarb, *J. Bombay nat. Hist. Soc.*, 11: 432.

1899. *Octochaetus aitkeni*, Michaelsen, *Zool. Jb. (Syst.)*, 12: 242.

1922. *Octochaetus (Octochaetoides) aitkeni*, Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 37.

1923. *Octochaetus (Octochaetoides) aitkeni*, Stephenson, *Fauna Br. India, Oligochaeta*: 373.

1962. *Octochaetoides aitkeni*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 209.

Length 119 mm, diameter 3 mm, 180 segments. Prostomium (?). First dorsal pore 19/20 or 18/19 (?). Clitellum xiii-xvii. Setae  $aa = 2 ab$ , slightly greater than  $bc$ , which is equal to  $cd$ . Male pores paired, minute and close together (in seminal grooves ?), on xviii; prostatic pores paired (at the ends of seminal grooves ?), on xvii and xix. Female pore single, on xiv. Spermathecal pores paired, small, close together, in 7/8/9. Genital markings absent.

Gizzards 2, in vii and viii (?). Calciferous glands discrete, extramural, in region of xiv-xv (?), 2 pairs or one pair and then each gland bilobed. Intestine begins in xvi; intestinal caeca, supra-intestinal glands and typhlosole absent. Last pair of hearts in xii. Holandric, testes and male funnels in x and xi; seminal vesicles in ix and xii (?). Prostates paired, in xvii and xix. Penial setae smooth, with nodulus at about one third from the distal end, three times as long as the normal setae. Spermathecae paired, in viii and ix, each with a tubular diverticulum arising from about the middle of the duct.

*Type locality* : Travancore, Kerala, S. India.

*Type specimens* : In BMNH, holotype, longitudinal sections on slides, 1904. 10. 20. 244-249.

*Distribution* : So far known from the type locality.

### Genus 17. *Octochaetona* Gates, 1962

1909. *Octochaetus* (in part), Michaelsen, *Mem. Indian Mus.*, 1: 203.

1923. *Octochaetus* (*Octochaetoides*) (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 371.

1945. *Octochaetoides* (in part), Gates, *Jl. R. Asiat. Soc. Beng.*, 11: 75.

1962. *Octochaetona* Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 211.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in vi or in a space between septa 4/5 and 7/8 or 8/9 or 9/10, and one pair of discrete extramural asymmetrical calciferous glands opening into the gut close to the attachment of septum 15/16; supra-intestinal glands absent; typhlosole lamelliform, bifid ventrally. Micromeronephridia astomate; paired, enteronephric tufts in iv; several, exonephric on the body wall in v and posteriad segments, slightly enlarged and stomate with preseptal and intrasegmental funnels in caudal segments. Megameronephridia absent.

*Type species* : *Octochaetus surensis* Michaelsen, 1910.

*Description* : Setae lumbricine throughout the body. Clitellum annular. Male pores paired, in seminal grooves, on the setal arc of xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Female pores paired, within *a* lines, sometimes unpaired and median, on xiv. Spermathecal pores paired. Nephridiopores not recognized.

Oesophageal gizzard single, in vi or in a space where septa are absent. Calciferous glands one pair, discrete, extramural, shortly and slenderly stalked, asymmetrical, opening into oesophagus close to the attachment of septum 15/16, one gland in xv and the other in xvi. Intestinal caeca and supra-intestinal glands absent; typhlosole

lamelliform, ventrally bifid. Dorsal vessel single and complete; supra-oesophageal vessel single, viii-xiii; extra-oesophageal vessels paired from v and opening into supra-oesophageal in viii; lateroparietal vessels paired, each joining the extra-oesophageal vessel in xiii, subneural vessel absent; lateral hearts originating from supra-oesophageal with delicate connectives to the dorsal vessel in x-xii, xiii. Holandric or metandric. Prostates paired, in xvii and xix, extending posteriorly to a few segments. Penial setae present. Spermathecae paired, in viii and ix, diverticulate. Ovisacs paired in xiv. Micromeronephridia astomate; large enteronephric tufts in iv; several biramous, exonephric on the body wall in v and posteriad segments, slightly enlarged and arranged in two transverse rows in each of caudal segments, the anterior row with preseptal funnels and posterior row with intrasegmental funnels. Megameronephridia absent.

*Distribution* : Peninsular India, but extended to other parts of the country, Pakistan, Nepal, Burma, Malaya Peninsula and Philippines presumably due to transportation of the type species and *O. beatrix*.

*Remarks* : Gates (1962b) characterized *Octochaetona* in having astomate micromeronephridia throughout the body. A careful examination of the excretory system in its 11 species, including the type species *O. surensis* (Michaelsen, 1910), shows that micromeronephridia in the caudal segments are slightly enlarged and stomate with preseptal and intrasegmental funnels; median megameronephridia being absent.

#### Key to the species of *Octochaetona*

- |   |                    |
|---|--------------------|
| 1. Spermathecal pores in 7/8/9 .....    | 2                  |
| Spermathecal pores on viii and ix ..... | 6                  |
| 2. Seminal vesicles in xii .....        | <i>O. excavata</i> |
| Seminal vesicles in ix and xii .....    | 3                  |

- |  |                       |
|--|-----------------------|
| 3. Intestinal begins in xvii; copulatory setae on viii   | <i>O. barnesi</i>     |
| Intestine begins in xviii; copulatory setae on viii<br>and one of the adjacent segments.....   | 4                     |
| 4. Copulatory setae on vii and viii .....  | <i>O. serrata</i>     |
| Copulatory seate on viii and ix .....  | 5                     |
| 5. Septum 7/8 present, muscular .....  | <i>O. prashadi</i>    |
| Septum 7/8 absent .....  | <i>O. pattoni</i>     |
| 6. Holandric .....   | 7                     |
| Metandric.....   | <i>O. beatrix</i>     |
| 7. Seminal vesicles 2 pairs, in ix and xii, or xi and<br>xii .....                             | 8                     |
| Seminal vesicles 3 pairs, in ix, xi and xii .....  | <i>O. compta</i>      |
| 8. Seminal vesicles in ix and xii .....  | 9                     |
| Seminal vesicles in xi and xii .....   | 13                    |
| 9. Last pair of hearts in xii .....  | 10                    |
| Last pair of hearts in xiii .....  | 11                    |
| 10. Copulatory setae on viii and ix; septum 7/8<br>present muscular .....                      | <i>O. paliensis</i>   |
| Copulatory setae on viii; septum 7/8 absent .....  | <i>O. barkudensis</i> |
| 11. Spermathecal pores just posterior to 7/8 and<br>8/9; intestine begins in xviii .....       | <i>O. albida</i>      |
| Spermathecal pores on or close to setal arcs of<br>viii and ix; intestine begins in xvii ..... | 12                    |
| 12. Testes and male funnels free; septum 7/8<br>present, muscular .....                        | <i>O. phillotti</i>   |
| Testes and male funnels enclosed in sacs;<br>septum 7/8 absent .....                           | <i>O. surensis</i>    |
| 13. Copulatory setae on viii and ix .....  | <i>O. parva</i>       |
| Copulatory setae absent .....  | 14                    |
| 14. Unpaired and median genital markings on xiii ..  | <i>O. maindroni</i>   |
| Unpaired and median genital markings on<br>some of 16/17-19/20, xx-xxv .....                   | <i>O. thurstoni</i>   |

**80. Octochaetona albida (Gates)**

(Figs. 317-321)

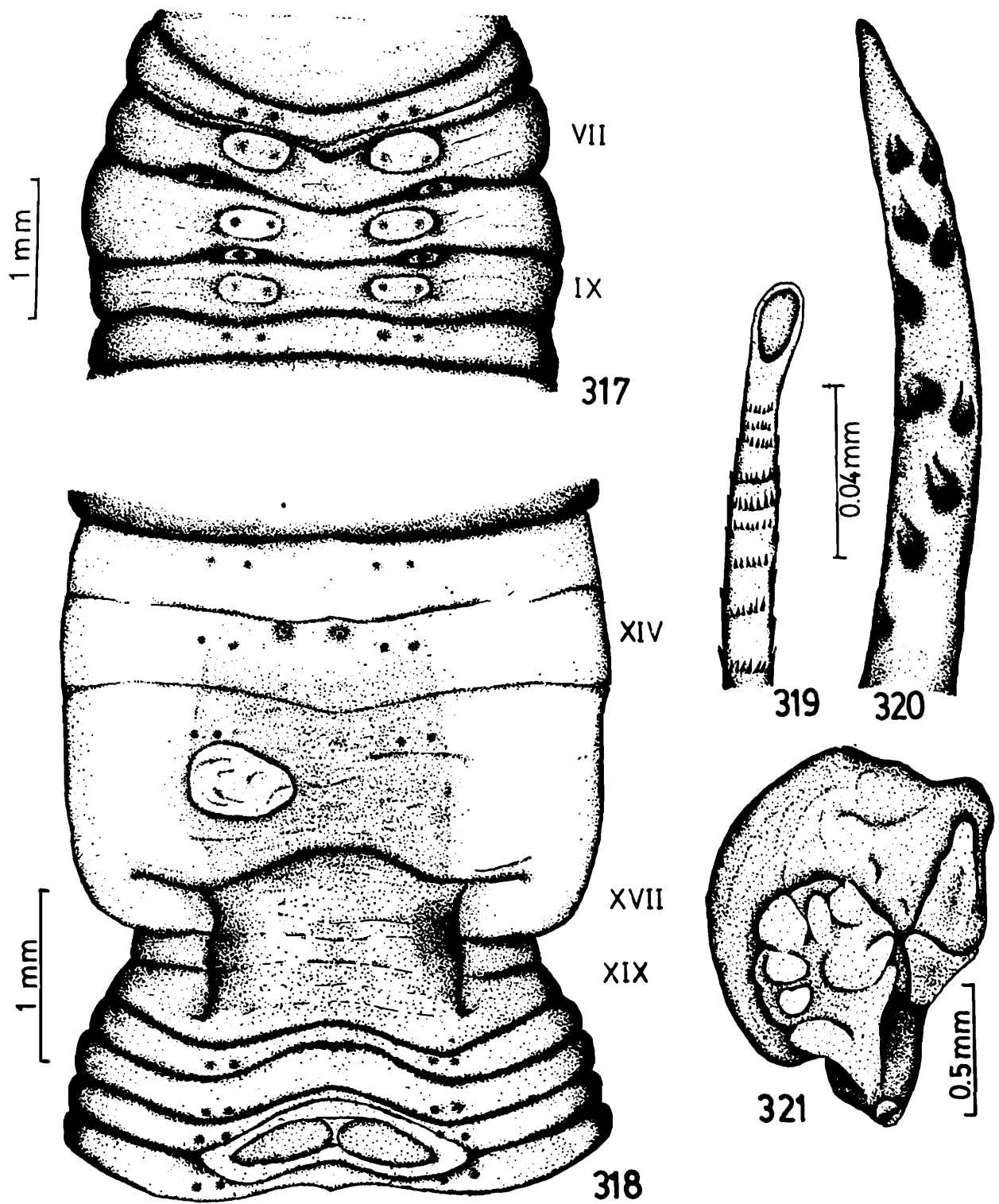
1945. *Octochaetoides albidus* Gates, *Jl. R. Asiat. Soc. Beng.*, 11: 77.

1962. *Octochaetona albida*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*; 5: 213.

Length 53-96 mm, diameter 3-5 mm, 154-185 segments. Prostomium epilobic, tongue open, sometimes closed. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 3-3.7$   $ab = 1.2-1.5$   $bc = 2-2.6$   $cd = 0.2$   $dd$  on xii,  $aa = 4.4-5$   $ab = 1.2-1.7$   $bc = 3-3.1$   $cd = 0.22$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix, sometimes on vii and x, copulatory being surrounded by oval to spindle-shaped tumescences. Male genital field indistinct. Male pores minute, at  $b$ ; prostatic pores minute, at or slightly lateral to  $b$ ; seminal grooves almost straight or slightly concave between the setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, presetal, a little posterior to intersegmental furrows, on viii and ix, slightly lateral to  $b$ . Genital markings oval to almost circular; paired, on 15/16/17, sometimes on 14/15, at  $aa$ , occasionally reaching laterally to  $bc$  (one of the pair may sometimes be absent); unpaired and median but usually with a pair of central areas, on 19/20-24/25, reaching laterally to  $a$  or  $b$  or well into  $bc$ .

Septa 4/5, 8/9-11/12 muscular, 5/6/7 delicate, 7/8 slightly muscular. Gizzard in vi. Intestine begins in xviii, typhlosole in xxiii-xxv to cxxv. Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with 13-16 irregularly interrupted circles of fine spines, tip slightly flattened and hollowed into a scoop-shape, 0.82-0.94 mm long, 12-14  $\mu$  diameter. Each spermatheca with a rather fan-shaped, shortly stalked, ectal diverticulum, duct shorter than ampulla. Copulatory setae ornamented with gouges or excavations, tip bluntly pointed, 0.55-0.62 mm long, 20-25  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Kurnool, Andhra Pradesh, India.



FIGS. 317-321. *Octochaetona albida* (Gates). 317. spermathecal pore region, 318. genital region, 319. penial seta, 320. copulatory seta, 321. spermatheca (all drawn from a syntype).

*Type specimens* : In ZSIC, W 3660/1.

*Material examined* : 0-0-9, syntypes, W 3660/1, in ZSIC.

*Distribution* : So far known from the type locality.

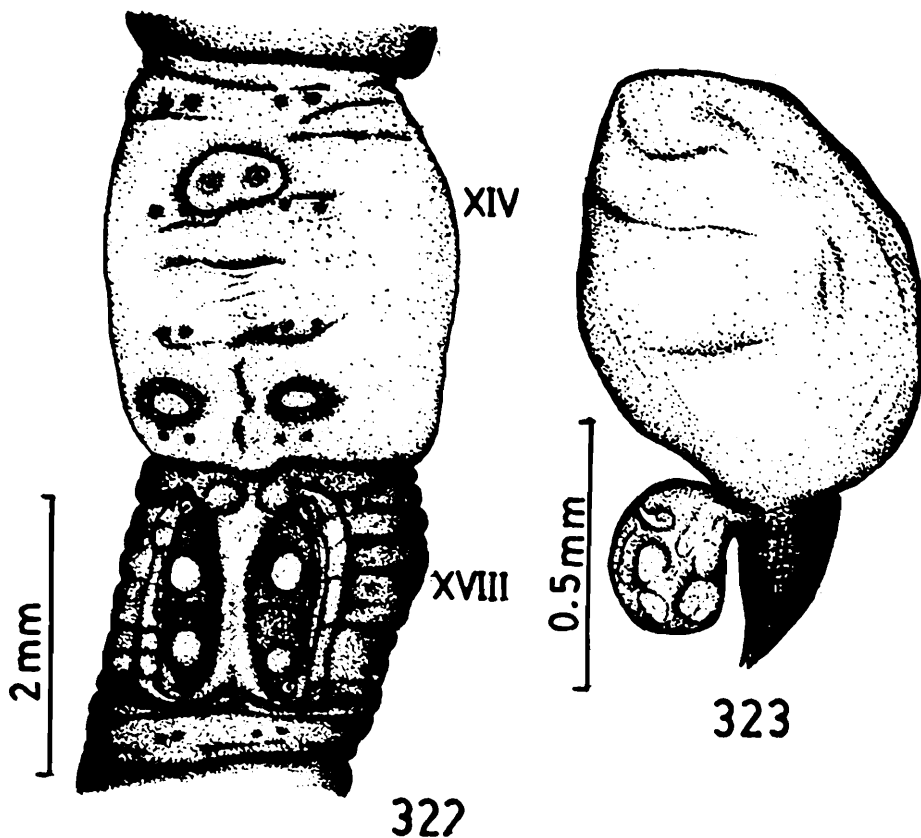
**81. *Octochaetona barkudensis* (Stephenson)**

(Figs. 322-323)

1916. *Octochaetus barkudensis* Stephenson, *Rec. Indian Mus.*, 12: 340.

1923. *Octochaetus (Octochaetoides) barkudensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 373.

1962. *Octochaetona barkudensis*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.



FIGS. 322-323. *Octochaetona barkudensis* (Stephenson). 322. genital region, 323. spermatheca.

Length 40-91 mm, diameter 1.5-3 mm, 72-149 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13, sometimes 11/12. Clitellum xiii-xvi. Setae  $aa = 2.9$   $ab = bc = 1.4$   $cd = 0.22$   $dd$  on xii,  $aa = 2.7$   $ab = 1.2$   $bc = 1.8$   $cd = 0.26$   $dd$  on xxiv,  $a, b$  on viii copulatory being surrounded by epidermal tumescences. Male genital field slightly tumescent between 16/17 and 19/20, extending laterally into mid  $bc$ . Male pores minute, just lateral to  $b$ ; prostatic pores minute, at or slightly median to  $b$ ; seminal grooves almost straight or slightly concave between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, on presetal annulus of viii and ix, at  $ab$ . Genital markings oval to circular; paired, presetal on xvi, sometimes on xv, xviii and xix, at  $ab$ ; unpaired and median, presetal, sometimes on xx-xxix, at  $aa$ .

Septa 4/5, 8/9-11/12 muscular, 5/6/7/8 absent. Gizzard in a space between septa 4/5 and 8/9. Intestine begins in xvii; typhlosole in xxii-xxiii to xcvi-xcix. Last pair of hearts in xii. Holandric, testes and male funnels free, in x and xi; seminal vesicles acinous, in ix and xii. Penial setae ornamented with large spines, ectal end sinuous, tip pointed, 0.58 mm long, 10  $\mu$  diameter. Each spermatheca with a shortly stalked, distally broadened, ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with marginal serrations, tip claw-shaped, 0.52 mm long, 17  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Barkuda Island, Chilka Lake, Orissa, India.

*Type specimens* : In ZSIC, ZEV 6575/7; BMNH, 1933: 2: 16: 4-5.

*Material examined* : 0-1-1, syntypes, ZEV 6575/7, in ZSIC.

*Distribution* : India: Orissa: Barkuda Island, Athgarh nr. Cuttack, Baupada nr. Konarak, Gopalpur, Banki, Cuttack, Berhampur, Jagatsinghpur, Khallikote, Bhubaneswar.

## 82. *Octochaetona barnesi* (Stephenson)

1925. *Octochaetus (Octochaetoides) barnesi* Stephenson, *Rec. Indian Mus.*, 27: 68.

1962. *Octochaetona barnesi*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 75 mm, diameter 3.5 mm, 201 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 3.5$   $ab = 0.9$   $bc = 1.4$   $cd = 0.12$   $dd$  on xii,  $aa = 4.3$   $ab = 1.4$   $bc = 2.6$   $cd = 0.16$   $dd$  on xxiv,  $a, b$ , on viii copulatory being surrounded by epidermal tumescences. Male genital field depressed on posterior portion of xvii and anterior portion of xix. Male pores minute, at  $b$ ; prostatic pores minute, at  $a$ ; seminal grooves concave between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, in 7/8/9, at  $a$ . Genital markings usually absent; when present, paired, oval, postsetal on ix, slightly lateral to  $b$ , on 14/15, at  $ab$ .

Septa 4/5, 8/9-11/12 muscular, 5/6/7/8 absent. Gizzard between septa 4/5 and 8/9. Intestine begins in xvii; typhlosole in (?). Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with circles of fine spines, ectal end flattened and slightly hollowed, 1.4 mm long, 24  $\mu$  diameter. Each spermatheca with a cylindrical ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with semi-circular depressions with sharp margins, tip claw-shaped, 0.8 mm long, 20  $\mu$  diameter.

*Type locality* : Horsleykonda, Chitoor district, Andhra Pradesh, India.

*Type specimens* : In BMNH, 1933: 2: 23: 478-480.

*Material examined* : 2-0-0 Vandolre, Tamil Nadu, 29 Oct 1981, coll. Koshy Mathew, An 763, 0-1-0, Madras, coll. S. Ismail, An 765, in HAZFS, ZSI, Solan.

*Distribution* : India: *Andhra Pradesh*: Horsleykonda; *Tamil Nadu*: Vandolre, Madras.

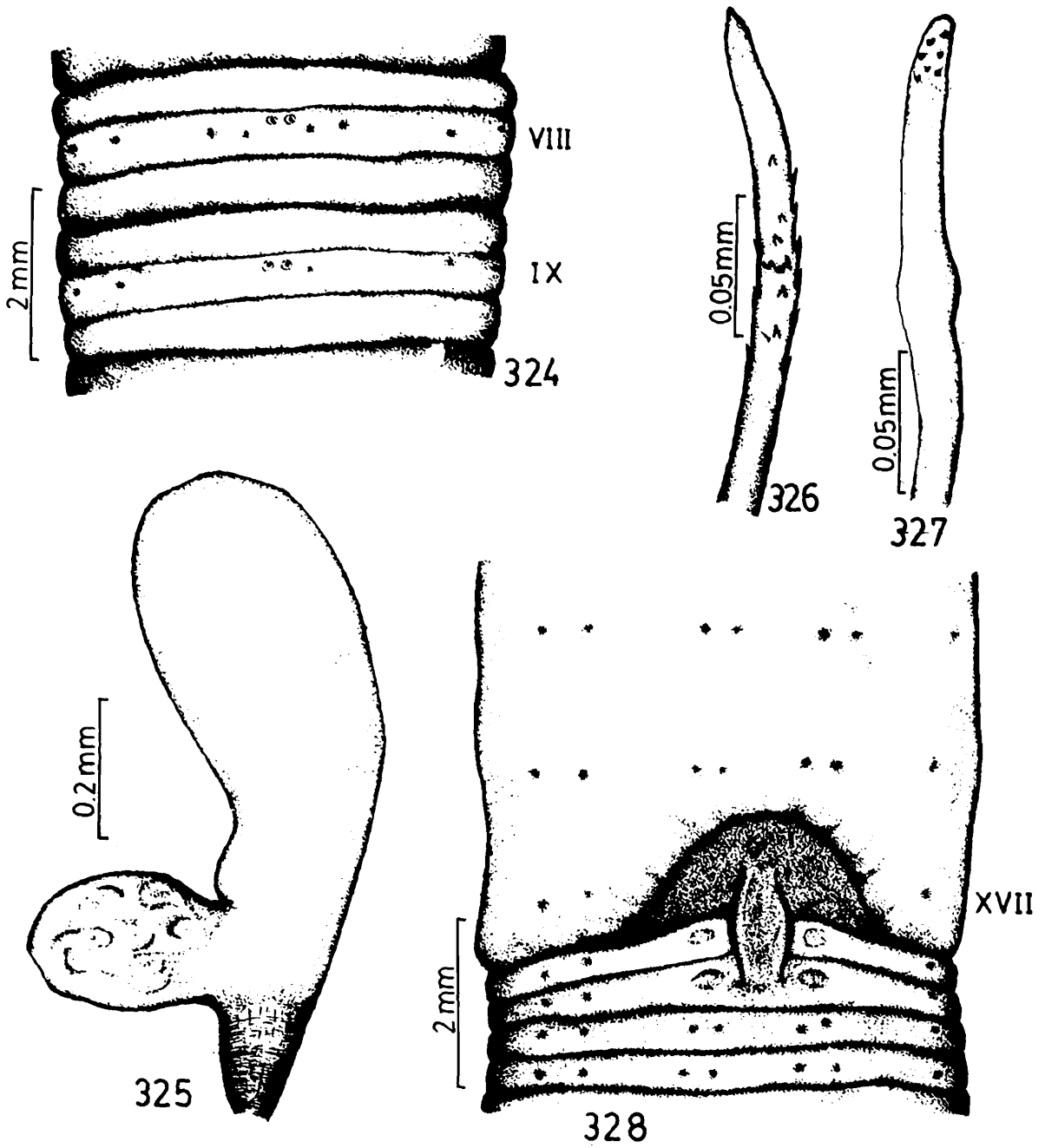
### 83. *Octochaetona beatrix* (Beddard)

(Figs. 324-328)

1902. *Octochaetus beatrix* Beddard, *Ann. Mag. nat. Hist. (ser. 7)*, 9: 456.

1907. *Octochaetus fermori* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 171.
1907. *Octochaetus hodgarti* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 172.
1910. *Octochaetus Pittnyi* Michaelsen, *Abh. Geb. Naturw., Hamburg*, 19: 86.
1914. *Octochaetus dasi* Stephenson, *Rec. Indian Mus.*, 10: 346.
1923. *Octochaetus (Octochaetoides) beatrix*, Stephenson, *Fauna Br. India, Oligochaeta*: 376.
1923. *Octochaetus (Octochaetoides) fermori*, Stephenson, *Fauna Br. India, Oligochaeta*: 378.
1923. *Octochaetus (Octochaetoides) hodgarti*, Stephenson, *Fauna Br. India, Oligochaeta*: 381.
1923. *Octochaetus (Octochaetoides) pittnyi*, Stephenson, *Fauna Br. India, Oligochaeta*: 391.
1924. *Octochaetus (Octochaetoides) fermori* f. *typica*, Stephenson, *Rec. Indian Mus.*, 26: 343.
1924. *Octochaetus (Octochaetoides) fermori* f. *tetracystis* Stephenson, *Rec. Indian Mus.*, 26: 343.
1929. *Octochaetus lunatus* Gates, *Proc. U.S. natn. Mus.*, 75: 24
1933. *Octochaetoides fermori*, Gates, *Rec. Indian Mus.*, 35: 559.
1945. *Octochaetoides beatrix*, Gates, *Proc. natn. Acad. Sci. India, (B)* 15: 48.
1955. *Octochaetoides beatrix*, Gates, *Rec. Indian Mus.*, 52: 76.
1962. *Octochaetona beatrix*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.
1972. *Octochaetona beatrix*, Gates, *Trans. Am. phil. Soc.*, 62: 308.

Length 40-134 mm, diameter 2-5 mm, 133-197 segments. Prostomium epilobic, tongue closed. First dorsal pore 12/13, sometimes 11/12. Clitellum xiii-xvii, xviii. Setae  $aa = 2-2.3$   $ab = 0.7-0.8$   $bc = 1.1-1.3$   $cd = 0.09-0.1$   $dd$  on xii,  $aa = 2.3-2.7$   $ab = 0.8-0.9$   $bc = 1.4-1.5$   $cd = 0.11$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix slightly sigmoid and enlarged. Male genital field slightly depressed. Male pores minute, at or just median to  $a$ ; prostatic pores minute, median to  $a$ ; seminal grooves concave between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, on or slightly anterior to the setal arcs of viii and ix, median to  $a$ . Discrete genital markings absent, but paired oval to circular slightly thickened areas present, lateral to seminal grooves, on xviii and xix.



FIGS. 324-328. *Octochaetona beatrix* (Beddard). 324. spermathecal pore region, 325. spermatheca, 326. penial seta, 327. seta *a* on viii, 328. genital region.

Septa 4/5, 8/9-11/12 muscular, 5/6/7/8 absent. Gizzard between septa 4/5 and 8/9. Intestine begins in xvii; typhlosole in xxv to civ-cxii. Last pair of hearts in xiii. Metandric, testes and male funnels enclosed in a sub-oesophageal, U-shaped sac in xi, male funnels present in x; seminal vesicles small, in xii. Penial setae ornamented with sparse triangular teeth, tip pointed, 0.5-0.85 mm long, 15-20  $\mu$  diameter. Each spermatheca with a spheroidal, shortly pyriform, oval or flattened and shelf-like, shortly stalked ental diverticulum. Setae *a*, *b* on viii and ix ornamented with a few scattered excavations, sigmoid, 0.29-0.32 mm long, 30-35  $\mu$  diameter.

*Type locality* : Calcutta, West Bengal, India.

*Type specimens* : *O. beatrix*: BMNH, 1904: 10: 5: 242. *O. fermori*: NHRS, 146; MNHU, 7358, ZMUH, 7136. *O. hodgarti*: ZSIC, ZEV 2852/7; ZMUH, 7139. *O. pittnyi*: ZSIC, ZEV 4174/7. *O. dasi*: ZSIC, W 34/1. *O. fermori* f. *tetracystis*: BMNH, 1933: 2: 23: 409-10. *O. lunatus*: USNM, 19255; BMNH, 1928: 2: 4: 8.

*Material examined* : In HAZFS, ZSI, Solan - *Uttar Pradesh*: 0-0-1 Kandholi Forest nr. Dehra Dun, 17 Oct 1975, coll. R.N. Chopra, An 615; 0-0-1 Rishikesh, 5 July 1973, coll. J.C. Tripathi, An 613. *Himachal Pradesh*: coll. K.K. Mahajan: 0-0-4 Kandhor nr. Bilaspur, 18 Aug 1972, An 600; coll. M. Chandra: 0-0-2 Sarahan, Sirmour dist., 28 July 1972, An 607, 0-0-5 Dehra, Kangra dist., 18 July 1973, An 599, 0-0-5 Bherighat, Bilaspur dist., 1 Aug 1973, An 606; coll. H.P. Agarwal: 0-0-1 Kunihar, Solan dist., 3 Aug 1971, An 610, 0-0-1 Sabathu, 7 Sept 1971, An 612, 0-0-1 Tikkar nr. Sarahan, Sirmour district, 27 Sept 1973, An 608, 0-0-3 Gisani vill. nr. Banethi, Sirmour dist., 15 Sept 1973, An 601, 0-0-2 Paonta, 18, 20 Sept 1973, An 609, 611; coll. J.M. Julka, 1978, Kangra district: 0-0-12 Nurpur, 8,9 Aug, An 588, An 589, 0-3-10 Jasoor, 10 Aug, An 589, 0-1-2 Gangwal c. 20 km from Nurpur, 10 Aug, An 596, Chamba district: 0-0-5 Rajpura c. 10 km from Chamba, 15 Aug, An 598, 0-1-3 Chamba, 16 Aug, An 597a, 0-0-2 Rakh c. 20 km from Chamba, 16 Aug, An 597, Mandi district:

0-0-4 Joginder Nagar, 22 Aug, An 595, 0-0-4 Dak Bagda c. 8 km from Joginder Nagar, 25 Aug, An 590, 0-0-5 Sunder Nagar, 28 Aug, An 593, 0-0-1 Harabagh c. 10 km from Sunder Nagar, 29 Aug, An 592, 0-0-3 Tatta Pani, 31 Aug, An 594. *Punjab*: 0-0-2 Nangal, 22 Aug 1972, coll. K.K. Mahajan, An 616. *Jammu & Kashmir*: 0-0-1 Budhwani vill., Samba district, 1 Oct 1978, coll. H. Khajuria, An 605. *Goa*: 0-0-19 Sanvordem, 31 Aug 1979, coll. J.M. Julka, An 602. *Karnataka*: 0-0-5 Belgaum, 29 Aug 1979, coll. J.M. Julka, An 603; 0-0-1 Shimoga, 3 Sept 1979, coll. J.M. Julka, An 604.

*Distribution* : India: *West Bengal*: Calcutta, Raniganj; *Uttar Pradesh*: Saharanpur, Dehra Dun, Lucknow, Allahabad, Chakia, Varanasi, Chunar, Mirzapur, Madho Singh, Janghai, Jhusi, Pratabgarh, Fyzabad, Rae Bareli, Bara Banki, Fatehpur, Tanda Falls, Sohagi, Manikpur Junction, Robertsganj; *Punjab*: Hoshiarpur, Nangal; *Chandigarh*; *Himachal Pradesh*: Kasauli, Kandhor nr. Bilaspur, Sarahan, Dehra, Bherighat nr. Bilaspur, Kunihar, Sabathu, Tikkar, Gisani, Nurpur, Jasoor, Gangwal, Rajpura, Chamba, Rakh, Joginder Nagar, Dak Bagda, Sunder Nagar, Harabagh, Tatta Pani; *Jammu & Kashmir*: Budhwani vill., Samba district; *Rajasthan*: Udaipur, Pilani; *Madhya Pradesh*: Gwalior, Maunanj, Rewa, Nowgong, Jubbulpore, Baraila, Safraha, Gaurighat; *Orissa*: Antrakyari nr. Balugaon, Sankara vill. nr. Sundargarh, Jharsuguda, Khejuri Poda, Baripada, Bisoi, Cuttack, Jagatsinghpur, Kendrapada, Pattamundai, Bhawani-patna, Kesinga, Burla, Bargarh, Godabaga; *Gujarat*: Baroda, Dhanu, Surat, Ahmedabad; *Maharashtra*: Bombay; *Goa*: Sanvordem; *Karnataka*: Mangalore, Bangalore, Belgaum, Shimoga; *Kerala*: Karakulam, Trivandrum.

Outside India: Pakistan, Nepal, Burma, Malay Peninsula, Philippines.

*Biology* : It inhabits sandy loam and clay loam soils with low organic matter, in lawns, grasslands, in flower pots and on the edges of roadside ditches. Maximum population density of 300/m<sup>2</sup> was recorded in a grassland in Orissa. It undergoes diapause during

periods of low soil moisture and high soil temperature. However, activity may be continued throughout the year in swampy habitats. Cocoons are round and thin-walled; incubation period is about 3-4 weeks at 25°C ( $\pm 3^\circ\text{C}$ ) soil temperature and 15 g% ( $\pm 2$  g%) soil moisture. Usually one (rarely two) young worm hatches from each cocoon. Reproduction is biparental. Copulation and feeding take place beneath the soil surface.

#### 84. *Octochaetona compta* (Gates)

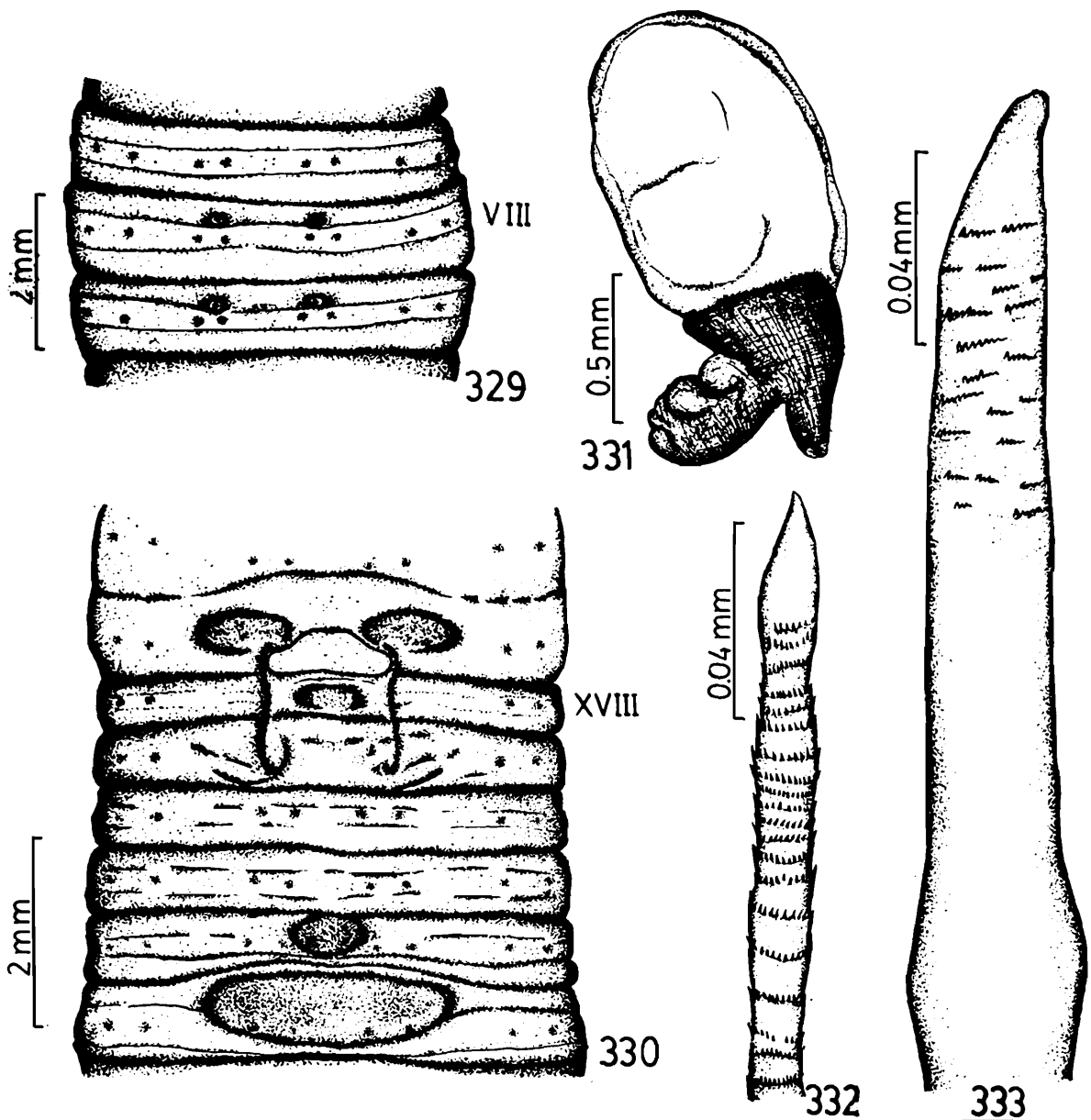
(Figs. 329-333)

1945. *Octochaetoides comptus* Gates, *J. Roy. Asiat. Soc. Beng.*, 11: 80.

1962. *Octochaetona compta*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 70-150 mm, diameter 3-7 mm, 131-176 segments. Prostomium epilobic, tongue closed. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 2.5-3.2$   $ab = 1.1-1.3$   $bc = 1.9-2.1$   $cd = 0.14$   $dd$  on xii,  $aa = 3.2-4$   $ab = 1.1-1.3$   $bc = 1.9-2$   $cd = 0.17$   $dd$  on xxiv,  $a$ ,  $b$  on viii sometimes copulatory being surrounded by tumescences. Male genital field transversely oval between 16/17 and 19/20. Male pores minute, slightly median to  $b$ ; prostatic pores minute, just median to  $b$ ; seminal grooves nearly straight or irregularly biconcave with indentations on the setal arc of xviii, between the setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, slightly anterior to the setal arcs of viii and ix, at  $ab$ , sometimes at  $a$  or  $b$ . Genital markings oval, unpaired and median, presetal, usually on xiii, sometimes on xv, xx-xxv, at  $aa$  or  $bb$  or reaching laterally well into  $bc$ .

Septa 4/5, 8/9-11/12 muscular, 7/8 delicate to slightly muscular, 5/6/7 absent. Gizzard between septa 4/5 and 7/8. Intestine begins in xvii; typhlosole in xxiv-xxv to cxiv-cxviii. Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix, xi and xii. Penial setae ornamented with 15-30 circles of small teeth, tip sharp or rounded, narrowed or widened, flattened, 0.74-0.85 mm long, 14-16  $\mu$  diameter. Each spermatheca with a dorso-ventrally flattened and circular disc-like



FIGS. 329-333. *Octochaetona compta* (Gates). 329. spermathecal pore region, 330. genital region, 331. spermatheca, 332. penial seta, 333. sigmoid seta on viii.

ectal diverticulum. Setae *a*, *b* on viii and ix sigmoid and ornamented with short transverse serrate lines, those on viii sometimes copulatory and ornamented with longitudinal rows of fairly stout and long spines.

*Type locality* : Nellore, Andhra Pradesh, India.

*Type specimens* : In ZSIC, W 3661/1.

*Material examined* : 0-2-13, syntypes, W 3661/1, in ZSIC.

*Distribution* : India: *Andhra Pradesh*: Nellore, Ongole, Narasaravupet, Viravasmu.

### 85. *Octochaetona excavata* (Stephenson)

(Figs. 334-337)

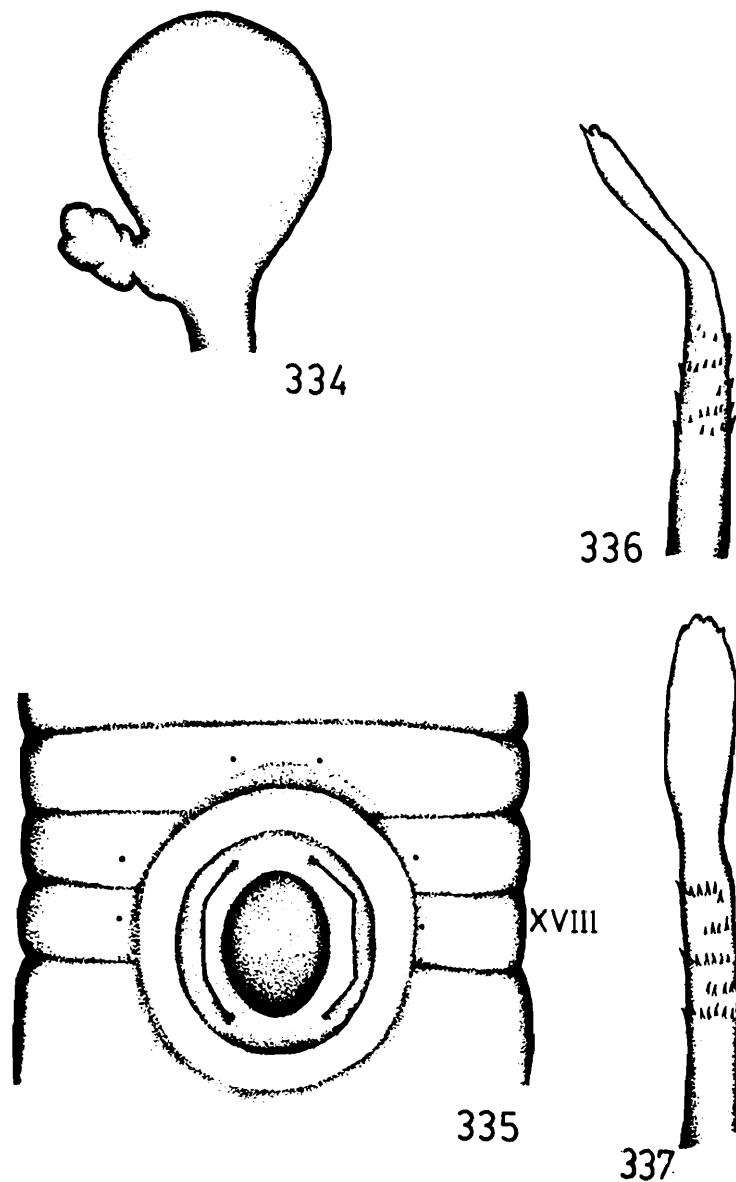
1925. *Octochaetus (Octochaetoides) excavatus* Stephenson, *Rec. Indian Mus.*, 27: 69.

1962. *Octochaetona excavata*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 46-70 mm, diameter 2-3 mm, 150 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 3.5$   $ab = bc = 1.4$   $cd$  anterior to clitellum,  $aa = 2.5$   $ab = 1.1bc = 1.9$   $cd$  posterior to genital region,  $a, b$  on viii copulatory. Male genital field circular to rather hexagonal, depressed with a well marked lip, extending from xvii to  $\frac{1}{2}xx$ . Male pores minute, at  $b$ ; prostatic pores minute, at  $a$ ; seminal grooves concave between the setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, in 7/8/9, at  $a$ . Genital markings absent.

Septa 4/5, 10/11-12/13 muscular, 5/6-9/10 absent. Gizzard between septa 4/5 and 10/11. Intestine begins in (?), typhlosole (?). Last pair of hearts in xiii. Holandric, testes and male funnels in unpaired U-shaped sacs, in x and xi; seminal vesicles in xii. Penial setae ornamented with c. 5 irregular rings of small spines, tip flattened, 1.27 mm long, 16  $\mu$  diameter. Each spermatheca with a short, stumpy, slightly curved ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with short irregular rows of teeth forming incomplete circles, tip claw-shaped, 0.7 mm long, 16  $\mu$  diameter.

*Type locality* : Horsleykonda, Chitoor district, Andhra Pradesh, India.



FIGS. 334-337. *Octochaetona excavata* (Stephenson). 334. spermatheca, 335. genital region, 336, 337. penial setae (all redrawn, after Stephenson 1925).

*Type specimens* : In BMNH, 1933: 2; 23: 481-3.

*Distribution* : So far known from the type locality.

### 86. *Octochaetona maindroni* (Michaelsen)

1907. *Octochaetus maindroni* f. *typica* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 168.

1907. *Octochaetus maindroni* var. *chaperi* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 169.
1923. *Octochaetus (Octochaetoides) maindroni*, Stephenson, *Fauna Br. India, Oligochaeta*: 382.
1923. *Octochaetus (Octochaetoides) maindroni* var. *chaperi*, Stephenson, *Fauna Br. India, Oligochaeta*: 383.
1962. *Octochaetona maindroni*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 50-180 mm, diameter 2.5-5 mm, c. 130-198 segments. Prostomium epilobic. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 2.5$   $ab = bc = 1.7$   $cd$  on (?),  $a$ ,  $b$  on viii and ix sigmoid. Male genital field depressed. Male pores minute, median to  $b$ ; prostatic pores minute, at  $b$ ; seminal grooves convex between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, anterior to setal arcs of viii and ix, lateral to  $a$ . Genital markings unpaired and median, postsetal on xiii, reaching laterally into  $bc$ , sometimes on xviii between seminal grooves.

Septa 4/5, 7/8-13/14 muscular, 5/6/7 absent (?). Gizzard anterior to the septum 7/8 (between septa 4/5 and 7/8). Intestine begins in (?), typhlosole (?). Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in xi and xii. Penial setae ornamented with irregular transverse rows of large rather slender teeth, ectal end flattened, tip pointed, 1.2 mm long, 10  $\mu$  diameter. Each spermatheca with a shortly stalked, multiloculate ectal diverticulum. Genital marking glands (?).

*Type locality* : Gingi, S. Arcot district, Tamil Nadu, India.

*Type specimens* : Typus amissus.

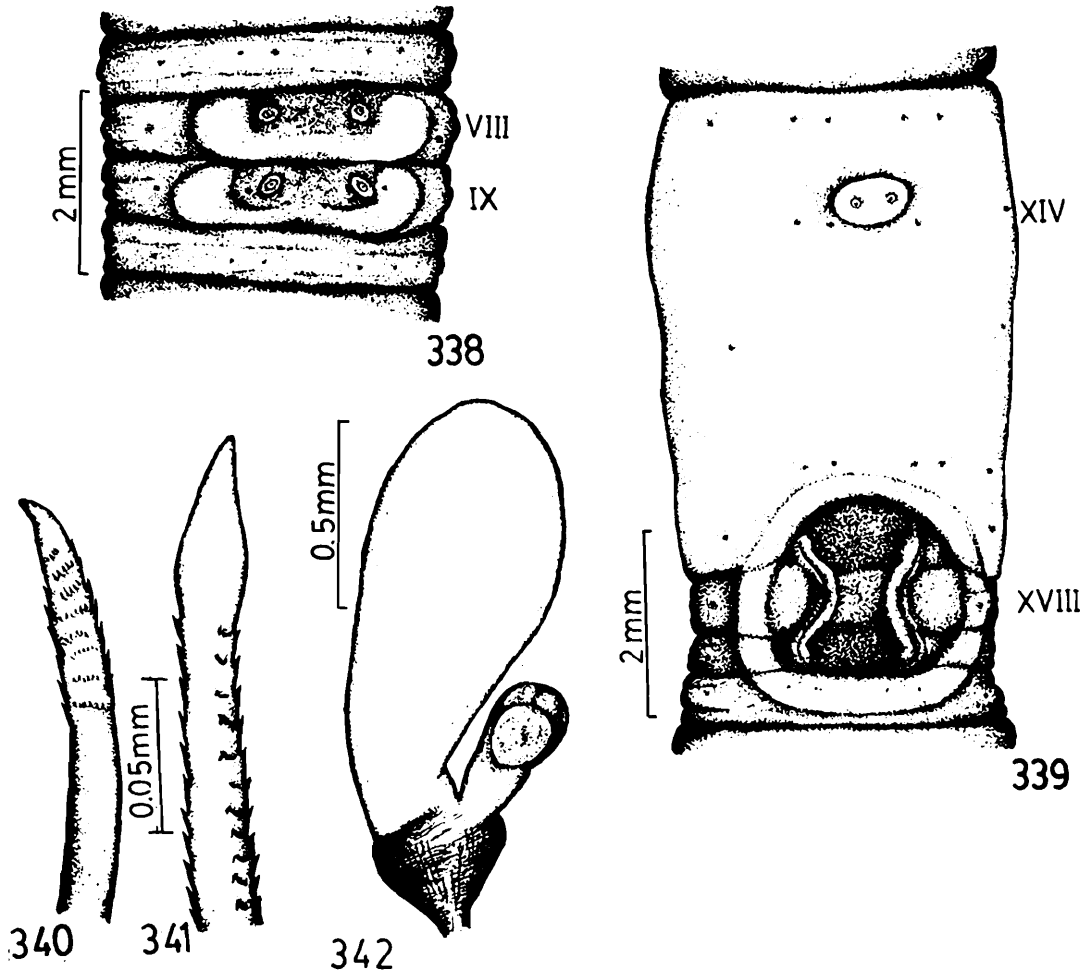
*Distribution* : India: Tamil Nadu: Gingi, Weyra Karur.

### 87. *Octochaetona paliensis* (Stephenson)

(Figs. 338-342)

1907. *Octochaetus phillotti* (in part, excluding specimens with last pair of hearts in xiii) Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 169.
1920. *Octochaetus paliensis* Stephenson, *Mem. Indian Mus.*, 7: 228.

1920. *Octochaetus paliensis* var. *riparius* Stephenson, *Mem. Indian Mus.*, 7: 231.
1920. *Octochaetus ganeshae* Stephenson, *Mem. Indian Mus.*, 7: 238.
1923. *Octochaetus (Octochaetoides) ganeshae*, Stephenson, *Fauna Br. India, Oligochaeta*: 379.
1923. *Octochaetus (Octochaetoides) paliensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 385.
1923. *Octochaetus (Octochaetoides) paliensis* var. *riparius*, Stephenson, *Fauna Br. India, Oligochaeta*: 386.
1923. *Octochaetus (Octochaetoides) phillotti* (in part, excluding specimens with last pair of hearts in xiii), Stephenson, *Fauna Br. India, Oligochaeta*: 390.
1962. *Octochaetona paliensis*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.



FIGS. 338-342. *Octochaetona paliensis* (Stephenson). 338. spermathecal pore region, 339. genital region, 340. penial seta, 341. copulatory seta, 342. spermatheca.

Length 35-92 mm, diameter 2-3.5 mm, 119-182 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 2.7-4.3$   $ab = 0.9-1.1$   $bc = 1.4-2.5$   $cd = 0.15-0.16$   $dd$  on xii,  $aa = 3.3-3.4$   $ab = 1.2-1.3$   $bc = 1.9-2.5$   $cd = 0.16-0.19$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix copulatory being surrounded by tumescences. Male genital field depressed, deeply so on xvii and xix. Male pores minute, at or slightly lateral to  $a$  or  $b$ ; prostatic pores minute, at  $b$ ; seminal grooves straight or convex between the setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, presetal on viii and ix, close to setal arcs, at  $ab$ . Genital markings, when present, oval, unpaired and median or 19/20-23/24, at  $aa$  or  $bb$ , paired on xviii, at  $bc$ .

Septa 4/5, 7/8-11/12 muscular, 5/6/7 absent. Gizzard between septa 4/5 and 7/8. Intestine begins in xvii, typhlosole xxii-xxiii to lxxxix-xcviii. Last pair of hearts in xii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with circles of fine spines, tip bluntly pointed, 0.55-0.73 mm long, 13-17  $\mu$  diameter. Each spermatheca with a somewhat clavate ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with transverse rows of serrated ridges, tip claw-shaped, 0.51-0.82 mm long, 15-23  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Palia, Madhya Pradesh, India.

*Type specimens* : *O. paliensis*: BMNH, 1938: 5: 25: 886-8. *O. paliensis* var. *riparius*: ZSIC, W 271/1, W 270/1, W 269/1; BMNH, 1925: 5: 12: 131. *O. ganeshae*: ZSIC, W 262/1; BMNH, 1933: 5: 25: 914-5.

*Material examined* : In ZSIC - *O. phillotti*: 0-1-5 syntypes, Hyderabad, coll. D.C. Phillott, ZEV 2853/7. *O. paliensis* var. *riparius*: 0-1-0, 4-3-3, 2-1-0, syntypes, Gwalior, coll. B. Prashad, W 271/1, W 270/1, W 269/1. *O. ganeshae*: 0-1-0, holotype, Ganesh Khund 4 miles from Poona, B. Prashad, W 262/1. *O. paliensis*: 1-1-0 Poona, coll. B. Prashad, W 320/1; 46-1-5 Nowgong, coll. G.E. Gates, W 3663/1.

In HAZFS, ZSI, Solan - *Andhra Pradesh*: 0-0-7 Vijaypuri, 28 Aug 1962, coll. B. Nath, An 582; 3-5-3 Hyderabad, 27 Sept 1979, coll. J.M. Julka, An 581. *Maharashtra*: coll. J.M. Julka, 1979: 0-2-8 Poona, 23 Aug, An 583, 0-0-3 Panchgani, 26 Aug, An 584.

*Distribution* : India: *Madhya Pradesh*: Palia, Indore, Bina, Gwalior, Nowgong; *Maharashtra*: Poona, Panchgani; *Andhra Pradesh*: Hyderabad, Vijaypuri.

*Remarks* : An examination of 6 syntypes of *O. phillotti* (ZEV 2853/7) in the Zoological Survey of India, Calcutta shows that the last pair of hearts are in xii and do not belong to *O. phillotti* which is characterised by the location of last pair of hearts in xiii. Possibly, Michaelsen (1907) mistook the coils of dorsal blood vessel in xiii for the last pair of hearts in these syntypes.

### 88. *Octochaetona parva* (Gates)

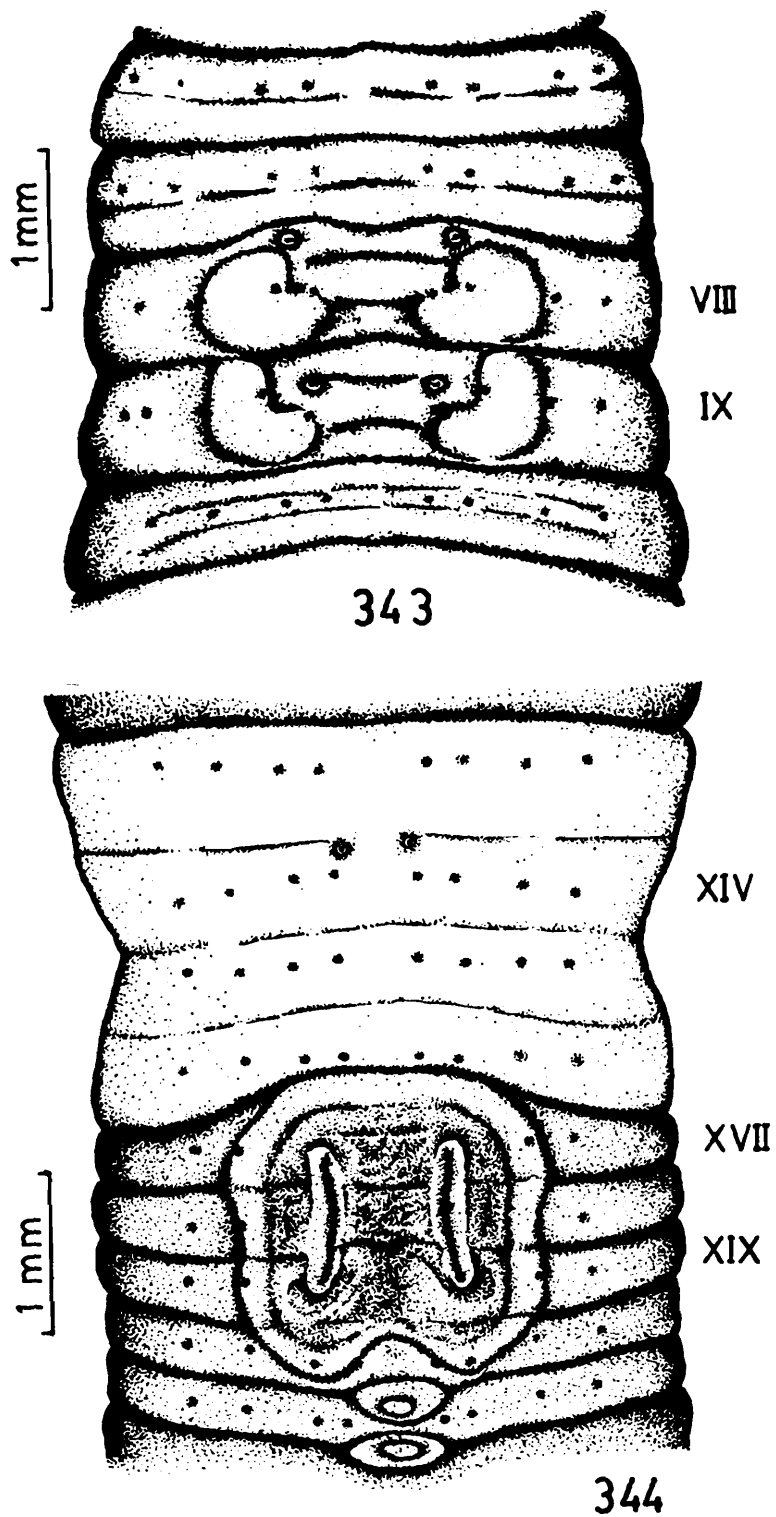
(Figs. 343-344)

1945. *Octochaetoides parvus* Gates, *Jl. R. Asiat. Soc. Beng.*, 11: 84.

1962. *Octochaetona parva*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 70-100 mm, diameter 3-4 mm, 80 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum xiii-xvi, xvii. Male genital field usually indistinct, slightly depressed between seminal grooves. Male pores minute, slightly median to *b*; prostatic pores minute, at *b*; seminal grooves almost straight or slightly concave between setal arcs of xvii and xix. Female pores paired. Spermathecal pores small, transverse or diagonal or sometimes longitudinal, straight or crescent slits, anterior to setal arcs on viii and ix, at or close to *a* or *b*. Genital markings oval, unpaired and median, on 20/21/22, sometimes on 19/20, postsetal on xxi, at *aa*.

Septa 4/5, 8/9-11/12 muscular, 7/8 delicate, 5/6/7 absent. Gizzard between septa 4/5 and 7/8. Intestine begins in xvii, typhlosole in xxiv-xxv to (?). Last pair of hearts in xiii. Holandric, testes and male funnels free (?), in x and xi, seminal vesicles in xi



FIGS. 343-344. *Octochaetona parva* (Gates). 343. spermathecal pore region, 344. genital region (both drawn from a syntype).

and xii. Penial setae ornamented with circles of fine spines, tip sharply pointed to bluntly rounded, 0.96-1.1 mm long, 20-25  $\mu$  diameter. Each spermatheca with a flattened disc-like ectal diverticulum, duct shorter than ampulla. Copulatory setae ornamented with longitudinal rows of fairly stout and long spines, tip more or less claw-shaped, 0.88-1.2 mm long, 24-30  $\mu$  diameter. Genital marking glands (?).

*Type locality* : Nellore, Andhra Pradesh, India.

*Type specimens* : In ZSIC, W 3662/1.

*Material examined* : 0-0-1, syntype, W 3662/1, ZSIC.

*Distribution* : India: *Andhra Pradesh*: Nellore, Ongole.

### 89. *Octochaetona pattoni* (Michaelson)

(Figs. 345-349)

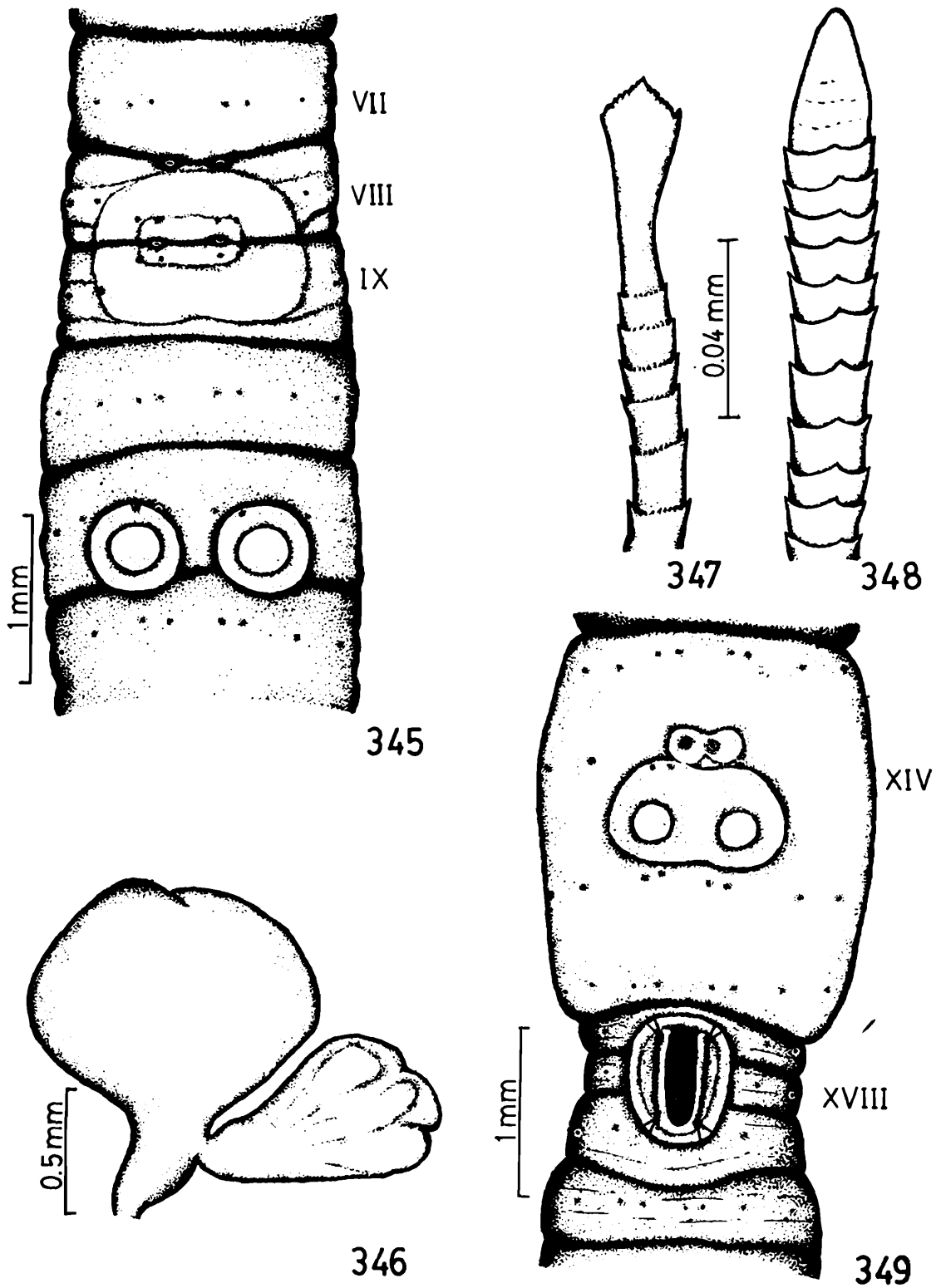
1907. *Octochaetus pattoni* (in part) Michaelson, *Jb. hamb. wiss. Anst.*, **24**: 170 (excluding specimens with copulatory setae on vii and viii, genital markings on postclitellar segments).

1923. *Octochaetus (Octochaetoides) pattoni* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 388 (exclusion as above).

1962. *Octochaetona pattoni*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, **5**: 213.

Length 65-113 mm, diameter 2.5-4 mm, 141-157 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum  $\frac{1}{2}$ xiii-xvi,  $\frac{1}{2}$ xvii. Setae *aa* = 2.2-2.7 *ab* = *bc* = 1.1-1.4 *cd* = 0.11 *dd* on xii, *aa* = 3-3.7 *ab* = 1.1-1.2 *bc* = 2.1-2.5 *cd* = 0.13 *dd* on xxiv, *a*, *b* on viii and ix copulatory being surrounded by tumescences. Male genital field longitudinally oval and depressed. Male and prostatic pores minute, at *a*; seminal grooves straight between setal arcs of xvii and xix. Female pores paired. Spermathecal pores small, transverse slits, in 7/8/9, at *a*. Genital markings oval, paired, postsetal on xi, on 14/15, at *aa* or *ac*.

Septa 4/5, 10/11-12/13 muscular, 9/10 delicate, 5/6-8/9 absent. Gizzard between septa 4/5 and 9/10. Intestine begins in xviii, typhlosole in xviii to xcix-c. Last pair of hearts in xiii.



FIGS. 345-349. *Octochaetona pattoni* (Michaelsen). 345. spermathecal pore region, 346. spermatheca, 347. penial seta, 348. copulatory seta, 349. genital region.

Holandric, testes and male funnels enclosed in sacs (?), in x and xi, seminal vesicles in ix and xii. Penial setae ornamented with rings of small to large teeth, ectal end expanded with sharp lateral and distal serrated edges, 0.72-1.08 mm long, 15-19  $\mu$  diameter. Each spermatheca with a shortly stalked ental diverticulum. Copulatory setae ornamented with 12-13 transverse and concave ridges, projecting into spines on the margins of the setae, tip bluntly rounded, on viii 0.27-0.59 mm long, 22-26  $\mu$  diameter, on ix 0.19-0.2 mm long, 17-19  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Madras, Tamil Nadu, India.

*Type specimens* : In ZSIC, ZEV 2856-2862/7; BMNH, 1925: 5: 12: 124; MNHU, 7336; ZMUH, 7159.

*Material examined* : ZSIC - *O. pattoni*: 0-2-0 Red Hills, Madras, coll. E. Thurston, syntypes, ZEV 2857/7; 1-1-0 People's Park, Madras, coll. E. Thurston, syntypes, ZEV 2858/7; 1-3-1 Pursevaukann, Madras, coll. E. Thurston, syntypes, ZEV 2856/7; 0-1-0 Kilpauk, Madras, coll. E. Thurston, syntypes, ZEV 2860/7; 0-3-0 Egmore Spur Tank, Madras, coll. E. Thurston, syntypes, ZEV 2861/7; 0-0-1 Mackay's Garden, Madras City, coll. Capt. W.S. Patton, syntypes, ZEV 2862/7.

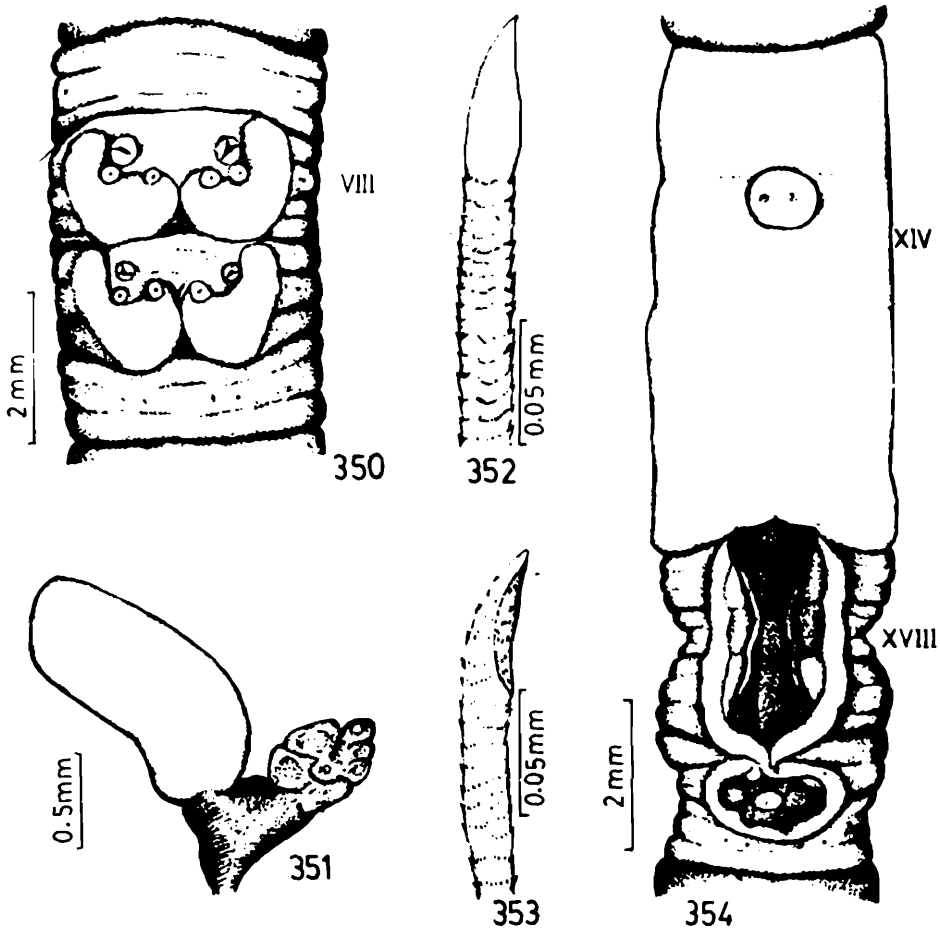
*Distribution* : So far known from the type locality.

*Remarks* : The type material of *O. pattoni* (Michaelsen, 1907) in Zoological Survey of India comprises 7 lots (ZEV 2856-2862/7). An examination of these shows that 4 lots (ZEV 2856-2857/7, 2859/7, 2860/7) contain specimens of both *O. pattoni* and *O. serrata* (Gates, 1945).

### 90. *Octochaetona phillotti* (Michaelsen)

(Figs. 350-354)

1907. *Octochaetus phillotti* (in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 169 (excluding specimens with last pair of hearts in xii).



FIGS. 350-354. *Octochaetona phillotti* (Michaelsen). 350. spermathecal pore region, 351. spermatheca, 352. copulatory seta, 353. penial seta, 354. genital region.

1923. *Octochaetus (Octochaetoides) phillotti*, Stephenson, *Fauna Br. India, Oligochaeta*: 390 (exclusions as above).

1962. *Octochaetona phillotti*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 93-128 mm, diameter 2-5.5 mm, 157-199 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum xiii-xvi,  $\frac{1}{2}$ xvii. Setae  $aa = 2.6-2.8$   $ab = 0.9-1.2$   $bc = 1.6-1.9$   $cd = 0.1-0.12$   $dd$  on xii,  $aa = 3-3.9$   $ab = 1.1-1.3$   $bc = 1.9-2.4$   $cd = 0.18-0.19$   $dd$  on xxiv,  $a, b$  on viii and ix copulatory being surrounded by tumescences. Male genital field rectangular, deeply depressed on xvii and xix, floor of depression slightly raised on xviii. Male pores minute, at  $a$ ; prostatic pores minute, slightly lateral to  $a$ ;

seminal grooves convex between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute to small diagonal slits, presetal, on viii and ix, slightly median to *b*. Genital markings, when present, oval, unpaired and median depressions with 3-4 central areas, postsetal on xx, presetal on xxi, at *bb*, paired, postsetal, on xvii-xix, at *bc*.

Septa 4/5, 7/8-11/12 muscular, 5/6/7 absent. Gizzard between septa 4/5 and 7/8. Intestine begins in xvii, typhlosole in xxiv-xxv to cvii-cxix. Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with circles of spines, tip bluntly pointed, 1.25-1.43 mm long, 16-19  $\mu$  diameter. Each spermatheca with a shelf-like ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with transverse serrated ridges, tip claw-shaped, 0.79-0.89 mm long, 27-32  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Hyderabad, Andhra Pradesh, India.

*Type specimens* : In ZSIC, ZEV 2853/7; BMNH, 1925: 5: 12: 42; MNHU, 7343; ZMUH, 7138.

*Material examined* : In BMNH, London: 0-0-1, Hyderabad, syntype, 1925: 5: 12: 42, examined by E.G. Easton; ZSIC: 0-0-3 Kurnool, coll. G.E. Gates, W 3665/1; HAZFS, ZSI, Solan: 0-9-10 Hyderabad, 26 Sept 1979, coll. J.M. Julka, An 585.

*Distribution* : India: *Andhra Pradesh*: Hyderabad, Kurnool.

### 91. *Octochaetona prashadi* (Stephenson)

1920. *Octochaetus prashadi* Stephenson, *Mem. Indian Mus.*, 7: 233.

1923. *Octochaetus (Octochaetoides) prashadi*, Stephenson, *Fauna Br. India, Oligochaeta*: 392.

1962. *Octochaetona prashadi*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 51-61 mm, diameter 2.5-3.5 mm, 150-155 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum (?). Setae *aa* = 3.3 *ab* = 1.2 *bc* = 2. *cd* = 0.14 *dd* on xii, *aa*

= 3.5 *ab* = 1.4 *bc* = 2.8 *cd* = 0.16 *dd* on xxiv, *a*, *b* on viii and ix copulatory being surrounded by tumescences. Male genital field quadrangular, deeply depressed on xvii and xix. Male pores minute; prostatic pores minute, at *b*; seminal grooves between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, in 7/8/9, at or slightly median to *b*. Genital markings absent.

Septa 4/5, 7/8-11/12 muscular, 5/6/7 absent. Gizzard between septa 4/5 and 7/8. Intestine begins in xviii, typhlosole in xxi to ciii-cv. Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with a large number of closely set rings of spines, tip hooked and hollowed on one side, 1.5 mm long, 40  $\mu$  diameter. Each spermatheca with a clavate ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with longitudinal rows of gouges, tip slightly claw-shaped, 0.8 mm long, 20  $\mu$  diameter.

*Type locality* : Kalayan, Maharashtra, India.

*Type specimens* : In ZSIC, W 267/1, BMNH, 1933: 5: 25: 897-901.

*Material examined* : In ZSIC: 0-1-0 Kalayan, coll. B. Prashad, syntype, W 267/1; 0-2-0 Sakarwari, coll. B. Prashad, W 268/1.

*Distribution* : India: *Maharashtra*: Kalyan, Sakarwari on way to Mahabaleshwar.

## 92. *Octochaetona serrata* (Gates)

(Figs. 355-359)

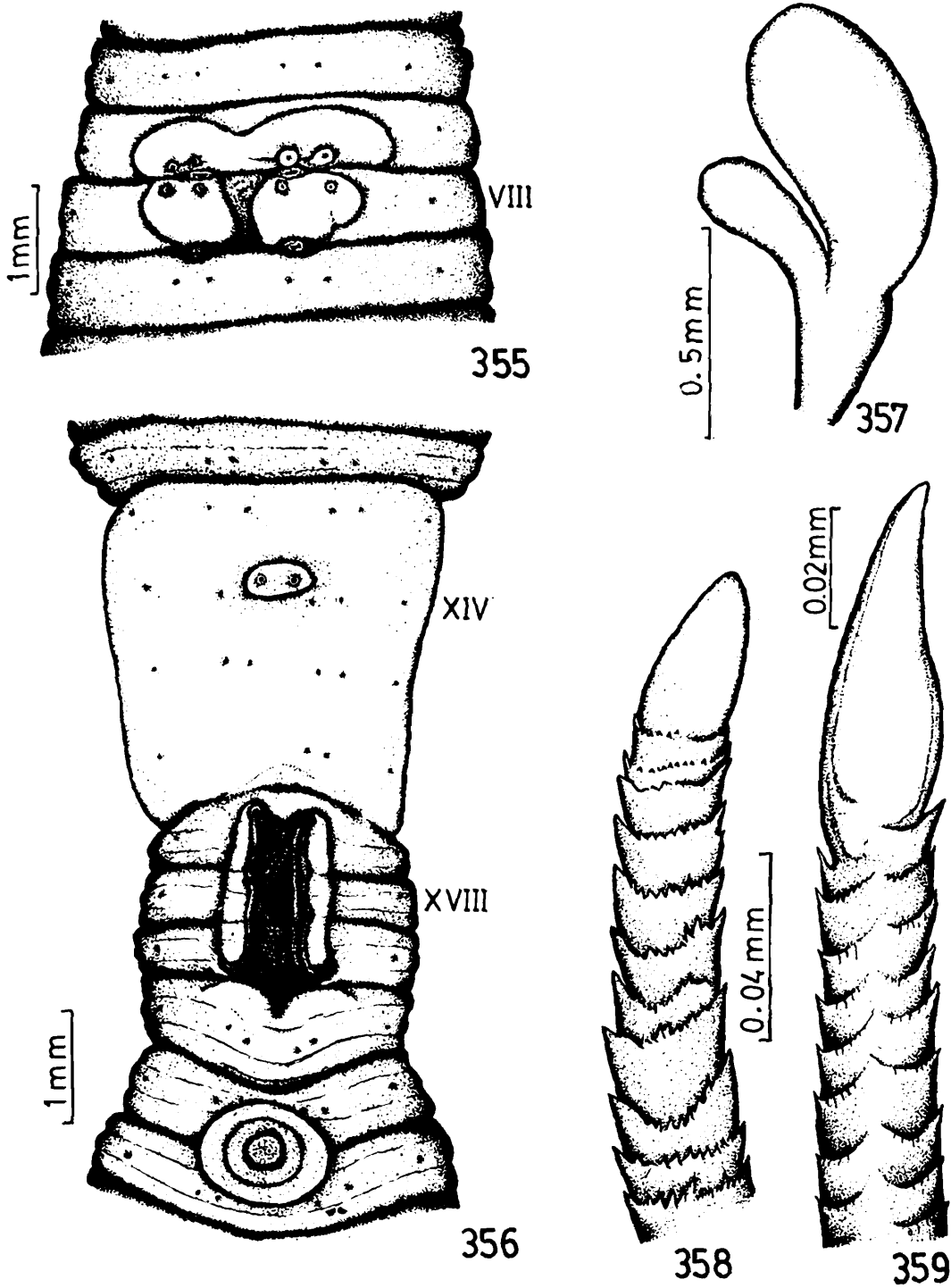
1907. *Octochaetus pattoni* (in part) Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 170 (excluding specimens with copulatory setae on viii and ix, genital markings on xi and 14/15).

1923. *Octochaetus (Octochaetoides) pattoni* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 388 (exclusions as above).

1945. *Octochaetoides serratus* Gates, *Jl. R. Asiat. Soc. Beng.*, 11: 87.

1962. *Octochaetona serrata*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 80-150 mm, diameter 3-4 mm, 161-188 segments. Prostomium epilobic, tongue closed, sometimes open. First dorsal



FIGS. 355-359. *Octochaetona serrata* (Gates). 355. spermathecal pore region, 356. genital region, 357. spermatheca, 358. penial seta, 359. copulatory seta.

pore 12/13. Clitellum xiii,  $\frac{1}{2}$ xiii-xvi. Setae  $aa = 2.2-2.7$   $ab = bc = 1.9-2.3$   $cd = 0.16$   $dd$  on xii,  $aa = 2.9-4$   $ab = bc = 2.9$   $cd = 0.17$   $dd$  on xxiv,  $a$ ,  $b$  on vii and viii copulatory being surrounded by tumescences. Male genital field depressed, rectangular. Male pores minute, at or just lateral to  $a$ ; prostatic pores minute, slightly lateral to  $a$ ; seminal grooves almost straight between setal arcs of xvii and xix. Female pores paired. Spermathecal pores large transverse slits on 7/8/9, at  $a$ . Genital markings oval, unpaired and median, on 21/22, sometimes on 20/21, 22/23-28/29, at  $aa$ , occasionally with two central areas.

Septa 4/5, 10/11-13/14 muscular, 9/10 delicate, 5/6-8/9 absent. Gizzard between septa 4/5 and 9/10. Intestine begins in xviii, typhlosole in xviii to cii-cxviii. Last pair of hearts in xiii. Holandric, testes and male funnels in sacs (?), in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with circles of triangular teeth, tip bluntly rounded, 0.97-1.09 mm long, 22-26  $\mu$  diameter. Each spermatheca with a broadly clavate ental diverticulum. Copulatory setae ornamented with circles of fine spines, tip claw-shaped, 0.61-0.83 mm long, 19  $\mu$  diameter. Genital marking glands absent.

*Type locality* : Madras, Tamil Nadu, India.

*Type specimens* : Typus perditus.

*Material examined* : In ZSIC - *O. pattoni*: 0-0-1 Madras, coll. E. Thurston, syntype, ZEV 2859/7; 1-2-0 Red Hills, Madras, coll. E. Thurston, syntypes, ZEV 2857/7; 0-3-0 Pursevaukann, Madras, coll. E. Thurston, syntypes, ZEV 2856/7; 1-2-0 Kilpauk, Madras, coll. E. Thurston, syntypes, ZEV 2860/7.

*Distribution* : So far known from the type locality.

### 93. *Octochaetona surensis* (Michaelsen)

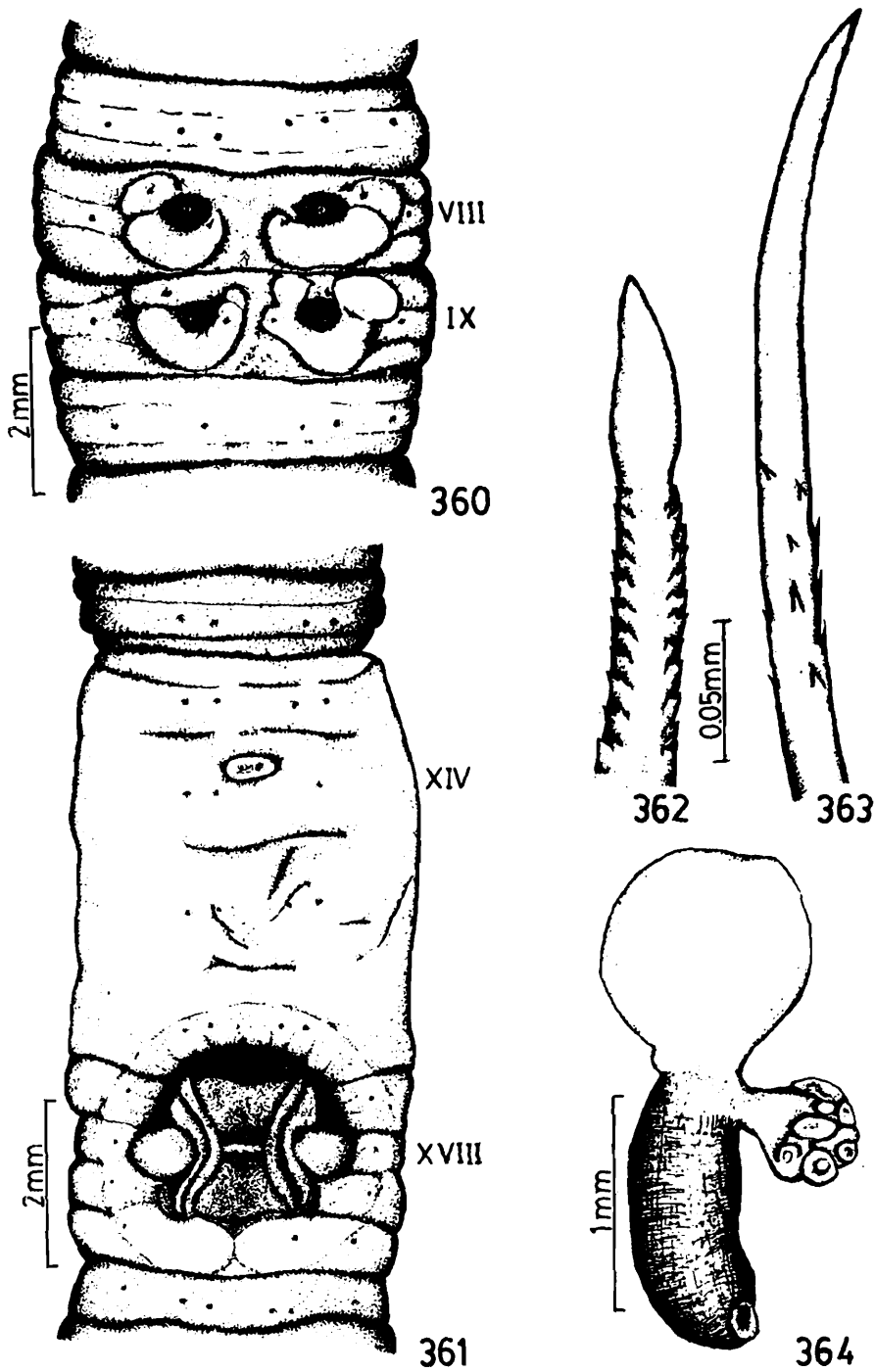
(Figs. 360-364)

1910. *Octochaetus surensis* Michaelsen, *Abh. Geb. Naturw., Hamburg*, 19(5): 88.

1916. *Octochaetus surensi* (lapsus pro *surensis*), Stephenson, *Rec. Indian Mus.*, 12: 338.
1923. *Octochaetus* (*Octochaetoides*) *surensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 394.
1925. *Octochaetus* (*Octochaetoides*) *birmanicus* Gates, *Ann. Mag. nat. Hist. (ser. 9)*, 16: 55.
1926. *Octochaetus birmanicus*, Gates, *Rec. Indian Mus.*, 28: 162.
1933. *Octochaetoides birmanicus*, Gates, *Rec. Indian Mus.*, 35: 557.
1955. *Octochaetoides surensis*, Gates, *Rec. Indian Mus.*, 52: 78.
1962. *Octochaetona surensis*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.
1972. *Octochaetona surensis*, Gates, *Trans. Am. phil. Soc.*, 62: 309.

Length 60-140 mm, diameter 2.5-6 mm, 111-180 segments. Prostomium epilobic, tongue closed. First dorsal pore 12/13. Clitellum xiii-xvi, xvii. Setae  $aa = 2.7-4.3$   $ab = 1-1.1$   $bc = 1.4-2.5$   $cd = 0.15-0.16$   $dd$  on xii,  $aa = 3.3-3.4$   $ab = 1.2-1.3$   $bc = 1.9-2.5$   $cd = 0.16-0.19$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix copulatory being surrounded by tumescences. Male genital field extends from xvi to xx, with deep unpaired transverse depressions, postsetal on xvii and presetal on xix. Male pores minute, median to  $b$ ; prostatic pores minute, at  $b$ ; seminal grooves convex between setal arcs of xvii and xix. Female pores paired, sometimes unpaired and median. Spermathecal pores minute, on or close to the setal arcs of viii and ix, at  $ab$ . Genital markings oval, paired or unpaired and median, postsetal on some of xviii-xxii, at  $aa$  or  $bb$ .

Septa 4/5, 8/9-10/11 muscular, 5/6/7/8 absent. Gizzard between septa 4/5 and 8/9. Intestine begins in xvii, typhlosole in xxii-xxiii to ci-cxv. Last pair of hearts in xiii. Holandric, testes and male funnels in cylindrical sacs, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with a few longitudinal rows of triangular teeth, tip pointed or claw-shaped, 1.2-1.8 mm long, 25-30  $\mu$  diameter. Each spermatheca with a shortly stalked, multilobulate ental diverticulum, duct longer than ampulla. Copulatory setae ornamented with longitudinal rows of spikes or thorn-like protuberances, tip slightly claw-shaped, 0.85-1.2 mm long, 20-25  $\mu$  diameter. Genital marking glands absent.



FIGS. 360-364. *Octochaetona surensis* (Michaelsen). 360. spermathecal pore region, 361. genital region, 362. copulatory seta, 363. penial seta, 364. spermatheca.

*Type locality* : Sur Lake, Puri district, Orissa, India.

*Type specimens* : *O. surensis*: Typus amissus. *O. birmanicus*: In ZSIC, W 1176/1, W 1228/1; BMNH, 1926: 6: 6: 14-5; USNM, 19655.

*Material examined* : 1-1-23 Balaghat, 15 Mar 1964, An 586, HAZFS, ZSI, Solan.

*Distribution* : India: *Orissa*: Sur Lake, Sambalpur, Cuttack, Barkul, Brajarajpur and Balugaon nr. Chilka Lake, Bisoi, Antra-kyari nr. Balugaon, Sundargarh, Sankara vill. nr. Sundargarh, Bolangir, Puri, Gopalpur, Baripada, Jagatsinghpur, Kendrapara, Pattamundai, Bhawanipatna, Kesinga, Bargarh, Barpali, Burla, Jharsuguda, Godbhaga, Kharmuda, Rajgangpur, Surda; *Uttar Pradesh*: Robertsganj; *Madhya Pradesh*: Safraha, Baraila, Gaurighat, Jubbalpore, Balaghat; *Assam*: Kinchana nr. Amingaon.

Outside India: Burma.

*Biology* : It inhabits sandy loam and clay loam soils with comparatively low organic matter (< 5 g%) in grasslands, hillocks, peripheral parts of compost pits, non-irrigated uplands, crop fields and around roots of potted plants. *O. surensis* is geophagous. Copulation and feeding take place beneath soil surface at 15-30 cm depth. Activity in grasslands and pastures is restricted to June-February. Maximum population densities of 186/m<sup>2</sup> and 133/m<sup>2</sup> have been observed in an ungrazed upland pasture and a grazed upland pasture respectively. Quiescence in summer is characterised by a diapause coil (Dash and Senapati, 1980; Senapati, 1980). It comprised 50% of the total earthworm population in western Orissan pastures. Population turnover was 4.2 and 3.9 in grazed and ungrazed pasture ecosystems respectively.

Reproduction is biparental. Cocoons are thin-walled and spherical; average weight 31.5 mg, length 5.34 mm, diameter 4.09 mm, diameter: length ratio 0.76; colour initially pale lemon yellow changing gradually to deep green to brownish red. Incubation period is 4 weeks at 26°C ( $\pm$  3°C) soil temperature and 16 g%

( $\pm 1$  g%) soil moisture; 98 days with similar soil moisture but at 20°C soil temperature. Normally one (rarely two) juvenile worm hatches from each cocoon. Peak cocoon production occurs during November. Newly hatched juveniles take about 20 months to reach the maturity. Life cycle is, however, disrupted for 3-5 months due to low soil moisture ( $< 10$  g%) and high soil temperature ( $> 28^\circ\text{C}$ ) during the summer months. Clitellum degenerates during the post-reproductive period and these individuals are often prone to fungal infection (Dash *et al.*, 1979).

*O. surensis* deposits casts on the soil surface in the form of globules which often fuse with each other to form large irregular pyramidal structures of about 4-5 cm height in soils with high moisture content. A population dominated with *O. surensis* has been reported to produce 47 tons of dry worm casts per acre per year.

#### 94. *Octochaetona thurstoni* (Michaelsen)

(Figs. 365-368)

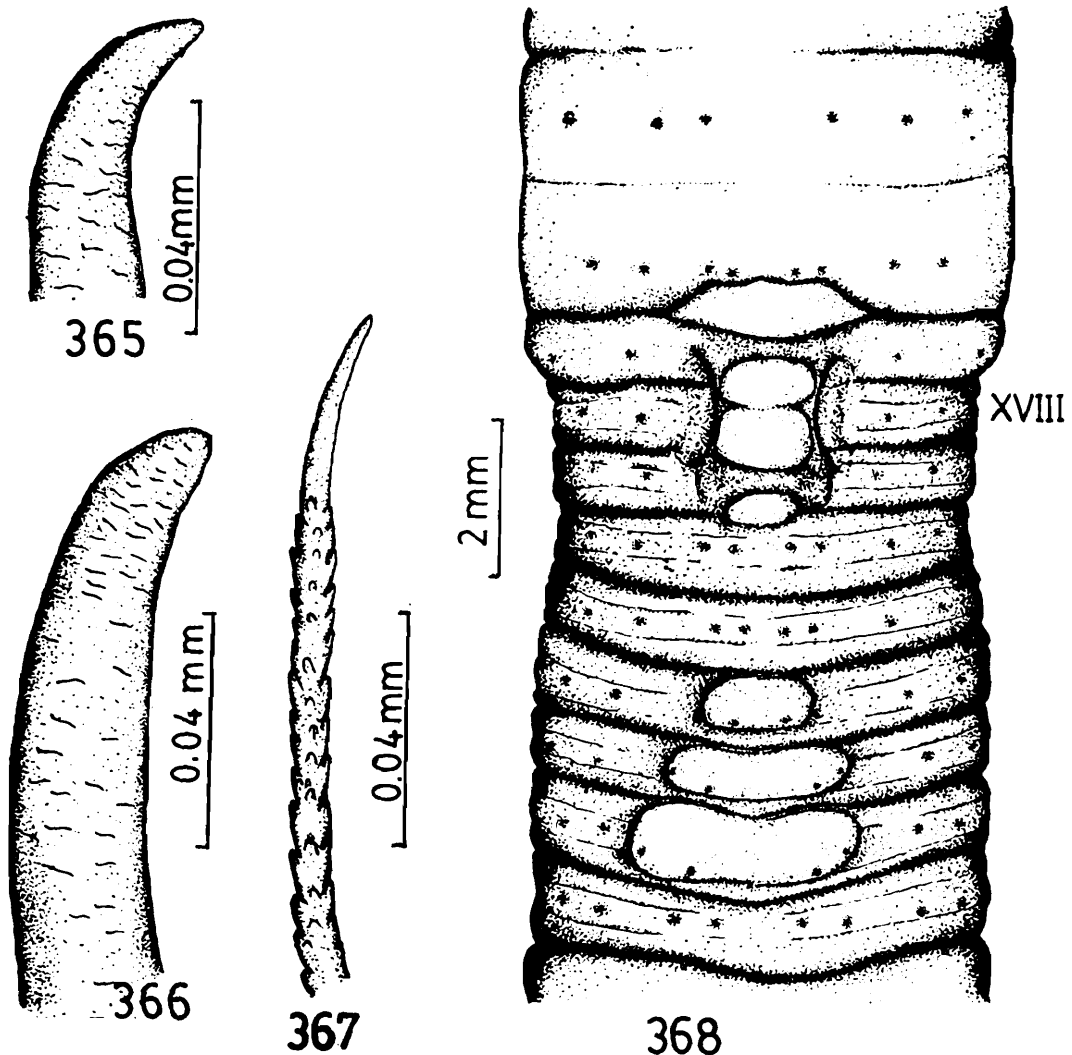
1907. *Octochaetus thurstoni* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 173.

1923. *Octochaetus (Octochaetoides) thurstoni*, Stephenson, *Fauna Br. India, Oligochaeta*: 396.

1962. *Octochaetona thurstoni*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

Length 130-242 mm, diameter 5-6 mm, 198-231 segments. Prostomium epilobic, tongue closed. First dorsal pore 12/13. Clitellum xiii-xvii. Setae  $aa = 2.4$   $ab = 0.9$   $bc = 2$   $cd = 0.11$   $dd$  on xii,  $aa = 3.5-4$   $ab = 1.2-1.3$   $bc = 3.5-4$   $cd$  posterior to genital region,  $a$ ,  $b$  on viii and ix enlarged and slightly sigmoid. Male genital field slightly depressed, extending from xvii to xix. Male pores minute, slightly median to  $a$ ; prostatic pores minute, at  $b$ ; seminal grooves convex between setal arcs of xvii and xix. Female pores paired. Spermathecal pores minute, presetal, on viii and ix, at  $ab$ . Genital markings oval, cushion-like, unpaired and median, on 16/17, 17/18, 19/20 postsetal xviii, xix, presetal xxii-xxiv, sometimes xx-xxi, xxv, at  $aa$  or  $bb$ .

Septa 4/5, 7/8-12/13 muscular, 5/6/7 absent. Gizzard between septa 4/5 and 7/8. Intestine begins in xviii, typhlosole in xxiv to cxxx-cxxxii. Last pair of hearts in xiii. Holandric, testes and male funnels free, in x and xi; seminal vesicles in xi and xii. Penial setae thin, hair-like, ornamented with 12-16 irregular rings of very small spines or scale-like structures, tip pointed, 1-1.15 mm long, 10-13  $\mu$  diameter. Each spermatheca with a shortly stalked, flattened, shalf-like multiloculate ental diverticulum, duct shorter than ampulla. Setae *a*, *b* on viii and ix slightly sigmoid, ornamented with short ridges, 0.5 mm long, 28  $\mu$  diameter. Genital marking glands absent.



FIGS. 365-368. *Octochaetona thurstoni* (Michaelsen). 365-366. copulatory setae, 367. penial seta, 368. genital region.

*Type locality* : Madras, S. India.

*Type specimens* : In ZSIC, ZEV 2855/7; ZMUH, 7158.

*Material examined* : In ZSIC: 0-1-0, syntype, ZEV 2855/7; 0-0-1 Madras City, coll. R. Hodgart, ZEV 4150/7. In HAZFS, ZSI, Solan: 2-0-0 Vandolre, 29 Oct 1981, coll. Koshy Mathew, An 764.

*Distribution* : India: *Tamil Nadu*: Madras, Vandolre.

### Genus 18. *Octonochaeta* gen. nov.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with a single gizzard in a space between septa 4/5 and 7/8, and one pair of discrete extramural calciferous glands, in xvi; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate, paired large enteronephric tufts in iv, several to numerous exonephric on the body wall in iii and posteriad segments, stomate with preseptal and intrasegmental funnels in caudal segments; megameronephridia absent.

*Type species* : *Octochaetus (Octochaetoides) roseus* Stephenson, 1926.

*Description* : As for the only species, *rosea*.

*Distribution* : Andhra Pradesh, S. India.

*Etymology* : *Octonochaeta*, gender feminine, anagram of *Octochaetona*.

*Remarks* : Gates (1962b) included *Octochaetus (Octochaetoides) roseus* Stephenson, 1926 in his genus *Octochaetona*, which was defined by the ventrally bifid typhlosole and one pair of asymmetrical calciferous glands, one gland in xv and the other in xvi, that open into oesophagus close to the attachment of septum 15/16. An examination of its syntypes in Zoological Survey of India, Calcutta (15 clitellate, "types", Secunderabad, Deccan, coll. Prof. J.P. Mullan, W 3152/1) and other recently collected

specimens from Hyderabad (a twin-city of Secunderabad, type locality) reveals that the typhlosole is not ventrally bifid and one pair of calciferous glands are symmetrically placed in xvi, opening into oesophagus in the same segment. Because of these taxonomically important differences, *Octochaetus (Octochaetoides) roseus* cannot be referred to *Octochaetona* and any other known octochaetid genera. It is therefore assigned to *Octonochaeta* gen. nov., which belongs to a group of octochaetid genera with a single oesophageal gizzard, discrete extramural calciferous glands and stomate exonephric micromeronephridia in the caudal segments, and lack megameronephridia. It can be distinguished from other members of the group, *Octochaetona* Gates, 1962 and *Chaetocotoides* gen. nov. (described elsewhere in this work) by the characters as given in Table 3.

### 95. *Octonochaeta rosea* (Stephenson)

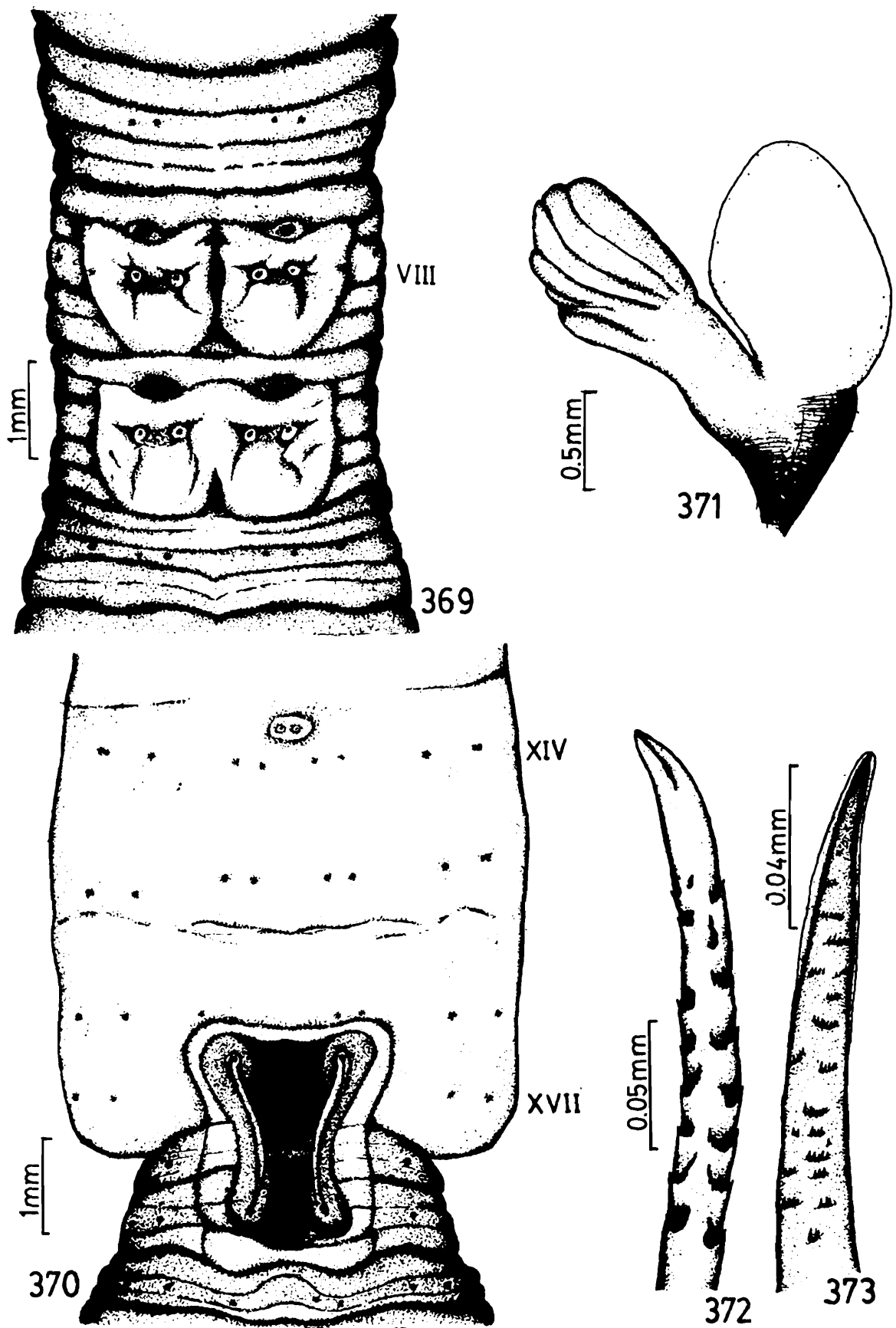
(Figs. 369-373)

1926. *Octochaetus (Octochaetoides) roseus* Stephenson, *Rec. Indian Mus.*, 28: 259.

1962. *Octochaetona rosea*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 213.

1970. *Octochaetoides sudarshensis* Sharma and Chacko, *J. zool. Soc. India*, 22: 2.

Length 52, 125-300 mm, diameter 3-5 mm, 200-280 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum annular, xiii-xvii. Setae lumbricine,  $aa = 3.2-3.3$   $ab = 1-1.2$   $bc = 1.8-2.2$   $cd = 0.12-0.14$   $dd$  on xii,  $aa = 3.4-3.8$   $ab = 1.1-1.4$   $bc = 2.1-2.8$   $cd = 0.13-0.14$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix, sometimes either on left or right side on x and xi copulatory, being surrounded by tumescences. Male genital field somewhat rectangular with rounded corners, between 16/17 and 19/20, extending laterally to  $c$  or mid  $bc$ , deeply depressed on xvii and xix. Male pores paired, minute, in seminal grooves, on the setal arc of xviii, just median to  $a$ ; prostatic pores paired, minute, at the ends of seminal grooves, on xvii and xix, at or slightly lateral to  $a$ ; seminal



FIGS. 369-373. *Octonochaeta rosea* (Stephenson). 369. spermathecal pore region, 370. genital region, 371. spermatheca, 372. copulatory seta, 373. penial seta.

grooves convex, between setal arcs of xvii and xix. Female pores paired, presetal, within *a* lines, on xiv. Spermathecal pores paired, large transverse slits, presetal, on viii and ix, at *ab*. Genital markings, when present, oval, unpaired and median with 1-3 central areas, presetal on xvi, postsetal on xx, on 15/16, 20/21, at *aa* or *bb*. Nephridiopores not recognized.

Septa 4/5, 7/8-11/12 muscular, 5/6/7 absent. Gizzard large, between septa 4/5 and 7/8; calciferous glands discrete, extramural, reniform, one pair, in xvi, opening into oesophagus through short stalks dorso-laterally; intestinal caeca and supra-intestinal glands absent; intestine begins in xviii; typhlosole lamelliform, simple, xviii to cxxvii-clxix. Dorsal vessel single and complete; supra-oesophageal vessel single, vii-xv; extra-oesophageal vessels paired, v-xv, a small vessel from each extra-oesophageal joins the supra-oesophageal vessel in viii; latero-parietal vessels paired, each bifurcates in xiii, one branch joins the supra-oesophageal vessel and the other passes to the extra-oesophageal vessel; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to dorsal vessel, in x-xiii. Holandric testes and male funnels free, in x and xi; seminal vesicles narrowed and slightly coiled distally, in ix and xii. Prostates paired, in xvii and xix. Penial setae ornamented with short transverse rows of fine spines, tip bluntly pointed but slightly hollowed out on one side, 1.5-2 mm long, 28  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a long, broad, flat, multiloculate ental diverticulum, duct shorter than ampulla. Copulatory setae ornamented with longitudinal rows of gouges with serrated margins, tip slightly claw-shaped, 1-1.1 mm long, 24  $\mu$  diameter. Ovisacs paired, in xiv. Genital marking glands absent. Micromeronephridia astomate, enteronephric paired tufts in iv, several to numerous exonephric on the body wall in iii and posteriad segments, slightly enlarged and stomate in caudal segments, arranged in two transverse rows in each segment, the anterior row with preseptal and the posterior row with intra-segmental funnels; megameronephridia absent.

*Type locality* : Secunderabad, Andhra Pradesh, S. India.

*Type specimens* : *Octochaetus (Octochaetoides) roseus*: In ZSIC, W 3152/1; BMNH, 1973: 2: 23: 472-3. *Octochaetoides sudarshensis*: In New Science College, Hyderabad.

*Material examined* : In ZSIC: 0-0-15, syntypes, W 3152/1; 2-5-2 labelled as "*Octochaetoides roseus*", under stones in the bed of Sagal Eru stream, 5 miles from Diguvematta, Nallamalai Hills, South India, 21 Aug 1929, coll. H.S. Pruthi, W 3561/1. In HAZFS, ZSI, Solan: 1-6-11 Hyderabad, 26 Sept 1979, coll. J.M. Julka, An 753. In New Science Collge, Hyderabad: 1-5-6 labelled as "*Octochaetoides sudarshensis*", types, sent by the authors G.H.R. Sharma and T. Chacko.

*Distribution* : India: *Andhra Pradesh*: Secunderabad, Hyderabad, Diguvematta in Nallamalai Hills.

*Remarks* : A study of the type material of *Octochaetoides sudarshensis* Sharma and Chacko, 1970 shows no taxonomic differences from *Octonochaeta rosea*.

### Genus 19. *Pellogaster* Gates, 1939

1920. *Eudichogaster* (in part), Stephenson, *Mem. Indian Mus.*, 7: 246.

1923. *Eudichogaster* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 402.

1939. *Pellogaster* Gates, *Rec. Indian Mus.*, 41: 200.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix. Oesophagus with 2 gizzards, in v-vi and 4 pairs of discrete extramural calciferous glands in x-xiii; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate; paired exonephric tufts in ii-ix; few, exonephric on the body wall in xii-xix and posteriad segments. Paired, stomate, exonephric megameronephridia in each of few posteriormost segments.

*Type species* : *Eudichogaster bengalensis* Michaelsen, 1910.

*Description* : Setae lumbricine throughout the body. Clitellum annular. Male pores paired, in seminal grooves on xviii; prostatic pores paired, at the ends of seminal grooves on xvii and xix; seminal grooves between setal arcs of xvii and xix. Female pores paired, presetal, on xiv. Spermathecal pores paired, on viii and ix. Genital markings present, sometimes absent. Nephridiopores not recognized.

Septa 4/5/6 delicate, 6/7-12/13 slightly to moderately muscular. Gizzards 2, in v-vi. Calciferous glands 4 pairs, discrete, extramural, in x-xiii, with vertical calciferous lamellae in longitudinal hemi-ellipsoid protuberances ventrally and a well-developed ventral ridge. Intestinal caeca and supra-intestinal glands absent; typhlosole simple, lamelliform. Dorsal vessel single and complete; supra-oesophageal vessel single, ix-xiii; extra-oesophageal vessels paired, x-xiii, ending posteriorly within the ventral longitudinal ridge in oesophagus; latero-parietal vessels paired, passing to the ventral surface of oesophagus in xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric. Prostates 2 pairs, in xvii and xix. Penial setae present or absent. Spermathecae paired, in viii and ix. Copulatory setae usually present. Ovisacs paired, in xiv. Micromeronephridia astomate, exonephric paired tufts on the body wall in ii and on anterior faces of septa in iii-ix, a few on the body wall in xii and posterior segments, arranged in 2-3 longitudinal rows on each side in post-prostatic region; paired stomate exonephric megameronephridia in caudal segments, funnels close to the nerve cord.

*Distribution* : Northeastern portion of the peninsular India from Jubbulpore to Orissa and West Bengal, and the Western Ghats in Maharashtra.

#### Key to the species of *Pellogaster*

1. Penial setae and genital markings present;  
intestine begins anterior to xviii ..... 2

- Penial setae and genital markings absent;  
intestine begins in xviii..... *P. simsi*
2. Prostomium epilobic or pro/epilobic; setae *a, b*  
on viii and ix copulatory; genital markings  
present on xii..... *P. isabellae*
- Prostomium tanylobic; no setae copulatory;  
genital markings absent on xii..... *P. bengalensis*

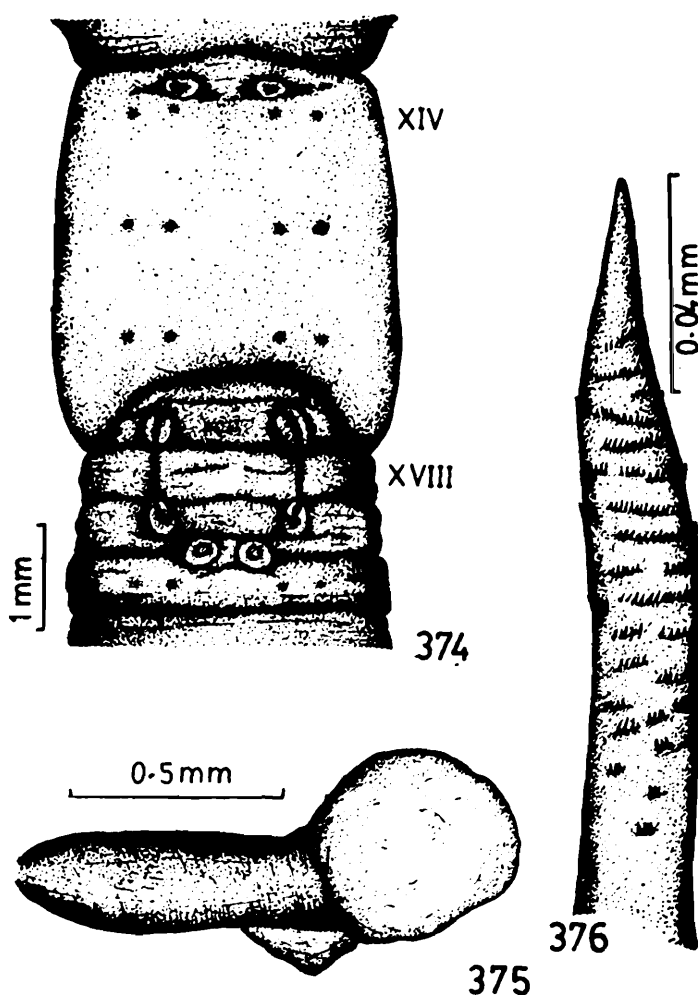
### 96. *Pellogaster bengalensis* (Michaelsen)

(Figs. 374-376)

1910. *Eudichogaster bengalensis* Michaelsen, *Abh. Geb. Naturw., Hamburg*, 19: 96.
1923. *Eudichogaster bengalensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 410.
1939. *Pellogaster bengalensis*, Gates, *Rec. Indian Mus.*, 41: 201.
1939. *Pellogaster bengalensis* f. *orissanus* Gates, *Rec. Indian Mus.*, 41: 205.
1939. *Pellogaster bengalensis* f. *jubbulporensis* Gates, *Rec. Indian Mus.*, 41: 206.
1978. *Pellogaster bengalensis*, Julka, *Mitt. zool. Mus., Berlin*, 54: 194.

Length 40-74 mm, diameter 2-3 mm, 94-140 segments. Prostomium tanylobic. First dorsal pore 10/11 or 11/12. Clitellum  $\frac{1}{2}$ xiii, xiv-xvi, xvii. Setae *aa* = 2.6-3 *ab* = 1-1.2 *bc* = 1.6-2.1 *cd* = 0.26-0.27 *dd* on xii, *aa* = 2.8 *ab* = 1.8 *bc* = 1.8 *cd* = 0.27 *dd* on xxiv, *a* on viii and ix absent, no setae copulatory. Male pores minute, at *ab*; prostatic pores minute, at *ab*; seminal grooves straight. Female pores slightly within *a* lines. Spermathecal pores tiny, transverse or crescentic slits, at or close to the sites of missing setae *a*. Genital markings tiny, circular to oval, paired, close to the spermathecal pores on viii-ix, presetal on xvii, postsetal on xix, at *ab*, sometimes on the setal annuli of x, xx, posterior margin of xix, in or slightly posterior to 19/20, at *aa*.

Intestine begins in xvi, typhlosole xviii to lxxiii. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles in xi and xii, those of xii extending to the dorsal line. Penial



FIGS. 374-376. *Pellogaster bengalensis* (Michaelsen). 374. genital region, 375. spermatheca, 376. penial seta.

setae ornamented with *c.* 15 irregular, broken circles of fine to triangular spines, tip claw-shaped or simply pointed and bluntly rounded, 0.7-1.3 mm long, 16-20  $\mu$  diameter. Each spermatheca with a sessile ental diverticulum, duct as long as or longer than ampulla.

*Type locality* : Tribeni, W Bengal, India.

*Type specimens* : In ZSIC, ZEV 3506/7; ZMUH, 3608.

*Material examined* : 0-0-4 Sambalpur, Nov 1979, coll. B.K. Senapati, An 755, HAZFS, ZSI, Solan.

*Distribution* : India: *West Bengal*: Tribeni, Rajmahal: *Orissa*: Kendupatna and Athgarh nr. Cuttack, Bisoi, Balugaon, Sundargarh, Jharsuguda, Sambalpur, Jajpur, Jagatsinghpur, Bhawanipatna, Bargarh: *Madhya Pradesh*: Jubbulpore, Baraila, Safraha, Gaurighat.

*Biology* : It inhabits soil in cultivated fields, grasslands and on river banks. *Plagiotoma pellogasteri*, a ciliate protozoan has been recorded from its coelomic cavity (Mandal and Nair, 1976).

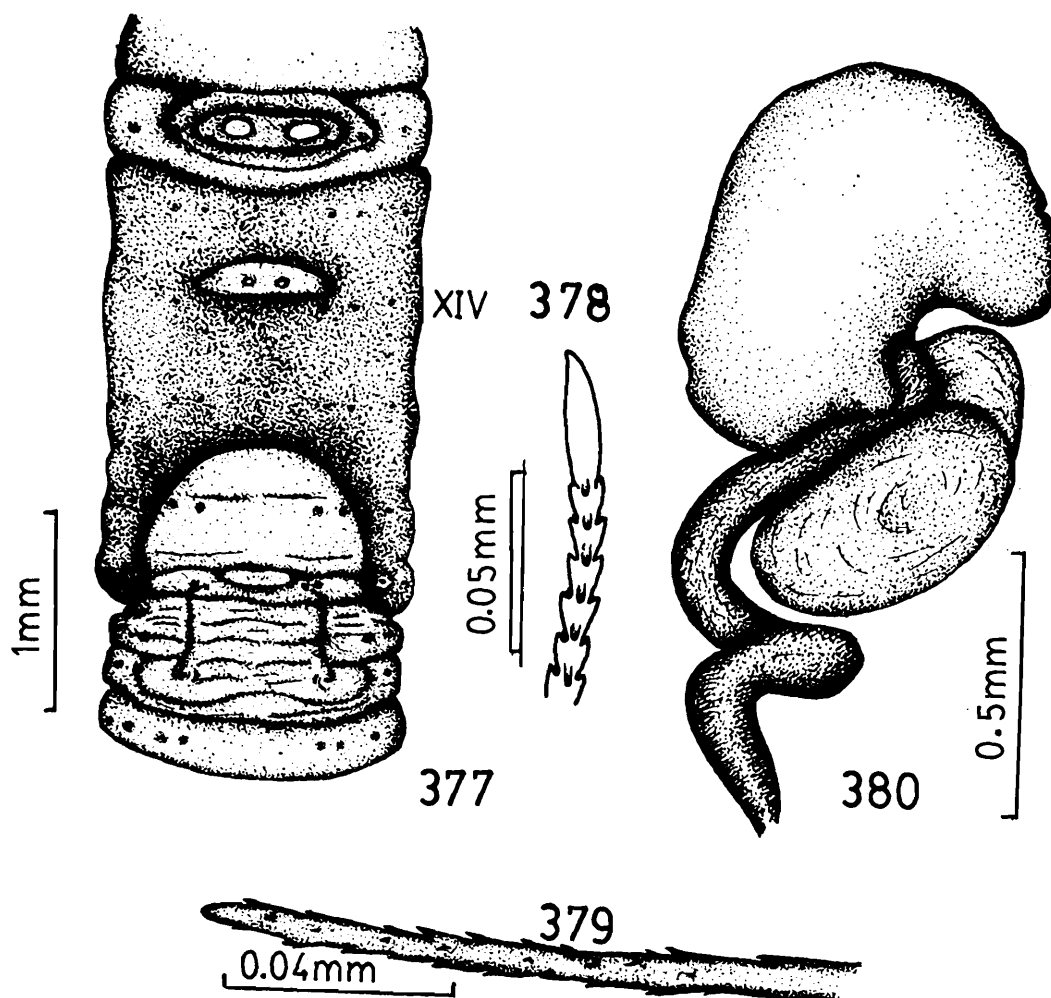
### 97. *Pellogaster isabellae* Gates

(Figs. 377-380)

1945. *Pellogaster isabellae* Gates, *Proc. Indian Acad. Sci.*, (B) 21: 245.

Length 40-70 mm, diameter 2 mm, 141-153 segments. Prostomium pro/epilobic or epilobic, tongue open. First dorsal pore 9/10, sometimes 7/8 or 8/9. Clitellum xiii-xvii. Setae *aa* = 2.8 *ab* = 1.1 *bc* = 2.3 *cd* = 0.27 *dd* on xii, *aa* = 4.3 *ab* = 1.4 *bc* = 3.7 *cd* = 0.26 *dd* on xxiv, *a*, *b* on viii and ix copulatory. Male pores minute, at or slightly lateral to *a*; prostatic pores minute, at or just lateral to *a*; seminal grooves almost straight, at *ab*. Female pores within *a* lines. Spermathecal pores minute, slightly anterior to the setal arcs, at *ab*, those on ix sometimes on the setal arc. Genital markings circular to oval, small; a group of 2-4 presetal markings on xii, at *aa* or *bb*; paired, presetal on xvi, xvii, xx at *aa*, postsetal on xvi at *b* and on xx at *ab*; unpaired, median, presetal on xx and on setal arc of xxi.

Intestine begins in xv, typhlosole xvii-xix to lxxx-lxxxv. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles in xi and xii. Penial setae sparsely ornamented with triangular teeth, tip sharply pointed, 2-2.3 mm long, 6-8  $\mu$  diameter. Each spermatheca with a digitiform to elongately ellipsoidal, ventrally directed ental diverticulum, closely adherent to the lateral face of a slender duct, which is longer than ampulla. Copulatory setae ornamented with closely crowded gouges, tip slightly claw-shaped, 0.31-0.36 mm long, *c.* 10  $\mu$  diameter.



FIGS. 377-380. *Pellogaster isabellae* Gates. 377. genital region, 378. copulatory seta, 379. penial seta, 380. spermatheca (all drawn from a syntype).

*Type locality* : Naini, Allahabad district, Uttar Pradesh, India.

*Type specimens* : In ZSIC, W 3667/1, W 3668/1.

*Material examined* : In ZSIC: 0-1-1, syntypes, W 3667/1; 0-0-2, syntypes, W 3668/1.

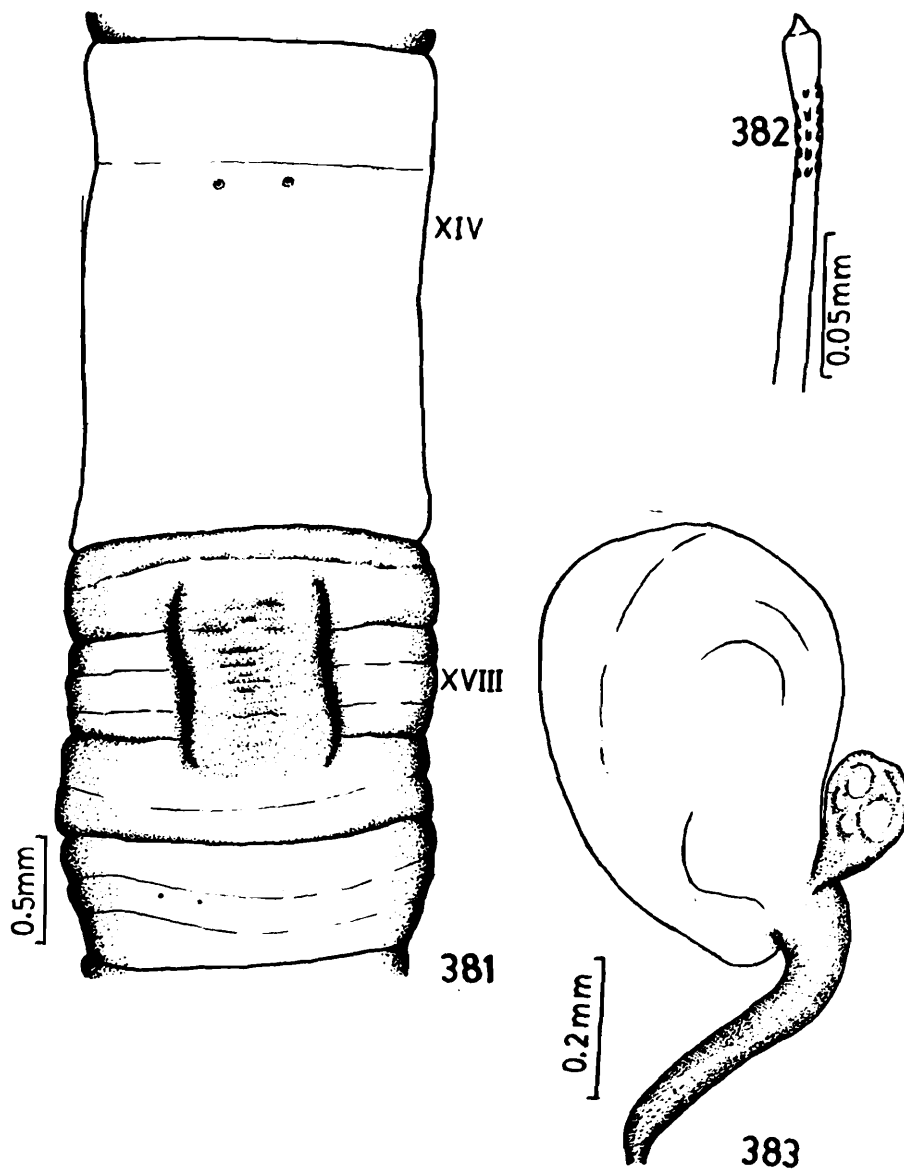
*Distribution* : India: *Uttar Pradesh*: Naini, Allahabad, Fatehpur.

*Biology* : Its activity is restricted to the rainy season from July to October.

98. *Pellogaster simsi* sp. nov.

(Figs. 381-383)

Length 33-42 mm, diameter 1.5-2 mm, 87-102 segments.  
 Prostomium epilobic, tongue closed. First dorsal pore 4/5.



FIGS. 381-383. *Pellogaster simsi* sp. nov. 381. genital region, 382. copulatory seta, 383. spermatheca.

Clitellum xiii-xvi,  $\frac{1}{2}$ xvii. Setae  $aa = 2.4-2.6$   $ab = 0.9-1$   $bc = 1.5-1.8$   $cd = 0.3-0.35$   $dd$  on xii,  $aa = 2.2$   $ab = 0.8$   $bc = 1.7$   $cd = 0.25$   $dd$  on xxiv,  $a$ ,  $b$  on viii and ix sometimes copulatory, being surrounded by indistinct epidermal tumescences. Male pores minute, slightly lateral to  $a$ ; prostatic pores minute, at about  $a$ ; seminal grooves almost straight but slightly bent medially on xviii, between the setal arcs of xvii and xix. Female pores within  $a$  lines. Spermathecal pores minute, presetal on viii and ix, at  $b$ . Genital markings absent.

Intestine begins in xviii, typhlosole xx-xxi to xlvi-li. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles acinous, in xi and xii, extending to the dorsal line. Penial setae absent. Each spermatheca with a shortly stalked, club-shaped ental diverticulum, duct as long as or slightly shorter than the ampulla. Copulatory setae, when present, ornamented with a few longitudinal rows of gouges, tip truncate but with a short tooth or spine at the apex, 0.25-0.28 mm long, 9-11  $\mu$  diameter.

*Type locality* : Panchgani, Maharashtra, India.

*Material examined* : 5-7-10 soil red loam, Panchgani, 17.58 N, 73.43 E, altitude *c.* 1400 m, 26 Aug 1979, coll. J.M. Julka (holotype and 2 paratypes in Zoological Survey of India, Calcutta, An 1833/1, An 1834/1, 19 paratypes in HAZFS, ZSI, Solan, An 754).

*Distribution* : So far known from the type locality.

*Remarks* : *Pellogaster simsi* sp. nov. can be distinguished from other known species of the genus, *P. bengalensis* (Michaelsen) and *P. isabellae* Gates, by the characters noted in Table 10. This species

TABLE 10. Comparison of *Pellogaster simsi* sp. nov. with the known species of *Pellogaster*.

Character	<i>P. simsi</i>	<i>P. bengalensis</i>	<i>P. isabellae</i>
Length (mm)	33-42	40-74	40-70
Diameter (mm)	1.5-2	2-3	2
Segments	87-102	94-140	141-153

Character	<i>P. simsi</i>	<i>P. bengalensis</i>	<i>P. isabellae</i>
Prostomium	epilobic	tanylobic	pro/epilobic to epilobic
First dorsal pore	4/5	10/11 or 11/12	9/10
Copulatory setae	sometimes <i>a, b</i> on viii and ix	absent	<i>a, b</i> on viii and ix
Genital markings	absent	present	present
Intestine begins	xviii	xvi	xv
Typhlosole	xx-xxi to xlvi-li	xviii to lxxiii	xvii -xix to lxxx-lxxxv
Penial setae	absent	present	present

is named after Mr. R.W Sims, British Museum (Natural History), London who has done considerable work on the earthworm taxonomy.

#### Genus 20. **Priodochaeta** Gates, 1940

1894. *Perichaeta* (in part), Bourne, *Q. Jl microsc. Sci.*, **36**: 13.

1900. *Diporochoeta* (in part), Michaelsen, *Tierreich*, **10**: 207.

1923. *Diporochoeta*, Stephenson, *Fauna Br. India, Oligochaeta*: 315.

1940. *Priodochaeta* Gates, *Rec. Indian Mus.*, **42**: 116.

**Diagnosis** : Perichaetine. Combined male and prostatic pores paired, on xviii. Oesophagus with a single gizzard in v and 3 pairs of discrete extramural calciferous glands in xiv-xvi; supra-intestinal glands absent; typhlosole rudimentary. Micromeronephridia astomate; small, exonephric, paired tufts in v-xiii; few, in transverse bands, exonephric, on the body wall in xiv and posteriad segments. Stomate, exonephric, paired megameronephridia in each caudal segment.

**Type species** : *Perichaeta pellucida* Bourne, 1894.

**Description** : As for the only species, *pellucida*.

*Distribution* : Nilgiri Hills, S. India.

*Remarks* : The generic definition is tentative, since the excretory system is not adequately known in the type species.

### 99. *Priodochaeta pellucida* (Bourne)

1894. *Perichaeta pellucida* Bourne, *Q. Jl microsc. Sci.*, 36: 13.

1900. *Diporochoeta pellucida*, Michaelsen, *Tierreich*, 10: 207.

1923. *Diporochoeta pellucida*, Stephenson, *Fauna Br. India, Oligochaeta*: 317.

1940. *Priodochaeta pellucida*, Gates, *Rec. Indian Mus.*, 42: 116.

Length 180-450 mm, diameter 4-4.5 mm, 268 segments. Prostomium prolobic or proepilobic, usually retracted. First dorsal pore 9/10, sometimes 8/9. Clitellum 2/3-1/3 xii to xix, xx, annular xiii-xvii. Setae perichaetine, *aa* = 4-6 *ab*, *zz* = 2 *aa* on anterior segments, 31-40 on iii, 32-39 on viii, 36-40 on xii, 29-36 on xx. Combined male and prostatic pores paired, minute, transverse slits, at or close to the centres of slightly depressed oval porophores, on xviii, at *be*. Female pores paired, presetal, at *a* or *ab*, on xiv. Spermathecal pores paired, small, transverse slits on the anterior margins of viii and ix, just posterior to 7/8/9, at *bd* or *be*. Genital markings absent. Nephridiopores not recognized.

Septa present from 4/5, 5/6-11/12 muscular. Gizzard large, in v. Calciferous glands discrete, extramural, 3 pairs, in xiv-xvi, opening directly into oesophagus through vertical slit-like apertures. Intestine begins in xix; caeca and supra-intestinal glands absent; typhlosole in the form of a low ridge, xxii-xxv to ci. Dorsal vessel single and complete; supra-oesophageal vessel single, in vii-xiv; extra-oesophageal vessels paired, passing posteriorly into a well-developed vascular plexus on the ventral surface of gut, in ix-xii; latero-parietal vessels paired, joining the plexus in xii; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric, testes and male funnels free, in x and xi; seminal vesicles acinous, in xi and xii. Vasa deferentia on each side unite in xiii and

join the ectal end of prostatic duct, in xviii. Prostates paired, in xviii. Penial setae absent. Spermathecae paired, in viii and ix, each with a median digitiform to club-shaped diverticulum, duct shorter than ampulla. Micromeronephridia astomate, small, exonephric (?), paired tufts (?) in v-xiii, few, arranged in transverse bands, exonephric in xiv and posteriad segments; stomate; exonephric (?), paired megameronephridia in each of caudal segments.

*Type locality* : Coonoor, Nilgiri Hills, S. India (designated by Gates, 1940a).

*Distribution* : India: *Tamil Nadu*: Coonoor, Ootacamund in Nilgiri Hills.

### Genus 21. *Priodoscolex* Gates, 1940

1940. *Priodoscolex* Gates, *Rec. Indian Mus.*, 42: 122.

*Diagnosis* : Perichaetine. Combined male and prostatic pores paired, on xviii. Oesophagus with a single gizzard in v and 4 pairs of discrete extramural calciferous glands in xiv-xvii, those in xv-xvii bilobed; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate; exonephric paired tufts in iii, vi-xiii, larger enteronephric paired tufts in iv and v; several exonephric on the body wall in xiv and posteriad segments, stomate with preseptal funnels posterior to the typhlosolar region. Megameronephridia absent.

*Type locality* : *Priodoscolex montanus* Gates, 1940.

*Description* : As for the only species, *montanus*.

*Distribution* : Nandydroog (Nandi Hills), Karnataka, India.

*Remarks* : Gates (1940a) defined *Priodoscolex* in having 6 pairs of calciferous glands: 2 pairs in each of the segments xv-xvii. A careful study of recently collected specimens of the type species from its type locality shows that it possesses 4 pairs of calciferous glands: one pair of rudimentary glands in xiv and 3 pairs of bilobed glands in xv-xvii, two lobes of each gland open into oesophagus

through a common duct. Possibly, Gates (1940a) considered the bilobed condition in each pair of glands in xv-xvii as 2 distinct pairs, and he failed to recognize the rudimentary glands in xiv.

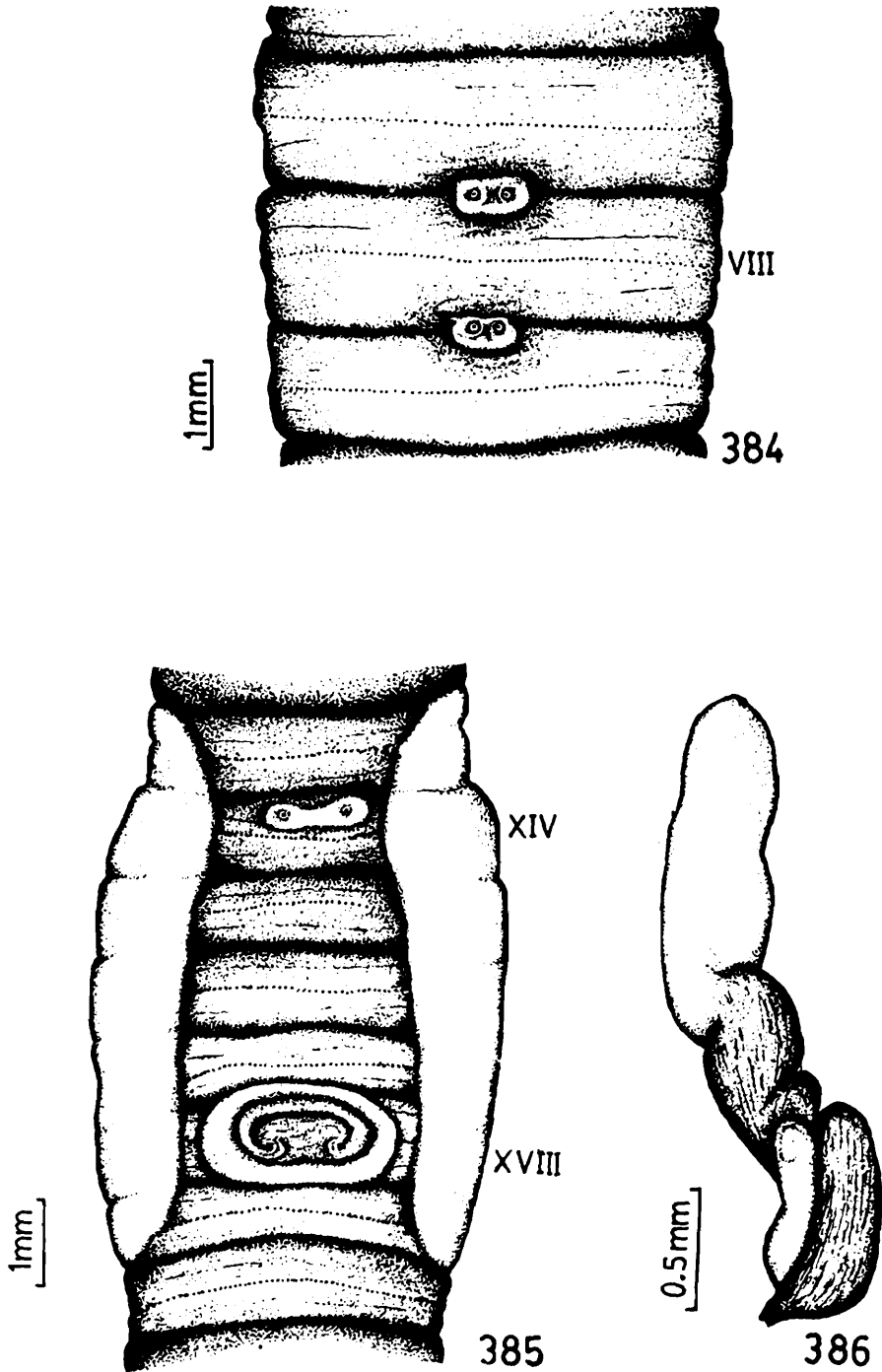
### 100. *Priodoscolex montanus* Gates

(Figs. 384-386)

1940. *Priodoscolex montanus* Gates, *Kec. Indian Mus.*, 42: 123.

Length 230-313 mm, diameter 3-4 mm, 306-384 segments. Prostomium retracted, intersegmental furrow 1/2 absent (segments i and ii united with each other). First dorsal pore 10/11, sometimes 11/12. Clitellum saddle-shaped, xiii, ½xiii-xix. Setae perichaetine,  $aa = 1.1-2$   $ab = 2$   $bc = 0.7-0.8$   $yz = 0.2-0.3$   $zz$  on xii,  $aa = 1.7-2$   $ab = 2-2.5$   $bc = 0.5-0.7$   $yz = 0.2-0.3$   $zz$  on xxiv, 40-52 on iii, 64-75 on vii, 80-93 on xii, 79-86 on xxi. Combined male and prostatic pores paired, transverse slits, 0.04 body circumference apart, at the ends of a median C-shaped groove with concave side posterior, on an oval, transverse genital shield on xviii. Female pores paired, presetal, on xiv. Spermathecal pores paired, minute, located on unpaired tumescences on viii and ix (slightly posterior to 7/8 and 8/9), 0.02 body circumference apart. Genital markings absent. Nephridiopores not recognized.

Septa 4/5 delicate, 5/6/7/8 slightly muscular, 9/10/11/12 muscular. Oesophagus with a large gizzard in v; 4 pairs of discrete extramural reniform calciferous glands, in xiv-xvii, those in xiv rudimentary, those in xv-xvii bilobed, two lobes of each gland open into oesophagus through a short lateral stalk. Intestine begins in xix; caeca and supra-intestinal glands absent; typhlosole lamelliform, simple, xxvii-xxxi to cxcviii-ccxix. Dorsal vessel single and complete; supra-oesophageal vessel single in viii-xi, paired in xii-xiii; extra-oesophageal vessels paired, iv-xiii, each bifurcating in viii, one branch to the supra-oesophageal and the other runs posteriorly to meet the latero-parietal vessel on the ventral surface of oesophagus in xiii; latero-parietal vessels paired, each bifurcates in



FIGS. 384-386. *Priodoscolex montanus* Gates. 384. spermathecal pore region, 385. genital region, 386. spermatheca.

xiii, one branch joins the supra-oesophageal vessel and the other meets the extra-oesophageal vessel; subneural vessel present from posterior end, turning laterally in xvi-xix to meet the latero-parietal vessel in xiii-xvi; lateral hearts originating from the supra-oesophageal vessel with delicate connectives, in x-xii. Holandric, testes and male funnels free, in x and xi; seminal vesicles acinous, in xi and xii. Prostates paired, in xviii; vas deferens joins the prostatic duct ectally in xviii. Penial setae absent. Spermathecae paired, in viii and ix, each with a short, median, digitiform, ectal diverticulum, duct longer than ampulla. Micromeronephridia astomate; exonephric paired tufts in iii, vi-xiii, larger paired enteronephric tufts in iv and v; several exonephric, arranged in transverse bands in xiv and posteriad segments, stomate with preseptal funnels posterior to the typhlosolar region; megameronephridia absent.

*Type locality* : Nandydroog (Nandi Hills), Karnataka, S. India.

*Type specimens* : Typus amissus.

*Material examined* : 0-6-4 at c. 30 cm depth of red loam soil in a dense forest, Nandi Hills, c. 65 km from Bangalore, altitude 1250 m, 23 Sept 1979, coll. J.M. Julka, An 749, in HAZFS, ZSI, Solan.

*Distribution* : So far known from the type locality.

## Genus 22. **Ramiella** Stephenson, 1921

1914. *Octochaetus* (in part), Stephenson, *Rec. Indian Mus.*, 10: 347.  
 1921. *Ramiella* Stephenson, *Proc. zool. Soc. Lond.*, 1921: 109.  
 1922. *Ramella* (lapsus pro *Ramiella*), Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 37.  
 1923. *Ramiella*, Stephenson, *Fauna Br. India, Oligochaeta*: 397.  
 1957. *Ramiella*, (in part), Gates, *Breviora*, no. 75: 6 (excluding American species).  
 1972. *Ramiella*, Gates, *Trans. Am. phil. Soc.*, 62: 311.

*Diagnosis* : Lumbricine. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on

xvii and xix. Oesophagus with a single gizzard in v or vi and calciferous lamellae in viii-xi; discrete calciferous glands and supra-intestinal glands absent; typhlosole in the form of a low ridge to a simple lamella. Micromeronephridia astomate, exonephric, few, on the body wall in iii and posteriad segments. Paired, stomate, exonephric megameronephridia in each of few posteriormost segments.

*Type species* : *Octochaetus bishambari* Stephenson, 1914.

*Description* : Setae lumbricine throughout the body. Male pores paired, in seminal grooves, in xviii; prostatic pores paired at the ends of seminal grooves on xvii and xix. Female pore (s) single and median or paired, presetal, on xiv. Spermathecal pores 2 pairs, in 7/8/9 or on viii and ix. Genital markings usually present. Nephridiopores not recognized.

Septa present from 4/5. Gizzard single in v or vi. Oesophagus tubular with calciferous lamellae in viii-xi; discrete calciferous glands absent. Intestine begins in or anterior to xvi; supra-intestinal glands and intestinal caeca absent; typhlosole simple, in the form of a low ridge to lamelliform. Dorsal vessel single and complete; supra-oesophageal vessel single, viii, ix-xii; extra-oesophageal vessels paired, joining the latero-parietal vessels in xii-xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives, to the dorsal vessel in x-xii. Holandric. Prostates 2 pairs, in xvii and xix, extending posteriorly to a few segments. Spermathecae paired, in viii and ix. Ovisacs paired, in xiv. Micromeronephridia astomate, exonephric, few, discoidal, on the body wall in iii and posteriad segments, arranged in 2-7 longitudinal rows on each side in postclitellate segments; paired, stomate, exonephric, megameronephridia in caudal segments, funnels close to the nerve cord.

*Distribution* : Indo-Gangetic Plain, Peninsula and Coorg, India. Extended to Burma, Christmas Island, Philippines and China probably as a result of transportation of the type species.

Key to the species of *Ramiella*

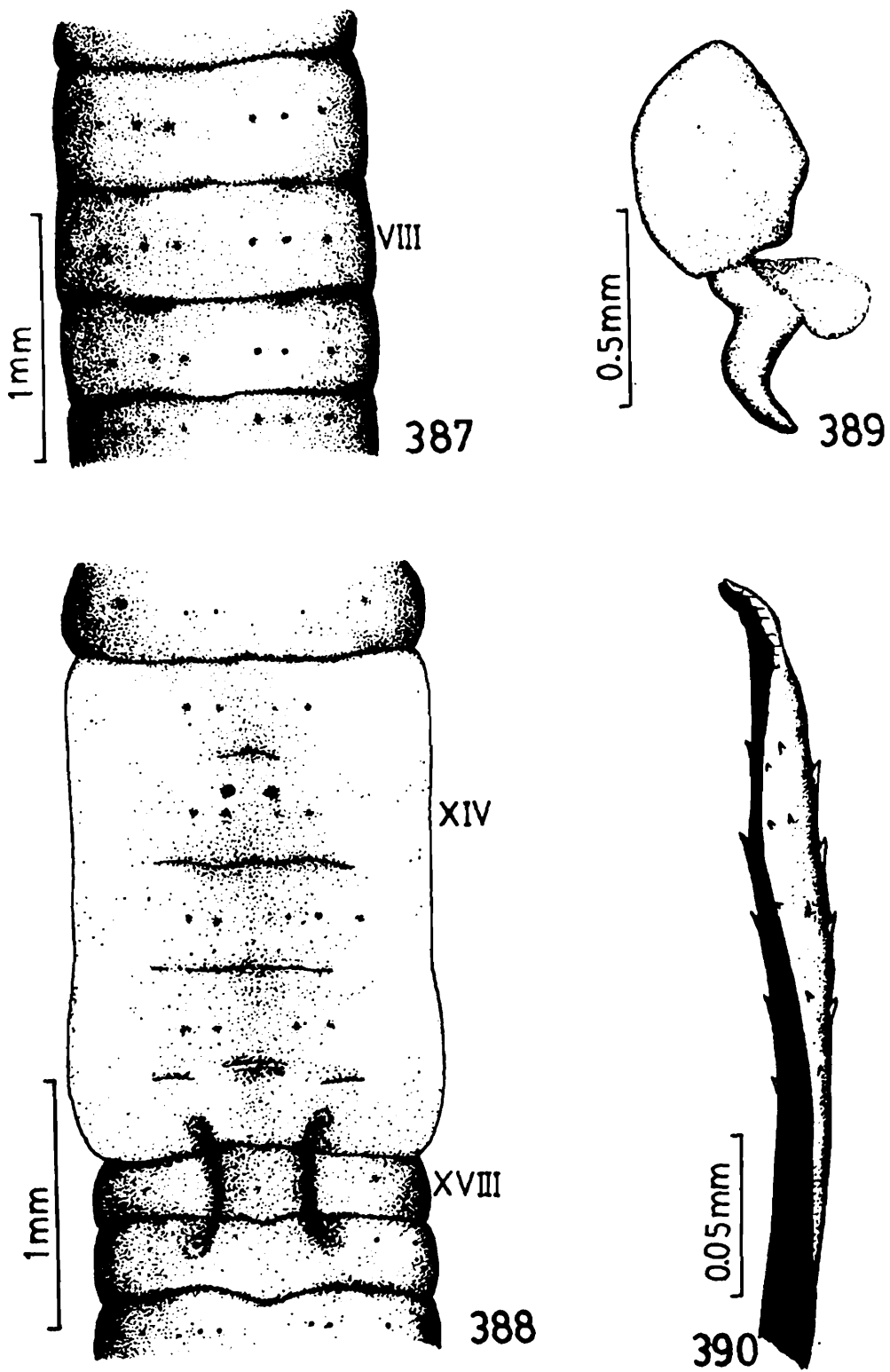
1. All spermathecal pores intersegmental, at c; gizzard in v ..... *R. heterochaeta*  
     All spermathecal pores not intersegmental, at or median to b; gizzard in vi ..... 2
2. Intestine begins in xiv, typhlosole absent or rudimentary ..... *R. bishambari*  
     Intestine begins posterior to xiv, typhlosole well-developed and lamelliform ..... 3
3. Intestine begins in xv; clitellum annular; female pore single and median ..... 4  
     Intestine begins in xvi, clitellum saddleshaped; female pores paired ..... *R. pallida*
4. Spermathecal pores on viii and ix ..... *R. nainiana*  
     Spermathecal pores in 7/6 and on ix ..... *R. sundargarhensis*

*Remarks* : The above key excludes *Ramiella parva* Stephenson, 1924. An examination of its 2 syntypes in the Zoological Survey of India, Calcutta (W 1134/1) shows that it belongs to the family Ocnerodrilidae with the following characteristics: intestine begins in xii, last pair of hearts in xi, spermathecae adiverticulate and holonephric excretory system.

101. *Ramiella bishambari* (Stephenson)

(Figs. 387-390)

1914. *Octochaetus bishambari* Stephenson, *Rec. Indian Mus.*, 10: 347.  
 1920. *Octochaetus pachpaharensis* Stephenson, *Mem. Indian Mus.*, 7: 239.  
 1921. *Ramiella bishambari*, Stephenson, *Proc. zool. Soc. Lond.*, 1921: 109.  
 1921. *Ramiella pachpaharensis*, Stephenson, *Proc. zool. Soc. Lond.*, 1921: 109.  
 1923. *Ramiella bishambari*, Stephenson, *Fauna Br. India, Oligochaeta*: 398.  
 1923. *Ramiella pachpaharensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 400.



FIGS. 387-390. *Ramiella bishambari* (Stephenson). 387. spermathecal pore - region, 388. genital region, 389. spermatheca, 390. penial seta.

1931. *Ramiella cultrifera* Stephenson, *Rec. Indian Mus.*, 33: 187.  
 1935. ? *Howascolex sinicus* Chen, *Contr. biol. Lab. Sci. Soc. China (zool.)*, 11: 113.  
 1955. *Ramiella bishambari*, Gates, *Rec. Indian Mus.*, 52: 75.  
 1972. *Ramiella bishambari*, Gates, *Trans. Am. phil. Soc.*, 62: 312.

Length 20-38 mm, diameter 0.8-1.2 mm, 78-91 segments. Prostomium epilobic, tongue open. First dorsal pore in region of 6/7-10/11. Clitellum annular, weakly developed ventrally at *aa*, *xiii*,  $\frac{1}{2}$ *xiii*- $\frac{1}{2}$ *xvii*, *xvii*. Setae *aa* = 3-3.1 *ab* = 1.3-1.6 *bc* = 1.8-2.2 *cd* = 0.22-0.25 *dd* on *xii*, *aa* = 3.1-3.3 *ab* = 1.4-1.6 *bc* = 2.2-2.5 *cd* = 0.26 *dd* on *xxiv*. Male pores at or slightly lateral to *a*; prostatic pores minute, at *b*; seminal grooves convex between setal arcs of *xvii* and *xix*. Female pores paired, presetal, within *a* lines. Spermathecal pores small, on *viii* and *ix*, slightly posterior to intersegmental furrows 7/8 and 8/9, at *b*. Genital markings, when present, small, circular to oval; paired, presetal on *vii*-*ix*, *xvii*, *xx*, postsetal on *vii*, *viii*, *x*, *xi*, at or close to *ab*; unpaired and median, postsetal on *xix* or 19/20.

Septa 4/5 slightly muscular, 5/6-12/13 muscular. Gizzard in *vi*. Intestine begins in *xiv*, typhlosole in the form of a low ridge, *xvii*-*xviii* to *c*. 15-20 posteriad segments. Testes and male funnels free, in *x* and *xi*; seminal vesicles in *xii*, or sometimes in *xi* and *xii*. Penial setae ribbon-like, rolled so as to appear solid, ornamented with 7-15 transverse rows of triangular teeth, 0.5-0.95 mm long, 20-36  $\mu$  diameter. Each spermatheca with a sessile, spherical to oval ental diverticulum. Genital marking glands absent.

*Type locality* : Saharanpur, Uttar Pradesh, India.

*Type specimens* : *O. bishambari*: In BMNH, 1933: 5: 25: 918-9. *O. pachpaharensis*: In ZSIC, W 258/1; BMNH: 1933: 5: 25: 909-13. *R. cultrifera*: In BMNH, 1930; 12: 27: 66. *H. sinicus*: In BLSS, 1015.

*Material examined* : In HAZFS, ZSI, Solan - Himachal Pradesh: coll. M. Chandra: 0-0-1 c. 4 km N. of Pulbahal, 19 July

1971, An 574; coll. H.P. Agarwal: 0-0-2 Kunihar, 8 Aug 1971, An 573; coll. J.M. Julka: 0-2-19 Nurpur, 8, 9 Aug 1978, An 571, An 572, 0-5-8 Jasoor, 10 Aug, 1978, An 578. *Maharashtra*: coll. J.M. Julka: 0-2-10 Poona, 23 Aug 1979, An 576-577. *Andhra Pradesh*: coll. J.M. Julka: 1-4-0 Hyderabad, 27 Sept 1979, An 575.

*Distribution* : India: *Andaman & Nicobar Islands*: Aberdeen, Port Blair; *Orissa*: Balugaon, Sundargarh, Titlagarh, Ushakothi; *Uttar Pradesh*: Saharanpur, Allahabad, Naini, Partabgarh, Madhosingh Junction, Tanda Falls, Mirzapur, Manikpur Junction, Fatehpur, Ahraura, Moghul Serai, Varanasi, Chunar, Zafarabad, Jaunpur, Janghai, Jhusi, Bhita, Ghoorpur, Sultanpur, Fyzabad, Rae Bareli, Lucknow, Bara Banki, Sohagi, Robertsganj; *Himachal Pradesh*: Pulbhal, Kunihar, Nurpur, Jasoor; *Rajasthan*: Pachpahar; *Madhya Pradesh*: Rewa, Nowgong, Ghaubara, Murbasha Hills, Jubbulpore, Baraila, Gaurighat; *Maharashtra*: Poona; *Andhra Pradesh*: Hyderabad.

Outside India: Pakistan, Burma, Christmas Island, Philippine Islands, ? China.

*Biology* : It is usually found in mineral soil with high organic matter ( $> 10\%$ ) and pH ranging from 6 to 8, mostly in grasslands, forests, lawns, municipal dumps, drainage ditches, among roots of mosses and ferns growing on rocks, and under stones on the banks of ponds and streams. Activity, including breeding, is possible round the year under favourable conditions. Quiescence is imposed during the summer months. Reproduction is biparental. The lost head and tail parts can be regenerated (Gates, 1972).

### 102. *Ramiella heterochaeta* Michaelsen

1922. *Ramella heterochaeta* Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 51.

1923. *Ramiella heterochaeta*, Stephenson, *Fauna Br. India, Oligochaeta*: 399.

Length about 80 mm, diameter 0.75-1.5 mm, *c.* 160 segments. Prostomium prolobic to slightly pro/epilobic. First dorsal pore (?). Clitellum saddle-shaped,  $\frac{1}{2}$ xiii-xvi. Setae  $aa = 4$   $ab = 0.7$   $bc = 2$   $cd =$

0.7 *dd* at about middle of the body. Male pores minute, at about *b*; prostatic pores minute, at *b*; seminal grooves almost straight, between setal arcs of xvii and xix. Female pores paired, presetal, within *a* lines. Spermathecal pores in 7/8/9, at *c*. Genital markings oval, paired in 11/12, slightly lateral to *b*.

Septa 6/7 slightly muscular, 7/8-11/12 muscular. Gizzard in v. Intestine begins in (?), typhlosole present. Testes and male funnels free, in x and xi, seminal vesicles in ix and xii. Penial setae ornamented with a number of small triangular teeth, tip expanded, slightly excavated, 0.6 mm long, 10  $\mu$  diameter. Each spermatheca with a small pear-shaped distal diverticulum, duct scarcely shorter than ampulla. Copulatory setae in the spermathecal region perhaps present (?). Genital marking glands (?).

*Type locality* : Somavarpatna, Coorg, Karnataka, India.

*Type specimens* : In ZMUH, 9154.

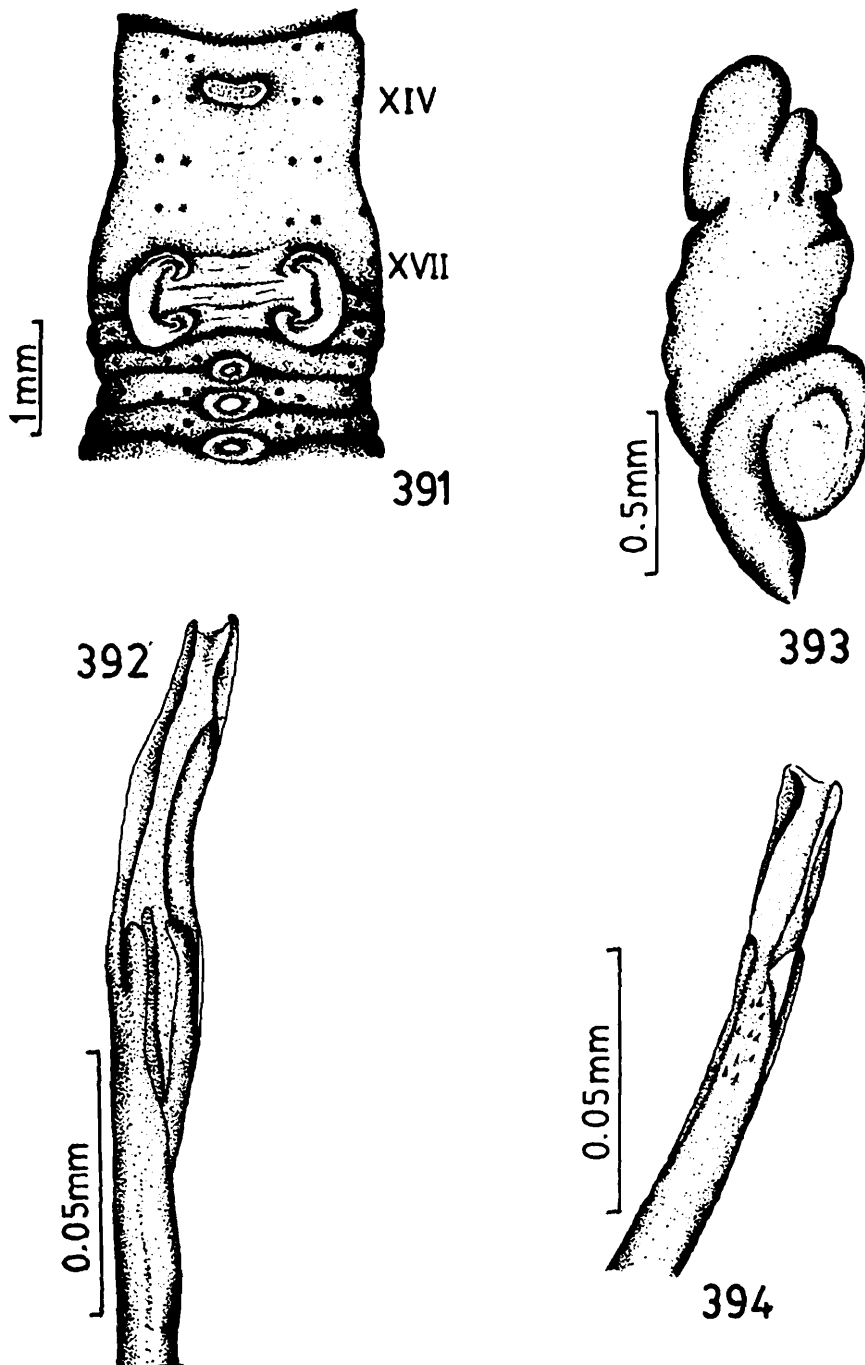
*Distribution* : So far known from the type locality.

### 103. *Ramiella nainiana* Gates

(Figs. 391-394)

1945. *Ramiella nainiana* Gates, *Proc. Indian Acad. Sci.*, (B) 21: 232.

Length 30-65 mm, diameter 1.5-3.5 mm, 144-162 segments. Prostomium epilobic, tongue closed. First dorsal pore 4/5, sometimes 3/4 or in region of 5/6-8/9. Clitellum annular, xiii, 2/3 xiii-xvii. Setae *aa* = 2.8-3 *ab* = 1.3-1.5 *bc* = 2.3-2.8 *cd* = 0.29 *dd* on xii, *aa* = 3.2-3.7 *ab* = 1.3 *bc* = 2.2-2.6 *cd* = 0.3 *dd* on xxiv. Male pores minute, at or slightly lateral to *b*; prostatic pores minute, at *b*; seminal grooves concave between the setal arcs of xvii and xix, at *ab*. Female pore single, median. Spermathecal pores minute, presetal, on viii and ix, at or close to *b*. Genital markings oval, unpaired, median, presetal with 1-4 central areas on xi-xii, sometimes on x, xiii, intersegmental with a single central area, on 20/21/22/23, sometimes on 16/17-19/20, 23/24-31/32.



FIGS. 391-394. *Ramiella nainiana* Gates. 391. genital region, 392, 394. penial setae, 393. spermatheca (all drawn from a syntype).

Septa 4/5-11/12 muscular. Gizzard in vi. Intestine begins in xv; typhlosole simple, lamelliform, xvii-xix to lxxxvii-xciv. Testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with a few scattered or more regularly spaced triangular teeth, membranous ectally with margins slightly curved and spade-shaped, tip concave, 1-1.8 mm long, 9-11  $\mu$  diameter. Each spermatheca with a ventrally directed digitiform ental diverticulum, adherent to the duct. Genital marking glands absent.

*Type locality* : Allahabad, Uttar Pradesh, India.

*Type specimens* : In ZSIC, W 3639/1.

*Material examined* : 0-4-52, syntypes, W 3639/1, in ZSIC.

*Distribution* : India: *Uttar Pradesh*: Naini, Rajpur, Allahabad, Fatehpur, Lakhaoti, Chakia, Ahraura, Zafarabad, Jaunpur, Bhita, Tanda Falls, Robertsganj, Sultanpur, Lucknow; *Madhya Pradesh*: Satna, Rewa, Baraila, Gaurighat.

*Biology* : It inhabits soil with high organic matter. Activity, including breeding, is from July to November. Bioluminescence has been observed in this species (Gates, 1944).

#### 104. *Ramiella pallida* (Stephenson)

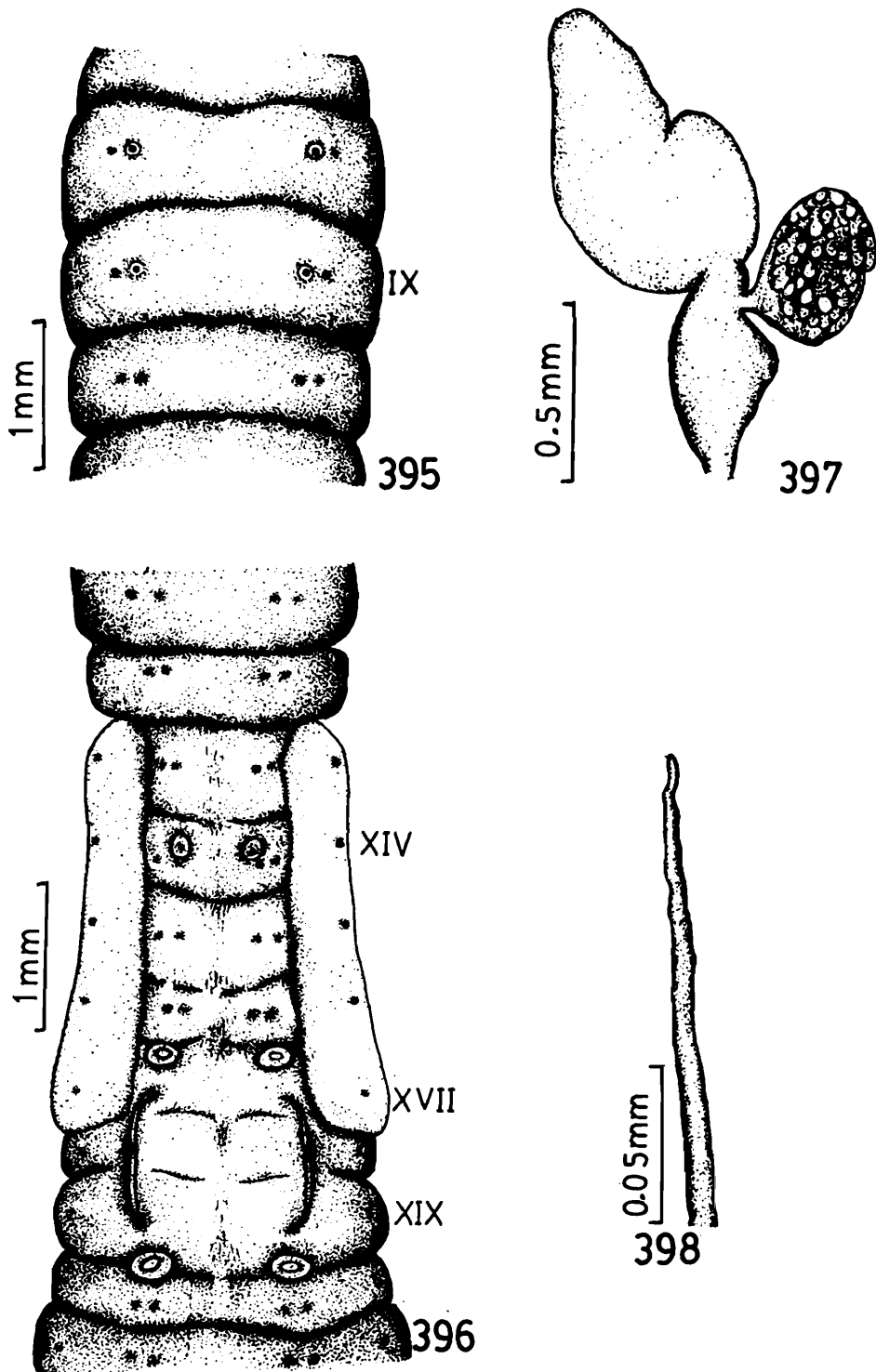
(Figs. 395-398)

1920. *Octochaetus pallidus* Stephenson, *Mem. Indian Mus.*, 7: 236.

1921. *Ramiella pallida*, Stephenson, *Proc. zool. Soc. Lond.*, 1921: 109.

1923. *Ramiella pallida*, Stephenson, *Fauna Br. India, Oligochaeta*: 401.

Length 40-66 mm, diameter 1.5-3 mm, 138-166 segments. Prostomium epilobic, tongue closed. First dorsal pore 10/11, sometimes 9/10 or 11/12. Clitellum saddle-shaped, xiii-xvii. Setae  $aa = 2.5$   $ab = bc = 1.2-1.4$   $cd = 0.15-0.17$   $dd$  on xii,  $aa = 2.8-3$   $ab = 1.1-1.2$   $bc = 1.5-1.8$   $cd = 0.18-0.21$   $dd$  on xxiv. Male pores minute, at *b*; prostatic pores minute, at or slightly median to *b*; seminal grooves slightly concave between setal arcs of xvii and xix. Female



FIGS. 395-398. *Ramiella pallida* (Stephenson). 395. spermathecal pore region, 396. genital region, 397. spermatheca, 398. penial seta.

pores paired, slightly within *a* lines. Spermathecal pores on the setal arcs of viii and ix, at the sites of setae *a*. Genital markings, when present, oval, paired, just median to spermathecal pores on ix, presetal on xx, at *aa*, on 16/17, 19/20 at *ab*, slightly lateral to seminal grooves on 17/18/19 at *bc*.

Septa 4/5 delicate, 5/6/7 slightly muscular, 7/8-11/12 muscular. Gizzard in vi. Intestine begins in xvi; typhlosole simple, lamelliform, xx-xxi to xcvi-ci. Testes and male funnels free, in x and xi; seminal vesicles in ix and xii; vasa deferentia of x and xi coiled into compact spheroidal masses of hair-pin loops in xi and xii respectively. Penial setae unornamented, ectal end slightly sinuous, tip bluntly rounded, 0.79-0.93 mm long, 7-11  $\mu$  diameter. Each spermatheca with a shortly stalked spheroidal ental diverticulum, duct shorter than ampulla. Genital marking glands absent.

*Type locality* : Panchgani, Maharashtra, India.

*Type specimens* : In ZSIC, W 260/1; BMNH, 1933: 5: 25: 906-8.

*Material examined* : 0-1-59 Panchgani, Maharashtra, 26 Aug 1979, coll. J.M. Julka, An 579, An 580, in HAZFS, ZSI, Solan.

*Distribution* : So far known from the type locality.

*Biology* : It is usually found in laterite and sandy loam soil at 15-30 cm depth in a grassland and on a hill slope. When disturbed, it slightly jumps with lashing movements of its anterior and posterior ends.

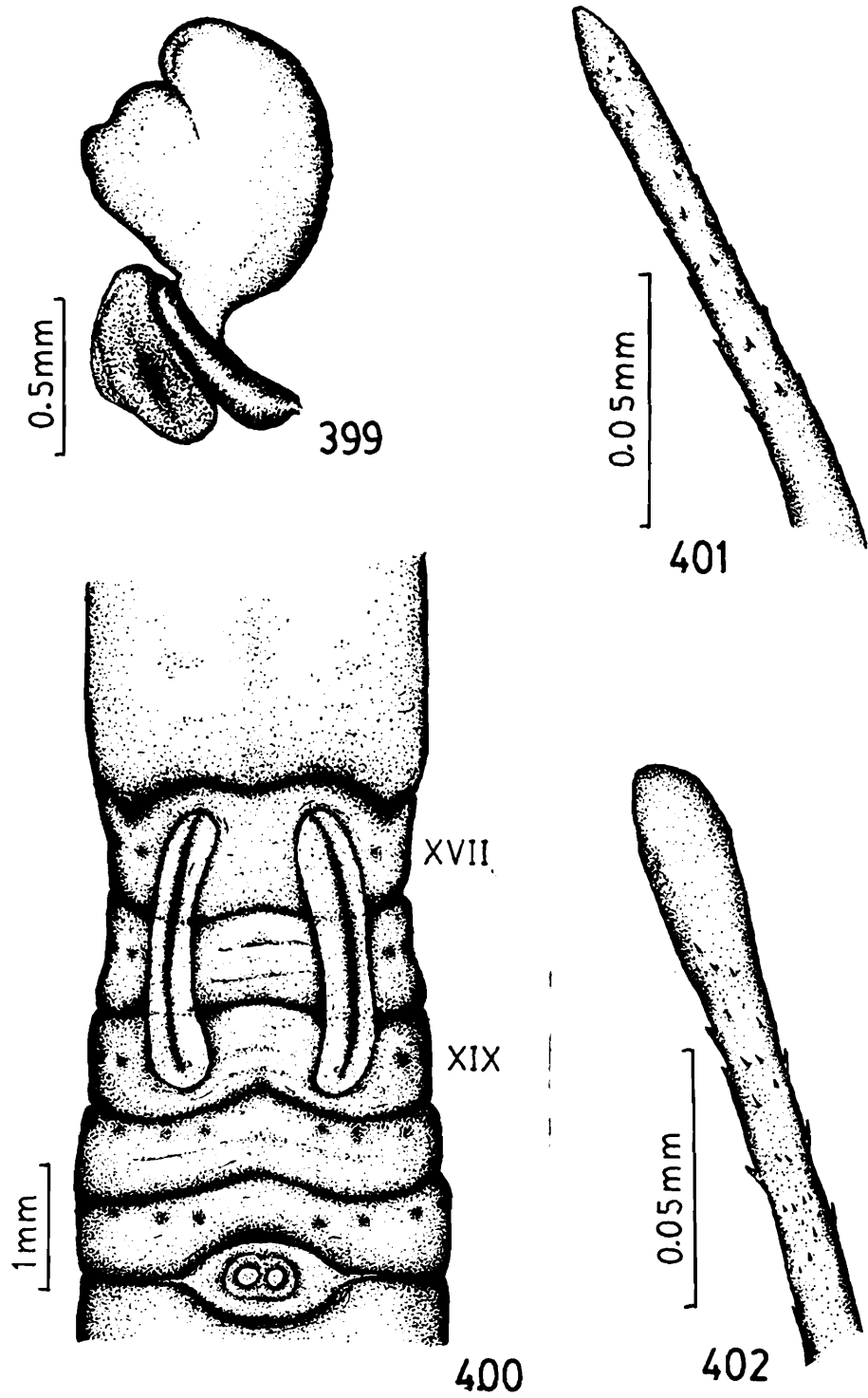
*Remarks* : Stephenson (1920, 1923) wrongly described the spheroidal masses of vasa deferentia in xi and xii as the compact bodies of nephridial tubules.

### 105. *Ramiella sundargarhensis* Julka

(Figs. 399-402)

1978. *Ramiella sundargarhensis* Julka, *Mitt. zool. Mus. Berlin*, 54: 190.

Length 52-77 mm, diameter 3 mm, 115-167 segments. Prostomium epilobitic, tongue closed. First dorsal pore 9/10, sometimes



FIGS. 399-402. *Ramiella sundargarhensis* Julka. 399. spermatheca, 400. genital region, 401. lateral view of penial seta, 402. dorsal view of penial seta (all drawn from the holotype).

10/11. Clitellum annular, 1/3 xiii, xiv-xvi, 1/3 xvii. Setae  $aa = 3.3-3.6$   $ab = 1.2-1.3$   $bc = 2.5-3.3$   $cd = 0.24$   $dd$  on xii,  $aa = 3.8-4.2$   $ab = 1.4$   $bc = 3.4$   $cd = 0.25$   $dd$  on xxiv. Male pores minute, close to  $b$ ; prostatic pores minute, slightly lateral to  $a$ ; seminal grooves almost straight or slightly concave between the setal arcs of xvii and xix, at  $ab$ . Female pore single, median. Spermathecal pores minute, in 7/8 and presetal on ix, at or close to  $b$  lines. Genital markings circular to oval; paired, postsetal on viii at  $aa$ , pre- or postsetal on ix, presetal on x-xii, at  $bc$ , on 19/20-23/24 at  $aa$ ; sometimes unpaired and median, postsetal on xi, pre- or postsetal on xii.

Septa 4/5/6, 8/9-11/12 muscular, 6/7/8 slightly muscular. Gizzard in vi. Intestine begins in xv; typhlosole simple, lamelliform, xviii to c-cii. Testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Penial setae ornamented with a few scattered triangular teeth, tip expanded, truncate or slightly rounded, 1.09-1.5 mm long, 10-17  $\mu$  diameter. Each spermatheca with a digitiform ventrally directed ental diverticulum, adherent to the duct. Genital marking glands absent.

*Type locality* : Sundargarh, Orissa, India.

*Type specimens* : In ZSIC, An 307-308/1.

*Material examined* : 0-0-1, holotype, An 307/1, 0-0-9, paratypes, An 308/1, in ZSIC.

*Distribution* : India: *Orissa*: Sundargarh, Bolangir, Burla, Godbhaga, Jyoti Vihar, Ushakothi.

*Biology* : It inhabits sandy loam mineral soil with  $> 5$  g% of organic matter and 6-7 pH in forests and grasslands. A maximum population of about 75/m<sup>2</sup> was observed at Ushakothi forest. Reproduction is biparental. Copulation and feeding occur beneath the soil surface. Cocoons are round and their colour gradually changes from pale lemon yellow to dark reddish brown; average live weight 40 mg. Peak cocoon production occurs during late August. Clitellar degradation and fungal infection of adults at post-reproductive period have been observed. This species under-

goes diapause during the summer stress. In laboratory cultures, it deposited globular casts on the surface, but no casts were observed in the field.

### Genus 23. *Rillogaster* Gates, 1939

1924. *Eudichogaster* (in part), Stephenson, *Rec. Indian Mus.*, 26: 345.

1939. *Rillogaster* Gates, *Rec. Indian Mus.*, 41: 207.

*Diagnosis* : Lumbricine. Combined male and prostatic pores paired, on xix; seminal grooves absent. Oesophagus with 2 gizzards, in vi-vii and 4 pairs of discrete extramural calciferous glands in x-xiii; supra-intestinal glands absent; typhlosole in the form of a low ridge. Micromeronephridia astomate; paired, exonephric large tufts in iv, smaller tufts in v-vii; few, exonephric on the body wall in viii and posteriad segments. Paired, stomate, exonephric megameronephridia in c. lxx and each of posteriad segments.

*Type species* : *Eudichogaster matheranensis* Stephenson, 1924.

*Description* : Setae lumbricine throughout the body. Clitellum annular. Combined male and prostatic pores paired, discharging on xix. Female pore single, median, presetal, on xiv. Spermathecal pores paired, in 7/8. Genital markings present. Nephridiopores not recognized.

Septa 4/5 thickly muscular, 5/6/7/8 delicate, 8/9-12/13 muscular. Oesophagus with 2 large gizzards in vi-vii. Discrete calciferous glands 4 pairs in x-xiii, reniform, opening through long stalks directly into oesophagus laterally. Intestine begins in xv, supra-intestinal glands and caeca absent, typhlosole in the form of a low ridge. Dorsal vessel single and complete; extra-oesophageal vessels paired, connected with each other by transverse commissures in v and vi, passing into calciferous glands in xiii after giving off branches to anterior glands; supra-oesophageal vessel bifurcates in x-xii, but branches being united with each other anterior to septa 11/12/13 and pass into the ventral faces of the calciferous glands in

xiii; latero-parietal vessels paired, entering into the posterior faces of calciferous glands in xiii; subneural vessel absent; lateral hearts with connectives to the dorsal and supra-oesophageal vessels in x-xii, last pair of hearts in xii. Holandric. Prostates paired, in xix, extending posteriorly to a few segments. Spermathecae paired, diverticulate. Ovisacs paired, in xiv. Micromeronephridia astomate and exonephric, small paired tufts on the body wall in iii and iv, on anterior faces of septa in v-vii, larger tufts on anterior face of septum 4/5, few on the body wall in viii and posterior segments arranged in transverse bands in viii-xviii, in longitudinal rows posterior to prostatic region; paired stomate, exonephric, megameronephridia in c. lxx and posterior segments, funnels close to the nerve cord.

*Distribution* : Western Ghats in Maharashtra and Goa, India.

### Key to the species of *Rillogaster*

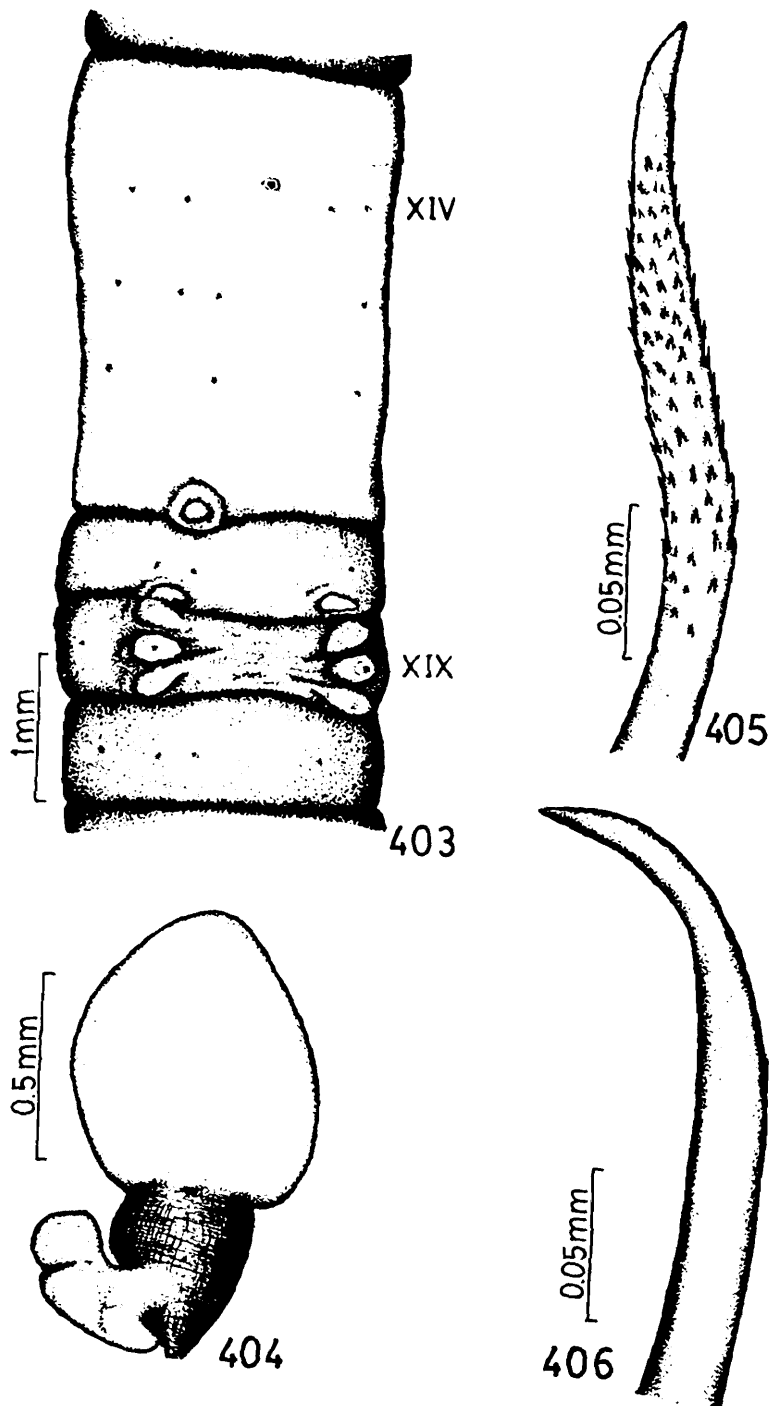
1. Spermathecal pores close to *b*, genital marking glands present ..... *R. matheranensis*
- Spermathecal pores at *c*, genital marking glands absent ..... *R. eastoni*

### 106. *Rillogaster eastoni* sp. nov.

(Figs. 403-406)

Length 57-79 mm, diameter 1.2-2 mm, 130-155 segments. Prostomium epilobic, tongue open. First dorsal pore 10/11, sometimes 11/12. Clitellum annular, xiii-xvii, xviii. Setae *aa* = 2.5-2.9 *ab* = 1.2-1.3 *bc* = 1.5-1.6 *cd* = 0.23-0.28 *dd* on xii, *aa* = 2.8-3 *ab* = 1.3-1.6 *bc* = 2 *cd* = 0.27 *dd* on xxiv. Combined male and prostatic pores small, discharging at centres of oval porophores, at or slightly lateral to *b*. Spermathecal pores minute, at *c*. Genital markings circular to ovoidal, single, median or slightly left or right side of midventral line, presetal on xx, xxi, xxii, postsetal on xv; paired postsetal on xvii, xviii, 20/21 at *ab* (one of the pair sometimes absent); paired, oval, epidermal tumescences anterior and posterior to male porophores on xix.

FIGS. 403-406. *Rillogaster eastoni* sp. nov. 403. genital region, 404. spermatheca, 405. ornamented penial seta, 406. unornamented penial seta.



Typhlosole in xx-xxii to lxxv-lxxxiii. Testes and male funnels free, in x and xi; seminal vesicles racemose in ix and xii. Vasa deferentia of a side uniting in xiii, each vas deferens enlarged into an ejaculatory bulb before joining the ectal end of the prostatic duct in xix, beneath the longitudinal muscle layer. Penial setae of two types

in each penisetal follicle, unornamented, and ornamented with several circles of sharp spines, tip bluntly pointed, 0.83-0.88 mm long, 23-27  $\mu$  diameter. Each spermatheca with an ectal hammer-shaped, shortly stalked, multiloculate diverticulum, duct *c.* half as long as ampulla.

*Material examined* : 0-14-6 sandy loam soil, Sanvordem, Goa, 15.27 N, 74.11 E, 31 Aug 1979, coll. J.M. Julka (holotype and 2 paratypes in ZSIC An 1835/1, An 1836/1, 17 paratypes in HAZFS, ZSI, Solan, An 750).

TABLE 11. Comparison of *R. eastoni* sp. nov. with *R. matheranensis*

Character	<i>R. eastoni</i>	<i>R. matheranensis</i>
Length (mm)	57-79	76-141
Diameter (mm)	1.5-2	3-5
Segments	130-155	152-249
Spermathecal pores	at <i>c</i>	at or slightly lateral to <i>b</i>
Genital markings	median or slightly left or right side of midventral line, postsetal on xv, pre-setal on xx-xxii.	median, presetal but on setal annuli on ix-xiii, xvii-xxi.
Unpaired		
Paired	postsetal on xvii - xviii, 20/21 at <i>ab</i> .	postsetal on vii, xviii, pre-setal on viii, xx, at <i>ab</i> .
Typhlosole	xxi-xxii to lxxv-lxxxiii.	xxiii to lxii.
Ejaculatory bulb	present	absent
Penial setae	two types, ornamented and unornamented, 0.83-0.88 mm long, 23 - 27 $\mu$ diameter.	one type, ornamented, 2-3 mm long, 35-38 $\mu$ diameter.
Spermathecal diverticulum	hammer-shaped	clavate
Genital marking glands	absent	present

**Abnormality** : Combined male and prostatic pores in one specimen are on the right side on xx and left side on xix.

**Distribution** : India: Goa: Sanvordem.

**Etymology** : The species is named after Mr. E.G. Easton, British Museum, London.

**Remarks** : *Rillogaster eastoni* sp. nov. can easily be distinguished from the other known species of the genus, *R. matheranensis* (Stephenson), by the characters noted in Table 11.

### 107. *Rillogaster matheranensis* (Stephenson)

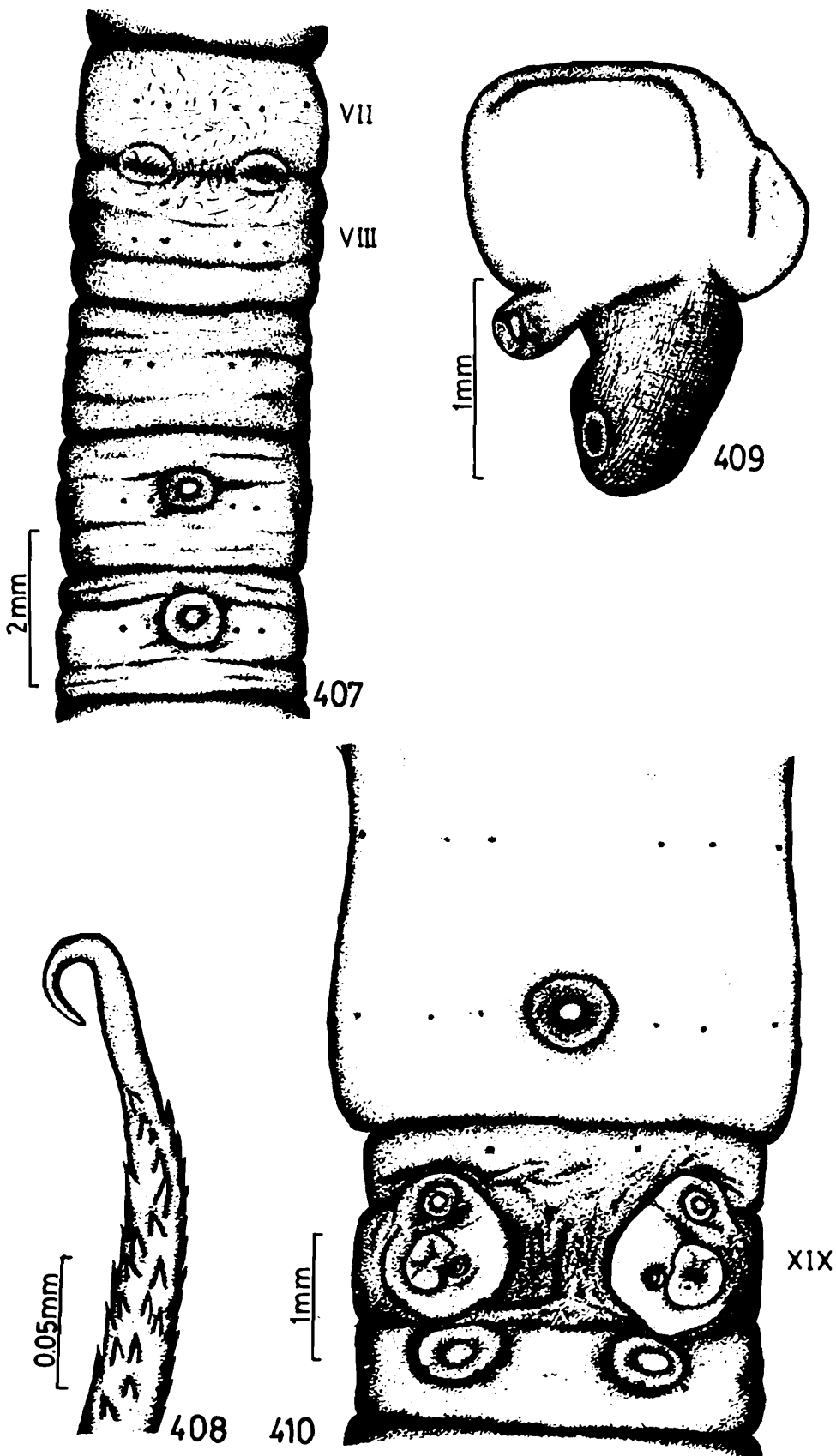
(Figs. 407-410)

1924. *Eudichogaster matheranensis* Stephenson, *Rec. Indian Mus.*, 26: 346.

1939. *Rillogaster matheranensis*, Gates, *Rec. Indian Mus.*, 41: 208.

Length 76-141 mm, diameter 3-5 mm, 152-249 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13. Clitellum xii,  $\frac{1}{2}$ xiii- $\frac{1}{2}$ xvii. Setae  $aa = 3.2-3.4$   $ab = 1.3-1.9$   $bc = 1.9-2.3$   $cd = 0.18-0.19$   $dd$  on xii,  $aa = 3-4$   $ab = 1.5-2$   $bc = 2.1-3.1$   $cd = 0.20-0.23$   $dd$  on xxiv,  $a$  and  $b$  in preprostatic region ornamented but sigmoid in shape. Combined male and prostatic pores small, transverse slits on circular porophores, slightly median to  $b$ . Spermathecal pores large, transverse slits at or slightly lateral to  $b$ . Genital markings tiny, circular to ovoidal; paired, postsetal slightly anteromedian to spermathecal pores, on viii, presetal on xx, sometimes postsetal on xviii, at  $ab$ , two pairs on male porophores on xix; unpaired and median, presetal but on setal annuli on ix-xiii, sometimes on xvii-xxi.

Typhlosole in xxxii to lxii. Testes and male funnels free, in x and xi; seminal vesicles racemose, in ix and xii. Vasa deferentia of a side uniting with each other in xviii, without any enlargement into an ejaculatory bulb before opening into the ectal end of prostatic



FIGS. 407-410. *Rillogaster matheranensis* (Stephenson). 407. spermathecal pore region, 408. penial seta, 409. spermatheca, 410. genital region.

duct. Penial setae ornamented with 19-26 closely arranged circles of triangular teeth, tip bluntly pointed, 2-3 mm long, 35-38  $\mu$  diameter. Each spermatheca with a small, clavate, multiloculate, shortly stalked posterior ental diverticulum, duct shorter than ampulla. Genital marking glands sessile, oval, slightly projecting into the coelomic cavity.

*Type locality* : Matheran, Maharashtra, India.

*Type specimens* : In ZSIC, W 1155/1; BMNH, 1925: 5: 12: 5.

*Material examined* : In ZSIC: 0-7-7 Lonavala, W 3202/1; 0-5-1, syntypes, W 1155/1. In HAZFS, ZSI, Solan: 3-1-2 Khandala, 24 Aug 1979, coll. J.M. Julka, An 751; 0-5-7 Khandala, 14 Sept 1979, coll. K. Mathew, An 752.

*Distribution* : India: *Maharashtra*: Matheran, Lonavala, Khandala.

#### Genus 24. *Scolioscolides* Gates, 1937

1907. *Megascolides*, Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 150.

1923. *Megascolides* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 192.

1937. *Scolioscolides* Gates, *Rec. Indian Mus.*, 39: 305.

1972. *Scolioscolides*, Gates, *Trans. Am. phil. Soc.*, 62: 313.

*Diagnosis* : Lumbricine Combined male and prostatic pores paired, on xviii. Oesophagus with a single gizzard between septa 5/6 and 8/9, and one pair of discrete intramural calciferous glands in xii; supra-intestinal glands present; typhlosole in the form of a low ridge. Micromeronephridia astomate; numerous, enteronephric in iii; exonephric, on the body wall in v and posterior segments; few, arranged in longitudinal rows posterior to clitellum. Paired, stomate, exonephric megameronephridia in each segment posterior to the supra-intestinal glands region.

*Type species* : *Megascolides bergtheili* Michaelsen, 1907.

*Description* : As for the only species, *bergtheili*.

*Distribution* : Possibly in the Himalayas east of Darjeeling, West Bengal, India.

**108. Scolioscolides bergtheili (Michaelsen)**

(Figs. 411-412)

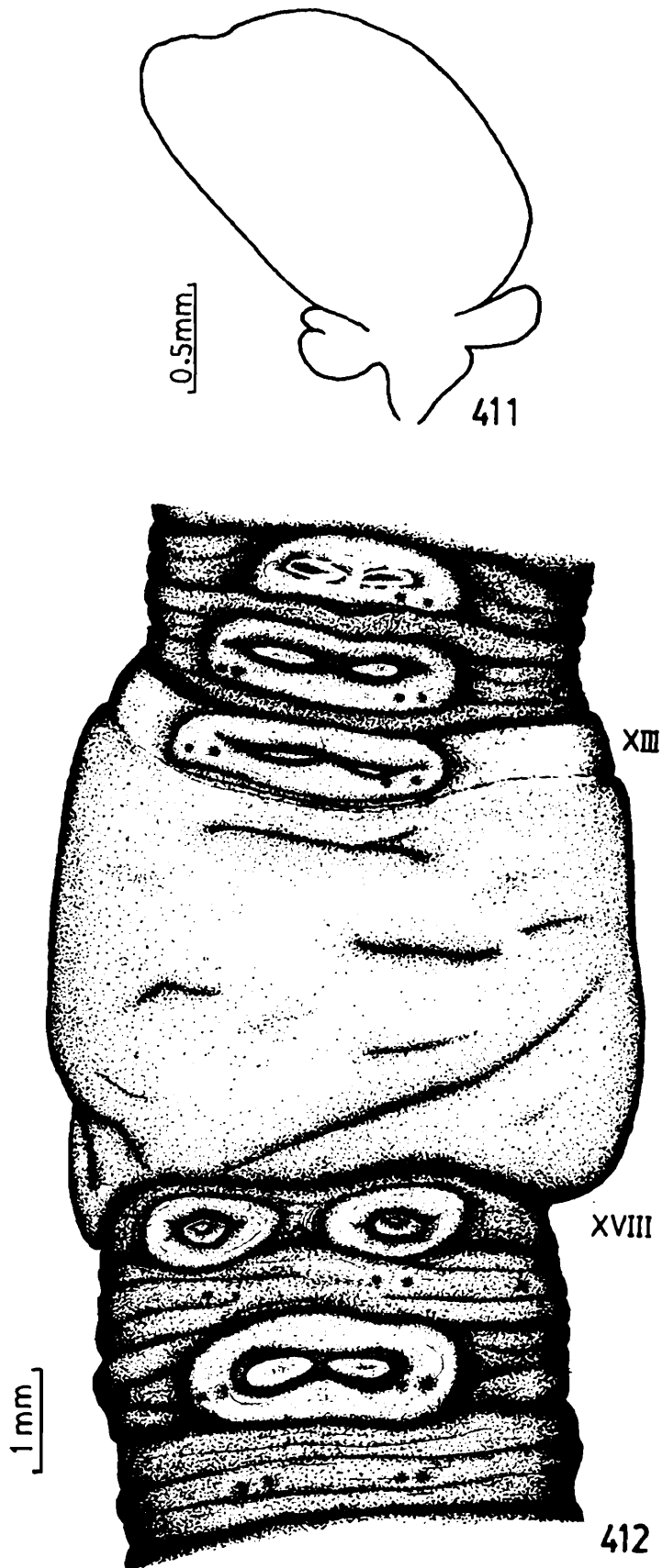
1907. *Megascolides bergtheili* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 150.

1923. *Megascolides bergtheili*, Stephenson, *Fauna Br. India, Oligochaeta*: 196.

1937. *Scolioscolides bergtheili*, Gates, *Rec. Indian Mus.*, **39**: 307.

Length 100-120 mm, diameter 4.5-5 mm, 146-175 segments. Prostomium tanylobic. First dorsal pore 11/12. Clitellum annular, xiii-xvii. Setae  $aa = 7.75$   $ab = 1.55$   $bc = 2.21$   $cd = 0.4$   $dd$  on xii. Combined male and prostatic pores paired, small, transversely crescentic within rather penis-like but small tubercles on oval porophores, on xviii, at or just median to *b*. Female pores paired, in transverse slit-like depressions, presetal, within *a* lines, on xiv. Spermathecal pores paired, on small oval porophores, in 7/8, slightly median to *b*. Genital markings oval, unpaired and median but with two central areas, on xii, xiii and xx, sometimes on xi and xxi, extending laterally into *bc*. Nephridiopores not recognized.

Septa 4/5/6, 8/9/10/11 muscular, 6/7/8 absent. Gizzard single, large, between septa 5/6 and 8/9. Calciferous glands paired, intramural, longitudinally hemi-ellipsoidal with flat faces mesially, in xii, each gland with numerous transverse vertical lamellae. Intestine begins in xv; lateral intestinal caeca paired, in xxi, unpaired and midventral intestinal caeca 5, in xxiv-xxviii; supra-intestinal glands 2 pairs, in lix-lx or lx-lxi; typhlosole in the form of a low ridge terminating posteriorly with the supra-intestinal glands. Dorsal vessel single and complete; supra-oesophageal vessel single, in xii-xiii; extra-oesophageal vessels paired, passing to anterior ends of calciferous glands in xii; latero-parietal vessels paired, passing to posterior ends of calciferous glands; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xiii; last pair of hearts in xiii.



FIGS. 411-412. *Scolioscolides bergtheili* (Michaelsen). 411. spermatheca, 412. genital region (both drawn from a syntype).

Holandric, testes and male funnels in x enclosed in U-shaped sacs and those of xi in annular sacs; seminal vesicles in ix and xii. Prostates one pair, in xviii, extending posteriorly to xix. Vasa deferentia join the ental ends of prostatic ducts. Penial setae absent. Spermathecae one pair, in viii, each with a median and a lateral, bi-or trilobed ental diverticula, duct shorter than ampulla. Ovisacs absent (?). Genital marking glands absent. Micromeronephridia astomate, numerous, enteronephric in iii, exonephric on the body wall in v and posteriad segments, fewer and arranged in longitudinal rows in postclitellate segments; paired, stomate, exonephric megameronephridia in each segment posterior to the supra-intestinal gland region, funnels close to the nerve cord.

*Type locality* : Sandakphu, Darjeeling district, West Bengal, India.

*Type specimens* : In ZSIC, ZEV 2951/7; ZMUH, 7137.

*Material examined* : 0-0-3, syntypes, ZEV 2951/7, in ZSIC.

*Distribution* : So far known from the type locality.

### Genus 25. *Travoscolides* Gates, 1940

1915. *Megascolides* (in part), Stephenson, *Mem. Indian Mus.*, 6: 63.

1923. *Megascolides* (in part), Stephenson, *Fauna Br. India, Oligochaeta*: 192.

1940. *Travoscolides* Gates, *Rec. Indian Mus.*, 42: 137.

*Diagnosis* : Lumbricine. Combined male and prostatic pores paired, on xviii. Oesophagus with a single gizzard in v and 4 pairs of discrete extramural calciferous glands in x-xiii; supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate, large, enteronephric, paired tufts in v, smaller, exonephric, paired tufts in vi-xiii; several stomate, enteronephric in xv and posteriad segments. Megameronephridia absent.

*Type species* : *Megascolides chengannures* Aiyer, 1929.

*Description* : Setae lumbricine throughout the body. Clitellum annular. Combined male and prostatic pores paired, on xviii. Female pores paired, presetal, within *a* lines on xiv. Spermathecal

pores paired, in or close to 7/8/9. Genital markings absent. Nephridiopores not recognized.

Septa present from 5/6. Gizzard single, in v. Calciferous glands discrete, extramural, reniform, 4 pairs, in x-xiii, opening into oesophagus ventrally through short stalks. Intestinal caeca and supra-intestinal glands absent; typhlosole lamelliform, simple. Dorsal vessel single and complete (?); supra-oesophageal, extra-oesophageal and latero-parietal vessels (?); subneural vessel absent; lateral hearts originating from vessels from calciferous glands (branches of supra-oesophageal ?) with delicate connectives to the dorsal vessel, in x-xii, xiii. Holandric; seminal vesicles in xi and xii. Prostates paired, in xviii. Vasa deferentia joining the ental ends of prostatic ducts. Penial setae present. Spermathecae paired, in viii and ix. Ovisacs (?). Micromeronephridia astomate, large, enteronephric, paired tufts in v, smaller, exonephric, paired tufts in vi-xiii; several, stomate (with preseptal nephrostomes), enteronephric micromeronephridia in xv and posteriad segments, discharging in each segment into a pair of septal excretory canals which open into intestine through an intra-typhlosolar longitudinal excretory duct.

*Distribution* : Kerala, S. India.

*Remarks* : Gates (1940a) included 4 Indian species of *Megascolides*, *chengannures*, *duodecimalis*, *pilatus* and *cochinensis* (tentatively), in his genus *Travoscolides*. Since several taxonomic characteristics are not known in these species, they can only be distinguished from each other (somewhat doubtfully) by the penial setae.

### Key to the species of *Travoscolides*

1. Last pair of hearts in xii ..... *T. duodecimalis*  
     Last pair of hearts in xiii ..... 2
2. Penial setae short, c. 0.33 mm long, tip not bayonet-shaped ..... 3  
     Penial setae longer, 0.57 mm long, tip bayonet-shaped, flattened and markedly hollowed ..... *T. pilatus*

3. Penisetal tip with a hair-like spine hooked to one side ..... *T. cochinensis*  
 Penisetal tip without a spine ..... *T. chengannures*

### 109. *Travoscolides chengannures* (Aiyer)

1929. *Megascolides chengannures* Aiyer, *Rec. Indian Mus.*, 31: 54.

1940. *Travoscolides chengannures*, Gates, *Rec. Indian Mus.*, 42: 139.

Length 120 mm, diameter 3 mm, 230 segments. Prostomium prolobic. First dorsal pore 11/12. Clitellum xiv-xviii. Setae  $aa = 2.9$   $ab = 1.3$   $bc = 2.1$   $cd = 0.14$   $dd$  on xii,  $aa = 5.7$   $ab = 1.7$   $bc = 2$   $cd = 0.17$   $dd$  on xxiv. Male genital field transversely placed, indistinctly demarcated area of translucence, slightly depressed, extending from 18/19 to just behind the setal arc of xvii and reaching laterally to *c*. middle of *bc*, with a pair of tumescences between 17/18 and 18/19; each tumescence with a groove (seminal ?), at *a*. Combined male and prostatic pores, minute, on small papillae, on the setal arc of xviii, slightly lateral to the grooves, at *ab*. Spermathecal pores minute, on anterior margins of viii and ix, at *a*, on slightly raised protuberances.

Septa 5/6 delicate, 6/7-12/13 muscular. Intestine begins in xv; typhlosole xxiv-xxv to cxlix. Last pair of hearts in xiii. Testes and male funnels free, in x and xi. Penial setae unornamented, tip with a slight longitudinal groove but without a terminal spine, shaft with a slight nodulus at the middle, *c.* 0.33 mm long, *c.* 15  $\mu$ . Spermathecae elongately sausage-shaped, each with a multiloculate disc-shaped diverticulum on the anterior face of an indistinct short duct.

*Type locality* : Chengannur, Kerala, S. India.

*Type specimens* : In ZSIC, W 1514/1.

*Material examined* : In ZSIC: 0-1-0, type, W 1514/1.

*Distribution* : So far known from the type locality.

110. *Travoscolides ? cochinensis* (Michaelsen)

1910. *Megascolides cochinensis* Michaelsen, *Abh. Geb. Naturw., Hamburg*, 19: 56.

1923. *Megascolides cochinensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 198.

1940. *Travoscolides ? cochinensis*, Gates, *Rec. Indian Mus.*, 42: 141.

Length 155 mm, diameter 2.5-4 mm, c. 280 segments. Prostomium (?). First dorsal pore 9/10. Clitellum xiii (?), xiv-xviii. Setae  $aa = 1.5 ab = 0.75 bc = cd$  anterior to clitellum,  $aa = 5 ab = 1.25 bc = 2.5 cd$  at about middle of the body, enlarged on iv-vii. Male genital field with a median depression on xviii, continuous anteriorly with a postsetal transverse depression on xvii, which extends laterally to c. Combined male and prostatic pores minute, on the slopes of the median depression, on the setal arc of xviii, at a. Spermathecal pores on anterior margins of viii and ix, at a.

Septa 5/6/7 (?), 7/8-11/12 muscular. Intestine beginning and typhlosole (?). Last pair of hearts in xiii. Testes and male funnels free (?), in x and xi. Penial setae unornamented, tip with a hair-like spine hooked to one side, shaft straight, c. 0.33 mm long, c. 12  $\mu$  diameter. Spermathecae elongately sausage-shaped, each with a small multiloculate disc-like diverticulum that joins a short duct beneath the longitudinal musculature of the body wall.

*Type locality* : Foot of Nelliampathis Hills, Kerala, S. India.

*Type specimens* : Typus amissus.

*Distribution* : So far known from the type locality.

*Remarks* : Michaelsen (1910) in describing his species, *M. cochinensis* stated that the calciferous glands were apparently absent; thus raising doubts about its inclusion in *Travoscolides* which is characterized by the presence of 4 pairs of discrete extramural calciferous glands, in x-xiii. Gates (1940a), however, included *cochinensis* provisionally in *Travoscolides* on the structure of the spermathecae, and at the same time suggested that the

absence of calciferous glands may be due to their fragile nature which might have been destroyed by jolting action during the transit of the specimens from India to Germany.

### 111. *Travoscolides duodecimalis* (Stephenson)

1915. *Megascolides duodecimalis* Stephenson, *Mem. Indian Mus.*, 6: 65.

1923. *Megascolides duodecimalis*, Stephenson, *Fauna Br. India, Oligochaeta*: 198.

1940. *Travoscolides duodecimalis*, Gates, *Rec. Indian Mus.*, 42: 142.

Length 160 mm, diameter 5 mm, c. 317 segments. Prostomium (?). First dorsal pore 11/12. Clitellum xiv-xvii. Setae  $aa = 10$   $ab = 1.5$   $bc = 3$   $cd$  anterior to clitellum,  $aa = 8$   $ab$  on postclitellate segments,  $aa = 6$   $ab$  in middle of body. Male genital field with a median rectangular depression on xviii. Combined male and prostatic pores on small porophores, on xviii, on the sides of the median depression, at  $ab$ . Spermathecal pores minute, in 7/8/9, at  $ab$ .

Septa 5/6 slightly muscular, 6/7-11/12 muscular. Intestine begins in xvi; typhlosole in xxiv to (?). Last pair of hearts in xii. Testes and male funnels free, in x and xi. Penial setae ornamented with a few, minute, scattered teeth, tip simple and bluntly pointed, shaft curved and recurved ectally, 0.82 mm long, 14  $\mu$  diameter. Spermathecae elongately digitiform (sausage-shaped), each with a small spherical diverticulum on an indistinct, short and slightly dilated duct.

*Type locality* : Parambikulam, Kerala, S. India.

*Type specimens* : In ZSIC, ZEV 6596/7; BMNH, 1933: 5: 25: 80.

*Material examined* : 0-0-1, syntype, ZEV 6596/7, in ZSIC.

*Distribution* : So far known from the type locality.

### 112. *Travoscolides pilatus* (Stephenson)

1915. *Megascolides pilatus* Stephenson, *Mem. Indian Mus.*, 6: 68.

1923. *Megascolides pilatus*, Stephenson, *Fauna Br. India, Oligochaeta*: 200.

1940. *Travoscolides pilatus*, Gates, *Rec. Indian Mus.*, 52: 142.

Length more than 123 mm, diameter 4 mm, segments (?). Prostomium and clitellum (?). First dorsal pore 11/12. Setae  $aa = 3-4$   $ab, bc = 2-3$   $ab = 2$   $cd$  anterior to male pore area,  $aa = 6-7$   $ab, bc = 3$   $ab = 2$   $cd$  posterior to male pore region, much enlarged on iii-ix. Male genital field an oval tumescent area on xviii, extending slightly to xix. Combined male and prostatic pores on small porophores, at  $ab$ , on xviii. Spermathecal pores on minute papillae, on anterior margins of viii and ix, just behind 7/8/9 at  $a$ .

Septa 6/7-12/13 muscular. Intestine begins in xvi; typhlosole xxiv to lxiv. Last pair of hearts in xiii. Testes and male funnels free, in x and xi. Penial setae unornamented, tip bayonet-shaped, flattened and hollowed, 0.57 mm long, 21  $\mu$  diameter. Spermathecae cylindrical (sausage-shaped), diverticula not developed (immature specimens).

*Type locality* : Parambikulam, Kerala, S. India.

*Type specimens* : In ZSIC, ZEV 6919/7; BMNH, 1933: 5: 25: 86.

*Distribution* : So far known from the type locality.

### Genus 26. **Wahoscolex** gen. nov.

*Diagnosis* : Lumbricine throughout the body, or at least in the anterior or anterior and middle regions, often perichaetine in the posterior region. Male pores paired, in seminal grooves, on xviii or 17/18 or on porophores on xvii; prostatic pores 2 pairs at the ends of seminal grooves, on xvii and xix or xvii and xviii, or one pair on xvii. Oesophagus with a single gizzard in v (rarely vi) and with calciferous lamellae in xvi, sometimes extending slightly into adjacent segments; discrete calciferous glands and supra-intestinal glands absent; typhlosole lamelliform, simple. Micromeronephridia astomate; paired, enteronephric tufts in iii-vi, exonephric tufts in vii-xii; few to several exonephric on the body wall in xiii and

posteriad segments. One or two pairs of stomate enteronephric megameronephridia in each segment from about middle of body to posterior end.

*Type species* : *Howascolex corethrurus* Michaelsen, 1922.

*Etymology* : Anagram of *Howascolex*, gender masculine.

*Description* : Setae lumbricinè either throughout the body, or at least in the anterior or anterior and middle regions; often perichæ-tine at the posterior part of the body. Male pores paired, in seminal grooves, on xviii or 17/18, or on porophores and combined (?) with prostatic pores on xvii. Prostatic pores 2 pairs on xvii and xix or xvii and xviii at the ends of seminal grooves, or one pair on xvii. Female pore (s) presetal, on xiv. Spermathecal pores paired, rarely unpaired, between 7/8 and 9/10. Nephridiopores not recognized.

Oesophagus with a single large gizzard in v (rarely vi), enlarged and with calciferous lamellae in xvi, sometimes extending to posterior half of xv or anterior half of xvii; discrete calciferous glands absent. Intestine begins posterior to xvii; caeca and supra-intestinal glands absent; typhlosole lamelliform, simple. Dorsal vessel single and complete, supra-oesophageal vessel single, in viii-xiii; extra-oesophageal vessels paired, uniting with paired latero-parietal vessels in xiii; subneural vessel absent; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii, xiii. Testes holandric. Spermathecae paired or unpaired. Prostates paired. Ovisacs (?). Micromeronephridia astomate; small enteronephric tufts in iii and iv, larger in v and vi, exonephric tufts in vii-xii; few to several exonephric on the body wall in xiii and posteriad segments. Megameronephridia stomate, enteronephric, one or two pairs in each segment from about middle of body to the posterior end, loops extending laterally to *c.* mid-dorsal line, ducts discharging into intestine near the dorsal vessel (? through dorsal longitudinal excretory canals).

*Distribution* : Western and Nandi Hills in Karnataka, and Nilgiri Hills in Tamil Nadu, South India.

*Remarks* : Michaelsen (1901) erected the genus *Howascolex* for his species *madagascariensis* from Madagascar with holonephridia in the anterior region and meronephridia in the posterior region of the body. Michaelsen (1922) added 3 more species, *bidens*, *corethrurus* and *merkaraensis* from the Western Hills in Karnataka, S. India, although these differed considerably from the type species in possessing a typhlosole, holonephridia in the posterior region and meronephridia in the anterior region of the body. The genus was redefined by Pickford (1937) to include New World species of *Acanthodrilus* and *Wegeneriella* with both "mega-" and "micro-nephridia" Jamieson (1971b) rejected Pickford's suggestion and retained *Wegeneriella* as a distinct genus and referred the meronephric species of *Acanthodrilus* to *Ramie-lona* following Gates (1962a).

Both Gates (1940b) and Jamieson (1971b) pointed out that the Indian section of *Howascolex* was not congeneric with that of the Malagasian section, but the separation was deferred for lack of detailed information on the excretory system. Recently, the author could collect a number of well preserved specimens of *corethrurus* from Bhagamandla in Coorg section of the Western Hills in Karnataka, which is very close to its type locality Somvarapatna. A careful study of its excretory system reveals: "astomate micromeronephridia arranged in paired enteronephric tufts in iii-vi and paired exonephric tufts in vii-xii, 11-16 astomate exonephric micromeronephridia on the body wall on each side in each of segments xiii-xvi, decreasing in number to 6-7 on each side in xvii and posteriad segments; paired, stomate, enteronephric megameronephridia in each segment from about the middle of body to the caudal end, size increasing gradually so that the loops reach to the mid-dorsal line in the caudal segments" These details in the excretory system of *corethrurus* show that it is completely meronephric, and not partly holonephric and partly meronephric as stated by Michaelsen (1922). Probably, Michaelsen could not recognize micromeronephridia in the posterior segments of *corethrurus*

(possibly also in other 2 Indian species, *bidens* and *merkaraensis*) because of the presence of coelomic coagulum and much enlarged megameronephridia, the latter perhaps mistaken for holonephridia. It is, thus, evident that wholly meronephric *corethrurus* (also *bidens* and *merkaraensis*) is generically distinct from the Malagasian type species of *Howascolex*. Moreover, *corethrurus* possessing an oesophagus with a single gizzard and calciferous lamellae in xvi extending slightly into xv or xvii, without discrete calciferous glands and excretory system with caudal enteronephric megameronephridia cannot be assigned to any known octochaetid genera, a new genus *Wahoscolex* is erected to accommodate this species. The distinctiveness of *Wahoscolex* gen. nov. from the related octochaetid genera is shown in Table 7.

It is pertinent to discuss the status of other *Howascolex* species described during the last 50 years, viz., *H. sinicus* from China by Chen (1935); *H. lasiurus*, *H. sauerlandti* and *H. tecumumami vulcanicus* from America by Graff (1957); *H. bahli* and *H. stephensoni* from Goa, India by Soota and Julka (1972). Both Jamieson (1971b) and Gates (1972) regarded *H. sinicus* as *species dubium* and possibly a synonym of the peregrine *Ramiella bishambari*. *H. lasiurus*, *H. sauerlandti* and *H. tecumumami vulcanicus* were referred to *Ramiellona* by Gates (1962a). On the basis of morphology of the excretory system, *H. bahli* and *H. stephensoni* are assigned to *Konkadrilus* Julka (described elsewhere in this work).

#### Key to the species of *Wahoscolex*

- |   |   |
|---|---|
| 1. Setae lumbricine throughout the body .....                   | 2 |
| Setae perichaetine in the posterior region of the<br>body ..... | 6 |
| 2. Prostates 2 pairs, in xvii and xix .....                     | 3 |
| Prostates one pair, in xvii .....                               | 5 |

3. Spermathecal pores unpaired and median, in 7/8/9 ..... *W. bouchei*  
 Spermathecal pores paired ..... 4
4. Spermathecal pores 2 pairs, in 7/8/9 ..... *W. veereshi*  
 Spermathecal pores one pair, in 8/9..... *W. (?) bidens*
5. Spermathecal pores 2 pairs, in 7/8/9 ..... *W. horai*  
 Spermathecal pores one pair, in 8/9 ..... *W. nandiensis*
6. Prostates in xvii and xix ..... 7  
 Prostates in xvii and xviii ..... *W. curgensis*
7. Spermathecal pores one pair, in 8/9 ..... *W. (?) ditheca*  
 Spermathecal pores more than one pair ..... 8
8. Spermathecal pores 3 pairs, in 7/8/9/10..... *W. corethrurus*  
 Spermathecal pores 4 pairs, in 5/6/7/8/9.... *W. (?) merkaraensis*

### 113. *Wahoscolex (?) bidens* (Michaelsen)

1922. *Howascolex bidens* Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 38

1923. *Howascolex bidens*, Stephenson, *Fauna Br. India, Oligochaeta*: 366.

Length 70-90 mm, diameter 1.5-1.75 mm, *c.* 110-180 segments. Prostomium epilobic, tongue (?). First dorsal pore (?). Clitellum xiii-xvi. Setae lumbricine throughout the body,  $aa = 1.25 bc$ ,  $bc = 2 ab = 1.33 cd$  on anterior segments. Male pores minute, at posterior ends of seminal grooves, on xviii; prostatic pores minute, on xvii and xix, close to *b* lines, those on xvii at the centres of large porophores, those on xix inconspicuous; seminal grooves short, from posterior margin of porophores on xvii to the setal arc of xviii. Female pore single and median. Spermathecal pores paired, large transverse slits, in 8/9, at *ab*. Genital markings unpaired and median, at 11/12.

Septa 6/7-13/14 muscular. Gizzard in v; intestine begins in xx; typhlosole in (?). Last pair of hearts in (?). Testes and male funnels free, in x and xi; seminal vesicles lobed, in ix and xii. Prostates 2

pairs, those in xix slightly smaller than those in xvii. Penial setae ornamented with short transverse zigzag markings, flattened ectally, tip bifid, 0.55 mm long, 22-25  $\mu$  diameter. Spermathecae paired, in ix, each with an ental club-shaped diverticulum, duct shorter than ampulla. Genital marking glands absent (?).

*Type locality* : Shiboga, Karnataka, S. India.

*Type specimens* : In ZMUH, 9161.

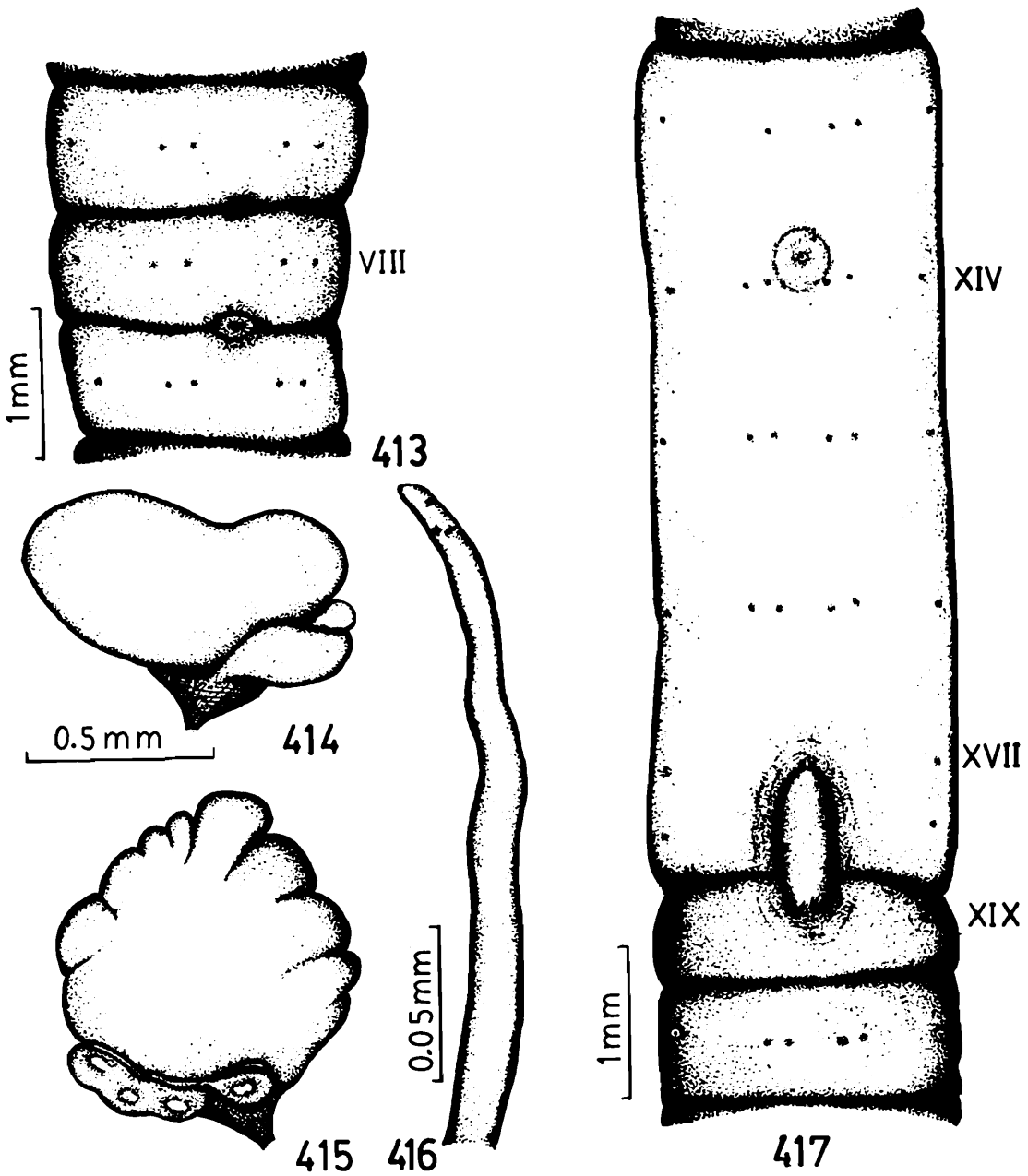
*Distribution* : So far known from the type locality.

#### 114. *Wahoscolex bouchei* sp. nov.

(Figs. 413-417)

Length 118-136 mm, diameter 2-2.5 mm, 158-182 segments. Prostomium epilobic, tongue open. First dorsal pore 11/12. Clitellum annular, xiii-xviii. Setae lumbricine throughout the body,  $aa = 2.2-2.3$   $ab = 0.9-1.1$   $bc = 1.1$   $cd = 0.16-0.17$   $dd$  on xii,  $aa = 2.5-2.7$   $ab = 1.1$   $bc = 1.2$   $cd = 0.15-0.17$   $dd$  on xxiv. Male pores minute, in seminal grooves, on setal arc of xviii, at  $a$ ; prostatic pores minute, at the ends of seminal grooves, on xvii and xix, close to midventral line; seminal grooves almost straight with ends slightly bent medially. Female pore single and median. Spermathecal pores unpaired, median, in 7/8/9, at centres of low, circular to oval papillae, in 7/8 minute and circular, in 8/9 comparatively larger and a transverse slit. Genital markings absent.

Septa 4/5/6 delicate, 6/7 slightly muscular, 7/8-12/13 muscular. Gizzard in v; intestine begins in  $\frac{1}{2}$ xviii; typhlosole in xxii-xxiii to xciv-cxxx. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Prostates 2 pairs, those in xvii longer than those in xix. Penial setae undulating ectally, ornamented with 2-3 short transverse rows of fine spines, those associated with prostates in xvii, 0.65-0.76 mm long, 19-22  $\mu$  diameter, those associated with prostates in xix, 0.25-0.48 mm long, 9-14  $\mu$  diameter. Spermathecae unpaired, median, in viii and ix; of viii small, vestigial, pear-shaped and adiverticulate, of ix larger,



FIGS. 413-417. *Wahoscolex bouchei* sp. nov. 413. spermathecal pore area, 414, 415. spermathecae, 416. penial seta, 417. genital region.

usually with 2, short, digitiform to fan-shaped ental diverticula, rarely adiverticulate. Stomate, enteronephric megameronephridia one pair in each of *c.* 100 posteriormost segments, funnels close to the nerve cord.

*Material examined* : 1-2-6 open grassland on a hill slope, soil laterite, Kemmengundi, Karnataka, 13.48 N, 75. 69 E, altitude *c.* 1480 m, 4 Sept 1979, coll. J.M. Julka (holotype and 1 paratype in ZSI Calcutta, An 1808/1, An 1809/1, 7 paratypes in HAZFS, ZSI, Solan, An 756).

*Distribution* : India: *Karnataka*, Kemmengundi.

*Etymology* : This species is named after Dr. M. Bouché, a well-known French Oligochaetologist.

*Remarks* : *Wahoscolex bouchei* sp. nov. belongs to a group of species with lumbricine arrangement of setae throughout the body and 2 pairs of prostates in xvii and xix. It can be easily distinguished from the other species of the group, *Wahoscolex* (?) *bidens* (Michaelsen, 1922) and *Wahoscolex veereshi* sp. nov. (described elsewhere in this work), by the characteristics as shown in Table 12.

### 115. *Wahoscolex corethrurus* (Michaelsen)

(Figs. 418-421)

1922. *Howascolex corethrurus* Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 42.

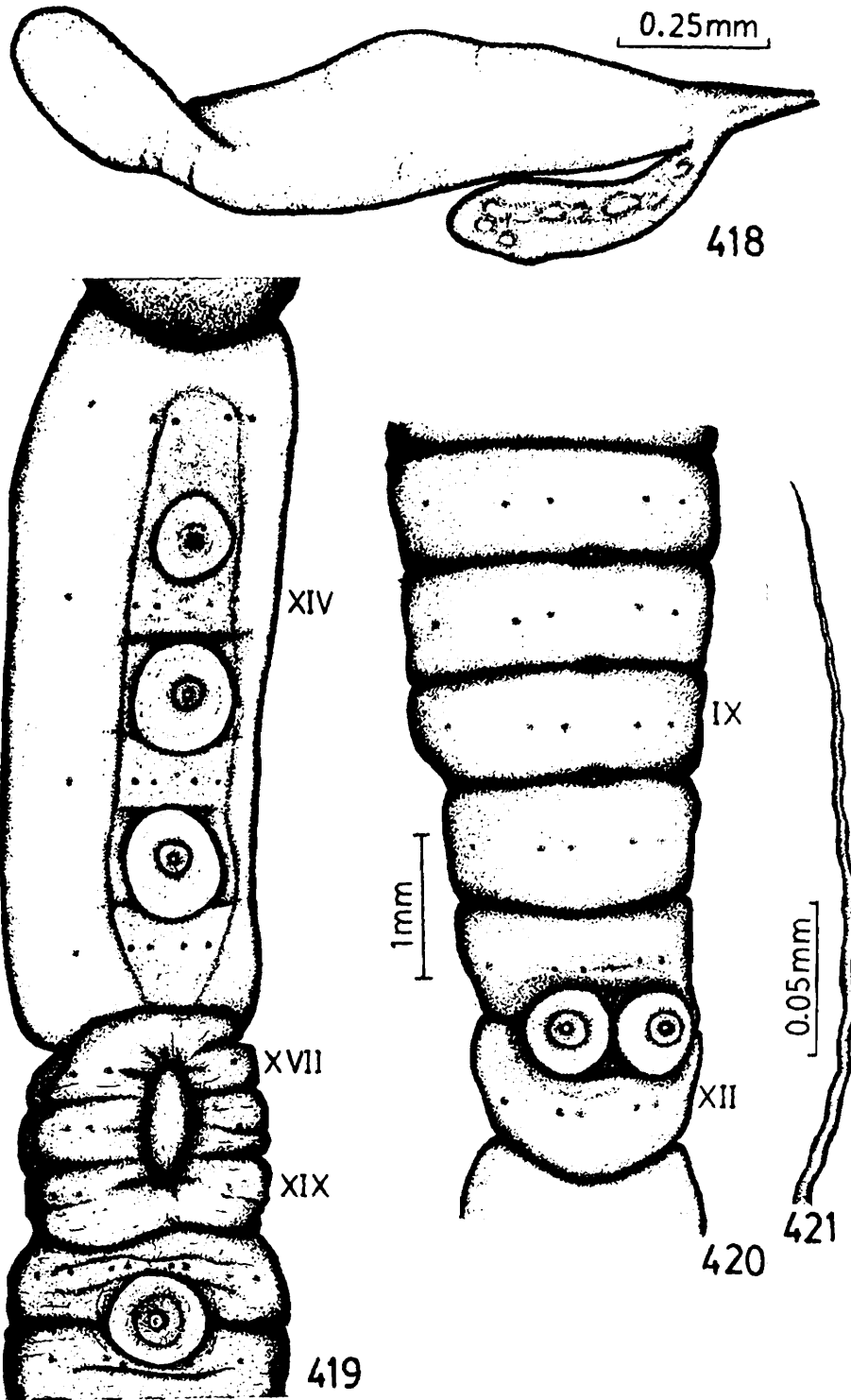
1923. *Howascolex corethrurus* f. *typica* Stephenson, *Fauna Br. India, Oligochaeta*: 367.

Length 85-119 mm, diameter 1-2.3 mm, *c.* 180, 189-206 segments. Prostomium epilobic, tongue open. First dorsal pore 11/12. Clitellum annular, xiii-xvi. Setae lumbricine in anterior and middle regions, and perichaetine in posterior region of the body, *aa* = 2-2.6 *ab* = 0.9-1 *bc* = 1.1-1.3 *cd* = 0.13-0.15 *dd* on xii, *aa* = 3-3.7 *ab* = 1-1.9 *bc* = 1.8-2 *cd* = 0.15-0.18 *dd* on xxiv, 9-20 on segments in the perichaetine region. Male pores minute, in seminal grooves, on the setal arc of xviii, at *a*; prostatic pores minute, at the ends of seminal grooves, on xvii and xix, slightly ventral to *a*; seminal grooves concave between the setal arcs of xvii and xix. Female pore single and median. Spermathecal pores paired, minute, in 7/8/9/10 close to the midventral line at the centres of unpaired slightly raised oval papillae. Genital markings circular; closely paired, near the midventral line, on 11/12, sometimes 10/11; unpaired, median, extending laterally to *b*, usually on 14/15-15/16, 20/21, occasionally 21/22.

Septa 4/5 delicate, 5/6/7/8 slightly muscular, 8/9-12/13 muscular. Gizzard in v; intestine begins in ½xviii; typhlosole xxiii-

TABLE 12. Comparison of *W. bouchei* and *W. veereshi* spp. nov. with related species.

Character	<i>W. bouchei</i>	<i>W(?) . bidens</i>	<i>W. veereshi</i>
Length (mm)	118-136	70-90	39-83
Segments	158-182	c. 110-180	124-154
Clitellum	xiii-xviii	xiii-xvi	xiii-xvii
Seminal grooves	between setal arcs of xvii and xix	between setal arcs of xvii and xviii	between setal arcs of xvii and xix
Female pore (s)	single and median	single and median	paired
Spermathecal pores	unpaired and median, in 7/8/9	paired, in 8/9	paired, in 7/8/9
Genital markings	absent	unpaired and median in 11/12	absent
Spermathecae	unpaired and median, in viii and ix, of viii vestigial and adiverticulate, of ix larger and usually bidiverticulate, rarely adiverticulate	paired, in ix, unidiverticulate	paired, in viii and ix, unidiverticulate.



FIGS. 418-421. *Wahoscolex corethrurus* (Michaelsen). 418. spermatheca, 419. genital region, 420. spermathecal pore region, 421. penial seta.

xxiv to cxi-cxliii. Last pair of hearts in xiii. Testes and male funnels free, in x and xi; seminal vesicles lobed, in xii. Prostates 2 pairs, in xvii and xix, almost of equal length. Penial setae undulating ectally, unornamented, 0.57-0.74 mm long, 5-9  $\mu$  diameter. Spermathecae paired, in viii, ix and x, each with an ental digitiform diverticulum, about one third the combined length of duct and ampulla. Genital marking glands absent. Stomate, enteronephric megameronephridia one pair in each segment in *c.* posterior half of body, funnels close to the nerve cord.

*Type locality* : Somavarapatna, Coorg, Karnataka, S. India.

*Type specimens* : In ZMUH, 9160, 9163.

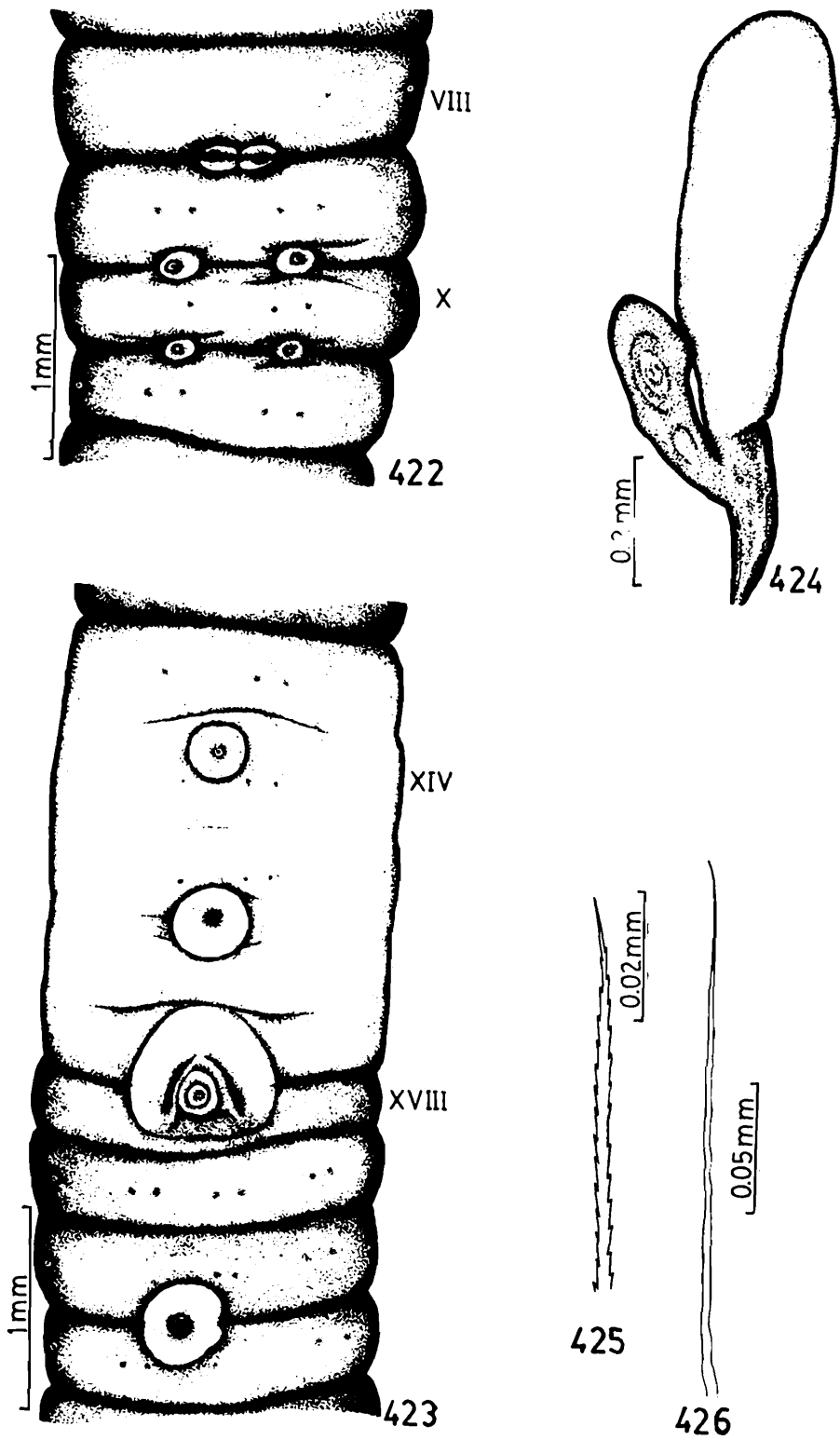
*Material examined* : 0-18-13 soil red loam, Bhagamandla, Karnataka, South India, 10 Sept 1979, coll. J.M. Julka, An 757, in HAZFS, ZSI, Solan.

*Distribution* : India: *Karnataka*: Somavarapatna, Bhagamandla.

#### 116. *Wahoscolex curgensis* sp. nov.

(Figs. 422-426)

Length 64-66 mm, diameter 1-1.5 mm, 144-145 segments. Prostomium epilobic, tongue open. First dorsal pore 11/12. Clitellum annular, xiii-xvii. Setae lumbricine in anterior region and perichaetine posterior to the clitellum  $aa = 1.9-2.2$   $ab = 0.8-0.9$   $bc = 1.1$   $cd = 0.11-0.15$   $dd$  on xii,  $aa = 2.4-2.5$   $ab = 1.1-1.4$   $bc = 1.3-1.7$   $yz = 0.2-0.24$   $zz$  on xxiv, 9-12 on perichaetine segments. Male pores minute, in seminal grooves, on the setal arc of xviii, at *a*; prostatic pores minute, at the ends of seminal grooves, on xvii and xviii, those on xviii slightly posterior to male pores; seminal grooves short, straight to concave, posterior ends divergent. Female pore single and median. Spermathecal pores paired, minute, in 8/9, slightly ventral to *a* lines. Genital markings circular to oval, paired, at *ab*, on 9/10/11 (one of the pair sometimes absent); unpaired, median, on 15/16, 20/21, presetal on xviii slightly posterior to 17/18 between the seminal grooves.



FIGS. 422-426. *Wahoscolex curgensis* sp. nov. 422. spermathecal pore region, 423. genital region, 424. spermatheca, 425, tip of penial seta enlarged, 426. penial seta.

Septa 4/5 and 7/8 slightly muscular, 5/6/7 delicate, 8/9-12/13 muscular. Gizzard in v; intestine begins in ½xviii; typhlosole xxii to cvii. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vessels lobed, in ix and xii. Prostates 2 pairs, those in xvii longer than those of xviii. Penial setae undulating ectally, ornamented with 15-18 spines on the lateral margins, 1.03-1.15 mm long, 7-8  $\mu$  diameter. Spermathecae paired, in ix, each with an ental, clavate diverticulum, c. one-third the combined length of duct and ampulla. Genital marking glands absent. Stomate, enteronephric megameronephridia 2 pairs in each of c. 80 posteriormost segments, funnels at *ab* (close to the nerve cord) and *cd*.

*Material examined* : 4-4-2 grassland on a hill slope, soil laterite, Mercara, 12.26 N, 75.47 E, altitude c. 1220 m, 12 Sept 1979, coll. J.M. Julka (holotype in ZSIC, An 1810/1, 9 paratypes in HAZFS, ZSI, Solan, An 758).

*Distribution* : India: *Karnataka*: Mercara.

*Etymology* : Derived from the word 'Coorg' Hills in Karnataka, the location of the type locality.

*Remarks* : *Wahoscolex curgensis* sp. nov. belongs to a group of species with lumbricine setae in the anterior and perichaetine setae in the posterior region of the body. It can be easily recognized from other members of the group, *W* (?). *ditheca*, *W. corethrurus* and *W* (?). *merkaraensis* all of Michaelsen (1922) by the characters as shown in Table 13.

### 117. *Wahoscolex* (?) *ditheca* (Michaelsen)

1922. *Howascolex corethrurus* f. *ditheca* Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 42.

1923. *Howascolex corethrurus* f. *ditheca*, Stephenson, *Fauna Br. India, Oligochaeta*: 368.

Length 80 mm, diameter 0.67-1 mm, c. 170 segments. Prostomium epilobic. First dorsal pore 11/12. Clitellum annular, xiii-xvi. Setae lumbricine in anterior and middle regions and

TABLE 13. Comparison of *W. curgensis* sp. nov. with related species.

Character	<i>W. curgensis</i>	<i>W. corethrurus</i>	<i>W(?)</i> . <i>ditheca</i>	<i>W(?)</i> . <i>merkaraensis</i>
Length (mm)	64-66	85-119	80	c. 60
Segments	144-145	180, 189-206	c. 170	c. 200
Clitellum	xiii-xvii	xiii-xvi	xiii-xvi	?
Spermathecal pores	one pair, in 8/9	3 pairs, in 7/8/9/10	one pair, in 8/9	4 pairs, in 5/6/7/8/9
Seminal grooves	between setal arcs of xvii and xviii	between setal arcs of xvii and xix	between setal arcs of xvii and xix	between setal arcs of xvii and xix
Last pair of hearts	xii	xiii	?	xiii
Prostates	in xvii and xviii	in xvii and xix	in xvii and xix	in xvii and xix
Spermathecae	one pair, in ix, diverticulate	3 pairs, in viii, ix, x, diverticulate	one pair, in ix, diverticulate	4 pairs, in vi-ix, those in vi and vii vestigial and adiverticulate, those in viii-ix diverticulate
Penial setae	ornamented, 1.03-1.15 mm long	unornamented 0.59-0.74 mm long	ornamentation and length (?)	ornamented 1.2 mm long

perichaetine in the posterior region of the body,  $aa = 4$   $ab = 1.6$   $bc = 2.4$   $cd = 0.22$   $dd$ ,  $c$ . 18 on perichaetine segments. Male pores minute, in seminal grooves, on xviii; prostatic pores minute, at the ends of seminal grooves, on xvii and xix. Female pores (?). Spermathecal pores paired, in 8/9, at  $a$ . Genital markings (?).

Septa 6/7-12/13 moderately muscular. Gizzard in v; intestine begins in (?); typhlosole from (?). Last pair of hearts (?). Testes and male funnels free, in x and xi; seminal vesicles lobed, in ix and xii. Prostates paired, in xvii and xix. Penial setae present, undulating ectally, ornamentation (?). Spermathecae paired, in ix, each with a cylindrical diverticulum. Stomate, enteronephric megameronephridia (?).

*Type locality* : Shimoga, Karnataka, India.

*Type specimens* : In ZMUH, 9158.

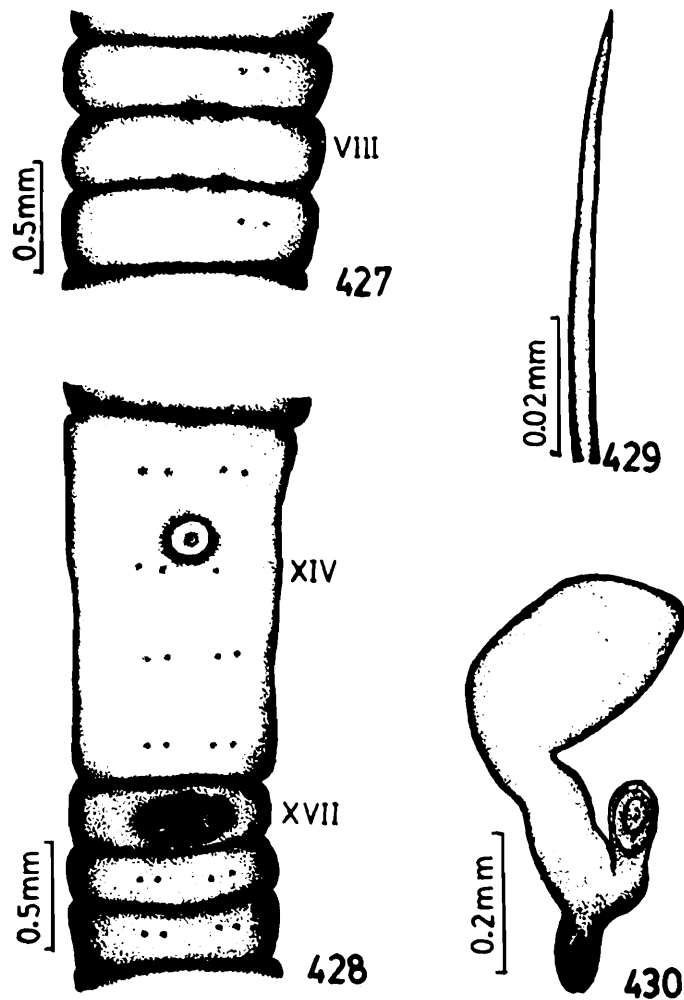
*Distribution* : So far known from the type locality.

*Remarks* : The species was described as a form *ditheca* of *Howascolex corethrurus* by Michaelsen (1922) with one pair of spermathecal pores in 8/9 but having overall morphological similarity with the typical form. Since the number and location of spermathecal pores appear to be of specific importance (see key to the species of *Wahoscolex*), the form *ditheca* is considered to be a distinct species. However, it is tentatively retained in *Wahoscolex* for lack of information on its excretory system.

### 118. *Wahoscolex horai* sp. nov.

(Figs. 427-430)

Length 37-53 mm, diameter 1-1.2 mm, 94-109 segments. Prostomium epilobic, tongue open. First dorsal pore 10/11. Clitellum annular, xiii-xvi. Setae lumbricine throughout the body,  $aa = 2.1-2.2$   $ab = 1.2-1.4$   $bc = 1.2-1.5$   $cd = 0.2$   $dd$  on xii,  $aa = 2.4-2.7$   $ab = 1.3-1.5$   $bc = 1.3-1.7$   $cd = 0.19-0.22$   $dd$  on xxiv. Combined (?) male and prostatic pores minute, at the centres of slightly protuberant porophores, on the setal arc of xvii, at  $a$ ,



FIGS. 427-430. *Wahoscolex horai* sp. nov. 427. spermathecal pore region, 428. genital region, 429. penial seta, 430. spermatheca.

porophores lateral in an oval depression. Female pore single and median. Spermathecal pores paired, minute, in 7/8/9, slightly ventral to *a*. Genital markings absent.

Septa 4/5/6 delicate, 6/7-11/12 slightly muscular. Gizzard in v; intestine begins in xix; typhlosole xxi to lxxxii. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles in ix and xii. Prostates one pair, in xvii; vas deferens on each side entering the body wall slightly anterior to the opening of the

prostatic duct in xvii, united (?) with the latter ectally beneath the longitudinal musculature. Penial setae taper gradually towards ectal ends, unornamented, 0.36-0.58 mm long, 5-7  $\mu$  diameter. Spermathecae paired, in viii and ix, each with an ental digitiform diverticulum. Stomate, enteronephric megameronephridia 2 pairs in each of c. 30 posteriormost segments, funnels at *ab* (close to the nerve cord) and *c*.

*Material examined* : 0-0-2 under decaying leaves, soil red sandy loam, Bhagamandla, c. 45 km from Mercara, altitude 1050 m, 10 Sept 1979, coll. J.M. Julka (holotype in ZSIC, An 1811/1, paratype in HAZFS, ZSI, Solan, An 759).

*Distribution* : India: Karnataka: Bhagamandla, c. 45 km from Mercara.

*Etymology* : The species is named after late Dr. S.L. Hora, a well-known Indian Zoologist.

TABLE 14. Comparison of *W. horai* sp. nov. and *W. nandiensis* sp. nov.

Character	<i>W. horai</i>	<i>W. nandiensis</i>
Length (mm)	37-53	30-42
Segments	94-109	72-100
Clitellum	xiii-xvi	xiii-xvii
Seminal grooves	absent	short, setal arc of xvii to 17/18
Spermathecal pores	2 pairs, in 7/8/9	one pair, in 8/9
Intestine begins	in xix	in xviii
Typhlosole	xxi to lxxxii	xix-xx to lviii-lxxxiii.
Penial setae	unornamented, shaft straight, 0.36 - 0.58 mm long	ornamented, shaft undulating ectally, 0.71-0.96 mm long
Spermathecae	2 pairs, in viii and ix	one pair, in ix

**Remarks :** *Wahoscolex horai* sp. nov. belongs to a group of species with lumbricine arrangement of setae throughout the body and one pair of prostates in xvii. It can be distinguished from the other member of this group, *Wahoscolex nandiensis* sp. nov. (described elsewhere in this work), by the characters shown in Table 14.

### 119. *Wahoscolex* (?) *merkaraensis* (Michaelsen)

1922. *Howascolex merkaraensis* Michaelsen, *Jb. hamb. wiss. Anst.*, 38: 47.

1923. *Howascolex merkaraensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 368.

Length *c.* 60 mm, diameter 1.75-2 mm, *c.* 200 segments. Prostomium epilobic. First dorsal pore (?). Clitellum (?). Setae lumbricine in the anterior and middle parts of the body, and perichaetine in posterior region,  $aa = 3.4$   $ab = 1.4$   $bc = 1.8$   $cd = 0.41$   $dd$ , usually 12 on perichaetine segments. Male pores minute, in seminal grooves, on xviii; prostatic pores at the ends of seminal grooves, on xvii and xix, slightly median to *a*, those on xvii larger than those on xix; seminal grooves almost straight, between setal arcs of xvii and xix. Female pore single and median. Spermathecal pores paired, in 5/6-8/9, near mid-ventral line, size of the pores increasing posteriorly. Genital markings paired, oval, in 11/12, at *ab*.

Septa 8/9-12/13 muscular, 13/14 delicate, anterior septa (?). Gizzard in vi (?v); intestine begins in xviii; typhlosole in (?). Last pair of hearts in xiii. Testes and male funnels free, in x and xi; seminal vesicles lobed, in ix and xii. Prostates 2 pairs, those in xvii longer than those in xix. Penial setae undulating ectally, ornamented with a few scar-like markings with serrated borders, 1.2 mm long, 13  $\mu$  diameter. Spermathecae paired, in vi-ix, increasing in size posteriorly, those in vi and vii vestigial and adiverticulate, those in viii and ix each with a sausage-shaped ental diverticulum, duct shorter than ampulla. Genital marking glands absent (?).

*Type locality* : Merkara, Coorg, Karnataka, S. India.

*Type specimens* : In ZMUH, 9155-6.

*Distribution* : India: Karnataka: Merkara, Bhagamanola (probably misspelt for Bhagamandla).

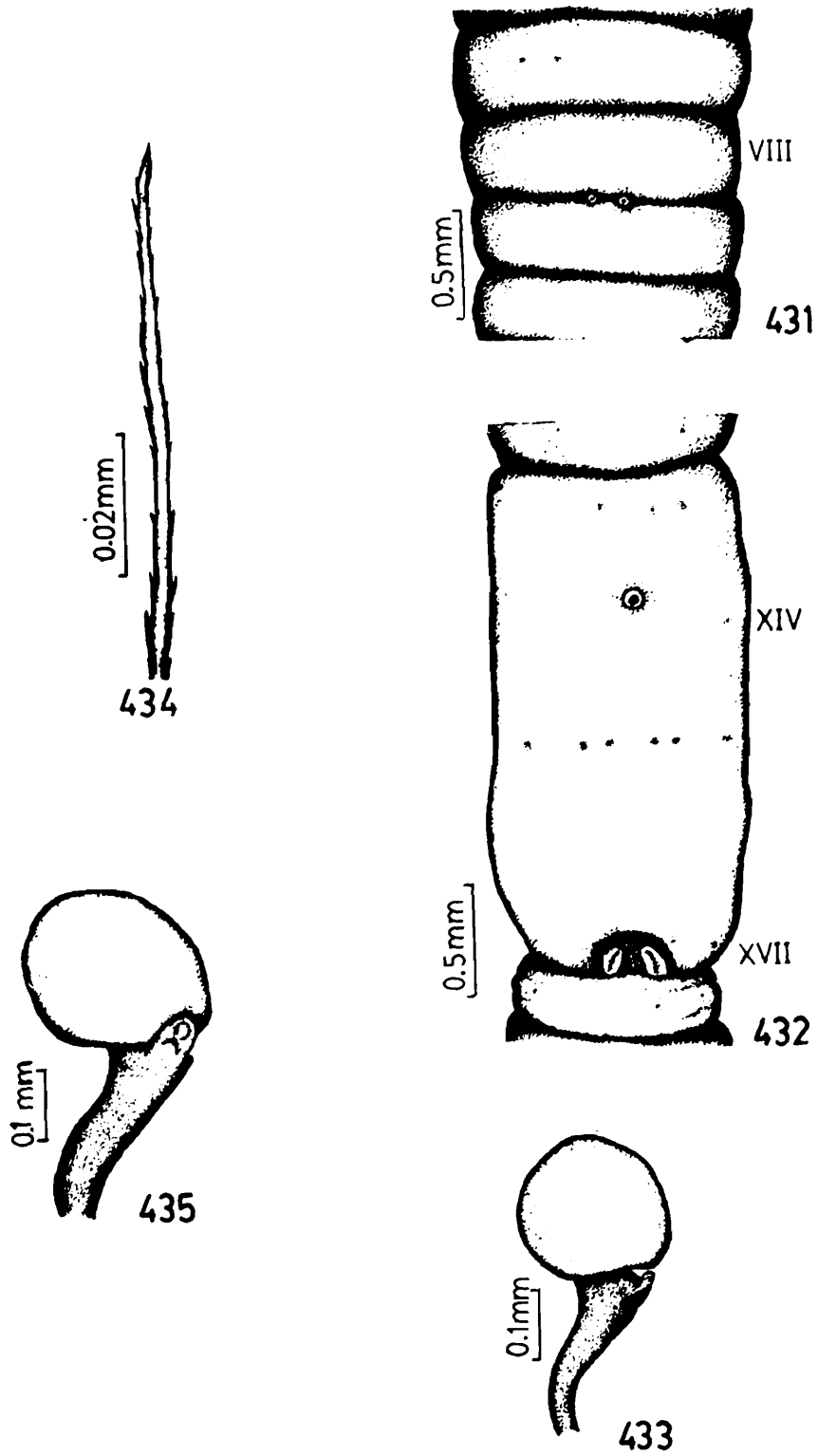
*Remarks* : This species is tentatively included in *Wahoscolex* because of lack of detailed information on its excretory system.

## 120. *Wahoscolex nandiensis* sp. nov.

(Figs. 431-435)

Length 30-42 mm, diameter 0.9 -1.1 mm, 72-100 segments. Prostomium epilobic, tongue open. First dorsal pore 11/12, occasionally 12/13. Clitellum annular, xiii-xvii. Setae lumbricine throughout the body,  $aa = 1.8-2.1$   $ab = 1-1.3$   $bc = 1.1-1.4$   $cd = 0.18-0.21$   $dd$  on xii,  $aa = 2-2.3$   $ab = 1-1.1$   $bc = 1.3-1.5$   $cd = 0.21-0.22$   $dd$  on xxiv. Male pores minute, at posterior ends of seminal grooves, in 17/18, at or slightly ventral to *b*; prostatic pores minute, at anterior ends of seminal grooves, on xvii, at *a*; seminal grooves short, almost straight or slightly curved, posterior ends divergent, between setal arc of xvii and 17/18, at centres of somewhat oval porophores. Female pore single and median. Spermathecal pores paired, minute, in 8/9, close to the mid-ventral line, sometimes equidistant from the mid-ventral and *a* lines. Genital markings absent.

Septa 4/5, 6/7-11/12 slightly muscular, 5/6 delicate. Gizzard in v; intestine begins in xviii; typhlosole xix-xx to lviii-lxxiii. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles lobed, in ix and xii. Prostates one pair, in xvii, extending to xviii. Penial setae undulating ectally, margins ornamented with sharp spines, 0.71-0.96 mm long, 5-9  $\mu$  diameter. Spermathecae paired, small, in ix, each with a short shelf-like ental diverticulum. Stomate, enteronephric megameronephridia 2 pairs in each of c. 25 posteriormost segments, funnels at *ab* (close to the nerve cord) and *c*.



FIGS. 431-435. *Wahoscolex nandiensis* sp. nov. 431. spermathecal pore region, 432. genital region, 433, 435. spermathecae, 434. penial seta.

**Material examined** : 0-0-19 under cow dung, soil black sandy, Nandi Hill, 65 km from Bangalore, 13.25 N, 77.56 E, altitude c. 1250 m, 22 Sept 1979, coll. J.M. Julka (holotype and 4 paratypes in ZSIC, An 1812/1, An 1813/1, 14 paratypes in HAZFS, ZSI, Solan, An 760).

**Distribution** : India: *Karnataka*: Nandi Hill, 65 km from Bangalore.

**Etymology** : *W. nandiensis* sp. nov. derived from the type locality, 'Nandi' Hills.

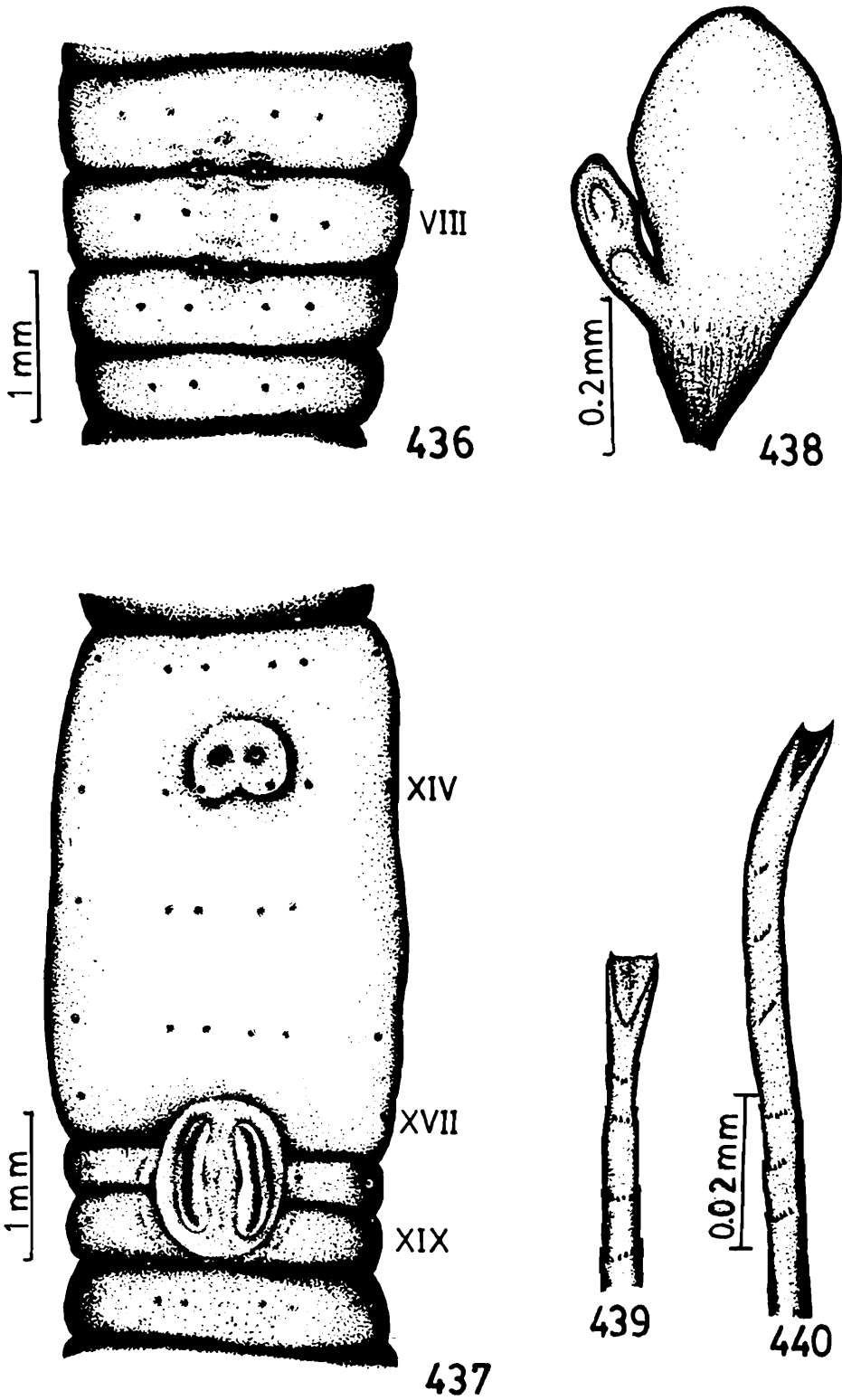
**Remarks** : *Wahoscolex nandiensis* sp. nov. belongs to a group of species with lumbricine arrangement of setae throughout the body and one pair of prostates in xvii. It can be easily distinguished from the other member of the group *Wahoscolex horai* sp. nov. (described elsewhere in this work) by the characters shown in Table 14. (Page 358)

#### 121. *Wahoscolex veereshi* sp. nov.

(Figs. 436-440)

Length 39-83 mm, diameter 1-2 mm, 124-154 segments. Prostomium epilobic, tongue open. First dorsal pore 12/13, sometimes 11/12. Clitellum annular, xiii-xvii. Setae lumbricine throughout the body,  $aa = 1.8-2$   $ab = 0.9$   $bc = 0.8-0.9$   $cd = 0.15-0.17$   $dd$  on xii,  $aa = 2.8$   $ab = 1.3-1.5$   $bc = 1.2-1.5$   $cd = 0.22-0.26$   $dd$  on xxiv. Male pores minute, in seminal grooves, on xviii, at  $a$ ; prostatic pores minute, at the ends of seminal grooves, on xvii and xix, slightly ventral to  $a$ ; seminal grooves almost straight or slightly concave between setal arcs of xvii and xix. Female pores paired, anteromedian to  $a$ , on xiv. Spermathecal pores paired, minute, in 7/8/9, just ventral to  $a$ . Genital markings absent.

Septa 4/5, 6/7-8/9 slightly muscular, 5/6 delicate, 9/10-12/13 muscular. Gizzard in v; intestine begins in xviii; typhlosole xxi-xxii to ci-cxix. Last pair of hearts in xii. Testes and male funnels free, in x and xi; seminal vesicles lobed, in ix and xii.



FIGS. 436-440. *Wahoscolex vereshi* sp. nov. 436. spermathecal pore region, 437. genital region, 438. spermatheca, 439, 440. penial setae.

Prostates, in xvii and xix, almost of equal length. Penial setae slightly undulating, ornamented with a few, short, transverse rows of 4-5 small spines, tip expanded and webbed, 0.65-0.74 mm long, 7-8  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a small, clavate, ental diverticulum. Stomate, enteronephric megameronephridia 2 pairs in each of c. 70 posterior most segments, funnels at *ab* (close to the nerve cord) and *c*.

*Material examined* : 0-0-2 grassland, soil red loam, Kemmengundi, 13.48 N, 75.69 E, altitude c. 1480 m, 4 Sept 1979, coll. J.M. Julka (holotype and paratype in ZSIC, An 1814/1, An 1815/1); 0-0-7 grassland on the bank of a stream, soil red loam, Gudalur, c. 52 km from Ootacamund on way to Mysore, 11.30 N, 76.26 E, altitude c. 1000 m, 16 Sept 1979, coll. J.M. Julka, HAZFS, ZSI, Solan, An 761.

*Distribution* : India: *Karnataka*: Kemmengundi, Bababudan Hills; *Tamil Nadu*: Gudalur, Nilgiri Hills.

*Etymology* : The species is named after the Indian soil biologist, Dr. G.K. Veeresh, University of Agricultural Sciences, Bangalore.

*Remarks* : *Wahoscolex veereshi* sp. nov. belongs to a group of species with lumbricine setae throughout the body and 2 pairs of prostates, in xvii and xix. It is distinguishable from the other members of the group *W(?)*. *bidens* (Michaelsen, 1922) and *W. bouchei* sp. nov. (described elsewhere in this work) by characters shown in Table 12. (Page 350)

## SPECIES INCERTAE SEDIS

122. *Dichogaster* (?) *travancorensis* (Fedarb)

1898. *Benhamia travancorensis* Fedarb, *J. Bombay nat. Hist. Soc.*, 11: 433.

1900. *Dichogaster travancorensis*, Michaelsen, *Tierreich*, 10: 353.

1923. *Dichogaster travancorensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 478.

Length 75 mm, diameter 2 mm, 131 segments. Clitellum saddle-shaped, xiv-xxi. Setae lumbricine, in pairs, very close together.

Gizzards 2, in viii-ix. Calciferous glands in xiv-xvi, pouch-shaped, the anterior ones the smallest. Intestine begins in xvii. Last pair of hearts in xiii. Spermathecae paired, each with a shortly cylindrical, sessile diverticulum, at the middle of the duct, which is thick and dilated, and as long as ampulla. Prostates tubular, 2 pairs. Penial setae ending in a whip-like tip, frequently bent into a hook. Meronephric.

*Type locality* : Travancore, Kerala, S. India.

*Type specimens* : In BMNH, 1904: 10: 5: 664.

*Distribution* : So far known from the type locality.

*Remarks* : All the known Indian species of *Dichogaster* can be assigned to a homogeneous *bolau* group with one pair of calciferous glands, each gland trilobed, a lobe in each of xv-xvii, the three lobes of a side open into oesophagus through a common duct in xvi. The position of calciferous glands in *travancorensis* in xiv-xvi, if correct, excludes it from the *bolau* group. According to Stephenson (1923), the original account of the species is inadequate and partly incorrect, e.g., position of gizzards, spermathecae and prostates. In absence of more exact information on the calciferous glands and other characteristics, the generic relationships of the species remain doubtful.

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

1924. *Diplocardia indica* Stephenson, *Rec. Indian Mus.*, 26: 353.

1939. *Diplocardia* (?) *indica*, Gates, *Rec. Indian Mus.*, 41: 214.

Length 50 mm, diameter 2.5 mm, 117 segments. Prostomium tanylobic. First dorsal pore 10/11. Clitellum xiv-xvii. Setae lumbricine,  $aa = 2.5$   $ab = 1.25$   $bc = 2.5$   $cd$  on preclitellar segments. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix; seminal grooves, slightly median to *b*, bent laterally on posterior portion of xvii and anterior portion of xix. Female pores paired (?), antero-medial to *a*, on xiv. Spermathecal pores paired, minute, on viii and ix, antero-lateral to *a*. Genital markings unpaired and median on xviii; paired, postsetal on viii, presetal on ix, at *aa*, postsetal on xiv and xv, 16/17, at *bc*. Nephridiopores not recognizable.

Septa 4/5 delicate, 5/6/7 slightly muscular, 7/8-11/12 muscular. Gizzards 2, in v-vi. Oesophagus moniliform in ix-xiv, with a ventral, median, typhlosole-like (calciferous ?) ridge, in x-xiii. Intestine begins in xvi; intestinal caeca and supra-intestinal glands absent; typhlosole simple, lamelliform, begins abruptly in xviii. Dorsal vessel single; supra-oesophageal vessel single, in x-xii; extra-oesophageal and latero-parietal vessels (?); subneural vessel absent; last pair of hearts in xii. Holandric, testes and male funnels in x and xi; seminal vesicles in xi and xii. Prostates paired, tubular, in xvii and xix. Penial setae with margins sinuous ectally, tip thin, flattened, truncate, 1.4-1.6 (+) mm long, 7  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a digitiform ental diverticulum. Genital marking glands absent.

*Type locality* : Buldana, Berar, Maharashtra, India.

*Type specimens* : In ZSIC, W 1148/1; BMNH, 1933: 2: 23: 614-6.

*Distribution* : So far known from the type locality.

**Remarks :** Stephenson (1924b) assigned his species *indica* from north peninsular India to an American genus *Diplocardia* in having 2 gizzards and acanthodrilid characteristics of tubular prostates and holonephric excretory system. Gates (1939b) re-examined three immature 'types' in the Indian Museum, and observed that *indica* was perhaps generically distinct from *Diplocardia* in possessing a single dorsal blood vessel and 'modified holonephridia' than the usual type (with preseptal funnels). He could not recognize meronephridia but stressed the need to confirm their absence in better preserved specimens. If meronephridia (possibly overlooked by Stephenson and Gates) are present in *indica*, it is to be transferred to an octochaetid genus, possibly *Pellogaster*.

#### 124. *Diporochaeta* (?) *dorsochaeta* Jamieson

1977. *Diporochaeta* (?) *dorsochaeta* Jamieson, *Bull. Mus., natn. Hist. nat., Paris (ser. 3)*, no. 450, Zool. 313: 480.

Length 39-66 mm, diameter 1.1-1.4 mm, 110-118 segments. Prostomium epilobic, almost tanylobic, sides slightly convergent posteriad; hind end clubbed. First dorsal pore 5/6. Clitellum annular, ½xiii-xvi, xvii. Setae lumbricine throughout the body,  $aa = 1.9$   $ab = 1.05$   $bc = 0.9$   $cd = 1.6$   $dd$  on xii. Combined male and prostatic pores paired, on strongly protuberant porophores on xviii, at *b*. Female pores paired, presetal, within *a* lines, on xiv. Spermathecal pores paired, minute, in 7/8/9, at *b*. Genital markings indistinct, oval, paired, anterior to male porophores, on xviii.

Septa present from 4/5, 7/8-10/11 slightly muscular. Gizzard single, large, in vi; oesophagus without discrete calciferous glands but widened and with calciferous (?) lamellae in xiii-xiv or xiv-xv or xiii-xv. Intestine begins in xvii or ½xvii; caeca, supra-intestinal glands and typhlosole absent. Dorsal vessel single, not recognizable on or anterior to gizzard; supra-oesophageal vessel single, x-xii; subneural vessel absent; lateral hearts originating from supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xii. Holandric, testes and male funnels free, in x and xi; seminal vesicles

in ix and xii. Prostates tubular, paired, in xviii; vas deferens joining the ental end of the prostatic duct. Penial setae with a few, sparsely scattered small teeth, 0.23 mm long, 11  $\mu$  diameter. Ovaries paired, fan-shaped, in xiii; ovisacs (?) paired, in xiv. Spermathecae paired, in viii and ix, each with a short clavate ental diverticulum. Meronephric; micromeronephridia (?); megameronephridia exonephric, one pair on each side in each of pre-intestinal segment, the lateral nephridium with a (preseptal) funnel, median nephridium astomate; caudally both lateral and median megameronephridia stomate (in some segments another pair of lateral stomate megameronephridia may be present).

*Type locality* : Gundar Shola, Palni Hills, S. India.

*Type specimens* : In Paris Museum, AH 320-322; BJ, 1976. 5. 3-4, 1976. 5. 1-2.

*Distribution* : India: *Tamil Nadu*: Gundar Shola, Kodaikanal.

*Remarks* : Jamieson (1977) considered the meronephric condition of the nephridia in his species *dorsochaeta* as a purely specific character, and assigned it (though doubtfully) to the holonephric Australasian *Diporochoeta* (Fam. Acanthodrilidae sensu Gates, 1959). He redefined *Diporochoeta* to accommodate species with holo- or meronephridia, and tubular or racemose prostates, which is not acceptable. The meronephric *dorsochaeta* with tubular prostates is assignable to the Octochaetidae (*sensu* Gates, 1959). Within the Octochaetidae, it seems to be closely related to *Celeriella* with oesophagus with a single gizzard and calciferous lamellae in xiii-xiv but without discrete calciferous glands and intestinal typhlosole.

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

1898. *Dichogaster parvus* Fedarb, *Proc. zool. Soc. Lond.*, 1898, 499.

1900. *Trigaster parva*, Michaelsen, *Tierreich*, 10: 334.

1903. *Eudichogaster parva*, Michaelsen, *Jb. hamb. wiss. Anst.*, 19: 13.

1923. *Eudichogaster parvus*, Stephenson, *Fauna Br. India, Oligochaeta*: 415.

1939. *Lenogaster* (?) *parvus*, Gates, *Rec. Indian Mus.*, 41: 198.

Length 40 mm, diameter 2 mm, 132 segments. First dorsal pore 11/12. Clitellum annular, xiii-xvii, lacking ventrally on xvii. Setae *ab* paired, *cd* distant (as far apart as *bc*),  $bc = 2 ab = cd$ . Prostatic pores one pair, on xvii, obliquely placed on ill-defined wrinkled papillae; male pores (?); female pores (?). Spermathecal pores inconspicuous, on or slightly anterior to the setal arc of viii, at *ab*.

Gizzards 2, in v-vi. Calciferous glands small, in xi, xii and xiii, the anterior pair the largest. Andry (pro- or metandric ?); seminal vesicles in xi, tongue-shaped. Prostates one pair, in xvii. Penial setae absent; copulatory setae (?). Spermathecae paired, in viii, tubular, slightly bulbous at the inner end, adiverticulate. Meronephric.

*Type locality* : Dehra Dun, India.

*Type specimens* : ?

*Distribution* : So far known from the type locality.

*Remarks* : The above description of the species is inadequate and perhaps partly incorrect. According to Gates (1939); "The tongue-shaped seminal vesicles of xi may have been vertically placed testis sacs, and if the calciferous glands are in the usual locations (in x-xii, 'as in other species of *Lenogaster*') 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" If this interpretation is correct, then *parvus* belongs to *Lenogaster* and its relationships are with *L. pusillus* and *L. chittagongensis*. It may be noteworthy to mention that the author has collected several specimens of *L. chittagongensis* from low altitudes in Sirmour district of Himachal Pradesh which is not far off from the type locality of *parvus*. On the other hand, if the location of calciferous glands in the original description of *parvus* was correctly assigned by Fedarb,

in that case it does not belong to *Lenogaster*. Extensive collecting is required from the type locality to determine its exact generic status.

### 126. *Octochaetoides* (?) *castellanus* (Stephenson)

1917. *Octochaetus castellanus* Stephenson, *Rec. Indian Mus.*, 13: 407.

1923. *Octochaetus (Octochaetoides) castellanus*, Stephenson, *Fauna Br. India, Oligochaeta*: 376.

1962. *Octochaetoides castellanus*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, 5: 211.

Length 48 mm, diameter 2 mm, c. 125 segments. Prostomium (?). First dorsal pore 5/6. Clitellum (?). Setae widely paired,  $aa = 1.66$   $ab = bc = 1.5$   $cd$ ;  $a$ ,  $b$  (?) on viii and ix copulatory. Male genital field with a median circular depression. Male pores paired, minute, on xviii; prostatic pores paired, small pits, at the ends of seminal grooves, on xvii and xix, median to  $a$ ; seminal grooves bowed outwards. Female pore single, median, on xiv. Spermathecal pores paired, on setal arcs of viii and ix, at  $a$ . Genital markings (?).

Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 delicate or absent. Gizzard between septa 4/5 and 7/8. Calciferous glands discrete, extramural, without stalks, paired, around oesophagus, in xiv. Intestine begins in xvi (?); typhlosole lamelliform, simple. Last pair of hearts in xiii (?). Hollandric, testes and male funnels free, in x and xi; seminal vesicles lobed, small, in xii. Prostates paired, tubular, in xvii and xix. Penial setae ornamented with a few, small, sparsely scattered spines ectally, tip flattened with ectal margin slightly indented, 0.87-1 mm long, 14  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a club-shaped ental diverticulum. Copulatory setae ornamented with a series of rough notches on the margins, tip claw-shaped, 0.61 mm long, 20  $\mu$  diameter. Meronephric; micronephridia astomate, large, paired tufts in iv with composite ducts opening into pharynx (?), several, exonephric, on the body wall in v and posteriad segments, arranged in 4-5

longitudinal ranks on each side posterior to clitellum; paired stomate, exonephric megameronephridia in caudal segments, funnels close to the nerve cord.

*Type locality* : Castle Rock, Karnataka, India.

*Type specimens* : In ZSIC, W 134/1; BMNH, 1933: 5: 25: 877-80.

*Material examined* : 0-0-1, syntype, W 134/1, in ZSIC.

*Distribution* : So far known from the type locality.

*Remarks* : The syntype in the Zoological Survey of India, Calcutta is macerated and broken into two parts, but some characteristics of the digestive and excretory systems can still be recognized. An examination of these characteristics shows its relationship with octochaetid genera with a single gizzard, discrete extramural calciferous glands and stomate exonephric megameronephridia in caudal segments. Its affinities with the restricted bigiceriate *Octochaetoides* are doubtful.

#### 127. *Octochaetoides* (?) *kurmagarensis* Gates

1945. *Octochaetoides kurmagarensis* Gates, *Jl. R. Asiat. Soc. Beng.*, 11: 82.

Length c. 120 mm, diameter c. 6 mm Prostomium prolobic. First dorsal pore 7/8, sometimes 6/7. Clitellum annular, xiv-xvi, or slightly onto xvii dorsally. Setae *a* on viii and ix copulatory, those on viii being surrounded by tumescences. Male genital field indistinct. Male pores paired, in seminal grooves, on xviii; prostatic pores paired, at the ends of seminal grooves, on xvii and xix; seminal grooves almost straight, between setal arcs of xvii and xix, at or just median to *a*. Female pores paired, presetal, within *a* lines, on xiv. Spermathecal pores paired, small, transverse or diagonal slits, on or slightly posterior to setal arcs of viii and ix, median to *a*. Genital markings absent.

Septa 4/5/6 delicate, 6/7-12/13 slightly muscular. Gizzard in v. Calciferous glands unpaired, a low annular band around oesophagus, in xv. Intestine begins in xvii; caeca, supra-intestinal

glands and typhlosole absent. Dorsal vessel single and complete; supra-oesophageal vessel single, viii-xiii; extra-oesophageal vessels paired, each with small vessels joining the supra-oesophageal vessel in each of segments viii-xiii; latero-parietal vessels paired, joining the supra-oesophageal vessel in xiii; lateral hearts originating from the supra-oesophageal vessel with delicate connectives to the dorsal vessel in x-xiii. Holandric; seminal vesicles in ix and xii. Prostates paired, tubular, in xvii and xix. Penial setae ornamented with 40-50 circles of closely crowded fine spines, tip thin and flattened, terminal margin very finely toothed, 2(+) mm long. Spermathecae paired, in viii and ix, each with a sessile ental diverticulum with 1-3 seminal chambers. Copulatory setae ornamented with longitudinally placed rectangular depressions, tip claw-shaped, 1.5-1.8 mm long. Meronephric; micromeronephridia astomate, paired enteronephric (?) tufts in iv, several exonephric on the body wall in v and posteriad segments.

*Type locality* : Kurmagar Island, Karwar Harbour, Karnataka, S. India.

*Type specimens* : ?

*Distribution* : So far known from the type locality.

*Remarks* : Unpaired and annular condition of the calciferous glands in xv may be of sufficient taxonomic importance to require generic distinction from other known octochaetid genera (Gates, 1945a). More information on the characteristics of the excretory system, especially the caudal nephridia, is required to consider its generic status. Certainly, *Octochaetoides kurmagarensis* with a single gizzard cannot be assigned to the restricted bigiceriate *Octochaetoides*.

### 128. *Octochaetoides* (?) *raoi* Gates

1945. *Octochaetoides raoi* Gates, *Jl. R. Asiat. Soc. Beng.*, 11: 85.

Length 140 (+) mm, diameter 3 mm. First dorsal pore 12/13. Clitellum annular, xiii-xvi. Setae lumbricine,  $ab < cd < bc < aa$  at

posterior end. Male genital field longitudinally rectangular between 16/17 and 19/20, extending laterally to median portion of *bc*, slightly depressed between seminal grooves. Male pores paired, probably in seminal grooves on xviii; prostatic pores paired, probably at the ends of seminal grooves, on xvii and xix; seminal grooves bracket-shaped between the setal arcs of xvii and xix, at about *a*. Female pores paired, near midventral line, on xiv. Spermathecal pores paired, transverse slits in 7/8/9, slightly median to *a*. Genital markings oval, paired, on 11/12, at *ac*, unpaired and median, on 14/15, at *bb*.

Septa present from 4/5, 5/6 delicate, 6/7-11/12 muscular. Gizzard in v. Calciferous glands one pair, discrete, extra-mural, vertical, ovoidal, sessile, in xvi, associated with septum 15/16, opening into oesophagus through fairly large lateral slits. Intestine begins in xvii; caeca and supra-intestinal glands absent; typhlosole lamelliform, simple. Last pair of hearts in xiii. Holandric; seminal vesicles acinous, in ix and xii. Prostates paired, tubular, those of xvii extend to xvi, those of xix to xx. Penial setae unornamented, 0.45-0.73 mm long, 26-40  $\mu$  diameter. Spermathecae paired, in viii and ix, each with a shortly stalked uni- to multiloculate ectal diverticulum. Meronephric; micromeronephridia astomate, large, paired, (exo- or enteronephric ?) tufts in iv, v and vi, several on the body wall in other segments. Genital marking glands absent.

*Type locality* : Nandydroog (Nandi Hills), Karnataka, India.

*Type specimens* : ?

*Distribution* : So far known from the type locality.

*Remarks* : *O. raoi* with a single oesophageal gizzard cannot be assigned to the restricted bigiceriate *Octochaetoides*. More information on the characteristics of the excretory system is required for considering its relationship with other octochaetid genera.



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Names in *italics* are synonyms and numbers in **bold** indicate pages containing detailed descriptions.

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