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Earthworms (Oligochaeta : Annelida) of Orissa, India

by
J. M. JULKA
B. K. SENAPATI

Issued by the Director
Zoological Survey of India, Calcutta

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EARTHWORMS (OLIGOCHAETA : ANNELIDA) OF ORISSA, INDIA

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INTRODUCTION

Michaelsen (1910) provided the first records of earthworms from Orissa. Subsequently, several species were described from the area by Stephenson (1914, 1915, 1916, 1917, 1921, 1923, 1926) and Julka (1976, 1978). Due to their importance in the soil ecosystem, significant work has been carried out on the ecology and biology of the Orissan earthworms during the last decade by Patra and Dash (1973), Dash *et al.* (1974, 1980), Dash and Patra (1977, 1979), Senapati and Dash (1979, 1981, 1982, 1983a, 1983b), Dash and Senapati (1980), Senapati *et al.* (1979), Senapati (1980, 1983a, 1983b), Mishra and Dash (1983) and Senapati and Kabi (1983). This article presents a comprehensive systematic account, and ecological and biological observations on the earthworms of Orissa. In addition, some unpublished observations on their ecology and biology and new records derived from recent collections are presented for the first time. A key for the identification of the Orissan earthworms is also included. For a detailed synonomy of the species, the works of Gates (1972) and Julka (1976, 1978) may be referred. In this work the classification of Oligochaeta into orders and suborders as proposed by Brinkhurst and Jamieson (1971) and the division of the suborder Lumbricina into superfamilies and families as given by Sims (1980) are followed.

Key to the Identification of Earthworms of Orissa

1. Testes and male funnels intraseptal, male pores in 10/11, clitellum in *x-xiii*. ...2 (Fam. Moniligastridae)

   Testes and male funnels interseptal, male pores posterior to 10/11, clitellum in *xiii* and posteriad segments ...4

2. Genital markings with central pores, genital marking glands digitiform, prostate-like, distinctly protuberant into body cavity ...3

   Genital markings without central pores, genital marking glands spheroidal to oval between epidermis and longitudinal muscle layer ...*Drawida calebi*

3. Genital markings in 9/10, genital marking glands shorter than prostates ...*Drawida willsi*

   Genital markings usually close to spermathecal pores, rarely on *ix* and *x*, genital marking glands longer than prostates .. *Drawida limella*

4. Male and spermathecal pores inconspicuous, prostates absent, body wall protuberant at maturity as a longitudinal lamellar ridge ("Wing") through several clitellar segments ...*Glyphidrilus tuberosus* (Fam. Almidae)

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5. Prostates tubular ...6

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Metandric, male pores at anterior ends and prostatic pores at posterior ends of diagonally placed short seminal grooves ... *Malabaria sulcata*

11. Genital markings present ...12
Genital markings absent ... *Thatonia gracilis*

12. Genital markings internally with spheroidal glands, markings on *viii-x*, 15/16-16/17, 19/20-21/22 ... *Thatonia sambalpurensis*

Genital markings internally with prostate-like glands, markings on *xxii* ... *Thatonia bolangirensis*

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Two gizzards present ...21

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Discrete calciferous glands present ...17

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Prostates two pairs discharging on *xvii* and *xix*, male pores on *xviii*, calciferous glands extramural, one pair, usually asymmetrical, opening into gut at or close to the insertion of septum 15/16 ...19

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19. Holandric ... 20
Metandric ... *Octochaetona beatrix*

20. Last pair of hearts in *xii*, testes and male funnels free ... *Octochaetona barkudensis*

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Female pores paired ... 23

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Genital markings absent ... *Dichogaster modiglianii*

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Spermathecal pores 3 pairs in 6/7/8/9, nephridia vesiculate, nephridiopores alternating in position in successive segments on each side ... *Perionyx sansibaricus*

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Septum 8/9 absent, spermathecal pores 2 pairs opening on *vii* and *viii* close to 6/7/8, genital markings 1-4 slightly median to each spermathecal pore on *vii-viii*, 8-13 on roof and walls of each copu'atory pouch ... *Metaphire planata*

SYSTEMATIC ACCOUNT

Order HAPLOTAXIDA

Diagnosis. Testes and male funnels interseptal; male funnels at least one segment anterior to that bearing the male pores.

Suborder LUMBRICINA

Diagnosis. Male pores at least 2 segments posterior to testes. Clitellum formed from multiple layers of cells:

Superfamily GLOSSOSCOLECOIDEA

Diagnosis. Ovaries large, elongate, band or ribbon-shaped, tending to become lobate, oocytes not forming egg-strings.

Family ALMIDAE

Diagnosis. Body quadrangular in cross-section at least posterior to clitellum. Dorsal pores absent. Male pores inconspicuous, one pair between *xv-xxx*; spermathecal pores inconspicuous, multiple, usually posterior to testes. Prostates usually absent. Oesophageal gizzard(s) anterior to the testicular segment; extra-mural calciferou glands absent. Holonephric.

Distribution. Tropical America, Africa, peninsular India, Burma, Malaysia and Indochina eastwards to Sulawesi.

Genus Glyphidrilus Horst

Diagnosis. Setae lumbricine. Male pores inconspicuous, ventral to the laterally protuberant ridges or "wings" in clitellar segments. Oesophagus with a single gizzard in *vii* or *viii*, sometimes extending into an adjacent segment; calciferous glands, intestinal caeca and supra-intestinal glands absent; typhlosole simple lamelliform. Prostates absent. Nephridiopores at *b* lines, nephridia absent anterior to *xii*.

Distribution. India, Sri Lanka, Burma, Hainan, Malaya, Sumatra, Java, Borneo, Celebes, Tanzania.

Glyphidrilus tuberosus Stephenson
(Figs. 1-2)

1916. *Glyphidrilus tuberosus* Stephenson, *Rec. Indian Mus.*, **12** : 349 (Type locality : Cuttack, Orissa, India); Jamieson, 1971, in *Aquatic Oligochaeta of the world*, ed. Brinkhurst, R.O. and Jamieson, B.G.M., Oliver & Boyd, Edinburgh : 766.

Diagnosis. Length 60-118 mm, diameter 3 mm, 221 segments. Prostomium prolobic. Clitellum annular, *xiv, xv, xvi-xxviii, xxix*, with lateral, longitudinal, protuberant ridges (ala or 'wings') on *xx-xxiv*, extending forwards as slight ridges to *xiv* and sometimes back to *xxviii*. Setae $aa=2ab=0.9bc=2cd=0.72dd$ on *xii*, $aa=2ab=bc=2.25cd=0.78dd$ on *xxii*. Male pores inconspicuous. Female pores paired, minute, presetal, on *xiv*, slightly lateral to *b* lines. Spermathecal pores 2-4 on each side, in 13/14/15, at *a, b* and *bc*, sometimes at *c*. Genital markings small, rounded papillae, postsetal, usually arranged in a set of 6 in a transverse row on a segment; 2 in *aa*, 1 in *ab* and 1 slightly lateral to *b* on *x-xii, xiii*; 1 median to *a*, 1 in *ab* and 1 lateral to *b* on *xvi*, xvii, *xviii-xix, xxiv-xxviii, xxx*.

Gizzard in *vii*, sometimes slightly extending in *vi*, size variable. Intestine begins in *xv*. Last pair of hearts in *xi*. Holandric, testes and male funnels free in *x* and *xi*; seminal vesicles in *ix-xii*. Spermathecae small spherical sacs without diverticula, 2-4 on each side in *xiv* and *xv*. Nephridia avesiculate.

Distribution. India : Orissa : Cuttack, Burla, Godbhaga, Ladukhai, Snudargarh, Surda ; West Bengal ; Tamil Nadu.

Material examined. Several juvenile, aclitellate and clitellate specimens from Burla, Godbhaga, Ladukhai in Sambalpur Distt and Sundargarh and Surda in Sundargarh Distt., Orissa, Aug-Sept, 1980, coll. B.K. Senapati.

Habitat. Submerged soil with high organic matter (>10g%) particularly mulched materials, muddy soil, with about neutral pH, in lowland crop field soil and sewage system.

Biology. The maximum population density was 300/m² in a lowland crop field. Activity ceases at a lower soil moisture (<15-18g%). Reproduction is biparental; cocoons are flat, beetle leaf shaped; usually a single young hatches from each cocoon; incubation period is about 15-30 days. Reproduction is restricted to

the rainy season in August-September, but it may continue throughout the year in permanent moist habitats. Two reproductive peaks, one during rainy and the other during early summer, were observed in irrigated crop fields.

This species deposits casts on the soil surface in the from of elongated threads arranged in small tower-like structures. Cast production was estimated as 26 g/g dry wt. of body tissue/day.

Superfamily MEGASCOLECOIDEA

Diagnosis. Ovaries large, fan to rosette-shaped with the oocytes forming several egg strings.

Family ACANTHODRILIDAE

Diagnosis. Body cylindrical. Dorsal pores present or absent. Male pores posterior to *xvi.* Spermathecae in pre-testicular segments; prostates tubular with central canals. Last pair of hearts posterior to *xi.* Holonephric.

Distribution. America, tropical and southern Africa, ? south-eastern Asia, Australasia, islands of the Southern Ocean.

Genus **Pontodrilus** Perrier

Diagnosis. Setae lumbricine. Male pores (combined with prostatic pores) paired, on *xviii* ; female pores paired, on xiv. Calciferous glands, intestinal caeca, supra-intestinal glands and typhlosole absent. Holonephridia absent in preclitellar segments.

Distribution. Circummundane, on the seashores in the tropics and warmer parts of the temperate zones in both hemispheres.

Pontodrilus bermudensis Beddard

1891. *Pontodrilus bermudensis* Beddard, *Ann. Mag. nat. Hist., ser. 6,* **7** : 96 (Type locality : Bermuda, West Indies); Stephenson, 1923, *Fauna Br. India. Oligochaeta* : 180; Gates, 1972, *Trans. Am. phil. Soc.* **62**(7) : 47.

Diagnosis. Length 32-120 mm ; diameter 2-4 mm, 78-125 segments. Prostomium epilobic, tongue open. Dorsal pores absent. Clitellum saddle-shaped, *xiii-xvii, xviii.* Setae ornamented ectally, *ab*$<$ *cd, aa* and *bc* about$=$*cd, dd*$<\frac{1}{2}$C. Male pores minute, at *b,* on small papillae Spermathecal pores paired in 7/8/9, at or slightly lateral to *b.* Genital markings transversely oval, unpaired, median, usually in 19/20, sometimes in 12/13, 13/14. Nephridiopores inconspicuous.

Septa 5/6-12/13 muscular. Gizzard absent, gut somewhat thickened in *v* but not muscular; intestine begins in *xvii*. Last pair of hearts in *xiii*. Holandric, testes and male funnels free in *x* and *xi*; seminal vesicles acinuous, in *xi* and *xii*. Penial setae absent. Spermathecae paired in *viii* and *ix*, each with an ectal digitiform to club-shaped diverticulum. Nephridial ducts slightly thickened before entering parietes in postclitellar segments. Genital marking glands absent.

Distribution. India : Orissa : Chilka Lake ; Andhra Pradesh ; Tamil Nadu ; Kerala ; Maharashtra ; Goa ; Andaman & Nicobar Islands ; Laccadives & Maldives . Sri Lanka, Burma, Vietnam, Indonesia, Australia, some islands in the Pacific Ocean, U.S.A., West Indies, South America, Africa, Madagascar.

Habitat. Mud with large content of organic matter and salt on seashore and margins of estuaries and brackish water lakes.

Family MEGASCOLECIDAE

Diagnosis. Body cylindrical. Dorsal pores present. Male pores posterior to *xvi*. Spermathecae in pre-testicular segments ; prostates racemose without central canals. Last pair of hearts posterior to *xi*. Holo or meronephric.

Distribution. Eastern U.S.S.R., Japan, Korea, Southern China to Australasia.

Genus **Lampito** Kinberg

Diagnosis. Setae perichaetine. Male pores (combined with prostatic pores) paired, on *xviii* ; female pores paired, on *xiv*. Oesophagus with a single gizzard in *v*, calciferous lamellae in *x-xiii* ; intestinal caeca and supra-intestinal glands absent; typhlosole present. Meronephric ; paired tufts of astomate micromeronephridia on septa *v-xiii, xiv*, with ducts from some tufts opening into pharynx ; numerous, v-shaped, astomate, exonephric micromeronephridia on the body wall in *xv* and posteriad segments ; paired, stomate, enteronephric megameronephridia in *xx* and posteriad segments.

Distribution. India : Palni and Cardomom Hills in S. India. One species, *Lampito mauritii*, widely distributed upto about 750 m altitude throughout India and also to other parts of the world probably due to transportation.

Lampito mauritii Kinberg

(Figs 3-5)

1866. *Lampito mauritii* Kinberg, *Ofvers. K. Vetens.—Akad. Forhandl. Stockholm,* **23** : 103 (Type locality : Mauritius) ; Gates, 1938, *Rec. Indian Mus.,* **40** : 413 ; Gates, 1960, *Bull. Mus. comp. Zool. Harv.,* **123** (6) : 243 ; Gates, 1972, *Trans. Am phil. Soc.,* **62** (7) : 133.

Diagnosis. Length 95-155 mm, diameter 3-6 mm, 157-201 segments. Prostomium epilobic, tongue closed. First dorsal pore in 10/11 or 11/12 or 12/13. Clitellum annular, *xiii*, ½*xiii-xvii*. Setae 26-39 on *iii*, 40-51 on *viii*, 38-50 on *xii*, 30-43 on *xx*. Male pores on slightly raised porophores, at or lateral to *b*. Female pores presetal, within *aa*. Spermathecal pores paired, in 6/7/8/9. Genital markings absent.

Septa present from 4/5, 7/8-12/13 muscular. Intestine begins in xv ; typhlosole rudimentary. Last pair of hearts in *xiii*. Holandric ; seminal vesicles in *ix* and *xii*. Penial setae ornamented with closely crowded circles of triangular teeth, tip horseshoe-shaped, 1 32-2 mm long, 24-31 μ diameter. Spermathecae paired in *vii-ix*, each with a median and a lateral digitiform diverticula.

Distribution. India : Orissa : Chandipur, Brajarajpur, Balugaon, Sabolia village, Mirzapur vill., Balaramgudi, Paradip Port, Konarak, Gopalpur, Baripada, Bisoi, Barkul, Jharsuguda, Sambalpur, Bolangir; widely distributed in other parts of India including Andaman & Nicobar Islands, Laccadive and Minicoy. Sri Lanka, Maldives, Burma, Bangla Desh, Pakistan, Seychelles, Comoro Islands, Madagascar, Mauritius, Zanzibar, Thailand, Malaysia, Sumatra, Christmas Island, Nordwachten, Sumba, Kiss Island, Labuan, British North Borneo, Philippines, Nias, Kowloon, China, Hongkong.

Habitat. Grassland, forest, crop field, compost pit, domestic garbage and sewage system Usually more abundant in soils with high organic matter (>5g%) and neutral to slightly alkaline pH (>7.0)

Biology. Population is at a low level during summer season (March-mid June). Maximum monthly population in some habitats are : grazed upland pasture 37/m^2 ; ungrazed upland pasture 42/m^2 (Senapati and Dash, 1981) ; grazed forest 64/m^2 (Mishra and Dash, 1983) ; ungrazed lowland pasture 240/m^2 (Dash and Patra, 1977) ; compost pit 400/m^2 (Senapati, unpublished). Population turnover (Maximum : minimum) is 2 in an upland ungrazed system and 3 in an upland grazed system (Senapati, 1980).

Reproduction in a swampy habitat (soil moisture >10g%) occurs throughout the year with two peaks : one around pre-rainy season and another around pre-summer months (Senapati, unpublished). In drier habitats, a single peak reproduction is noticed during post-rainy season. Cocoons are oval with a hatching and a non-hatching end ; average diameter 3.35 mm, length 4.7 mm, live weight 25.61 mg, ratio of diameter : length 0.70 ; incubation period around 4 weeks. Usually one, rarely 2 (10%) juveniles hatch from each cocoon. Worms and cocoons are comparatively larger in compost pits during the rainy season (Dash and Senapati, 1980). Cocoon production per adult worm is 3 per year in an ungrazed plot but more than 4 in a grazed (disturbed) plot. Cocoon mortality is higher in a grazed plot (Senapati, 1980). Newly hatched young worms take about 20 months to attain maturity in an upland pasture system. Quiescence during summer delays the maturity around 3-4 months (Senapati, 1980). In compost pits and laboratory culture the maturity is attained within 3-6 months (Senapati, unpublished).

L. mauritii deposits casts on the soil surface in the form of small heaps of spheroidal or nearly globular pellets. High percentage of fibrous materials might join the pellets to form a string. An average worm of one gram live weight produces 0.7 to 2.8g of dry worm casts/day (Dash *et al*, 1980). In a lowland ungrazed pasture, it produced about 31 tonnes of dry casts per year per acre.

Economic importance. This species is suitable for utilization as a waste conditioner. In laboratory, inoculation of *L. mauritii* stimulated decomposition of organic waste by 25% (Senapati and Dash, 1982, 1983a). It has been assessed that an earthworm population mainly dominated by *L. mauritii*, could process about 13% of the net organic matter input from vegetation compartment into soil system. Certain digestive enzymes like protease, amylase, invertase, cellulase and urease have also been reported from the gut of this species (Mishra and Dash, 1980). Because of high protein content in their body tissue (>50g%) these worms are quite suitable as fish bait, poultry and fish feed (Dash *et al.*, 1979). Dash *et al*, 1980 have shown that these worms can also be utilized as biological agents for controlling plant parasitic nematodes.

Genus **Metaphire** Sims & Easton

Diagnosis. Setae perichaetine. Male pores (combined with prostatic pores) paired within copulatory pouches on *xviii*, rarely *xix* or *xx*. Oesophagus with a single gizzard between septa 7/8 and 9/10

and without pouches ; intestinal caeca present ; originating in or near xxx*ii* ; supra-intestinal glands absent. Meronephric ; paired tufts of astomate, enteronephric micromeronephridia in *iv-vi* ; numerous, astomate, exonephric, v-shaped micromeronephridia on the body wall in *iii* and posteriad segments ; several stomate, enteronephric, slightly enlarged micromeronephridia on both sides of septa from 16/17 posteriorly ; nephridia absent from spermathecal ducts.

Distribution. Oriental region from Japan southwards through the Indo-Australasian archipelago to the rain forests of Australasis through Oceania.

Metaphire planata (Gates)

1926. *Pheretima planata* Gates, *Ann. Mag. nat. Hist. (ser. 9)*, **17** : 411 (Type locality : Rangoon, Burma) ; Gates, 1972, *Trans. Am. phil. Soc.*, **62** (7) : 211.

1972. *Metaphire planata,* Sims and Easton, *Biol. J. Linn. Soc* , **4** : 239.

Diagnosis. Length 64-176 mm, diameter 4-7 mm, 115-142 segments. Prostomium absent or rudimentary (?). First dorsal pore in 10/11 or 11/12. Clitellum annular, *xiv-xvi*. Setae 75-87 on *viii*, 63-78 on *xii*, 55-65 on *xx*, 35-42 between spermathecal pores, 8-14 between male pores. Male pores paired, on *xviii*. Female pores single, median, presetal on *xiv*. Spermathecal pores paired, minute, on anterior margins of *vii* and *viii*. Genital markings small, circular, 1-4 slightly median to each spermathecal pore, 8-13 on roof and walls of each copulatory pouch.

Septa 6/7/8 muscular, 8/9/10 absent, 10/11-12/13 slightly muscular. Intestine begins in *xv* ; intestinal caeca paired, simple, originating in *xxvii* and extending forward to *xx* ; typhlosole simple, lamelliform. Last pair of hearts in *xiii*. Holandric, testes and male funnels contained in paired sacs in *x* and *xi*, testis sacs of *x* ventral, those of *xi* vertical and include seminal vesicles of *xi* ; seminal vesicles in *xi* and *xii*. Spermathecae paired in *vii* and *viii*, each with a diverticulum which is longer than the main axis. Genital marking glands composite, stalked.

Distribution. India : Orissa : Jharsuguda ; Assam ; W. Bengal ; Andaman Islands, Burma, Bangla Desh, Thailand, Malaysia.

Metaphire posthuma (Vaillant)
(Figs. 6-7)

1868. *Pheretima posthuma* Vaillant, *Annls. Sci. nat. (ser. 5)*, **10** : 228 (Type locality : Java) ; Gates, 1972, *Trans. Am. phil. Soc.*, **62**(7) : 212.

1972. *Metaphire posthuma,* Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 239.

Diagnosis. Length 60-140 mm, diameter 3-8 mm, 91-124 segments. Prostomium epilobic, tongue usually open. First dorsal pore in 12/13. Clitellum annular, *xiv-xvi*. Setae 106-129 on *viii*, 63-75 on *xii*, 60-95 on *xx* 36-44 between spermathecal pores, 16-22 between male pores. Male pores on *xviii*, 0.25 body circumference apart. Female pore single, median, presetal on *xiv*. Spermathecal pores paired, minute, in 5/6-8/9, 0.26-0.33 body circumference apart. Genital markings paired, usually on setal arcs of *xvii* and *xix* slightly median to male pore lines, sometimes on *xvi* and a few segments posterior to *xix*.

Septa 5/6-8/9 muscular, 9/10 absent. Intestine begins in *xv*; intestinal caeca paired, simple, originating in *xxvii* and extending anteriorly to *xxiv*; typhlosole simple, lamelliform. Last pair of hearts in *xiii*. Holandric, testes and male funnels enclosed in unpaired sacs, those of *x* ventral, those of *xi* vertically U-shaped; seminal vesicles in *xi* and *xii*, those or *xi* small, included in the testis sac; pseudovesicles small, in *xiii*. Spermathecae paired, in *vi-ix*, each with an ental diverticulum of veriable length, Genital marking glands sessile.

Distribution. India : Orissa : Baleswar, Sundargarh ; W. Bengal ; Bihar ; Uttar Pradesh ; Punjab ; Rajasthan ; Madhya Pradesh ; Maharashtra ; Andaman & Nicobar Islands. Bangla Desh, Burma, Pakistan, Thailand, Malay Peninsula, S.E. Asia, Formosa, Indonesia, Philippines, U S.A

Material examined. 2 clitellate, Baleswar, Sept 1980, B.K. Senapati ; 1 clitellate, Sundargarh, Aug 1980, B.K. Senapati.

Habitat. It inhabits subsoil at 10-20 cm depth in sandy loam soil with a high organic content (>5g%). It is usually found in grassland, lawn and kitchen garden.

Biology. At one site near a well in a grassland at Baleswar the population density was 30 worms/m^2 Breeding is interrupted by summer and the worms undergo quiescence. However, breeding is apparently possible throughont the year where adequate moisture is available (Bahl, 1922). Incubation period is about 8 weeks in the field and 4-5 weeks under the laboratory conditions (Tembe and Dubash, 1959). Usually one young hatches from each cocoon, which is spheroidal in shape. A newly hatched worm matures after 8 weeks (Gates, 1972). *Metaphire posthuma* is geophagous and feeds underg ouud. Casts are deposited on the soil surface in the form of small heaps of loose ovoidal pellets.

Economic importance. It is most commonly used as a laboratory material in India.

Genus Perionyx Perrier

Diagnosis. Setae perichaetine. Male pores (combined with prostatic pores) paired, on *xviii* ; female pore unpaired, median, presetal on *xiv*. Oesophagus without or with a single, small gizzard in *v* or *vi* ; discrete calciferous glands, intestinal caeca, supra-intestinal glands and typhlosole absent. Holonephric.

Distribution. India, Burma, possibly Sri Lanka and Malayasia.

Perionyx excavatus Perrier

1872. *Perionys excavatus* Perrier, *Nouv. Archs Mus. Hist. nat. Paris,* 8 : 126 (Type locality : Saigon, Vietnam) ; Gates, 1972, *Trans. Am. phil. Soc.,* 62 (7) : 141.

Diagnosis. Length 30-180 mm, diameter 3-7 mm, 123-178 segments. Prostomium epilobic, tongue open. First dorsal pore in region of 2/3-5/6. Clitellum annular, *xiii-xvii*. Setae 46-56 on *ix*, 47-52 on *xii*, 46-52 on *xx*, 4-6 between spermathecal pores. Male pores on small papillae in a single male field, each papilla with 4-9 penisetal follicles contained in a transverse groove. Spermathecal pores paired, near mid-ventral line, in 7/8/9. Genital markings absent. Nephridiopores inconspicuous, in one rather irregular longitudinal rank on each side.

Septa all present from 4/5. Gizzard absent or slightly developed in *v* ; oesophagus widened and moniliform in *xiii* : intestine begins in *xv* or *xvi*. Last pair of hearts in *xii*. Holandric, testes and male funnels free in *x* and *xi* ; seminal vesicles in *xi* and *xii*, those of *xii* extend to septum 14/15. Penial setae or namented with 6-16 circles of triangular spines, 0.60-0.69 mm long, 15-25 μ diameter. Spermathecae paired, large, in *viii* and *ix*, each with intramural seminal chambers near ental end of duct. Nephridia avesiculate.

Distribution. India : Orissa : Sambalpur, Burla, Bargarh, Jyoti Vihar, Rajgangpur, Sundargarh ; Assam ; Arunachal Pradesh ; W. Bengal; Uttar Pradesh; Himachal Pradesh; Maharashtra; Andaman & Nicobar Islands. Widely transported, successful colonization restricted to tropical lowlands from Madagascar east to the Hawaiian Islands.

Material examined. Several juvenile, aclitellate and clitellate, Burla, Sundargarh, Rajgangpur, July-Aug 1980, B.K. Senapati.

Habitat This species inhabits mainly the top 10 cm of soil with high moisture and very high organic material (>10 g%). It is usually found in manure near cow sheds, kitchen waste deposits and crop field receiving sewage.

Biology. Population density of *P. excavatus* from a kitchen waste deposit site at Rajgangpur was 600/m^2 during early rain. Cocoons are very much similar to those of *P. millardi*. Incubation period is about 3-4 weeks. Newly hatched young worm attains maturity within 60-70 days in the laboratory culture with field substrate. Peak cocoon production occurs twice a year : during late June-July and February-March. Breeding is possible throughout the year under favourable soil moisture conditions. Casts are deposited on soil surface in the from of short threads or rods.

Economic importance. This species thrives well in kitchen waste, sewage sludge and agricultural waste, and can easily be used as a waste conditioner. As this species can easily be cultured, it can also provide animal protein for utilization in poultry and fish feed.

Perionyx millardi Stephenson

1915. *Perionyx millardi* Stephenson, *Mem. Indian Mus.*, **6** : 74 (Type locality: Bombay, India); Stephenson, 1923, *Fauna Br. India, Oligochaete* : 342.

Diagnosis. Length 40-90 mm, diameter 2-2.5 mm, 126-170 segments. Prostomium epilobic, tongue closed or open. First dorsal pore in 4/5 or 5/6. Clitellum annular, *xiii-xvii*. Setae 40 on *ix*, 41 on *xii*, 48 on *xix*. Male pores near mid-ventral line, on small papillae. Spermathecal pores paired, in 7/8/9, near mid-ventral line, at *b*. Genital markings absent. Nephridiopores inconspicuous, in a rather irregular longitudinal rank on each side.

Septa all present from 4/5. Gizzard slightly developed in *vi*. Intestine begins in *xviii* or *xix*. Last pair of hearts in *xiii*. Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles in *xi* and *xii*, those of *xii* extend posteior to septum 13/14. Penial setae ornamented with 9 or 10 circles of fairly sized spines, 0.44-0.65 mm long, 15-18 μ diameter. Spermathecae paired, in *viii* and *ix*, each with an ental diverticulum. Nephridia avesiculate.

Distribution. India : Orissa : Brajarajpur, Chilka. Sambalpur, Jagatsinghpur, Burla, Jyoti Vihar ; Maharashtra ; Madhya Pradesh.

Material examined. 1 aclitellate, 11 clitellate, Jagatsinghpur, June 1980, B.K. Senapati.

Habitat. It is restricted to almost neutral soils (pH 7) with high soluble organic material and high moisture (>10 g%).

Biology. Population density at Jyoti Vihar ranged from 50/m^2 to 500/m^2 during summer and rainy months respectively. Breeding takes place during early rainy period (July-August). Cocoons are elongate and 'S'-shaped. They are initially of light colour and become dark gradually. Incubation period is about 3-4 weeks. Usually one young worm emerges from each cocoon (Senapati, unpublished). Casts are deposited on the soil surface in the form of short threads or rods ; threads are longer if the soil is rich in fibrous material.

Perionyx sansibaricus Michaelsen
(Figs. 8-9)

1891. *Perionyx sansibaricus* Michaelsen, *Mitt. naturh. Mus. Hamb* **9** : 4 (Type locality : Zanzibar) ; Stephenson, 1923, *Fauna Br. India, Oligochaeta* : 356.

Diagnosis. Length 32-65 mm, diameter 2.5-3.5 mm, 84-108 segments. Prostomium epilobic, first segment with a mid-dorsal groove. First dorsal pore in 2/3, but variable in location. Clitellum annular, *xiii-xvii.* Setae 54 on *ix*, 58 on *xii*, 47 on *xix*. Male pores usually presetal, near mid-ventral line, in a slightly depressed transverse male field. Spermathecal pores paired, near mid-ventral line, in 6/7/8/9. Genital markings absent. Nephridiopores conspicuous, in two series on each side, alternately dorsolateral and ventrolateral.

Septa present from 4/5. Gizzard slightly developed in *vi* ; oesophagus widened in *xiii* ; intestine begins in *xvi.* Last pair of hearts in *xii.* Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles racemose, in *xi* and *xii.* Penial setae absent. Spermathecae paired, in *vii-ix*, each with an ental pear-shaped, shortly stalked, multiloculate diverticulum. Nephridia vesiculate.

Distribution. India ; Orissa ; Jharsuguda ; Maharashtra ; Gujarat ; Madhya Pradesh ; Uttar Pradesh ; Tamil Nadu ; Kerala ; Zanzibar.

Family OCNERODRILIDAE

Diagnosis. Body cylindrical. Dorsal pores rarely present. Male pores posterior to *xvi.* Spermathecae in pre-testicular segments ; prostates tubular with central canal ; last pair of hearts or its homoetic equivalent in *xi.* Holonephric ; nephridia avesiculate.

Distribution. Tropical America, tropical and southern Africa, some Indian Ocean Islands, South India and nearby areas.

Genus Deccania Gates

Diagnosis. Setae lumbricine. Dorsal pores present. Male pores in seminal grooves on *xviii* ; prostatic pores at the ends of seminal grooves on *xvii* and *xix* ; female pores on *xiv*. Oesophagus with 2 gizzards, in *vi-vii*, moniliform in *viii-xi* ; extramural calciferous glands, intestinal caeca and supra-intestinal glands absent; typhlosole simple, lamelliform ; intestine begins in *xii*

Distribution. India.

Deccania alba Gates

1949. *Deccania alba* Gates, *Proc. Indian Acad. Sci.*, **30** (B) : 279 (Type locality : Baraila nr. Jubbalpore, Madhya Pradesh, India) ; Julka, 1976 *Mitt. zool. Mus. Berlin*, **52** (2) ; 325.

Diagnosis. Length 47-66 mm, diameter 2-2.5 mm, 137-190 segments. Prostomium prolobic. First dorsal pore in 12/13. Clitellum saddle shaped, *xiv-*$\frac{1}{2}$*xxii*. Setae *ab*=*cd*, *bc*<*aa*, *dd*=$\frac{1}{2}$C. Male pores paired, minute, near *a* ; prostatic pores, paired, minute, in *ab*. Female pores paired, presetal, near *b* lines. Spermathecal pores paired, inconspicuous, in 7/8/9, at *b*. Genital markings paired, usually postsetal, on *xx-xxi* at *ab*, sometimes on *ix*, *x*, *xiv* or *xv* at *bc* or *ab*.

Septa 5/6-9/10 muscular. Typhlosole in *xiii* to *xc*. Metandric, testes and male funnels, free, in *xi* ; seminal vesicles in *xii*. Spermathecae paired, in *viii* and *ix*, adiverticulate ; duct narrow, longer than saccular ampulla. Genital marking glands long, prostate-like.

Distribution. India : Orissa : Sambalpur, Bolangir ; Madhya Pradesh.

Genus Malabaria Stephenson

Diagnosis. Setae lumbricine. Dorsal pores absent. Male and prostatic pores on *xvii* ; female pores on *xiv*. Oesophagus with a single gizzard in *vii*, ventral wall thickened and vascular in *ix* and *x* ; extramural calciferous glands, intestinal caeca, supra-intestinal glands and typhlosole absent ; intestine begins in *xii*.

Distribution. India, Burma.

Malabaria biprostata Aiyer
(Figs. 10-12)

1929. *Malabaria biprostata* Aiyer, *Rec. Indian Mus.*, **31** : 73 (Type locality: Kumli, Kerala, India).

Diagnosis. Length 67-90 mm, diameter 1.4-1.8 mm, 145-215 segments. Prostomium epilobic, tongue closed. Clitellum annular, *xiii-xxi, xxii, xxiii.* Setae *aa*=3.25-3 7 *ab*=0 76-1,0 *bc*=3.25-3.7 *cd*=0 33-0.39 *dd* on *xii, aa*=5.5 *ab*=*bc*=5.5 *cd*=0,38 *dd* on *xxiv.* Male and prostatic pores minute, close together on circular porophores ; male genital field rectangular, on *xvii,* sometimes encroaching on *xviii.* Female pores presetal, at *b.* Spermathecal pores paired, in 8/9, at *b.* Genital markings oval, single, median, in 8/9 or postsetal on *viii* at *aa,* or postsetal on *xvi,* at *bb.*

Septa 5/6 membranous, 6/7/8/9 muscular. Holandric, testes and male funnels free, in *x* and *xi,* seminal vesicles in *xi* and *xii.* Prostates long, extending posterior to *xl-liii.* Spermathecae paired, in *ix,* adiverticulate. Genital marking glands sessile, oval.

Remarks. A study of the type specimens in the Zoological Survey of India, Calcutta shows the presence of genital markings which were probably overlooked by Aiyer (1929) in describing this species. The present material from Orissa slightly differs from the types in the location of the genital markings which are on segment *viii* than on *xvi* as in the types.

All the clitellate specimens from Orissa are parthenogenetic morphs as one or both spermathecal and prostatic pores are absent.

Distribution. India : Orissa : Burla, Godbhaga, Ladukhai in Sambalpur district ; Kerala.

Material examined. coll. B.K. Senapati : 4 clitellate, 2 aclitellate, Burla ; 8 juveniles, 10 aclitellate, Godbhaga ; 35 juveniles, 16 aclitellate, Ladukhai. 3 clitellate, Kumily, 26 Nov. 1927, "Types", W 1523/1, deposited in Zoological Survey of India, Calcutta.

Habitat. Found at a depth of about 5 cm in clay with sandy substratum with high organic matter (>10 g%) and slightly acidic pH (6.6-6.9).

Biology. M. biprostata occurs in rice fields and is mainly restricted to the root zone of the plants. A population of $5 \times 10^3/m^2$ has been recorded (Senapati, unpublished). It is active only during the rainy season and also attains the maxium population density during this period. Quiescence in the form of diapause coils occurs at a moisture less than 15 g%. Casts are piled in small heaps of globular pellets on the soil surface.

Malabaria sulcata Gates

1945. *Malabaria sulcata* Gates, *Proc. Indian Acad. Sci.*, **21** (B) : 218 (Type locality : Manikpur Junction, Uttar Pradesh, India).

Diagnosis. Length 27-55 mm, diameter 0.6-1.5 mm, 97-111 segments. Prostomium epilobic, tongue open. Clitellum indistinct. Setae *aa*=3.67*ab*=*bc*=4.4*cd*=o.34*dd* on *xii*, *aa*=4 *ab*=*bc*=4*cd*= 0.30 *dd* on *xxiv*. Male and prostatic pores minute, at anterior and posterior ends of seminal grooves respectively ; seminal grooves on diagonally placed porophores, convergent posteriorly. Female pores presetal, at or slightly lateral to *b*. Spermathecal pores paired, small transverse slits, in 8/9, at or close to *b*. Genital markings absent.

Septa 6/7-8/9 muscular. Metandric, seminal vesicles in *xii*. Prostates long, extending posterior to *xxii-xxx* or even a few segments more. Spermathecae paired, elongate, in *ix*. Paired pyriform bodies protuberant into coelomic cavity in *xvii*, which open to exterior alongwith the vasa deferentia into the seminal grooves.

Distribution. India : Orissa : Sundargarh, Jharsuguda, Sambalpur, Bolangir, Titlagarh ; Uttar Pradesh ; Madhya Pradesh.

Genus Ocnerodrilus Eisen

Diagnosis. Setae lumbricine. Male pores on *xvii* ; prostatic pores one pair, combined with male pores, on *xvii*, seldom a second pair on *xviii* ; male genitalia degraded due to parthenogenesis in some species. Oesophagus without gizzard, but wi h a pair of extramural calciferous glands in *ix* ; intestinal caeca, supra-intestinal glands and typhlosole absent.

Distribution. Tropical America and tropical Africa. Peregrine species transported to several parts of the world.

Ocnerodrilus occidentalis Eiseh

1878. *Ocnerodrilus occidentalis* Eisen, *Nova Acta R. Soc. Sci. Upsaliensis*, 3. **10** (4) : 218 (Type locality : California, U.S.A.) ; Gates 1972, *Trans. Am. phil. Soc.*, **62** (7) : 273 ; Gates, 1973, *Bull. Tall Timbers Res. Stat.*, **14** (7) : 14.

Diagnosis. Length 12-46 mm, diameter 1-2 mm, 70-84 segments. Prostomium epilobic, tongue open, sometimes closed. Clitellum annular, *xiii*, *xiv-xix*, *xx*. Setae *aa*=*bc*, *dd*=$\frac{1}{2}$C. Male pores (combined with prostatic pores) paired, minute, at centres of whitish porophores on *xvii*, each porophore lateral to *b*. Female pores paired, on *xiv*, at or slightly lateral to *b*. Spermathecal pores and genital markings absent.

Septa present from 4/5, 7/8-10/11 slightly muscular. Intestine begins in *xii*. Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles absent. Prostates paired, in *xvii*, sometimes extending to *xviii-xxx*. Spermathecae absent.

Distribution. India : Orissa : Titlagarh, Paradip, Bolangir, Kantabanji, Athagarh, Cuttack, Bargarh, Burla, Godbhaga, Ladukhai ; Uttar Pradesh ; Rajasthan, Maharashtra ; Kerala ; Andaman Islands, Burma, Pakistan, Sri Lanka, U.S.A., Mexico, St. Thomas Is., Denmark, Italy, Greece, Cape Verde Is,, Rhodesia, Southwest Africa, Great Comoro Is., Palestine, Lebanon, Central Asia, Singapore, China, Japan, Philippine Islands, New Hebrides, British Solomon Is.

Remarks. O. occidentalis is polymorphic. It is known from parthenogenetic morphs without spermathecae and seminal vesicles. Morphs with degraded male terminalia in various forms (absence of testes, male gonoducts, prostates and male pores) have also been recorded.

Habitat. Found in a wide range of moist habitats in alkaline sandy loam and clay loam soils especially in lowland and upland pastures, crop fields, compost pits and sewage.

Biology. A maximum population of about 550/m² in a lowland protected pasture and 27/m² from a protected upland pasture has been recorded by Dash and Patra (1977) and Senapati (1980) respectively. Clitellate worms are available during the rainy season and juveniles are abundant during the post-rainy season period. Reproduction by parthenogenesis is suspected as cocoons were not observed in the field as well as in the laboratory cultures. This species undergoes diapause at low soil moisture (< 15 g%).

Genus Thatonia Gates

Diagnosis. Setae lumbricine. Dorsal pores absent. Male pores paired, in seminal grooves, on *xviii* ; prostatic pores paired, at the ends of seminal grooves, on *xvii* and *xix* ; female pores paired, on *xiv*. Oesophagus with a single gizzard in *vii*, without discrete calciferous glands, but with the ventral wall thickened in *ix-x*, containing dentrically branched system of spaces ; intestinal caeca, Supra-intestinal glands and typhlosole absent ; intestine begins in *xii*.

Distribution. India : Orissa, Uttar Pradesh, Madhya Pradesh, Andaman Islands ; Burma.

Thatonia bolangirensis Julka

1976. *Thatonia bolangirensis* Julka, *Mitt. zool. Mus. Berlin*, 52 (2) : 326 (Type locality : Bolangir, Orissa, India).

Diagnosis. Length 37 mm, diameter 1.5 mm, 76-95 segments. Ptostomium epilobic, tongue open. Clitellum saddle-shaped, ½*xiii-xxii*. Setae *aa* × 5*ab*=0.75*bc*=5*cd*=0.26*dd* on *xiii*, *a*, *b* on *iii-ix* slightly enlarged. Male pores anteromedian to *a*. Prostatic pores minute, at the centres of rounded porophores at the ends of seminal grooves in line with a, each porophore extends from *a* to mid *bc*. Male genital field distinct, almost squarish, from 16/17 to 19/20 and laterally to *c*. Female pores presetal, slightly lateral to *b* lines. Spermathecal pores paired, in 7/8/9, at *b*. Genital markings paired, somewhat circular, on *xxii*, at *a* to mid *bc*.

Septa 5/6-8/9 muscular. Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles in *xi* and *xii*. Prostates long, extending posterior to *xxviii*. Spermathecae paired, large, in *viii* and *ix*, adiverticulate. Genital marking glands, tubular, shorter than the prostates, reaching posteriorly through 4 segments.

Distribution. India : Orissa : Bolangir, Sundargarh.

Thatonia gracilis Gates

1942. *Thatonia gracilis* Gates, *Bull. Mus. comp. Zool. Harvard,* **89** : 101 (Type locality : Thongwa, Burma) ; Gates, 1972, *Trans. Am. phil. Soc.*, **62** (7) : 266.

Diagnosis. Length 63-87, diameter 1 mm, ? segments. Prostomium epilobic, tongue open. Clitellum saddle-shaped, *xiii-xxii, xxiii*. Setae *aa* slightly<*bc*, *dd*=⊃½C *a*, *b* on some or all of *ii-xii* enlarged, especially so on *viii* and *ix*. Male pores minute, anteromedian to *a*. Prostatic pores minute, in *ab*. Male genital field distinct, with seminal grooves forming an H-shaped figure. Female pores presetal, at *b*. Spermathecal pores paired, in 7/8/9, at *b*. Genital markings absent.

Septa 5/6-8/9 muscular. Holandric, seminal vesicles in *xi* and *xii*. Spermathecae paired, in *viii* and *ix*, tubular, adiverticulate.

Distribution. India : Orissa : Sambalpur, Bolangir , Andaman Islands, Burma.

Thatonia sambalpurensis Julka

1976. *Thatonia sambalpurensis* Julka, *Mitt. zool. Mus, Berlin,* **52** (2) : 328 (Type locality : Sambalpur, Orissa, India).

Diagnosis. Length 23-50 mm, diameter 1 1.5 mm, 52-109 segments. Prostomium epilobic, tongue open. Clitellum saddle-shaped, ½*xiii-xx* (?). Setae *aa*=5*ab*=0. 75*bc*=5*cd*=0. 25*dd* on *xii*, *a*, *b* on *iii-xi* enlarged. Male pores minute, slightly anterior to *a*.

Prostatic pores minute, in *ab*. Male genital field slightly thickened. Female pores, presetal, slightly lateral to *b*. Spermathecal pores paired, on 7/8/9, at *b*. Genital markings paired, somewhat circular, postsetal on *viii-x*, intersegmental on 15/16/17, 19/20-21/22.

Septa 5/6-8/9 muscular. Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles in *xi* and *xii*. Prostates long, extending to *xxiii-xxix*. Spermathecae paired, large, twisted or coiled, in *viii* and *ix* adiverticulate. Genital marking glands spheroidal.

Distribution. India : Orissa : Sambalpur.

Family OCTOCHAETIDAE

Diagnosis. Body cylindrical. Dorsal pores present. Male pores behind *xvi*. Spermathecae in pre-testicular segments ; prostates tubular with central canal. Last pair of hearts posterior to *xi*. Meronephric.

Distribution. Australasia, tropical America and Africa, India, Burma.

Genus **Dichogaster** Beddard

Diagnosis. Setae lumbricine. Male pores paired, in seminal grooves on *xviii* or 17/18 ; prostatic pores one pair on *xvii* or *xix*, or 2 pairs on *xvii* and *xix*. Oesophagus with 2 gizzards anterior to septum 8/9 and one pair of extramural calciferous glands, each gland trilobed, a vertically reniform lobe in each of segments *xv-xvii* with a common duct opening into gut in *xvi* ; intestinal caeca and supra-intestinal glands absent ; typhlosole simple, lamelliform. Micromeronephridia astomate, enteronephric paired tufts in *ii-iv*, several exonephric on the body wall in *v* and posteriad segments, arranged in longitudinal rows posterior to the prostatic region ; paired, stomate, exonephric megameronephridia in a few posterior-most segments.

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

Dichogaster affinis (Michaelsen)

(Figs. 13-15)

1890. *Benhamia affinis* Michaelsen, *Jb. hamb. wiss. Anst.*, 7 (1) : 29 (Type locality : Quilimane, Zanzibar).

1972. *Dichogaster affinis*, Gates, *Trans. Am. phil. Soc.*, **62** (7) : 278 ; Righi *et al.*, 1978, *Acta Amazonica*, **8** (3), suppl. 1 : 380.

Diagnosis. Length 27-60 mm, diameter 1-2 mm, 105-140 segments. Prostomium epilobic tongue closed. First dorsal pore 5/6. Clitellum annular, *xiii, xiv-xxi, xxii*. Setae *aa*=3*ab*=*bc*=3*cd*=0.07*dd* on x*ii*, *aa*=4.5-4.7*ab*=1.4-1.5*bc*=4.5-4.7*cd*=0.14*dd* on xx*iv*. Male pores paired, minute, in seminal grooves linking prostatic pores on the setal arc of x*viii*, at *a*. Prostatic pores paired, minute, at the ends of almost straight or slightly concave seminal grooves, on x*vii* and x*ix*, at *a*. Female pores paired, presetal, minute, at or slightly lateral to *a*. Spermathecal pores paired, minute, in 7/8/9, at or near *a*. Genital markings often present, unpaired and median on 8/9/10, sometimes on 7/8, 10/11

Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 absent. Gizzards between septa 4/5 and 7/8 ; typhlosole *xxi* to *lxviii-lxxvi* (?), x*c*-x*ci*. Last pair of hearts in x*ii*. Holandric, testes and male funnels enclosed in unpaired sacs formed by the peripheral apposition of septa 9/10/11/12, in x and x*i* ; seminal vesicles in x*i* and x*ii*, vestigeal. Penial setae slightly sinuous ectally, ornamented with scale-like markings or teeth in the sinuousities, tip bluntly rounded, knobbed or truncate, 0.29-0.43 mm long, 4-7 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a shortly stalked ental diverticulum. Genital marking glands circular to slightly dome-shaped, underneath longitudinal muscle layer.

Distribution. India ; Orissa ; Antrakyari nr. Balugaon ; Arunachal Pradesh ; Meghalaya ; Madhya Pradesh ; Gujarat ; Maharashtra ; Karnataka ; Kerala. Sri Lanka, Burma, Thailand, Pacific Ocean Islands, Cape Verde Island, Southwest Africa, Madagascar, Zanzibar, Comoro Island, Mexico, El Salvador, French Guiana, Brazil, West Indies.

Dichogaster bolaui (Michaelsen)

(Figs. 16-19)

1891. *Benhamia bolavi* Michaelsen *Jb. hamb. wiss. Anst.* **8** : 9 (Type locality : Bergedorf, Hamburg, Germany).

1972. *Dichogaster bolaui*, Gates, *Trans. Am. phil. Soc* , **62** (7) : 279 ; Righi *et al.*, 1978, *Acta Amazonica*, **8** (3), suppl. 1 : 38.

Diagnosis. Length 19-43 mm, diameter 1-3 mm, 70-98 segments. Prostomium epilobic, tongue closed. First dorsal pore 5/6, sometimes 6/7. Clitellum annular, x*iii*, x*iv*-x*viii*, x*ix*, xx, $\frac{1}{2}$xx*i*.

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 paired, minute, in seminal grooves linking prostatic pores, on *xviii*, at *a*. Prostatic pores paired, minute, at the ends of slightly concave seminal grooves on *xvii* and *xix*, at *a*. Female pore single, median, presetal. Spermathecal pores paired, in 7/8/9, 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*. Holandric male funnels and testes in unpaired sacs formed by the peripheral apposition of septa 9/10/11/12, in *x* and *xi* ; seminal vesicles acinous, vestigeal, in *xi* and *xii*. Penial setae unornamented or ornamented with a few to several triangular teeth, tip hooked or widened and then scalpel-, oar-, spatula- or spoon-shaped, 0.22-0.4mm long, 3-7.5 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a small digitiform to pyriform ventrally directed ental diverticulum, duct rather barrel-shaped.

Distribution. India : Orissa : Paradip, Puri, Balugaon, Sundargarh, Sankara vill., Jharsuguda, Sambalpur, Bolangir, Harishankar, Kantabhanji, Bhawanipatna, Kesinga, Atabaria, Bargarh, Burla, Kharmunda ; Andaman & Nicobar Islands ; Arunachal Pradesh ; Meghalaya ; W. Bengal ; Sikkim ; Himachal Pradesh ; Uttar Pradesh ; Madhya Pradesh ; Rajasthan ; Gujarat ; Maharashtra ; Andhra Pradesh ; Karnataka ; Tamil Nadu ; Kerala. Sri Lanka, Pakistan, Bangla Desh, Burma, Malay Peninsula, Vietnam, China, Hainan Island, Indonesia, Philippines, Pacific Islands, Japan, Australia, Africa, Madagascar and adjacent islands, Germany, North, Central and South America, West Indies

Habitat. It inhabits top 5 cm soil with high organic matter (>10 g%). ; kitchen waste ; soil around compost pits ; rotten wood ; among roots of lichen growing on stones ; in tree holes ; in soil around palm and coconut leaves ; thatched roof of a house.

Biology. Population in a thatched roof of a house was 800/m^2 Activity is restricted to 2-3 months from early rainy to post-rainy period in mid-June to mid-September. Reproduction is bi-parental ; copulation occurring during heavy rains in July. Cocoons are small, thin-walled, light coloured and oval with ornamentations. Clitellar degeneration during post-reproductive period and diapause

during unfavourable period are distinct (Senapati, 1983 b). However, reproduction may continue throughout the year in moist places with high humus. Young worms hatch in about 12-18 days. Casts are deposited on the soil surface in small heaps of tiny globular pellets.

Economic importance. Decomposing enzyme like cellulase has been reported in its gut (Mishra and Dash, 1980) and it might be important in converting organic matter into available nutrients.

Dichogaster modiglianii (Rosa)

1896. *Benhamia modiglianii* Rosa, *Ann. Mus. Sto. Nat. Genova,* **36** : 510 (Type locality : Pedang, Sumatra).

1972. *Dichogaster modiglianii,* Gates, *Trans. Am. phil. Soc.,* **62** (7) : 280 ; Righi *et al.*, 1978, *Acta Amazonica,* **8** (3), suppl. 1 : 38.

Diagnosis. Length 22-60 mm, diameter 1-2.2 mm, 76-120 segments. Prostomium proepilobic. First dorsal pore 4/5 or 5/6. Clitellum annular, *xiii-xx*. Setae $aa=3.5ab=0.7bc=2.8cd=0.08dd$ on *xii*, $aa=5ab=1.2bc=5cd=0.15dd$ on *xxiv*. Male pores paired, minute, in seminal grooves linking prostatic pores, on *xviii*, at or close to *a*. Prostatic pores paired, minute, at the ends of seminal grooves, on *xvii* and *xix*, at *a*. Female pores paired, presetal, slightly median or posteromedian to *a* setae. Spermathecal pores paired, in 7/8/9, at or near *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-lxxxi*. Last pair of hearts in *xii*. Holandric, testes and male funnels enclosed in unpaired sacs, those of *x* ventral, those of *xi* formed by the peripheral apposition of septa 10/11/12 ; seminal vesicles absent or vestigeal in *xii*. Penial setae ornamented with scalelike markings near slight constrictions, tip slightly thickened or truncate or narrowed to a short filament, 0.31-0.42 mm long, 5-9 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a small, spheroidal to ellipsoidal shortly stalked diverticulum, arising from the middle of slightly bulbous spermathecal duct.

Distribution. India : Orissa : Sundargarh ; W. Bengal; Meghalaya; Andaman & Nicobar Islands. Pakistan, Burma, Malay Peninsula ; Indonesia ; Philippines, some of the islands in Pacific Ocean, Angola, Colombia, French Guiana, Brazil, Venezuela, ? Ecuador, Mexico.

Material examined. 2 clitellate, Sundargarh, July 1980, B K. Senapati.

Genus **Eutyphoeus** Michaelsen

Diagnosis. Setae lumbricine. Male pores paired, near to paired prostatic pores on *xvii* ; female pore(s) on *xiii* Oesophagus with a single gizzard between septa 5/6 and 8/9, one pair of discrete, intramural calciferous glands in *xii* ; intestinal caeca and supra-intestinal glands present ; typhlosole simple, lamelliform. Micro-meronephridia astomate, enteronephric 4-5 pairs of tufts in *iii*, numerous exonephric, y-shaped on the body wall in *iv* and posteriad segments ; paired, exonephric, stomate megamеronephridia in a few posteriormost segments.

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

Eutyphoeus incommodus (Beddard)

1910. *Typhoeus incommodus* Beddard, *Proc. zool. Soc. Lond.*, **1901** : 200 (Type locality : Calcutta, India)

1938. *Eutyphoeus incommodus,* Gates, *Rec. Indian Mus* **40** : 83.

Diagnosis. Length 25-147 mm, diameter 2.5-6 mm, 92-189 segments. Prostomium pro/epilobic or pro/tanylobic. First dorsal pore 11/12 or sometimes 10/11 or 12/13. Clitellum annular, *xiii*, $\frac{1}{2}$*xiii-xvii*, *xviii*. Setae *aa*=1.8-2.5*ab*=1.9*bc*=1.3-1 4*cd*=0.14*dd* on *xii*, *aa*=2 3-3.2*ab*=1.4*bc*=2-2.5*cd*=0.20*dd* on *xxiv*. Male pores within slight transversely placed fissures, at or close to *b*, each fissure at the centre of a disc-shaped to slightly conical porophore ; vestibula and penes absent. Female pores paired, presetal, at or slightly median to *a* lines. Spermathecal pores paired, small, transverse slits, in 7/8, slightly lateral to *b*. Genital markings paired, postsetal, on *xii*, *xiii-xvi*, at *ab*, rarely all markings may be absent.

Lateral intestinal caeca absent, ventral intestinal caeca 3-9 in *xxvii-xxxvi*, supra-intestinal glands 3-6 pairs in *lxii-lxxv*, typhlosole begins in *xxv-xxvi*. Dorsal blood vessel complete. Holandric, testes and male funnels enclosed in annular sacs, in *x* and *xi* ; seminal vesicles in *ix* and *xii*, those of *xii* extending posterior to *xiii*. Penial setae ornamented with sparse, rather widely separated

rows of very fine spines, tip bluntly rounded, 0.5-1.4 mm long, 15-17 μ diameter. Spermathecae paired, in *viii*, each with a circle of seminal chambers or 4-6 stalked ental diverticula. Genital marking glands absent.

Distribution. India : Orissa : Deogarh and Padhanpat Water Fall in Sambalpur district ; W. Bengal ; Bihar ; Uttar Pradesh ; Rajasthan ; Haryana ; Punjab ; Himachal Pradesh. Pakistan.

Material examined. 3 clitellate, Deogarh, 2 aclitellate, 5 clitellate, Padhanpat Water Falls, Sep 1980, B. K. Senapati.

Habitat. Geophagous, found in deep soil (>20 cm) with 6-6.9 pH.

Biology. Reproduction is biparental and copulation takes place during the rainy season. Casts are plenty during the rainy season and are deposited on the soil surface in the form of towers.

Eutyphoeus kherai Julka

1978. *Eutyphoeus kherai* Julka, *Mitt. zool. Mus. Berlin,* 54 : 191 (Type locality : Bisoi, Mayurbhanj district, Orissa, India).

Diagnosis. Length 90-222 mm, diameter 4-7 mm, 137-214 segments. Prostomium prolobic. First dorsal pore 11/12. Clitellum annular, $\frac{1}{2}$*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 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 paired, small, transverse slits, in 7/8, 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 sometimes be absent.

Lateral intestinal caeca absent, median, ventral intestinal caeca 25-26 in xxx*iv-lix*, supra-intestinal glands 4-5 pairs in *l*xxx*i-l*xxx*vii*, typhlosole begins in xx*vii*-xx*viii*. Dorsal blood vessel aborted usually anterior to *vii*, sometimes anterior to *vi*. Metandric, testes and male funnels enclosed in a ventral sac, in x*i* ; seminal vesicles in x*ii*, extending posterior to x*iv*. Penial setae ornamented with 3-4 spines in each of 2-3 rows, tip spoon-shaped, 1.6-1 7 mm long, 21-30 μ diameter. Spermathecae paired, in *viii*, each with ental

diverticula in the form of 4-5 seminal chambers with 2 openings, on the posterior surface of duct. Genital marking glands sessile, oval.

Distribution. India : Orissa : Bisoi.

Genus **Lennogaster** Gates

Diagnosis. Setae lumbricine. Male pores paired, in seminal grooves on *xviii* or 17/18 ; prostatic pores one pair on *xvii* or 2 pairs on *xvii* and *xix* ; female pores, paired, on *xiv*. Oesophagus with 2 gizzards, in *v-vi* and 3 pairs of discrete, extramural calciferous glands, in *x-xii* ; intestinal caeca and supra-intestinal glands absent ; typhlosole simple, lamelliform. Micromeronephridia astomate, enteronephric paired tufts in *iii*, few, exonephric on the body wall in *iv* and posteriad segments, arranged in 3-5 longitudinal rows in postclitellate segments ; paired, stomate, exonephric megameronephridia in caudal segments.

Distribution. India (from Burma border through the Gangetic plain and into the northern part of the peninsula), Burma, Bangla Desh.

Lennogaster pusillus (Stephenson)

(Figs. 23-25)

1920. *Eudichogaster pusillus* Stephenson, *Mem. Indian Mus.*, **7** : 253 (Type locality : Saugor, Madhya Pradesh, India).

1939. *Lennogaster pusillus*, Gates, *Rec. Indian Mus*, **41** : 199 ; Julka, 1978, *Mitt. zool. Mus Berlin* **54** : 192.

Diagnosis. 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 annular, *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 transversely thickened, on *xvii* ; male pores paired, minute, in or near 17/18 at posterior ends of seminal grooves, at *b*. Prostatic pores paired, minute, on the setal arc of *xvii* at anterior ends of seminal grooves, at *a*. Seminal grooves crescentic, diagonally placed on oval porophores, extending from the setal arc of *xvii* to 17/18, at *ab*. Spermathecal pores paired, minute, on *viii*, at *a*.

Septa 4/5-7/8 delicate, 8/9-12/13 slightly muscular. Typhlosole in *xvii-xviii* to *lxx-lxxvi*. Last pair of hearts in *xii*. Proandric but with male funnels in *xi*, testes and male funnels in *x* enclosed in paired sacs ; seminal vesicles absent. Prostates paired, 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 μ diameter. Spermathecae paired, in *viii*, elongate, each with a sessile spheroidal to tubular ental diverticulum, ampulla at right angle to the duct.

Distribution. India : Orissa : Baripada, Barkuda Island, Bisoi, Antrakyari nr. Balugaon, Sundargarh, Jharsuguda, Burla, Godbhaga, Ladukhai ; Uttar Pradesh ; Madhya Pradesh ; Himachal Pradesh , Karnataka.

Material examined. 4 clitellate, Burla ; 7 clitellate, Godbhaga, 3 clitellate, Ladukhai, Orissa, Aug-Sept, 1980, B. K. Senapati.

Habitat. It is litter dwelling and remains within top 5 cm alkaline soil (pH 7-8) with high organic matter (>10 g%). It also inhabits kitchen waste, compost pit near cow shed and in roofs of thatched houses.

Biology. Population density around a compost pit was 600/m^2 Activity is restricted to 2-3 months from late June to September. Diapause during unfavourable period is passed in immature stages. A soil moisture of about 15-20 g% is most favourable. 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 post-reproductive period. Activity may continue throughout the year where adequate moisture and organic matter are available (Senapati, 1983 b). Casts are deposited on the soil surface in the form of small towers with central openings.

Economic importance. This species might be important in the biodegradation of wastes to some extent.

Genus **Octochaetona** Gates

Diagnosis. Setae 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 and one pair of discrete, extramural, usually asymmetrical calciferous glands close to the attachment of septum 15/16 ; intestinal caeca and supra-intestinal glands absent, typhlosole ventrally bifid. Micromeronephridia astomate paired, enteronephric tufts in *iv*, several biramous, exonephric, on the body wall in *v* and posteriad segments, slightly enlarged and stomate in caudal segments with preseptal and intrasegmental funnels ; megameronephridia absent.

Distribution. Peninsular India, but extended presumably due to transportation of two species to include other parts of the country. Pakistan, Nepal, Burma, Malay Peninsula, Philippines.

Octochaetona barkudensis (Stephenson)

(Figs. 26-27)

1916. *Octochaetus barkudensis* Stephenson, *Rec Indian Mus.*, **12** : 340 (Type locality : Barkuda Island, Chilka Lake, Orissa, India).

1962. *Octochaetona barkudensis*, Gates, *Ann. Mag. nat. Hist. Soc. (ser. 13)*, **5** : 213 ; Julka, 1978, *Mitt. zool. Mus. Berlin*, **54** : 187.

Diagnosis. 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 annular, *xiii-xvii*. 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 to mid *bc*. Male pores minute, slightly lateral to *b* Prostatic pores minute, at or slightly median to *b*. Seminal grooves almost straight to slightly concave. Female pores paired, presetal, within *a* lines. Spermathecal pores paired, minute, on presetal annuli of *viii* and *ix*, at *ab*. Genital markings oval to circular, presetal, paired, on *xvi*, sometimes on *xv*, *xviii* and *xix*, at *ab* ; unpaired and median, 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 acinuous, in *ix* and *xii*. Penial setae ornamented with large spines, ectal end sinuous, tip pointed, 0.58 mm long, 10 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a shortly stalked distally broadened, ental diverticulum. Copulatory setae ornamented with marginal serrations, tip claw-shaped, 0.52 mm long, 17 μ diameter. Genital marking glands absent.

Distribution. India : Orissa : Barkuda Island, Athgarh nr. Cuttack, Baupada nr. Konarak, Gopalpur, Banki, Cuttack, Jagatsinghpur, Berhampur, Khallikote, Bhubaneswar.

Material examined. Coll. B. K. Senapati : 2 clitellate, Banki, 7 clitellate, Cuttack, 3 aclitellate, Jagatsinghpur, Aug. 1980 ; 1 aclitellate, 5 clitellate, Berhampur, Aug. 1980 ; 2 clitellate, Khallikote, 3 aclitellate, Bhubaneswar, Sep 1980.

Octochaetona beatrix (Beddard)

(Figs. 28-30)

1902. *Octochaetus beatrix* Beddard, *Ann. Mag. nat. Hist. (ser 7)*, **9** : 456 (Type locality : Calcutta, W. Bengal, India).

1962 *Octochaetona beatrix*, Gates, *Ann. Mag. nat. Hist. (ser. 13)*, **5** : 213 ; Gates. 1972, *Trans. Am. phil. Soc.*, **62** (7) : 308.

Diagnosis. Length 40-134 mm, diameter 2-5 mm, 133-197 segments. Prostomium epilobic, tongue closed. First dorsal pore 12/13, sometimes 11/12. Clitellum annular, *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 depressed ; male pores minute, at or slightly median to *a*. Prostatic pores minute, median to *a*. Seminal grooves concave. Female pores paired, presetal, within *a* lines. Spermathecal pores paired, minute, on or slightly anterior to the setal arcs of *viii* and *ix*, median to *a*. Genital markings absent.

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 *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 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a spheroidal, shortly pyriform, oval or flattened and shelf-like, shortly stalked ental diverticulum. Setae *a*, *b* on *viii* and *ix* ornamented, sigmoid, 0.29-0.32 mm long, 30-35 μ diameter.

Distribution. India : Orissa : Baripada, Bisoi, Balugaon, Sundargarh, Jharsuguda, Khejuri Poda, Cuttack, Jagatsinghpur, Kendrapada, Pattamundai, Bhawanipatna, Kesinga, Bargarh, Burla, Godabaga ;

W. Bengal ; Uttar Pradesh, Madhya Pradesh ; Himachal Pradesh ; Punjab ; Maharashtra ; Gujarat ; Karnataka ; Kerala. Burma, r Nepal, Pakistan, Malay Peninsula, Philippine Islands.

Material examined. Several juvenile, aclitellate, clitellate specimens from Cuttack, Jagatsinghpur, Kendrapada, Pattamundai in Cuttack Dist., Kesinga, Bhawanipatna in Kalahandi Dist., Bargarh, Burla, Godabaga in Sambalpur Dist., July-Sept 1980, B. K. Senapati.

Habitat. Sandy loam and clay loam soils with low organic matter in lawns and grasslands.

Biology. Maximum population density of 300/m^2 was recorded in grasslands. Diapaused worms are found during periods of low soil moisture and high soil temperature. However, activity is continued throughout the year in swampy habitats. Cocoons are round and thinwalled, and colour changes from pale lemon yellow to dark brownish red. Incubation period is about 3-4 weeks at 25°C ($\pm$3°C) soil temperature and 15 g% ($\pm$2g%) soil moisture. Usually one (rarely two) young worm hatches from each cocoon. Reproduction is biparental. Copulation and feeding take place beneath the soil surface.

Octochaetona surensis (Michaelsen)

(Figs. 31-34)

1910. *Octochaetus surensis* Michaelsen, *Abh. Geb. Naturw. Hamburg,* **19** (5) : 88 (Type locality : Sur Lake, Puri Dist., Orissa, India).

1962. *Octochaetona surensis,* Gates, *Ann. Mag. nat. Hist. (ser. 13),* **5** : 213 ; Gates, 1972, *Trans. Am phil. Soc* **62** (7) : 309.

Diagnosis. Length 60-140 mm, diameter 2.5-6 mm, 111-180 segments. Prostomium epilobic, tongue closed. First dorsal pore 12/13. Clitellum annular, *xiii-xvi, xvii.* Setae *aa*=2.7-4.3*ab*= 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 *xvi-xx*, with deep transverse depressions on *xvii* and *xix*. Male pores minute, median to *b*. Prostatic pores minute at *b*. Seminal grooves convex. Female pores paired, presetal, within *a* lines, sometimes single and median. Spermathecal pores paired, 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 μ diameter. Spermathecae paired in *viii* and *ix*, each with a shortly stalked, multiloculate ental diverticulum. Copulatory setae ornamented with longitudinal rows of spikes or thornlike protuberances, tip claw-shaped, 0.85-1.2 mm long, 20-25 μ diameter. Genital marking glands absent.

Distribution. India : Orissa : Sur Lake, Sambalpur, Cuttack, Barkul, Brajarajpur and Balugaon nr. Chilka Lake Gopalpur, Puri, Baripada, Bisoi, Antrakyari nr. Balugaon, Sundargarh, Sankara vill. nr. Sundargarh, Bolangir, Jagatsinghpur, Kendrapara, Pattamundai, Bhawanipatna, Kesinga, Bargarh, Barpali, Burla, Jharsuguda, Godbhaga, Kharmunda, Rajgangpur, Surda ; Uttar Pradesh ; Madhya Pradesh ; Assam Burma.

Material examined. Several juvenile, aclitellate, clitellate specimens, Cuttack, Jagatsinghpur, Kendrapara, Pattamundai in Cuttack Dist., Kalahandi Dist. (Bhawanipatna, Kesinga), Bargarh, Barpali, Burla, Jharsuguda, Godbhaga, Kharmunda in Sambalpur Dist., Rajgangpur, Surda in Sundargarh Dist., July-Oct 1979, 1980, B. K. Senapati.

Habitat. Sandy loam and clay loam soils with comparatively low organic matter (5 g%) in grasslands, hillocks, peripheral parts of compost pits, non-irrigated upland crop fields and around roots of potted plants.

Biology. It 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 density of 186/m^2 and 133/m^2 has been observed in an ungrazed upland pasture and grazed upland pasture respectively. Quiescence in summer is characterised by a diapause coil (Dash and Senapati, 1980 ; Senapati, 1980). It comprises >50% of the total earthworm population of western Orissan pastures. Population turnover is 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 ± 3°C soil temperature and 16 ± 1g% soil temperature. Normally one (rarely two) juvenile hatches from each cocoon. Peak cocoon production occurs during November. Cocoon production per adult worm is 4 per year in an ungrazed pasture. The size of cocoons varies in different habitats ; cocoons collected from the periphery of compost pits were larger than those from grasslands (Dash and Senapati, 1980). Newly hatched juveniles take about 20 months to reach the maturity stage. Life cycle is, however, disrupted for 3-5 months due to low soil moisture (<10 g%) and high soil temperature (>28°C) during the summer months. Clitellum degenerates during the post-reproductive period and furgal infection has been reported (Dash *et al.*, 1979).

Casts are deposited on the soil surface in the form of globules but when soil moisture is high the globules often fuse to form large irregular pyramidal structures of about 4-5 cm height. A population dominated by *O. surensis* has been reported to produce 47 tons of dry worm casts per acre per year.

Economic importance. An earthworm population, with *O. surensis* as a dominant species, can process 16% of the organic matter input into the soil system in grassland and pasture ecosystems (Senapati and Dash, 1982, 1983 a).

Genus **Pellogaster** Gates

Diagnosis. Setae lumbricine. Male pores paired, in seminal grooves, on *xviii*. Prostatic pores paired, at the ends of seminal grooves, on *xvii* and *xix*. Female pores on *xiv*. Oesophagus with 2 gizzards, in *v-vi* and 4 pairs of discrete extramural calciferous glands, in *x-xiii* ; intestinal caeca and supra-intestinal glands absent ; typhlosole simple, lamelliform. Micromeronephridia astomate, exonephric, paired tufts in *ii-ix*, a few on the body wall in *xii-xix* arranged in 2-3 longitudinal ranks posterior to prostatic region on each side ; paired stomate exonephric megameronephridia present in caudal segments.

Distribution. India (northern portion of the peninsula from Jubbalpore to Orissa and W. Bengal).

Pellogaster bengalensis (Michaelsen)

(Figs. 35-37)

1910. *Eudichogaster bengalensis* Michaelsen, *Adh. Geb. Naturw. Hamburg.* **19** : 96 (Type locality : Tribeni, W. Bengal, India).

1939. *Pellogaster bengalensis*, Gates, *Rec. Indian Mus*, **41** : 201 ; Julka, 1978, *Mitt. zool. Mus. Berlin*, **54** : 194.

Diagnosis. Length 40-74 mm, diameter 2-5 mm, 94-140 segments. Prostomium tanylobic. First dorsal pore 10/11 or 11/12. Clitellum annular, ½*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. Male pores minute slits, at *ab*. Prostatic pores minute, at *ab* ; seminal grooves straight. Female pores paired, presetal, within *a* lines. Spermathecal pores paired, tiny, transverse or crescentic slits, at or close to the sites of missing *a* setae, on *viii* and *ix*. Genital markings tiny, circular to oval, paired, close to the spermathecal pores on *viii-ix*, presetal on *xvii* and postsetal on *xix*, at *ab*, sometimes on the setal annuli of *x* and *xx*, posterior margin of *xix* and in or slightly posterior to 19/20, at *aa*.

Septa 4/5/6 delicate, 6/7-9/10 muscular, 10/11 slightly muscular. Intestine begins in *xvi* ; typhlosole *xvii* to *lxxiii*. Last pair of hearts in *xii*. Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles in *xi* and *xii*. Penial setae ornamented with *c*. 15 irregular broken circles of fine to triangular spines, tip claw-shaped to pointed or bluntly rounded, 0.7—1.3 mm long, 16—20 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a sessile ental diverticulum.

Distribution. India : Orissa : Kendupatna nr. Cuttack, Sundargarh, Jharsuguda, Sambalpur, Bisoi, Athgarh nr. Cuttack, Balugaon, Jajpur, Jagatsinghpur, Bhawanipatna, Bargarh ; W. Bengal ; Madhya Pradesh.

Material examined. 12 juvenile, 23 aclitellate, 19 clitellate specimens, Jajpur, Jagatsinghpur in Cuttack Dist., Bhawanipatna in Kalahandi Dist., Bargarh in Sambalpur Dist., June 1980, B. K. Senapati.

Genus Ramiella Stephenson

Diagnosis. Setae lumbricine. Male pores paired, in seminal grooves, on *xviii*. Prostatic pores paired, at the ends of seminal grooves, *xvii* and *xix*. Female pores on *xiv*. Oesophagus with a

single gizzard ; calciferous glands, intestinal caeca, supra-intestinal glands absent ; typhlosole in the form of a low ridge to a simple lamella. Micromeronephridia few, astomate, exonephric, discoidal on the body wall in *iii* and posteriad segments, arranged in longitudinal ranks posterior to clitellum ; paired, stomate, exonephric megameronephridia in caudal segments.

Distribution. India : Western portion of the Gangetic plain south through western part of the peninsula to Coorg. The distribution has been extended as a result of transportation of one species, *R. bishambari*, to include Burma, Christmas Island, Java, Philippine Islands, China.

Ramiella bishambari (Stephenson Parenthesis)

(Figs. 38-40)

1914. *Octochaetus bishambari* Stephenson, *Rec. Indian Mus.*, 10 : 347 (Type locality : Saharanpur, U. P., India).

1972. *Ramiella bishambari*, Gates, *Trans. Am. phil. Soc.*, 62 (7) : 312

Diagnosis. Length 20-38 mm, diameter 0.8-1.2 mm, 78-91 segments. Prostomium epilobic, tongue open. First dorsal pore 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*=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 x*xiv*. Male pores minute, at or slightly lateral to *a*. Prostatic pores minute, at *b* ; seminal grooves convex, at *ab*. Female pores paired, presetal, within *a* lines. Spermathecal pores paired, small, on *viii* and *ix*, slightly posterior to intersegmental furrows, 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 *xi*x or 19/20.

Septa 4/5 slightly muscular, 5/6-11/12 muscular. Gizzard in *vi* ; intestine begins in *xiv* ; typhlosole a low ridge in *xvii-xviii* to *c*. 15-20 segments posteriorly. Last pair of hearts in *xii*. Holandric, testes and male funnels free, in *x* and *xi* ; seminal vesicles in *xii*, sometimes in x*i* 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 μ diameter. Spermathecae, paired, in *viii* and *ix*, each with a sessile, spheroidal to oval ental diverticulum. Genital marking glants absent.

Distribution. India : Orissa : Balugaon, Sundargarh, Titlagarh, Ushakothi ; Uttar Pradesh ; Madhya Pradesh ; Andaman & Nicobar Islands. Pakistan, Burma, Christmas Island, Philippines, ? China.

Material examined 7 clitellate specimens, Ushakothi, Sambalpur district, October 1980, B. K. Senapati.

Habitat. Mineral soil with high organic material (>10 g%) and pH ranging from 6 to 8 ; mostly in grassland, forest, lawns and municipal dumps,

Biology. Population in a forest site at Ushakoti (National Wildlife Sanctuary) was a maximum of 26/m^2/month during October and nil during May. It remains in quiescence during the summer months. Reproduction is biparental.

Ramiella sundargarhensis Julka

(Figs. 41-43)

1978. *Ramiella sundargarhensis* Julka, *Mitt. zool. Mus. Berlin,* 54 : 190 (Type locality : Sundargarh, Orissa : India).

Diagnosis. Length 52-77 mm, diameter 3 mm. 115-167 segments. Prostomium epilobic tongue closed. First dorsal pore 9/10, sometimes 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. Female pore single, median, presetal. Spermathecal pores paired, 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*, presetal or postsetal on *ix* and presetal on *x-xii* at *bc*, on 19/20-23/24 at *aa* ; sometimes single and median, postsetal on *xi*, presetal 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*. 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 a few scattered triangular teeth, tip expanded, truncate or slightly rounded, 1.09-1.5 mm long, 10-17 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a digitiform ventrally directed ental diverticulum, adherent to the duct. Genital marking glands absent.

Distribution. India : Orissa : Sundargarh, Burla, Godbhaga Jyoti Vihar, Ushakothi.

Material examined. Several aclitellate and clitellate specimens, Burla, Godbhaga, Jyoti Vihar, Ushakothi in Sambalpur district, Aug-Sept. 1980, B. K. Senapati.

Habitat. Sandy loam mineral soil with >5 g% of organic matter and 6-7 pH in forests and grasslands.

Biology. Maximum population of about 75/m^2 was observed at Ushakothi forest. Reproduction is biparental. Copulation and feeding occurs 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 degeneration and fungal infection of adults during post-reproductive period has been observed. Worms undergo diapause coil during summer stress.

In laboratory cultures, this species laid globular casts, but no casts were observed in the field.

Order MONILIGASTRIDA

Diagnosis. Testes and male funnels intraseptal in paired dorsal testis sacs ; male pores at or close to the intersegmental furrow immediately posterior to the testis sac.

Family MONILIGASTRIDAE

Diagnosis. Dorsal pores absent. Male pores at or close to 10/11 or 11/12 or 12/13. Spermathecal pores anterior to male pores. Oesophageal gizzards posterior to the ovarian segment. Ovaries band-shaped, ova large, yolky. Holonephric.

Distribution. Southeast and eastern Asia, from South India to Manchuria, Korea, also Japan, the Philippines, Borneo, Sumatra.

Genus Drawida Michaelsen

Diagnosis. Setae lumbricine. Male pores paired, at or near 10/11 ; female pores paired, at or just posterior to 11/12 ; spermathecal pores paired, at or close to 7/8. Septa all present from 4/5, 5/6-9/10 muscular. Oesophagus with one to several gizzards, in *xii-xxvii* ; intestinal caeca and supra-intestinal glands absent. Capsular prostates paired, in *x*. Holonephridia in *iii* and posteriad segments.

Distribution. India, Nepal, Burma, Malay Peninsula, Thailand, Indo-China, China, Korea, Manchuria, Siberia, Japan, Philippine Islands, Borneo, Sri Lanka (?), Sumatra and Java (?).

Drawida calebi Gates

1945. *Drawida calebi* Gates, *Proc. Indian Acad. Sci.*, **21** (B) : 211 (Type locality : Jubbalpore, Madhya Pradesh, India) ; Julka, 1976, *Mitt. zool. Mus. Berlin,* **52** (2) : 322.

Diagnosis. Length 32-83 mm, diameter 2-4.5 mm, 115-170 segments. Male pores paired, transverse slits, at mid *bc*. Spermathecal pores paired, slightly median to *c* lines. Genital markings small, preor postsetal, usually single and median, widely paired in *bc*, on *vii-xiii* ; sometimes widely paired in *ab* on *xii* and closely paired in *aa* on *vii-x* ; one of the paired markings sometimes absent or doubled or tripled. Nephridiopores in a single series close to *d* lines.

Gizzards 2-4, in *xii-xvii* ; intestine begins in *xxvi* ($\pm$1). Vas deferns short, in a small column of loops in *ix*, almost straight in *x*, entering the anteromedian aspect of the prostate directly. Prostates muscular, almost spheroidal, sessile, with an internal ventral portion protrusible as a shortly tubular penis. Spermathecal atrium conical, in *viii*, smaller than prostate. Genital marking glands spheroidal to shortly oval, concealed beneath longitudinal muscles

Distribution. India : Orissa : Baripada, Bisoi, Athgarh, Sundargarh, Khazuri Bada, Cuttack, Kendrapara, Bhawanipatna, Kesinga, Bargarh, Barpali, Burla, Deogarh, Godbhaga, Ladukhai, Rourkela, Surda ; Madhya Pradesh ; Uttar Pradesh ; Karnataka.

Habitat. Geophagous ; usually found in pastures, grasslands, lawns, upland crop fields and compost pits at a depth below 10 cm of soil.

Biology. A maximum population of 131/m^2 and 32/m^2 has been reported in an upland pasture (Senapati and Dash, 1981) and a forest (Mishra and Dash, 1983) respectively. It has been estimated that this species comprises about 21% and 29% of total worm population in pasture and forest habitats respectively. Cocoons are round with distinct ornamentation, diameter 4.3 mm, length 4.56 mm, diameter : length ratio 0.94 (Senapati *et al.*, 1979). Live weight of cocoon was about 15.17 mg and the incubation period varied from 3 to 8 weeks. Usually one young worm hatches from each cocoon. A high rate of reproduction (3-5 cocoons per adult/year)

and high mortality rate has been reported in a grazed upland pasture as compared to in a protected upland pasture (Senapati, 1980). Young hatched worms may take 18-20 months to become adults, with 4-6 months of quiescence. *D. calebi* undergoes diapuse at low soil moisture (<10 g%) and higher soil temperature (>30°C).

This species deposits sub-soil casts in the form of globular pellets.

Economic importance. Digestive enzymes like protease, amylase, invertase, cellulase and urease in its gut have been reported by Mishra and Dash (1980). Abundance of these worms in compost pits and presence of cellulase degrading enzymes in their gut indicate that this species might be important in bio-degradation of waste biomass. Dash *et al.* (1979) have shown selective fungal feeding for this species, hence its importance in the decomposed sub-system.

Drawida limella Gates

1934. *Drawida limella* Gates, *Rec. Indian Mus.*, **36** : 241 (Type locality: Amingaon, Assam, India) ; Gates, 1972, *Trans. Am. phil. Soc.*, **62** (7) : 251 ; Julka, 1976, *Mitt. zool. Mus. Berlin*, **52** (2) : 323.

Diagnosis. Length 43-110 mm, diameter 1.5-3 mm, 92-192 segments. Clitellum annular, $\frac{1}{2}ix$, *x-xiii*, *xiv*. Setae $ab=cd$, $aa<bc$ on postclitellar segments. Male pores tiny, in *ab* or at *b* ; each pore located on a nipple-like projection at the ventral end of a conical porophore which apparently belongs to both *x* and *xi*. Spermathecal pores tiny, in 7/8 or on *vii* or *viii* or on one of the genital markings near 7/8, at mid *bc* or slightly lateral to *b* or close to *c* lines. Genital markings paired, circular to oval, each with a minute central pore, usually in *bc*, in 7/8 or postsetal on *vii* or presetal on *viii*, occasionally presetal on *ix-x*, sometimes in *ab* on *vii-viii* ; one of the paired markings may be absent. Nephridiopores in a single series on each side, at *d* lines.

Gizzards 2-4, in *xii-xvii* ; intestine begins in (?). Vas deferens short, looped back and forth before opening directly into the mid-dorsal face of prostates. Prostates circular, sessile, glandular ; prostatic capsule shortly tubular to digitiform. Spermathecal atrium short, tubular or pear-shaped, usually concealed beneath longitudinal muscles ; atrium sometimes absent, in that case ectal end of spermathecal duct beneath longitudinal muscles quite enlarged. Genital marking glands tubular, erect, projecting into coelomic cavity, much longer than the prostate.

Distribution. India : Orissa : Brajarajpur, Balugaon, Gopalpur, Sankara village, Sundargarh, Jharsuguda, Bolangir, Sambalpur, Titlagarh, Kantabanji, Athagarh, Banki, Bargarh, Barpali, Burla, Masonikani, Rourkela, Surda ; Assam Andhra Pradesh.

Material examined Several juvenile, aclitellate, clitellate specimens, Kantabanji in Bolangir dist., Athgarh, Banki in Cuttack dist., Bargarh, Barpali, Burla in Sambalpur dist., Masonikani, Rourkela, Surda in Sundargarh dist , June-Aug 1980, B. K. Senapati.

Drawida willsi Michaelsen

1907 *Drawida willsi* Michaelsen, *Mitt. naturh. Mus. Hamb.* **24** : 145 (Type locality : Hyderabad, Andhra Pradesh, India) ; Gates, 1945, *Proc. Indian Acad Sci.*, **21** (B) : 214.

Diagnosis. Length 55-60 mm, diameter 2.5 mm, 155-160 segments. Prostomium prolobic. Clitellum annular, *x-xiii.* Setae *aa=bc.* Male pores paired, minute, at or very close to *b* lines ; each pore on ventral end of slightly depressed or conically protuberant central area of circular to oval porophore. Spermathecal pores paired, small, at *ab.* Genital markings paired, circular, smaller than male porophores, with minute central pores, on 9/10, on or near *b* lines ; one of the paired markings sometimes absent

Gizzards 2-4, in *xii-xvi* ; intestinal origin in *xxi,* sometimes in *xxii* or *xxiii.* Vas deferens rather short, in several loops on anterior and posterior faces of septum 9/10, entering the ental end of the prostate directly. Prostates glandular, erect ; capsule digitiform. Spermathecae paired, in *viii* atrium digitiform, in *vii,* as long as or slightly longer than the prostate, arising from the ental end of the spermathecal duct. Genital marking glands digitiform, occasionally or slightly protuberant into coelomic cavity, smaller than the prostates.

Distribution. India Orissa : Brajarajpur, Bolangir, Balugaon, Konark, Gopalpur, Baripada, Barkul, Sundargarh, Jharsuguda, Sambalpur, Titlagarh, Puri Kantabanji, Banki, Cuttack, Jagatsingpur, Kendrapara, Bargarh, Barpali, Burla, Surda, Rourkela ; Madhya Pradesh ; Andhra Pradesh ; Uttar Pradesh.

Material examined. Several juvenile, aclitellate, clitellate specimens, Kantabanji, Bolangir in Bolangir dist., Banki, Cuttack, Jagatsingpur, Kendrapara in Cuttack dist., Bargarh, Barpali, Burla in Sambalpur dist., Rourkela, Surda in Sundargarh Dist., June-Sept. 1980, B. K. Senapati.

Habitat. *D. willsi* inhabits soils with high organic content (>10 g%). It is abundant in crop fields, compost pits and drains ; pH ranging from slight acidic to alkaline soils (6.8-7.5)

Biology. It is phytogeophagous. A maximum population density of 32/m^2 in an upland protected pasture, 250/m^2 in a low land crop field and 500/m^2 in a compost pit has been recorded (Senapati, 1980 ; unpublished).

Live cocoons are pale to reddish brown, round (diameter : length=0.9), 3.2 mm long and 2.9 mm diameter, and weigh around 6 mg. Incubation period is 14-18 days at 25°C of soil temperature and 16 g% of soil moisture. Usually two young worms hatch from each cocoon, rarely three, although four worms emerging from a single cocoon have been recorded (Dash and Senapati, 1980). Cocoons are laid throughout the year in complete moist habitats, but in rainfed areas they are found only during post-rainy season. A newly hatched worm takes about 90-180 days to reach maturity. However, in exclusively rain-fed habitats where quiescence disrupts growth, maturity is attained in about 18-20 months. It forms diapause coils during dry summer months.

About 5-6 kg of annual dry cast production per gram dry weight of worm has been estimated under laboratory conditions. Casts are deposited on the soil surface in the form of globular pellets. Rate of cast production has been estimated to be around 10 times higher than that of *Lampito mauritti.* Soil moisture of 15 to 22 g% is most suitable for wormcast production.

Economic importance. Dash *et al.* (unpublished) have demonstrated the presence of cellulase, urease, invertase and protease in its gut. Laboratory observations have shown that this species enhances decomposition of green manure and straw in culture.

SUMMARY

This paper deals with a systematic account of 30 species so far known from Orissa. *Malabaria biprostate* Aiyer is reported for the first time from the area. Range of habitat and biological notes for most of the species are also included.

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FIGURES

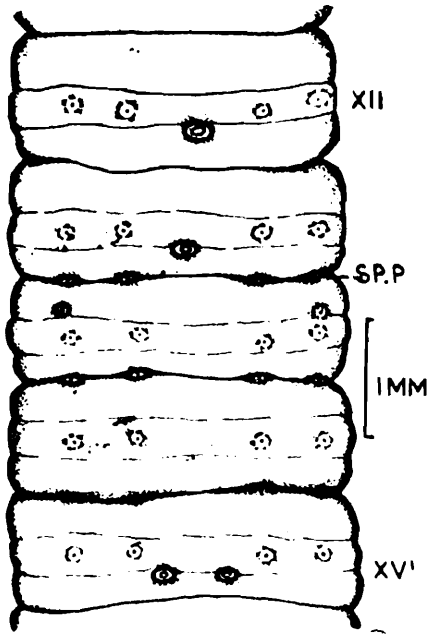


FIG.1

FIG. 5

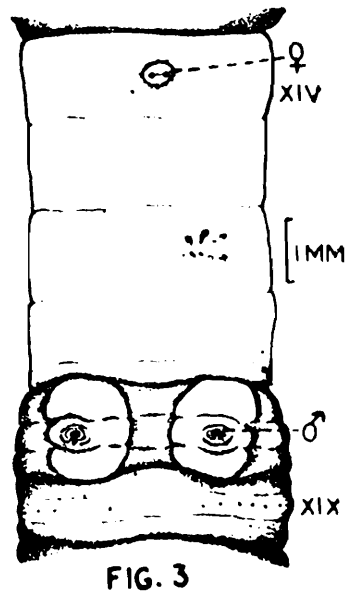


FIG. 3

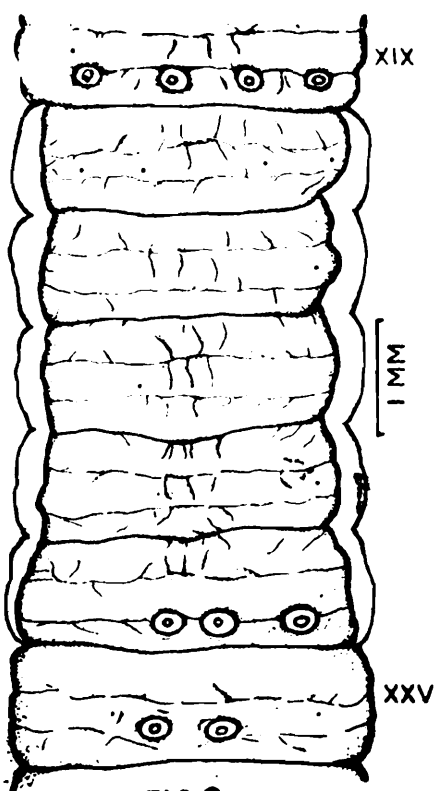


FIG.2

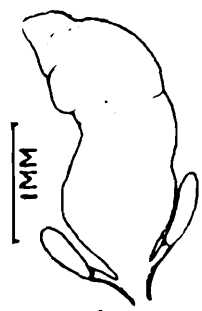


FIG. 4

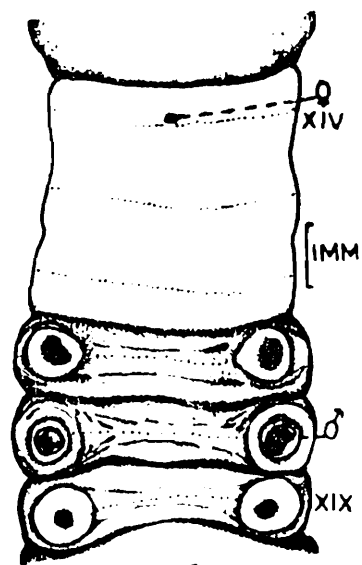


FIG. 6

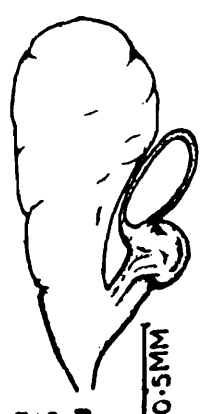


FIG.7

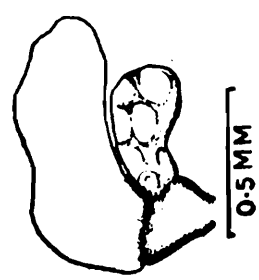
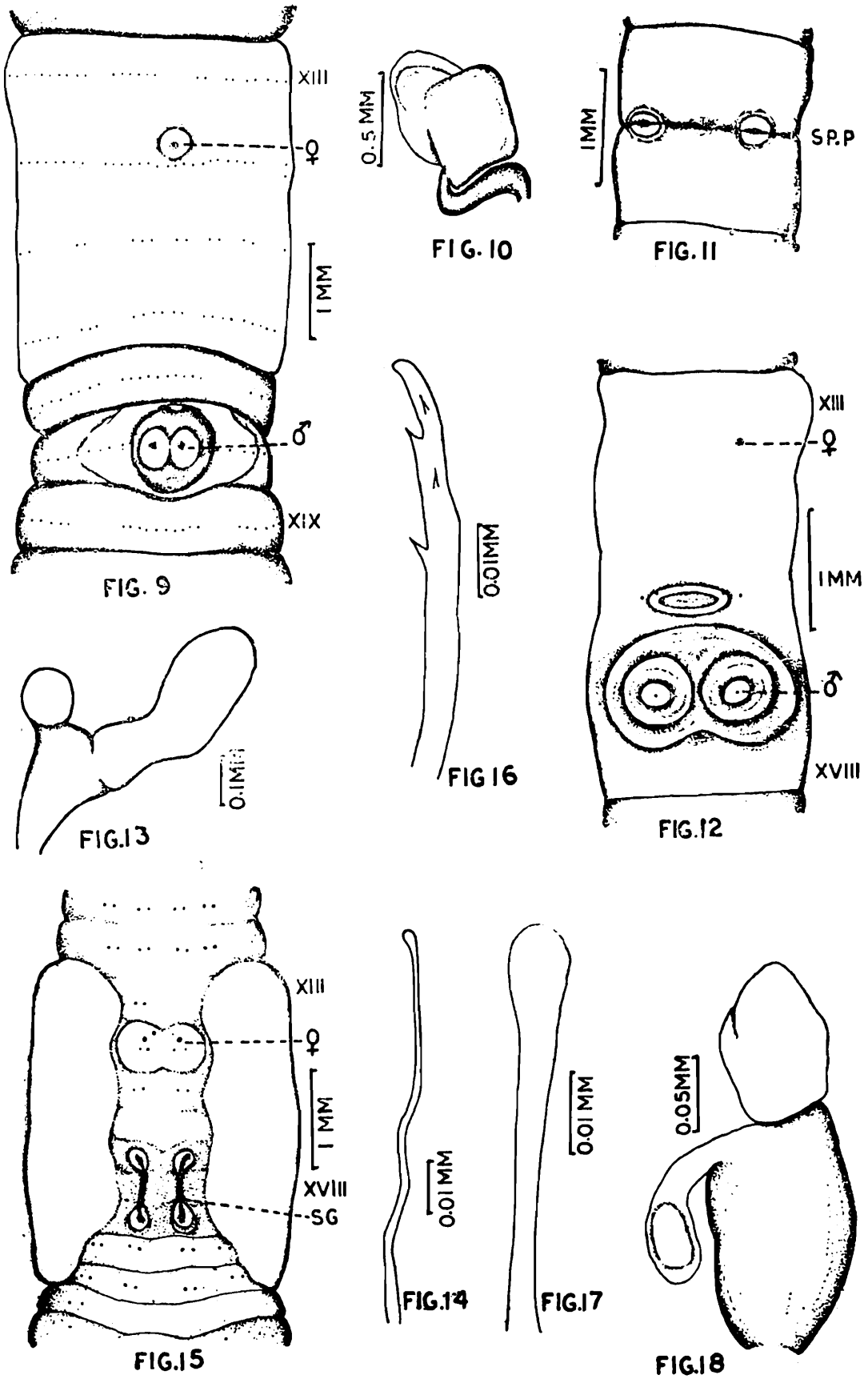


FIG. 8

Figs. 1-8. 1-2. *Glyphidrilus tuberosus* Stephenson, 1. Spermathecal pore area, 2. Clitellar region ; 3-5. *Lampito mauritii* Kinberg, 3. Male genital region, 4. Spermatheca, 5. Penial seta ; 6-7. *Metaphire posthuma* (Vaillant), 6. Male genital region, 7. Spermatheca ; 8. *Perionyx sansibaricus* Michaelsen.



Figs. 9-18. 9. *Perionyx sansibaricus* Michaelsen, Male genital region ; 10-12. *Malabaria biprostata* Aiyer, 10. Spermatheca, 11. Spermathecal pore area, 12. Male genital area ; 13-15. *Dichogaster affinis* (Michaelsen), 13. Spermatheca, 14. Penial seta, 15. Male genital area ; 16-18. *Dichogaster bolaui* (Michaelsen), 16-17. Penial setae, 18. Spermatheca.

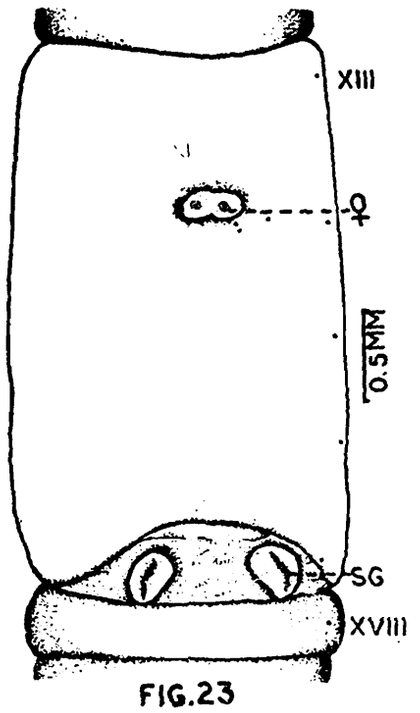


FIG.23

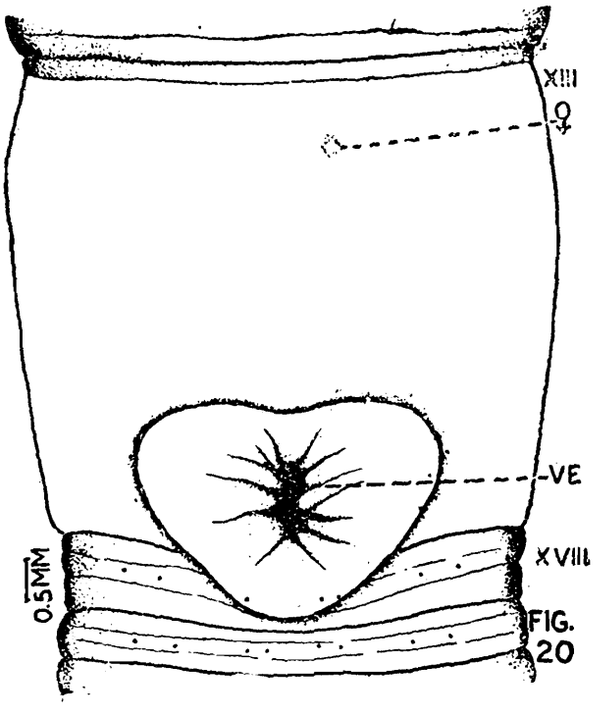


FIG. 20

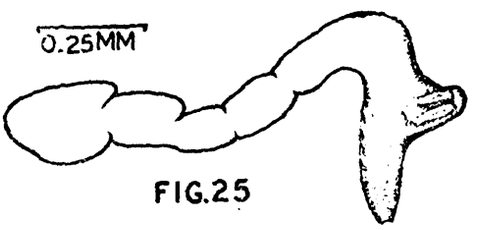


FIG.25

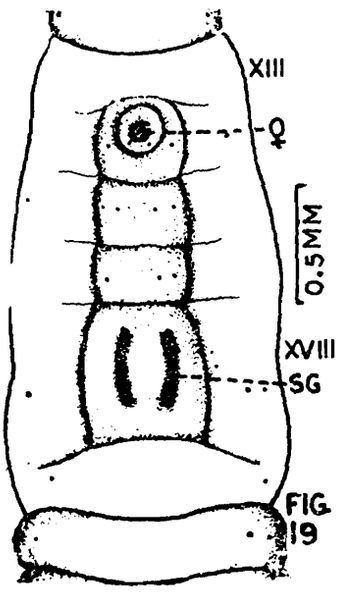


FIG. 19

FIG. 24

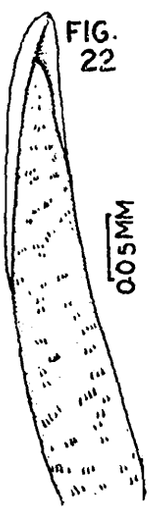


FIG. 22

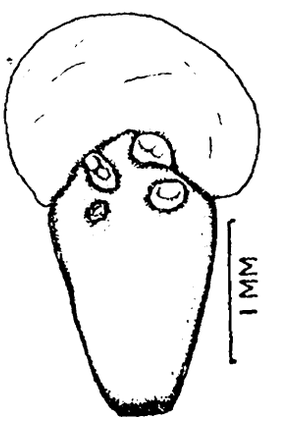
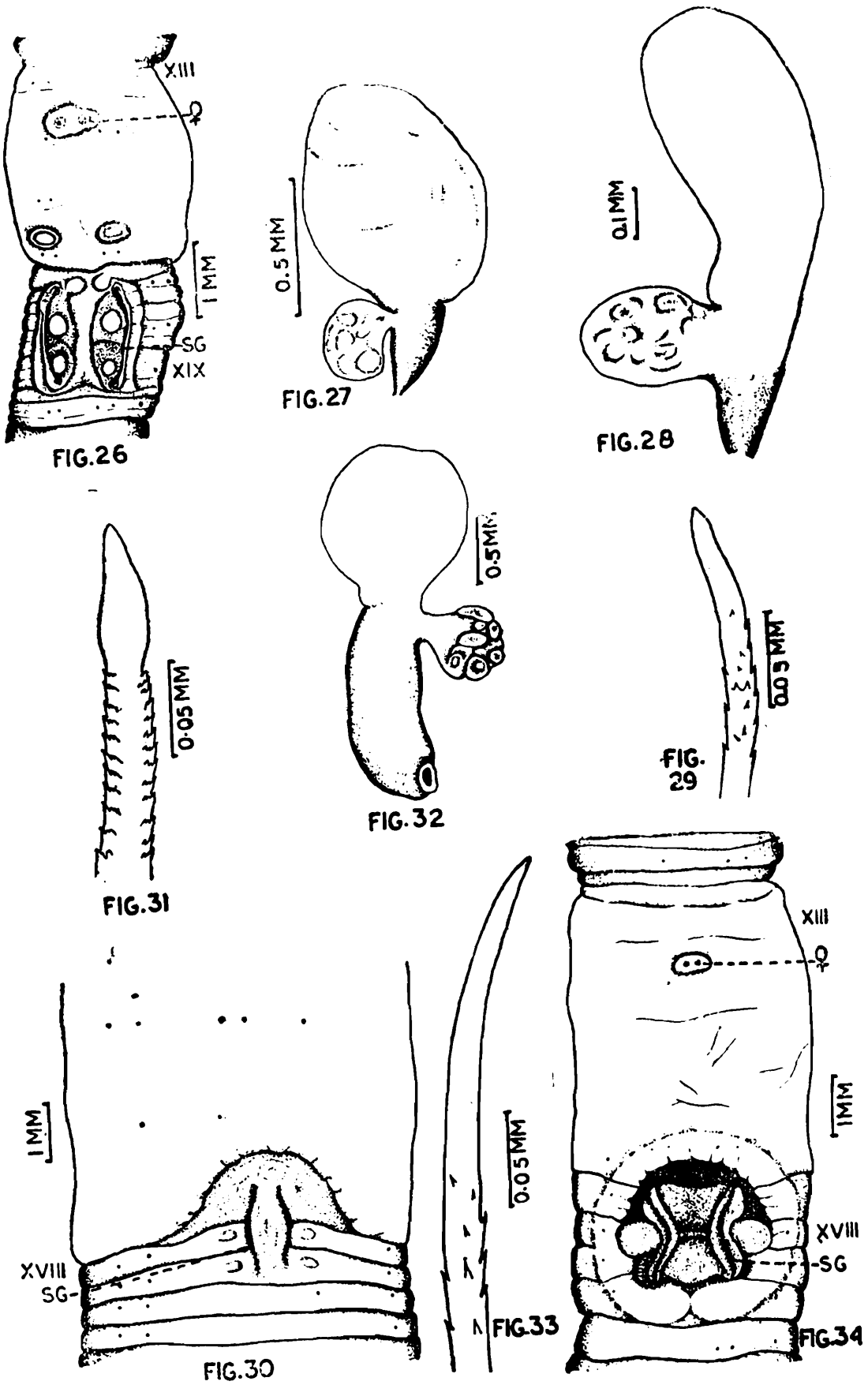
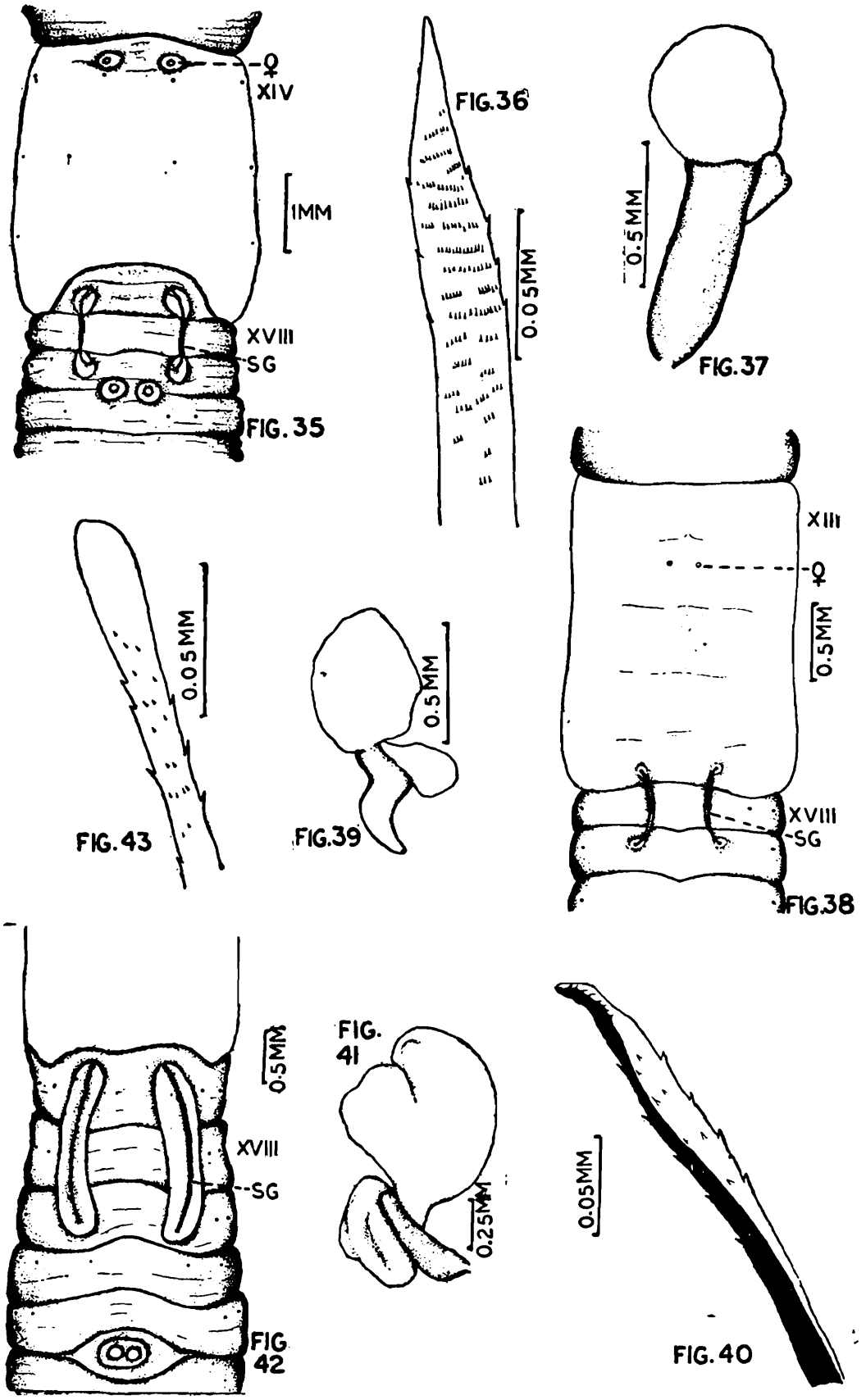


FIG.21

Figs. 19-25. 19. *Dichogaster bolaui* (Michaelsen), Male genital region ; 20-22. *Eutyphoeus kherai* Julka, 20. Male genital region, 21. Spermatheca, 22. Penial seta ; 23-25. *Lennogaster pusillus* (Stephenson), 23. Male genital region, 24. Penial seta, 25. Spermatheca.



Figs. 26-34. 26-27. *Octochaetona barkudensis* (Stephenson), 26. Male genital region, 27. Spermatheca ; 28-30. *Octochaetona beatrix* (Beddard), 28. Spermatheca, 29. Penial seta, 30. Male genital region ; 31-34. *Octochaetona surensis* (Michaelsen), 31. Copulatory seta, 32. Spermatheca, 33. Penial seta, 34. Male genital region.



Figs. 35-43. 35-37. *Pellogaster bengalensis* (Michaelsen), 35. Male genital region, 36. Penial seta, 37. Spermatheca ; 38-40. *Ramiella bishambari* (Stephenson), 38. Male genital region, 39. Spermatheca, 40. Penial seta ; 41-43. *Ramiella sundargarhensis* Julka, 41. Spermatheca, 42. Male genital region, 43. Penial seta.