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Note.—

*(An asterisk) preceding a name denotes a new variety or subspecies.
†(A dagger) indicates a new species.
‡(A double dagger) indicates a new genus or subgenus.
**(A double asterisk) indicates a new family or subfamily.
Synonyms are printed in italics.
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A SYSTEMATIC ACCOUNT OF THE MOLLUSCAN WOOD BORERS OF VISAKHAPATNAM HARBOUR

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(Plate I)

INTRODUCTION

The first piece of life work on Teredinidae was that of Godfrey Sellius[1] who wrote a treatise on the anatomy and habits of the shipworm. Since then several accounts of these specialised molluscs have appeared and a multitude of species have been described differing in minor morphological characters. Among others reference may be made to the important memoirs of Quatrefages[2]; to the series of reports issued by a commission of the Royal Academy of Sciences in Amsterdam; to Hatschek's[3] account of early development; and Sigerfoos's[4] elaborate monograph on the structure and life-history of the Teredinidae. In recent years the ravages of shipworms caused great disaster in unsuspected localities, and at once their economic importance was realised. Paul Bartsch[5], a very well-known authority on Mollusca, proposed a new system of classification of the shipworms which has become the basis of all recent works. He published an elaborate monograph on American shipworms (1922). In England, Dr. Calman[6] of the British Museum, reported on molluscan wood borers. Lamy[7] described the species of molluscan borers present in Paris museum and Roch[8] and Moll those of the Berlin museum, Hamburg museum, British and other museums. Sivickis[9] gave a detailed account of the philippine shipworms and Edmondson[10] from Hawaii described 15 species of Teredinidae. From Australia, as long ago as 1894 Charles Hedley[11] began an inquiry into the wood boring pests, especially the molluscan ones, and a complete account of these forms was published in 1901. Later Tom Iredale[12] *et al* gave an elaborate account of the Teredinidae of Port Jackson (1932).

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[1] Sellius, G., *Historia naturalis teredinis seu Xylophagi marini, tubulo-conchoidis speciatim* Belgici (*Trajecti ad Rhenum*, Besseling) (1733).

[2] Quatrefages, A. de, *Ann. Sci. nat.* (3), XI (1849).

[3] Hatschek, B., *Arb. Zool. Inst., Univ.* Wien, III (1881).

[4] Sigerfoos, C., *Bull. U. S. Bur. Fish* [1907] (1908).

[5] Bartsch, Paul., *Bull. U. S. nat. Mus.* CXXII (1922).

[6] Calman, W. T., *Proc. Zool. Soc. Lond.* (1920).

[7] Lamy, E., *J. Conchyliol.* LXXI (1927).

[8] Roch, F., and Moll, F., *Mitt. Zool. Mus. Hamb.* XLIV (1929).

[9] Sivickis, P. B., *Philip. J. Sci.* XXXVII (1928).

[10] Edmondson, C. H., *Occ. Pap. Bishop. Mus.* XVII (1942).

[11] Hedley, C., The marine wood borers of Australisia and their work. *Asstt. Assoc. Adv. Sci.,* Rept. 8th Meeting [1900] (1901).

[12] Tom Iredale, Johnson, R.A. and McNeill, F. A., *Sidney Harbour Trust.* (1932).

From the above account it is clear that though considerable work has been done on the systematics of marine borers in different parts of the world, in India this problem has received only scant attention in spite of the economic interest attached to such studies. The only work on this subject is that of Erlanson[1] (1936) who published a preliminary note on the common wood-boring organisms from Cochin harbour. The details about the systematics of marine borers in India, therefore, remain unexplored.

The present work was undertaken with a view to make a systematic study of the molluscan borers attacking wooden piles at Visakhapatnam harbour. In the course of my work I have come across ten species of *Teredo*, one species of *Bactronophorus*, two species of *Bankia* and two species of *Martesia*. The classification adopted for the molluscan borers is after Paul Bartsch (1922).

VISAKHAPATNAM HARBOUR

This work was carried out in Visakhapatnam harbour (Lat. 17′ 41″ N ; Long. 83′ 17·35″ E) situated in a typical tropical coast. It is one of the major ports of India located midway between the ports of Madras in the south and Calcutta in the north. This is an artificial land-locked harbour, approached by a dredged channel 300′ wide, and designed to admit ships drawing upto 28′ 6″ and 550′ in length, at all times of the year. The Vizag harbour receives the fullest benefit of the southwest monsoons as well as some precipitation from the northeast monsoons. The annual rainfall is about 45″, more than half of which falls in the four months, from July to October.

MATERIAL AND METHODS

The wood-boring organisms were collected only during low tides when all the timbr jetties were fully exposed. Collections were started as soon as the tide began to recede. Weekly collections were made throughout the one year of study. Small bits of wood from the jetty logs were opened with the help of chisel and hammer and the wood borers transferred into the collection bottles. It was found very difficult to collect entire specimens of *Teredo* and *Bankia* except from logs of dismantled jetties. It was, however, comparatively easy to collect *Martesia* as they attack the surface layers of wood.

ORGANISMS BORING INTO SUBMERGED TIMBER.

Family TEREDINIDAE

Wood boring bivalve molluscs with elongate bodies, only the anterior portion of which is protected by the shell. Siphons furnished with two posterior calcareous structures, called pallets.

Genus **Teredo** Linnaeus

1758. *Teredo*, Linnaeus, *Syst. Nat.* 10th ed., p. 651.

1922. *Teredo*, Bartsch, *Bull. U. S. nat. Mus.* CXXII, p. 17.

Pallets are either paddle- or spoon-shaped. They may be distally cupped or not.

[1] Erlanson, E. W., *Curr. Sci.* IV (7), pp. 726-732.(1936).

Subgenus **Teredo** Linnaeus

1758. *Teredo,* Linnaeus, *Syst. Nat.* 10th ed., p. 651.

1922. *Teredo,* Bartsch, *Bull. U.S. nat. Mus.* CXXII, p. 17.

Pallets paddle-shaped with the blade cupped distally terminating laterally in sharp points. Four species of this subgenus occur in Vizag harbour.

Teredo (Teredo) navalis Linnaeus

(Text-fig. 1. *a, b.*)

1767. *Teredo navalis,* Linnaeus, *Syst. Nat.* 12th ed., p. 1267.

1853. *Teredo navalis,* Forbes & Hanley, *Brit. Moll.* I, p. 74.

1915. *Teredo navalis,* Gatliff & Gabriel, *Proc. Roy. Soc. Victoria* (n.s.) XXVIII, p. 117.

Shell sub-globular and white ; auricle small, sub-triangular, anterior median area large in this type.

The basal portion of the blade of the pallet is calcareous, while the distal portion is covered by a brown chitinous epidermis. Stalk is of medium length and cylindrical.

Measurements.—Shell : length 4 mm. Pallets : total length 2·2 mm. of which 1 mm. belongs to the stalk.

Distribution.—Europe, from North Cape of Mediterranean ; South Africa ; Atlantic coast of North America ; San Francisco Bay ; Australia. In India it was previously recorded from Cochin harbour. Very common in Vizag harbour.

Teredo (Teredo) parksi Bartsch

(Text-fig. 1. *c, d.*)

1921. *Teredo (Teredo) parksi,* Bartsch, *Proc. biol. Soc. Wash.* XXXIV, p. 28.

1942. *Teredo (Teredo) parksi,* Edmondson, *Occ. Pap. Bishop. Mus.* XVII, No. 10, p. 106.

The pallets are paddle-shaped with long slender stalk which is slightly curved. Blade short, broad and excavated at the distal end, more deeply on the convex outer surface than on the flattened inner face. Dark brown epidermis covers the blade nearly to its base.

Measurements.—Pallets : total length 4·9 mm. out of which 3.8 mm. belongs to the stalk.

Distribution.—Hawaii, Samoa, Philippine Island ; very rare in Vizag harbour.

Remarks.—Unfortunately I have not been able to get entire specimens of this species and only the posterior end with the pallets have been examined.

Teredo (Teredo) bartschi Clapp

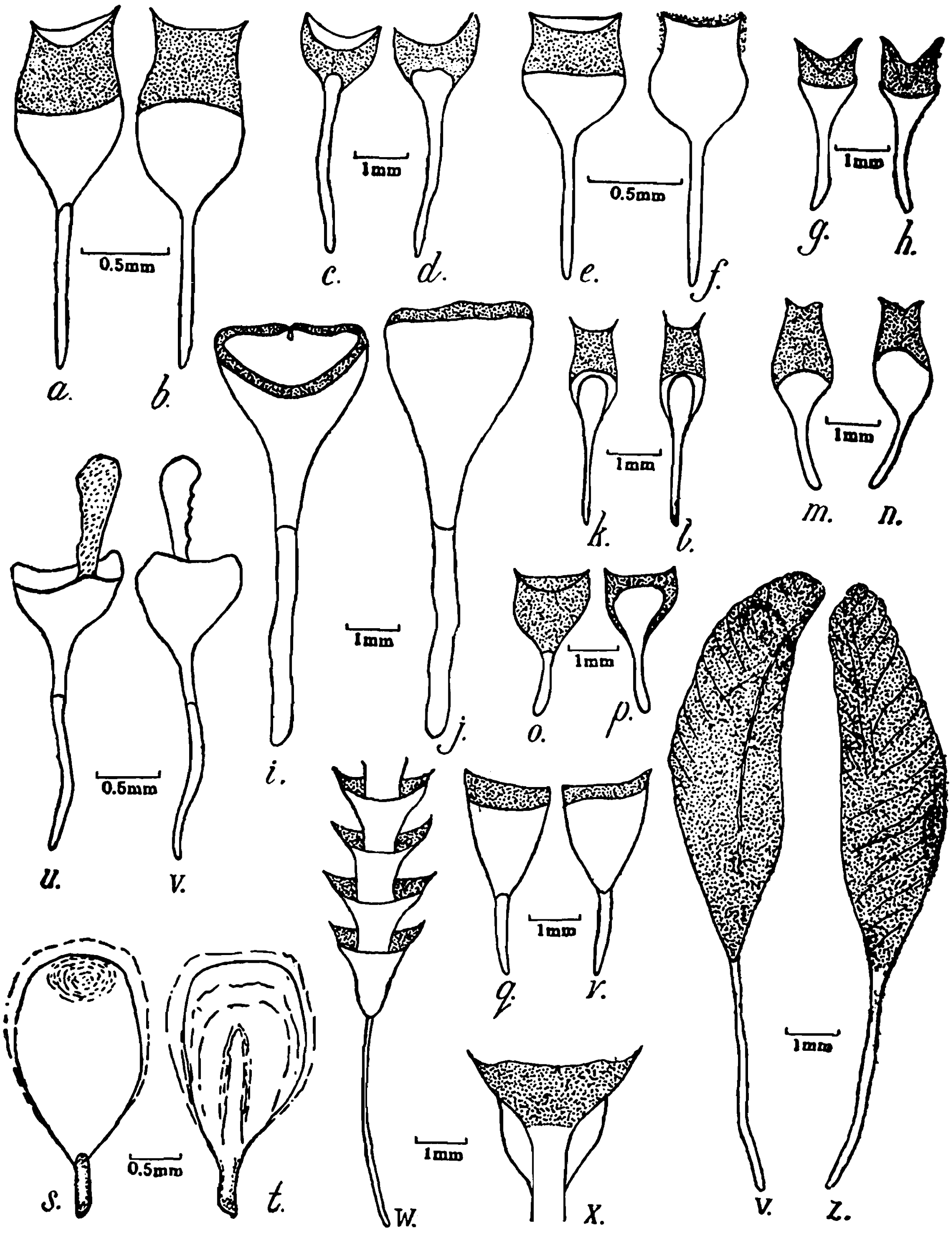
(Text-fig. 1. *e, f.*)

1923. *Teredo (Teredo) bartschi,* Clapp, *Proc. Boston Soc. nat. Hist.* [XXXVII, p. 33.

1942. *Teredo (Teredo) bartschi,* Edmondson, *Occ. Pap. Bishop. Mus.* XVII, No. 10, p. 108.

Pallets spatulate in form, stalk slightly longer than blade and straight, blade cup-shaped at extremity, distal two-thirds of the blade is covered by brown epidermis. Calcareous portion of the blade dumb-bell shaped.

Measurements.—Pallets: length of the stalk 0·8 mm. and length of the blade 0·6 mm.



TEXT-FIG. 1.—*a. Teredo* (*Teredo*) *navalis* : outer face of the pallet; *b.* Pallet of same, inner view. *c. Teredo* (*Teredo*) *parksi* : Pallet outer face; *d.* Pallet of same, inner face. *e. T.* (*Teredo*) *bartschi* : outer face of the pallet; *f.* Pallet of same, inner face. *g. T.* (*Teredo*) *furcillatus* : outer face of the pallet; *h.* Pallet of same, inner face. *i. T.* (*Teredothyra*) *mannii* : outer face of the pallet; *j.* Pallet of same, inner face. *k. T.* (*Teredops*) *diegensis* : outer face of the pallet; *l.* Pallet of same, inner face. *m. T.* (*Teredops*) *samoaensis* : outer view of the pallet; *n.* Pallet of same, inner view. *o. p. T.* (*Zopoteredo*) *trulliformis* : outer face of the pallet; *p.* Pallet of same, inner face. *q. R. T.* (*Zopoteredo*) *triangularis* : outer face of the pallet; *r.* Pallet of same, inner face. *s. T.* (*Teredora*) *thomosoni* : outer view of the pallet; *t.* Pallet of same, inner view. *u. Bactronophorus thoracites*: outer face of the pallet. *v.* Pallet of same, inner view. *w. Bankia* (*Bankia*) *setacea* : outer face of the pallet; *x.* Single cone enlarged. *y. B.* (*Nausitora*) *excolpa* : outer face of the pallet; *z.* Pallet of same, inner face.

Distribution.—Nawiliwii, Hawaii, Atlantic and Gulf coasts, from South Carolina to Texas with the exception of southern tip of Florida; San Diego Bay; rarely found in Vizag harbour.

Teredo (Teredo) furcillatus Miller

(Text-fig. 1. *g. h.*)

1924. *Teredo furcillatus,* Miller, *Univ. Calif. Pub. Zool.* XXVI, p. 149.
1942. *Teredo (Teredo) furcillatus,* Edmondson, *Occ. Pap. Bishop. Mus.* XVII, No. 10., p. 113.

Pallets with long stem and small blade, the distal portion of the blade is deeply excavated on the outer and also on the inner face. The important feature of the pallets is the absence of the dark periostracum which is present in *T parksi.* Stalk slightly curved and cylindrical.

Measurements.—Pallets : stalk 2 mm. blade 1·3 mm.

Distribution.—Samoa and Hawaii (Honolulu harbour) ; very rare in Vizag harbour.

Subgenus **Teredothyra** Bartsch

1921. *Teredothyra,* Bartsch, *Proc. biol. Soc. Wash.* XXXIV , p. 26.
1922. *Teredothyra,* Bartsch, *Bull. U.S. nat. Mus.* CXXII, p. 22.

In this subgenus the pallets are doubly cupped at the terminal portion.

Teredo (Teredothyra) mannii (Wright)

(Text-fig. 1. *i. j.*)

1865. *Kuphus? mannii,* Wright, *Trans. Linn. Soc.* XXV, p. 565.
1901. *Nausitoria mannii,* Hedley, *Aust. Assoc. Adv. Sci.* I.

Shell rather large, the extreme anterior portion being covered by a thick callus, median portion of the shell is wide ; the posterior part forms a conspicuous auricle which fuses with the median portion so intimately that the line of fusion is not seen externally.

The pallets with a long stalk which is larger than the blade and is somewhat stout and a little bit twisted. The stalk expands into a broad blade-like portion which is deeply cupped. The cavity of the cup is divided indistinctly into two portions ; it is flat on one side and convex on the outer portion.

The siphons are long and free for most of their length.

Measurements.—Shell : length 8·5 mm. Pallets : total length 17·5 mm. stalk 9·5 mm.

Distribution.—Queensland, Australia ; very common in Vizag harbour.

Subgenus **Teredops** Bartsch

1921. *Teredops,* Bartsch, *Proc. biol. Soc. Wash.* XXXIV, p. 26.

Pallets not deeply cupped, calcareous portion of the blade elongate-oval, partly covered by a heavy periostracum.

Teredo (Teredops) diegensis Bartsch

(Text-fig. 1. *k, l.*)

1916. *Teredo diegensis,* Bartsch, *Nautilus.* XXX, p. 48.
1922. *Teredo (Teredops) diegensis,* Bartsch, *Bull. U.S. nat. Mus.* CXXII, p. 29.
1942. *Teredo (Teredops) diegensis,* Edmondson, *Occ. Pap. Bishop. Mus.* XVII, No. 10,p. 130.

Shell with numerous, fine closely spaced denticulated ridges on anterior lobe. Auricle varies considerably in size.

Pallet with slender stalk which is slightly longer than blade. Stalk cylindrical and somewhat tapering towards the base. Blade consists of an oval calcareous portion, capped by an elongate periostracum; black in colour and typically excavated at the extremity. The two elements of the blade can be easily separated without injury.

Mesurements.—Pallets: length 3·8 mm. out of which 2 mm. go to form the stalk.

Distribution.—San Francisco Bay, Hawaiian Islands, Los Angeles harbour, San Diego Bay. In India Erlanson reported this species as occurring in Cochin harbour; common in Vizag harbour.

Teredo (Teredops) samoaensis Miller

(Text-fig. 1. *m, n.*)

1924. *Teredo samoaensis*, Miller, *Univ. Calif. Publ. Zool.* XXVI, p. 149.

Pallets with a small stalk and broad blade. The stalk is cylindrical and slightly curved. Blade distinguished into two portions just as in *T diegensis.* The basal portion comprising about one half of the length of the blade; the blade is broadly ovate and calcareous; the distal portion is narrower and nearly straight sided. The blade is flattened in the inner face. At the junction of the two elements of the blade the pallet is encircled by a band of brown epidermis, which in some cases envelops the distal portion.

Measurements.—Pallets: length of blade 1·8 mm. and length of stalk 1·2 mm.

Distribution.—Samoa; Cochin harbour and very rarely seen in Vizag harbour.

Subgenus **Zopoteredo** Bartsch

1923. *Zopoterodo*, Bartsch, *Proc. biol. Soc. Wash.* XXXVI, p. 26.

Calcareous portion of the blade semi-disc shaped or elongate terminal border slightly concave.

Teredo (Zopoteredo) trulliformis Miller

(Text-fig. 1. *o, p.*)

1924. *Teredo trulliformis*, Miller, *Unvi Calif. Publ. Zool.* XXVI, p. 150.

Pallets with stalk of medium size, which instead of tapering towards the end, becomes gradually expanded like the handle of a trowel. The distal portion of the blade is covered with a dark epidermis and the terminal border is slightly cupped.

Measurements.—Pallets: length of the blade 1·7 mm. and length of the stalk 1·4 mm.

Distribution.—Hawaiian islands; very common in Vizag harbour.

Teredo (Zopoteredo) triangularis Edmondson

(Text-fig. 1. *q, r.*)

1942. *Teredo (Zopoteredo) triangularis*, Edmondson, *Occ. Pap. Bishop. Mus.* XVII, No. 10, p. 126.

Shell with anterior median area occupying $\frac{1}{4}$ of the median area; auricle short, height about twice its length; internally the auricle overlaps the posterior median area in the upper part of the union; in the lower part the junction is marked only by a raised ridge.

Pallets with stout stalk, tapering near the proximal end. Blade flattened on the inner face, slightly convex on the outer surface merging gradually into the stalk proximally and broadening distally. The blade almost looks like a triangle and hence the name.

Measurments.—Shell: length 4 mm. Pallets: length of the blade 2·2 mm. length of the stalk 1·8 mm.

Distribution.—Hawaiian islands; only one specimen was collected in Vizag harbour.

Subgenus **Teredora** Bartsch

1921. *Teredora*, Bartsch, *Proc. biol. Soc. Wash.* XXXIV, p. 26.

In this subgenus the auricle is so placed upon posterior median portion that half of it projects as a shelf inwardly and the other half outwardly. Pallets spoon-shaped.

Teredo (Teredora) thomsoni Tryon

(Text-fig. 1. *s*, *t*.)

1863. *Teredo thomsoni*, Tryon, *Proc. Acad. nat. Sci. Philad.* p. 280.

Shell large, slightly black in colour on the outside. The anterior part is separated from the posterior median part by a straight line. The anterior part bears the dental ridges which in this type exceeds 50 in number. The posterior part forms a small auricle which is obliquely placed. The auricle projects as a shelf over the posterior median portion.

Pallets with short stalk which is subcylindrical; blade convex on the outer side and concave on the inner side. Inside of the blade is smooth and shows a rib running through its centre very much as if the stalk portion extends towards the tip through the pallet. At the tip of the blade on the convex side there is a small depression.

Measurements.—Shell: 9 mm. Pallets: length of the blade 8 mm. length of the stalk 1·5 mm.

Distribution.—American waters. Very common in Vizag harbour.

Remarks.—This species occurs in large numbers in this harbour. Every log of wood is attacked by this form. The largest form so far collected measured about 131 mm. in length.

Genus **Bactronophorus** Tapparone-Canefri

1877. *Bactronophorus*, Tapparone-Canefri, *Ann. Mus. Stor. Nat. Genoa.* IX.

1928. *Bactronophorus*, Sivickis, *Philipp. J. Sci.* XXXVII, No. 3, p. 289.

Pallets large, stilt-like, from the distal end of the pallet springs a long flat blade-like style.

Bactronophorus thoracites (Gould)

(Text-fig. 1. *u*, *v*.)

1856. *Teredo thoracites*, Gould, *Proc. Boston Soc. nat. Hist.* VI, p. 15.

1865. *Calobates thoracites*, Wright, *Trans. Linn. Soc.* XXV, p. 564.

1877. *Bactronophorus thoracites*, Tapparone-Canefri, *Ann. Mus. Stor. Nat, Genoa.* IX, p. 290.

Shell comparatively large, sub-globular and somewhat black in colour. The anterior part is wider than the posterior and bears the usual denticulated ridges, of which 120 can be counted in the type; the umbone is hidden from view, as it is covered by the shelf. Projecting downwards from the umbone is a well-developed flattened blade which extends to 1/3 of the distance towards ventral knob; the ventral knob is large.

Pallets stilt-like, long and stout; the style which is projecting from the distal end of the blade is flat and smooth on the inner surface and slightly convex on the outer. The outer surface is warty.

The two siphons are united throughout their length except at the terminal portion where they are separated. The tips of the siphons are black in colour and from their surface project small papillae-like structures.

Measurements.—Shell: length 17 mm. Pallets: length of blade 17 mm. and length of stalk 11 mm.

Distribution.—Burma, Singapore, Western Australia, Dutch New Guinea, Elphinstone Island; only found in fisherman's boats at Vizag.

Remarks.—It is interesting to observe that this form was found only attacking the logs of the catamaran (country craft of fishermen) and were not found in the wooden piles of the jetties. The largest specimen collected measured 28 cm. in length.

Genus **Bankia** Gray.

1840. *Bankia*, Gray, *Synop. Brit. Mus.* p. 76.
1922. *Bankia*, Bartsch, *Bull. U.S. nat. Mus.* CXXII, p. 7.

The pallets consisting of a series of cone-in-cone structures which give them the appearance of the ear of wheat.

Subgenus **Bankia** Gray.

1840. *Bankia*, Gray, *Synop. Brit. Mus.* p. 76.
1922. *Bankia*, Bartsch, *Bull. U.S. nat. Mus.* CXXII, p. 7.

The distal ends of the cones terminate in a thin membrane which is fimbriated at the free margin.

Bankia (Bankia) setacea Tryon

(Text-fig. 1. *w*, *x*.)

1863. *Xylotrya setacea*, Tryon, *Proc. Acad. nat. Sci. Philad.*, p. 144.
1922. *Bankia (Bankia) setacea*, Bartsch, *Bull. U.S. nat. Mus.* CXXII., p. 7.
1927. *Bankia (Bankia) setacea*, Hill & Kofoid, *San Frans. Bay Mar. Pll. Comm. Final Report.*

Anterior lobe of the shell is relatively small. It bears the usual dental ridges which expand slightly fan-shaped from the anterior margin to the posterior termination: auricle is of medium size.

The pallets form plume-like elements composed of a series of cup-in-cup structures which project at the lateral margin in the form of strong arms. Each cup is covered by a thin brown periostracum which is faintly fimbriated. Since all the specimens collected are small in size the pallets are slender with thin stalks.

Measurements.—Pallets : length of blade 5·4 mm. and length of stalk 4·8 mm.

Distribution.—Pacific coast : Cochin harbour, very common in Vizag harbour.

Subgenus **Nausitora** Wright

1864. *Nausitora*, Wright, *Trans. Linn. Soc. Lond.* XXIV, p. 51, pl. 46.
1922. *Nausitora*, Bartsch, *Bull. U.S. nat. Mus.* CXXII, p. 12.
1932. *Nausitora*, Iredale, *Sydney Harbour Trust.*

Pallets consisting of a series of cone-in-cone elements which are not entirely free at their ends, but fused on the exterior surface.

Bankia (Nausitora) excolpa Bartsch

(Text-fig. 1. *y*, *z*.)

1922. *Bankia* (*Nausitora*) *excolpa*, Bartsch, *Bull. U.S. nat. Mus.* CXXII. p. 13.
1927. *Bankia* (*Nausitora*) *excolpa*, Hill & Kofoid, *San Fran. Bay Mar. Pil. Final Report.*

Pallets asymetrical, the stalk being inserted to one side of the median line. Cones almost fused on the outerside where they are covered by a thin periostracum. On the inside the blade shows a series of transverse laminae, each alternating with a dark cord of periostracum.

Measurements.—Pallets : length of blade 8 mm. and length of stalk 5 mm.

Distribution.—Gulf of California ; rare at Vizag.

Remarks.—It is curious to record this species only from the catamarans used by the local fishermen and not even a single form has been collected from jetty logs.

Family PHOLADIDAE

Wood boring and rock boring bivalves ; the body is completely enclosed by the shell ; there are no pallets.

Genus **Martesia** (Leach) Sowerby

1824. *Martesia* (Leach), Sowerby, *Gen. Rec. & Foss. Shell*, Pt. 23, Pholas, pp. 2, 4.

Small bivalve molluscs of ovate or elongate-ovate outline broadly gaping at anterior ventral end in the young stages, the gap usually closing in the adult life. The shell is provided with three accessory pieces : protoplax, metaplax and hypoplax.

Subgenus **Martesia** (Leach) Sowerby

1824 *Martesia*, Sowerby, *Genera of Recent and Fossil Shells*, Part 23 Pholas, pp. 2, 4.

The members of this subgenus have a large more or less rectangular protoplax, the outline of which is coarse and variously wrinkled.

Martesia (Martesia) striata (Linnaeus)

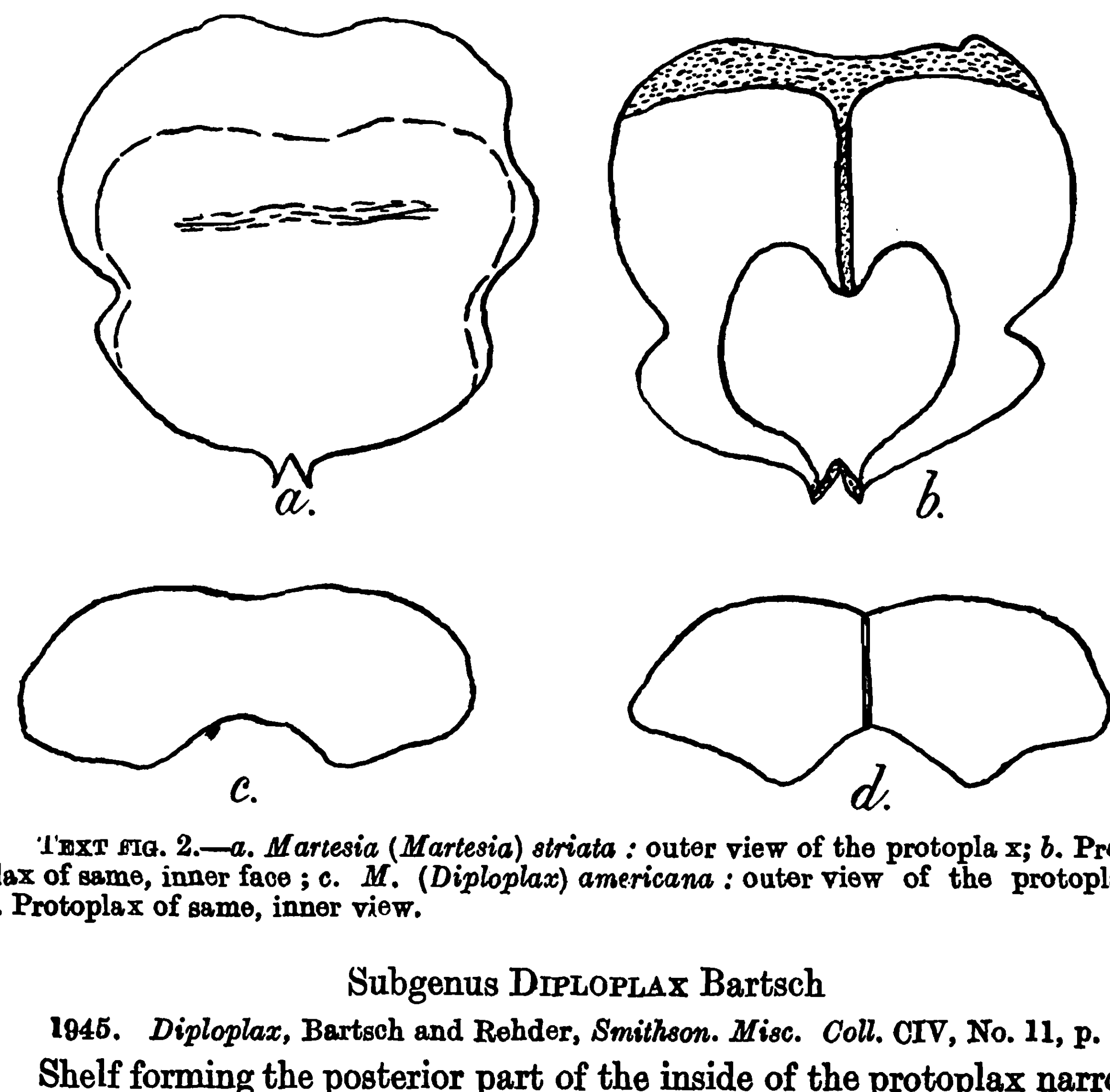
(Text-fig. 2. *a*, *b*.)

1758. *Pholas strita*, Linnaeus, *Syst. Nat.* 10 ed., p. 669.
1818. *Pholas calvata*, Lamarck, *Hist. Nat. Anim. S. Vert.* V, p 446.
1945. *Martesia* (*Martesia*) *striata*, Bartsch and Rehder, *Smithson. Mis. Coll.* CIV, No. 11, p. 4.

Shelf forming the posterior part of the inside of the protoplax is very broad. The protoplax is broad and its outer surface wrinkled. The inside, is concave, the anterior portion bearing a small incurved hook while the cavity of the posterior half is covered by a shelf. The margin of the protoplax is notched. The metaplax is narrow and long and marked on the outer side by a wrinkled periostracum. The hypoplax is also narrow and long and marked by transverse growth lines. Sometimes the shell is variously twisted depending upon its association with fellow borers. Sometimes the posterior portion is much more prolonged.

The largest specimen collected measured 42·1 mm. in length, breadth at the base 16·4 mm.

Distribution.—Cosmopolitan.



TEXT FIG. 2.—*a*. *Martesia* (*Martesia*) *striata* : outer view of the protopla x; *b*. Protoplax of same, inner face ; c. *M.* (*Diploplax*) *americana* : outer view of the protoplax ; *d*. Protoplax of same, inner view.

Subgenus DIPLOPLAX Bartsch

1945. *Diploplax*, Bartsch and Rehder, *Smithson. Misc. Coll.* CIV, No. 11, p. 10.

Shelf forming the posterior part of the inside of the protoplax narrow. Protoplax consists of two pieces.

Martesia (Diploplax) americana Bartsch
(Text-fig. 2. *c, d.*)

Shell similar to *M. striata* but smaller ; the anterior basal gap is not closed in the adult ; this gap being wide in this species. The protoplax consists of two pieces and when the two pieces are approximated a deep, wide V-shaped sinus is formed at the anterior end. The rest of the protoplax is slightly rough and wrinkled. Metaplax and hypoplax are very small and poorly developed ; in some forms the metaplax appears to be absent.

The largest specimen collected measured 23 mm. in length and 12 mm. in breadth at the base.

Distribution.—West coast of Florida ; very common in Vizag harbour.

SUMMARY

The observations on the molluscan wood boring organisms were based on specimens collected at Visakhapatnam harbour for a period of one year (1952-53). According to pallet morphology, ten species of *Teredo,* one species of *Bactronophorus,* two species of *Bankia* and two species of *Martesia* are recorded. Out of ten species of *Teredo,* only four species, viz., *Teredo (Teredo) navalis, Teredo (Teredothyra) mannii, Teredo Zopoteredo) trulliformis* and *Teredo (Teredora) thomsoni,* appear to be very common. *Bankia (Bankia) setacea* and *Martesia (Martesia) striata* and *Martesia (Diploplax) americana* are also of common occurrence.

In general it may be stated that the marine structures in Visakhapatnam harbour are subjected to great destruction by these borers.

ACKNOWLEDGEMENTS

I would like to acknowledge my indebtedness to Prof. P. N Ganapati, Director of the University Zoology Laboratory, Waltair, not only for suggesting this topic for investigation, but also for constant and invaluable help in the form of constructive criticism and encouragement. The above work has been carried out with funds provided by the Forest Research Institute specialy obtained from various sources for the execution of the scheme on the protection of Indian timbers against marine-organisms attack.

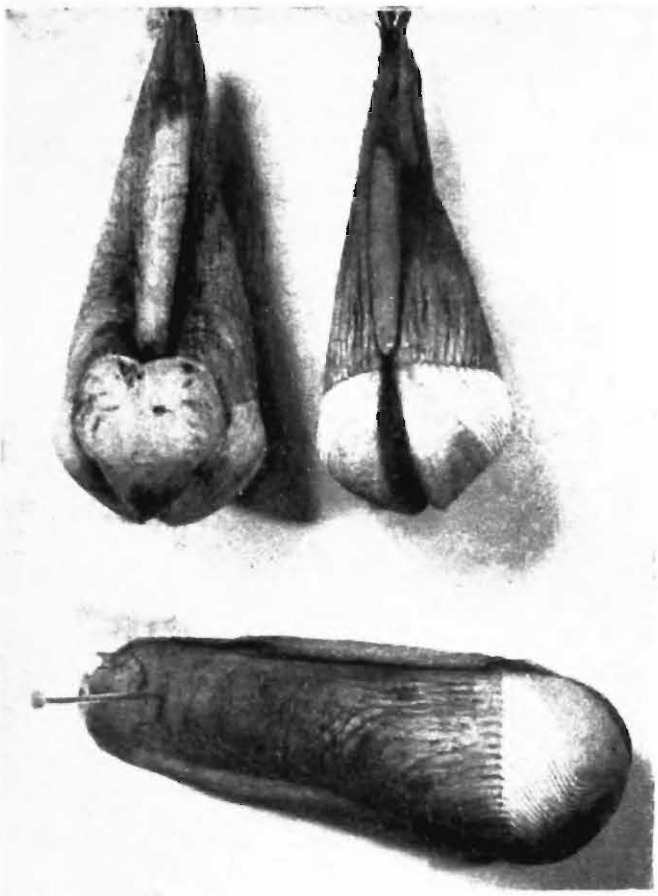
EXPLANATIONS OF PLATE 1.

1. *Martesia striata.*—Dorsal, ventral and lateral views.

2. *Martesia americana.*—Ventral view of the animal (above one); outer and inner views of the shells.

3. Block of wood in low tide showing pallets of *Bankia setacea* profecting from its surface.

4. T. S. of Wood.—Central holes made by snipworms and peripheral ones by *Martesia*.



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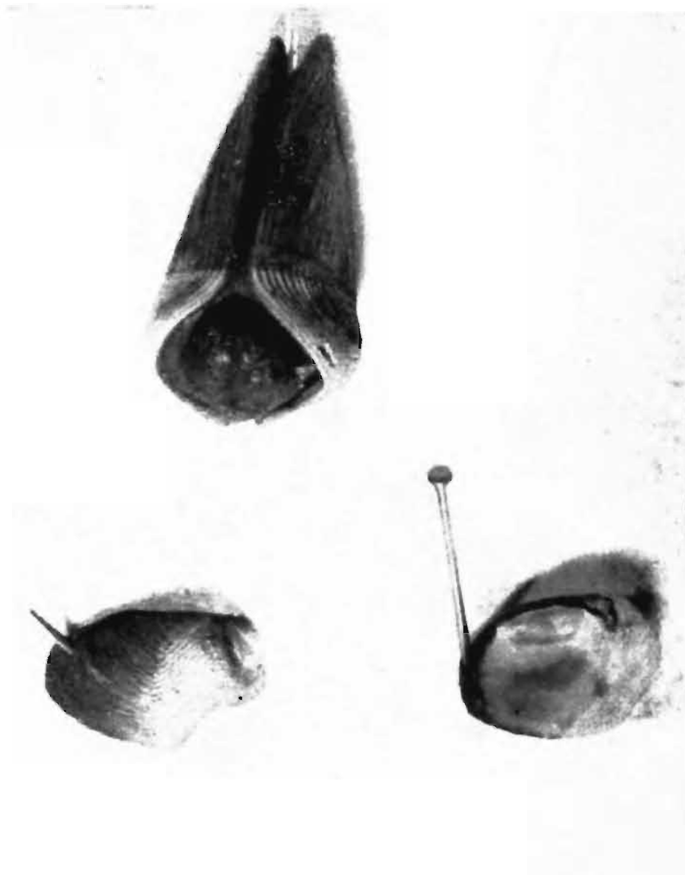

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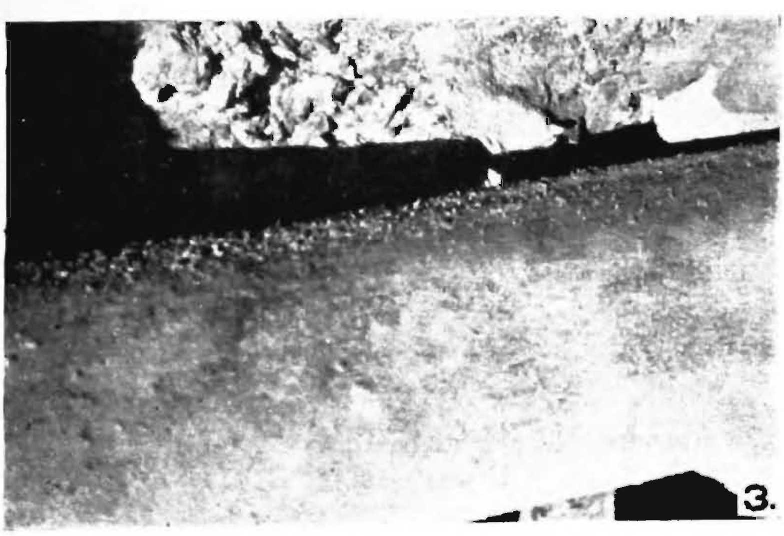

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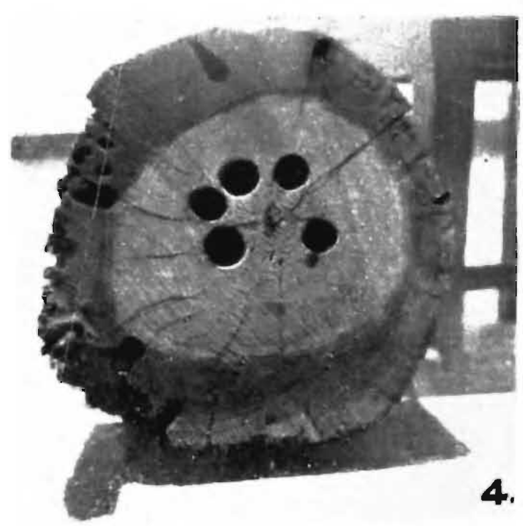


4.

Martesia striata (Linn.), *Martesia americana* Bartsch, pallets of *Bankia setacea* Tryon, and a log of wood showing holes.

ON A COLLECTION OF GYRINIDAE (COLEOPTERA) IN THE ZOOLOGICAL SURVEY OF INDIA, WITH THE DESCRIPTIONS OF TWO NEW SPECIES

By T. G. VAZIRANI, *B.Sc.* (*Hons.*), *Zoological Survey of India, Calcutta*

To almost everyone making aquatic collection, the wriggling beetles (Gyrinids) are familiar for their gyrating mode of locomotion and the way they form schools or colonies on the surface of quiet or slow moving water near the vegetation or under shade of large stones. Hatch[1] inferred from the materials studied by him that the adults formed two ecological groups : among the Indian genera, *Aulonogyrus*, *Gyrinus* and most *Dineutus* fall under the first group thought to inhabit standing water, while *Orectochilus* and certain species of *Dineutus* belong to the second group which inhabit streams. I have, however, collected *Gyrinus* and *Orectochilus* in the waters of the same stream not very far from each other. It is generally agreed that their natural food consists of animals swimming on water, most probably mayflies and similar insects which spend their life over water and fall in water accidentally. They have not been observed to catch animals in water and feeding is said to take place only at the surface. In captivity they have been fed on a variety of food including some vegetation, freshly killed and disabled animals, raw meat, live mealy-bugs, bread and cracker crumbs, etc. ; in each case it seems necessary that the food should float.

The present account deals with the material of Gyrinidae collected by the staff of the Zoological Survey of India from time to time since 1923, the earlier materials having been the subject of study by Ochs[2].

Two species appear to be new and have been described in the following pages. The rest of the material is referable to well known species and do not call for comments, except for remarks on the geographical distribution in the case of a few species.

Orectochilus orissaensis, sp. nov.

Form elongate, oval, moderately convex, a little more attenuated posteriorly than anteriorly. Head black except for the yellow labrum, pronotum and elytra black with lateral border yellow. Under surface reddish brown ; legs, anal sternites and epipleurae yellow.

Labrum semicircular, less than twice as wide as long, finely punctate, with long yellow cilia in front. Head finely granulose at the frons and clypeus. Pronotum finely punctate, anterior margin convex in the middle and concave below the eyes forming an acute angle with the

[1] Hatch, M. H., *Bull. Brooklyn Ent. Soc.* XX, pp. 101-104 (1925).

[2] Ochs, G., *Rec. Indian Mus.* XXVII, pp. 193-204 (1925) ; XXXI, pp. 241-249, 250-252 (1929), Catalogue of Indian Insects, Part 19—Gyrinoidae, pp. 1-39 (1930).

lateral margin Pubescent margin on the pronotum not so broad posteriorly, dilated anteriorly, extending upto the middle of the eye, inner margin of the pubescent area concave. Scutellum small and triangular. Elytra (text-fig. 1*d*) convex, slightly obliquely truncate apically, sutural angle almost a right angle, apical angle sub-obtuse, not rounded, pointed. Pubescent area on the elytra narrow anteriorly, suddenly dilating into a lobe directed upwards and inwards at about a point one-third from the posterior end of the elytron, inner pubescent margin beyond the lobe deeply concave, touching the suture at the apex. Anterior tibia of male sub-parallel, narrowing posteriorly, anterior tarsus dilated almost as broad as the tibia but shorter than the latter.

Aedeagus (text-fig. 1*c*) a little longer than three-fourths of the length of the parameres, broad at base, narrowing towards the apex, a little constricted sub-apically.

Size.—Male, length 4·5 mm., width 2·2 mm.; Female, length 4·6 mm., width 2·2 mm.

Type-specimens.—Holotype, No. 9657/H4, India: Chahala nulla, Simlipal Hills, Mayurbhanj dist., Orissa, 8. 11. 1951 (*B. Biswas*. Coll.).

Allotype, No. 9658/H4, same particulars as holotype.

Paratypes, 19 exs. No. 5659/H4 to 9677/H4. Same particulars as holotype.

Remarks.—This species closely resembles *O. andamanarum* in general appearance, size and the character of the bright yellow labrum. Both the species are characterised by having one lobe of the elytral pubescence, which is small and rounded in *O. andamanarum*, while it is rather elongate, directed upwards and inwards in the present species. Posterior to the lobe, the inner margin of the elytral pubescence is comparatively more concave in the present species than in *O. andamanarum*.

Orechtochilus ribeiroi, sp. nov.

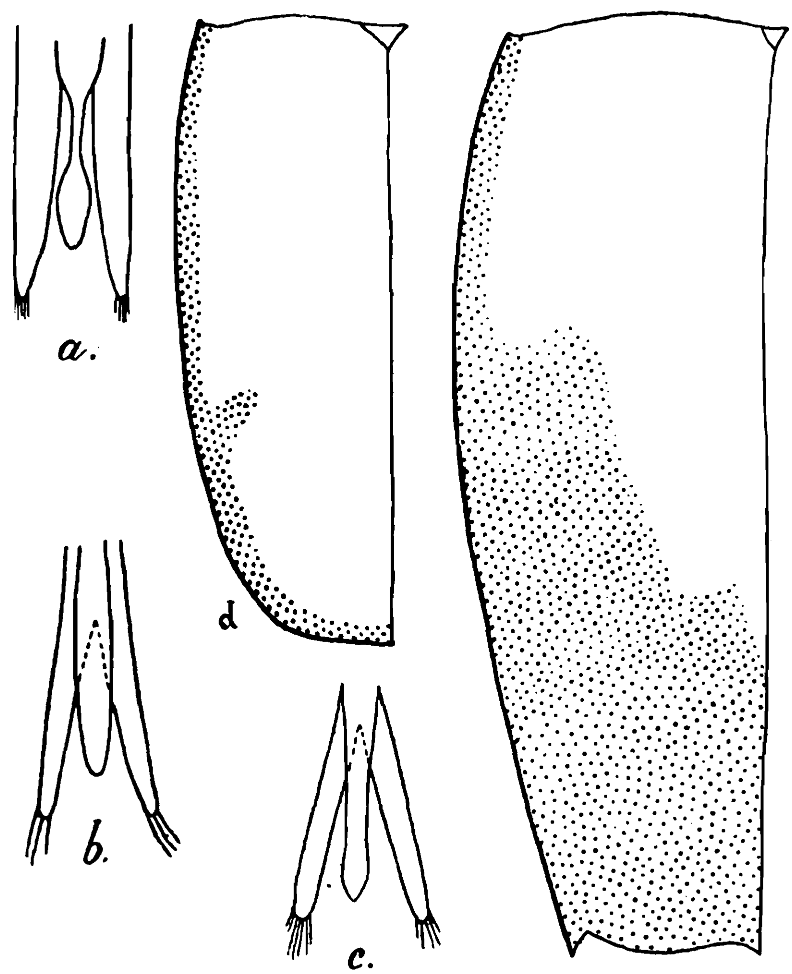
Form oblong, elongate, moderately convex. Head and pronotum black. Elytra dark brown. Undersurface dark brown, epipleurae, legs and anal sternites reddish brown.

Labrum semielliptical, coarsely punctate and with long yellow cilia in front. Head finely granulose at the frons and clypeus. Pronotum finely punctate, anterior margin minutely convex in the middle, concave below the eyes forming an acute angle with the yellow lateral margin. Pubescent margin broad posteriorly, slightly dilated anteriorly, reaching about the middle of the eye. Scutellum small and triangular. Elytra (text-fig. 1*e*) convex, slightly obliquely truncate posteriorly, outer apical angle prominent and pointed; sutural angle minutely pointed. Pubescent margin on the elytra sufficiently broad, almost uniformly wide in the anterior one-third; inner margin undulately dilating, bilobed and meeting the suture at the posterior quarter; anterior lobe convex beyond which the inner pubescent margin is slightly obliquely directed backwards to the suture; posterior lobe much smaller than the anterior one (rounded in the male and angular in the female), situated a little anterior to the posterior one-third. Male anterior tibia sub-parallel, broadened anteriorly, anterior tarsus dilated.

Aedeagus (text-fig. 1*a*) constricted in the middle one-third, narrowing towards the apex and rounded at the tip equal to four-fifth the length of the parameres.

Size.—Male, length 6·0 mm., width 7·5 mm. Female, length 6·8 mm. width 2·8 mm,.

Type-specimens.—Holotype, No. 9678/H. India : Brahmani river, Bengal, 7-8. III. 1931 (*S. Ribeiro* Coll.).



TEXT-FIG. 1.—*a.* Male genitalia of *Orectochilus ribeiroi*, sp. nov. ; *b.* Male genitalia of *O. haemorhous* Reg. ; c. Male genitalia of *O. orissaensis*, sp. nov. ; *d.* Elytron of *Orectochilus orissaensis*, sp. nov. ; *e.* Elytron of *O. ribeiroi*, sp. nov.

(Dotted portion on elytron indicates pubescent area).

Allotype,—No. 9679/H4. Same particulars as holotype,

Paratypes,—10 exs. No 9680/H4 to 9689/H4. Same particulars as holotype.

Remarks.—This species closely resembles *O. ritsemai* in shape and size but can be easily distinguished from it by its characteristic elytral pubescence. There is also a marked difference in the aedeagus of the two species ; in the case of *O. ritsemai* the aedeagus (text fig. 1*b*) is almost uniformly wide, not constricted in the middle as in the present species.

LIST OF SPECIES WITH LOCALITIES

Name of the species	Localities
Tribe ENHYDRINI	
1. *Dineutus spinosus* (Fabr.)	BIHAR : Morel river, near Burhait, Santal Parganas, 26. II. 1938 (*H. S. Rao & H. A. Hafiz*). BENGAL : Teesta river, Darjeeling Dist.,—X. 1931 (*S. L. Hora*).
2. *D. unidentatus* Aube .	BIHAR : Kusma, Santal Parganas, 28. II. 1938, (*H. S. Rao & H. A. Hafiz*) ; sta. 12, Dist. Hazaribagh, 30. X. 1928, (*M. Sharif*) ; BENGAL : Calcutta, 25. VII. 1950 (*T. G. Vazirani*) ; EASTERN GHATS : sta. 54, Cuddapah Dist., 29. VII. 1929, (*H. S. Pruthi*) ; Yercaud, 4600 ft., Shevaroy hills, 2-15. VI. 1929 (*H. S. Pruthi*) ; SIND : sta. 9, Hat river Karachi, 19. XII. 1927, (*B. Prasad & B. N. Chopra*). *Remarks on distribution.*—It is a widely distributed species and has been recorded from India, Ceylon, Burma, Malaya Peninsula, Java, Tonkin, East Indies, Annam and China. Ochs (1930), considers Karachi as doubtful within the range of its distribution, the present specimens mentioned above confirm the occurrence of the species in Sind.
3. *D. indicus* Aube . .	BENGAL : Kalimpong, Darjeeling Dist. 29. I. 1931, (*S. L. Hora*). BIHAR : Morel river, Santal Parganas, 23. XI. 1938, (*H. S. Rao & H. A. Hafiz*) ; Gurmani river, Santal Parganas, 29. I. 1931, (*H. S. Rao & H. A Hafiz*) ; Parasnath hills and Ranchi Survey,—IV. 1948, (*Sinha & Nath*) ; ORISSA : sta 5, Mayurbhanj Dist., Simlipal hills, 11. II. 1951, (*B. Biswas*) ; PUNJAB : sta. 3, Simla Hills, 23. VI. 1923 (*S.L. Hora*) ; RAJASTHAN: Rajputana Survey,— III. 1948 (*K. S. Pradhan*) ; BOMBAY : sta. 2, Gokak, Belgaum Dist., — XI. 1928, (*B. Prasad & H. S. Rao*) ; EASTERN GHATS : 6-15. VI. 1929, (*H. S. Pruthi*) ; sta. 15, Palkonda hills, 20-26. VIII. 1929, (*H. S. Pruthi*) ; sta. 16, 4600 ft., Shevaroy hills, 12. VI. 1929, (*H S. Pruthi*).
Tride GYRININI	
4 *Paragyrinus arrowi* (Reg.) .	PUNJAB : Kangra Valley, 2. VI. 1946, (*S. L. Hora*).
5. *Aulonogyrus obliquus* (Walk.)	EASTERN GHATS : 15. VI. 1929, (*H. S. Pruthi*).
6. *Gyrinus convexiusculus* Mac.	EASTERN GHATS : 3-5. VIII. 1929, (*H. S. Pruthi*) ; sta. 30, Chitteri, Salem Dist., 20—22. VI. 1929, (*H. S. Pruthi*) ; sta. 63, Palkonda hills, 3. VIII. 1929 (*H. S. Pruthi*) ; ORISSA : sta. 5, Simlipal hills, Mayurbhanj Dist., II. II. 1951, (*B. Biswas*). BIHAR : Chotnagpur, Ranchi, Hesal, 19. III. 1951, (*A. P. Kapur*).
Tribe ORECTOCHILINI	
7. *Orectochilus semivestitus* Guerin.	EASTERN GHATS : 6-15. VI. 1929, (*H. S. Pruthi*)
8. *O. oblongiusculus oblongiusculus* Reg.	BENGAL : Teesta Valley, Darjeeling Dist., 14. VI. 1934, (*S. L. Hora*) ; PUNJAB : Kangra valley, 5300 ft. 2. VI. 1936, (*S. L. Hora*).
9. *O. oblongiusculus parkeri* Ochs	PUNJAB : sta. 4, Simla hills, 26. VI. 1923, (*S. L. Horu*).
10. *O. limbatus* Reg. . .	BIHAR : Damodar river, Ranchi Dist., —. X. 1938, (*M. Sharif*) ; Gurmani river, Santal Parganas, 1938, (*H. S. Rao & H. A. Hafiz*) ; Morel river, Santal Parganas, 1938, (*H. S. Rao & H. A. Hafiz*) ; U. P. : Rihand river, Mirzapur, —. IV. 1947, (*H. A. Hafiz*).

LIST OF SPECIES WITH LOCALITIES—*contd.*

Name of the species	Localities
Tribe ORECTOCHILINI—*contd.*	
11. *O. cuneatus* Reg.	PUNJAB : sta. 4, Simla hills, 26. VI. 1923 (*S. L. Hora*) ; BENGAL : Teesta Valley, sta. 1, Teesta 3. II. 1953.
12. *O. discifer* (Walk)	EASTERN GHATS : 2-15. VI. 1939 (*H. S. Pruthi*) ; BIHAR : Parasnath hills and Ranchi Survey,—IV. 1948, (*Sinha* and *Nath*).
	Remarks on distribution.—It has been previously recorded from Ceylon, Central India & Calcutta by Ochs (1930). The present record confirms its range of distribution to Northern India.
13. *O. productus* Reg.	BENGAL : Brahmani river, 7-8. III. 1931 (*S. Ribeiro*).
14. *O. orissaensis*, sp. nov.	ORISSA : sta. 2, Chahala nulla, Simlipal hills, Mayurbhunj Dist., 8. II. 1951 (*B. Biswas*).
15. *O. fletcheri* Ochs .	BENGAL : Brahmani river, 7-8. III. 1931 (*S. Ribeiro*).
16. *O. haemorhous* Reg. .	BIHAR : Kusma, Santal Parganas, 28. II. 1938 (*H. S. Rao* & *H. A. Hafiz*) ; BENGAL : Brahman river, 7-8. III. 1931 (*S. Ribeiro*).
17. *O. ritsemai* Reg. .	BIHAR : Morel river, Santal Parganas, 1938 (*H. S. Rao* & *H.A. Hafiz*) ;U.P. : Rihand river, Mirzapur, April-May, 1947 (*H. A. Hafiz*) ; REWA STATE : Ner, budda Survey, sta. 39. 2650 ft., II. 1927 (*H. S. Pruthi*).
18. *O. ribeiroi*, sp. nov. .	BENGAL : Brahamani river, 7-8. III. 1931 (*S. Ribeiro*).
19. *O. undulans* Reg.	U.P. : Rihand river, April-May, 1947 (*H. A. Hafiz*). *Remarks on distribution.*—This is being recorded from India for the first time. Its already known distribution is from Tonkin.
20. *O. gangeticus* (Wied.)	BIHAR : Taljhari, Santal Parganas, 20. II. 1938 (*H.S. Rao* & *H. A. Hafiz*) ; U. P. : Rihand river, Mirzapur, April-May, 1947 (*H.A. Hafiz*).
21. *O. spiniger* Reg. .	ORISSA : Simlipal hills, sta. 30, Mayurbhanj Dist., 18. II. 1951 (*B. Biswas*).
	Remarks on distribution.—Regimbert[1] mentions a female example from "Inde" in Wehncke collection, referrable to this species. In the above collection also there is a female example referrable to this species. It has been recorded earlier from Malacca, Cambodia, Cochin, China, Laos, French Indo-China and Sumatra.
22. *O. indicus* Reg. . .	EASTERN GHATS : 1929 (*H. S. Purthi*).
23. *O. murinus* Reg. . .	BENGAL : Kalimpong, Darjeeling Dist., 29. I. 1931 ; PUNJAB : sta. 4, Simla hills. 26. VI. 1923 (*S.L. Hora*).

ACKNOWLEDGMENTS

I am grateful to Dr. S. L. Hora, Director, Zoological Survey of India for kindly permitting me to work on this collection.

[1] Regimbert. M., *Ann. Soc. ent. Fr.* (6) III, pp. 436-438, pl 12, fig. 129 (1883).

NEW AND LITTLE KNOWN PSYCHODIDAE FROM BORNEO AND THE MALAY PENINSULA.

By G. H. SATCHELL, *The Museum, Dunedin, New Zealand.*

Through the kindness of Mr. Paul Freeman of the British Museum, I have been permitted to study the collection of Psychodidae made by Mr. H. M. Pendlebury in British North Borneo and the Malaya Peninsula between the years 1924 and 1935. The collection is not a large one but is rich in new species and also contains many specimens of *Nemopalpus orientalis* Edwards, hitherto imperfectly known from the unique ♀. This species, and two species of *Trichopsychoda* Satchell[1], are the only described Psychodidae from this area. It is the purpose of this paper to describe a further 12 species.

Nemopalpus orientalis Edwards

1928. *Nemopalpus orientalis,* Edwards *J. F. M. S. Mus.* XIV, p. 65

In searching through the collection I initially came upon a single specimen of a male of this species. It is this specimen that has been used in drawing up the following description, and it thus constitutes the allotype of the species. Just before my stay at the British Museum was at an end, I found some 30 more specimens in a box I had overlooked. I was not able to incorporate these into the description in the short time left to me, but I managed to go through them and make sure that the description given below is applicable to them. This species has thus changed from being one of the least known and most poorly represented of the genus, to one of the best represented species in museum collections.

Male.—Head, antennae and palps a light ochraceous-brown; eyes separated by width of 4 facets. Flagellum of antenna broken at tip, but flagellar segments becoming progressively shorter (text-fig. 1*a*), the first 1·7 times as long as the second; ascoids paired on flagellar segments, each a heart shaped to irregularly triangular sac (text-figs. 1*b* & *c*).

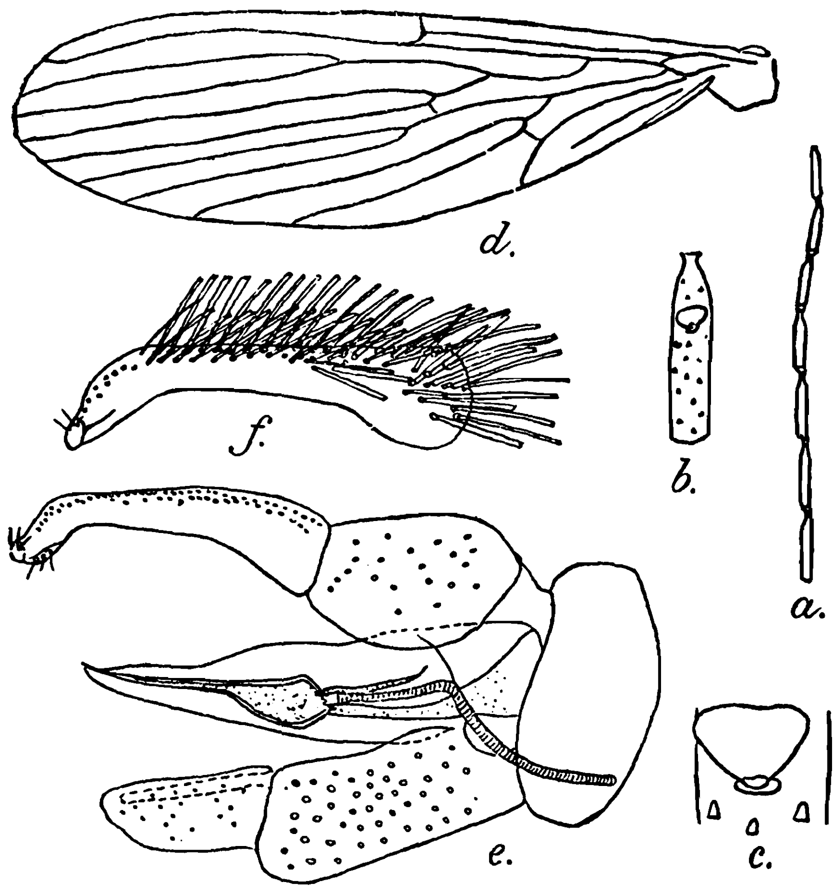
Thorax with long ochraceous hair; mesonotum with a darker brown lateral stripe; wing (text fig. 1*d*) with venational characters typical of old world representatives of the genus, R_2 2·1 times as long as R_{2+3}, r-m proximal to forking of M_{1+2}; Sc ending at a level just beyond that of forking of R_{4+5}; stem of M_{1+2} twice as long as r-m. Vestiture uniformly ochraceous and hairy; legs unicolourous.

Abdomen with a uniformly ochraceous vestiture lacking tufts and odoriferous pockets. Hypopygium as in text-fig. 1*e*, the 9th tergite almost twice as long as the cylindrical cercopod and thickly clothed with long setae; anal valve triangular, setose, almost as long as cercoped Coxite a little longer than wide, style straight in basal three quarters,

[1]Satchell, G.H., *Proc. Roy. ent. Soc. Lond.* B. XXIV pts. 3-4 (1955).

then bending to a blunt apex carrying a circular depression containing three small setae ; ventral side of style apex narrow and flat, bearing a row of 3 or 4 small setae ; inner face of style (text-fig. 1*f*) covered with numerous long straight setae with serrulate ends, densely clustered at base of style. Aedeagus (text-fig. 1*e*) consisting of a pointed sheath enclosing a sclerotized hollow internal structure which is swollen proximally and communicates with the wrinkled sclerotized sperm duct ; no parameres present.

Allotype ♂.—Fraser's Hill, 4,200 feet, Pahang, Malay Peninisula, 30. V 1932. The allotype comes from the same district (Pahang) as the type, but not from the same locality (Cameron's Highlands).



TEXT-FIG. 1.—*Nemopalpus orientalis* Edwards.

a. Basal flagellar segments ; *b*. A flagellar segment showing ascoid ; *c*. Ascoid ; *d*. Wing ; *e*. Hypopygium (lateral view) ; *f*. Style from inner side.

The species shows affinity with the old world species of the group (Fairchild[1]) particularly with *Bruchomyia edwardsi* Tonnoir, and *Nemopalpus capensis* Edwards. In the wing R_2 is longer than R_{2+3}, R_4 is at the wing tip, and r-m is proximal to the medial fork. In addition, the ♂ genitalia are similar, with simple undivided cerci and styles, and a symmetrical aedeagus lacking parameres. The heart-shaped to triangular ascoids are reminiscent of new world species but ascoids have not been described for all the old world species and the peltate and discoidal type may be of wider distribution.

[1]Fairchild, G.B. *Ann. ent. Soc. Amer.* XLV, p. 261 (1952).

Genus **Brunettia** Annandale

The genus *Brunettia* Annandale[1] even in the revised form proposed by Freeman[2] is not entirely satisfactory and as more species are described it becomes clear that a number of distinct segregates are involved. The change from a hairless to a hairy wing membrane is one that has probably occurred in a number of lines, and at present any hairy winged Psychodinae fly that does not fulfil the diagnosis of *Trichopsychoda* Tonnoir, is placed in *Brunettia.* As I intend to revise the genera of recent Psychodinae in a later paper I will not discuss it here. It is, however, clear that the three species *B. triangulata*, sp. nov., *B. pendleburyi*, sp. nov., and *B. brevifurca*, sp. nov. are closely related to the type species *B. superstes* Annandale, and to such species as *B. biformis* Edwards (which also occurs in Malaya) and *B. albonotata* Brun. This section of the genus is primarily Indo-malayan in its distribution, only the last species having acquired a cosmotropical distribution owing to its semi-domestic association with man. In this section of the genus the eye bridges are normally developed, the antennae are 15-segmented, the flagellar segments are eccentric, the ascoids are curled, the wing is often much broadened, and some or all of the retinaculae in the ♂ are racket-shaped.

The species *B. longipalpis*, sp. nov., *B. tormentosa*, sp. nov., and *B. alternata*, sp. nov. though known only from the ♂ s, are more closely related to the *B. splendens* Tonn.—*B. gloriosa* Tonn. species group. Here the eye ridges are widely separated, the antennae are 16 segmented, the flagellar segments are symmetrical, elongate, and appear to have a distinct collar around the neck, the ascoids are straight or slightly bent, the wing is usually ovolanceolate, and the retinaculae, though of diverse shapes, are not racket-like. Quates[3] has published a description of a species *B. nitida* from N. America which belongs in this group, so it is evidently of wide distribution.

The species *B. anomala* does not obviously belong to either of these segregates. Its antennae are reminiscent of some species of *Telmatoscopus* and even the hairing of the wing membrane is very incomplete and extends only round the periphery of the wing.

Brunettia triangulata, sp. nov.

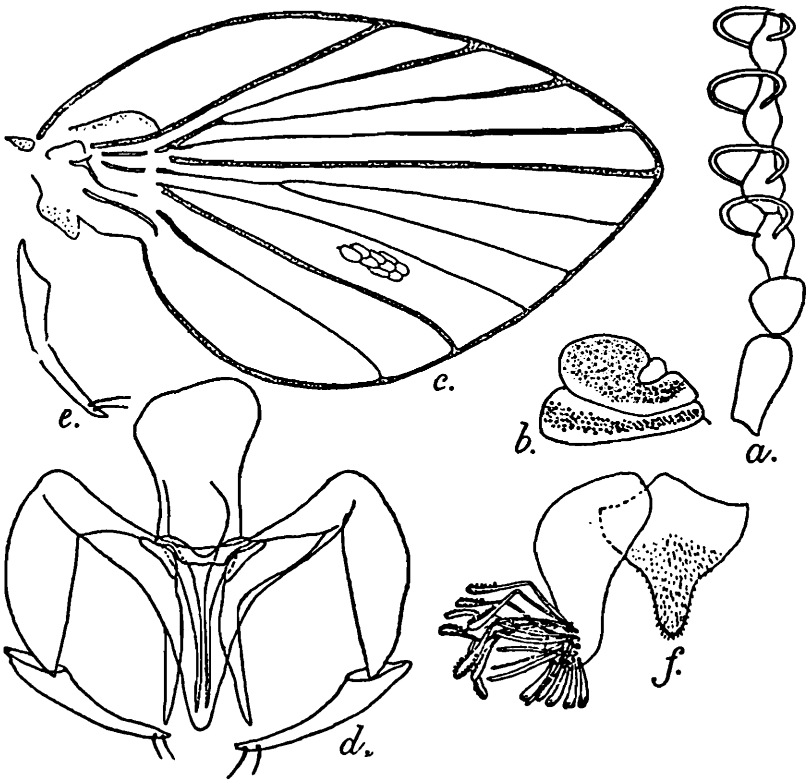
A black species with white spots at the vein tips very similar to *B. albonotata* Willist. but with broader wings.

Male.—A tuft of snow-white squamous hairs on clypeus, and brownish-black hairs on frons; eye bridges touching. Antenna 15-segmented, scape (text-fig. 2*a*) longer than wide, flagellar segments eccentric, bearing paired, strongly curved ascoids on segments 3-13. Palpi with first joint very small; formula 1 : 5 : 5·8 : 6·5.

Thorax with a vestiture of blackish-brown hairs anteriorly; posterior thorax rubbed. Allurement organ more extensively developed than in *B. albonotata* Willist. extending ventrally (text-fig. 2*b*) and curving

[1] Annandale, N., *Rec. Indian Mus.* V, p. 141 (1910).
[2] Freeman, P., *Proc. R. ent. Soc.* London, B, XX, p. 142 (1951).
[3] Quates, L., *Univ. Calif. Publ. Ent.* X, No. 3, pp. 103-273 (1954)

round the anterior spiracle, the portion ventral to the spiracle not as great as the portion dorsal to it ; allurement organ covered with numerous pores and flanked by a dense tuft of squamous hairs. Wing (text-fig. 2c) 2 mm. long, 1·7 times as long as broad, humeral region enlarged but not so extensively as to interrupt the line of curvature of the anterior wing margin ; R_5 at wing tip, medial fork after radial, with a well developed pedicil : upper surface of wing with a predominantly hairy vestiture, with scales intermixed over all but the apical sixth : lower surface evenly covered with blackish-brown iridescent scales ; on upper surface small tufts of white scales at vein tips, overlapping onto the unicolourous fringe ; alula tuft of rather short thick squamous hairs, scarcely extending to level of base of Cu which is a well developed vein. Legs black, tips of tibiae and metatarsi white.



TEXT-FIG. 2.—*Brunettia triangulata*, sp. nov.

a. Base of antenna ; *b.* Allurement organ ; *c.* Wing ; *d.* Hypopygium ; *e.* Style (drawn from a paratype♂) ; *f.* Cercopod and anal valve.

Hypopygium with 9th sternite much extended antero-posteriorly in the mid-line to form a triangular lobe that extends posteriorly beyond the level of the tip of the aedeagus (text-fig. 2a) : style slightly curved (text-figs. 2d and e), the apical half straight and parallel sided, not sinuate ; aedeagus of two long slender pointed valves ; parameres with the spine sword-like, projecting considerably from the triangular base and bent at an angle to it ; cercopods a little longer than 9th tergite, bearing apically (text-fig. 2f) five or so rather strongly sclerotised spatulate retinaculae ; more basally a group of narrow, straight, bluntly ending retinaculae, and more basally still, 12 or so angulated racket-shaped retinaculae of the usual type ; anal valve as in fig. 2f.

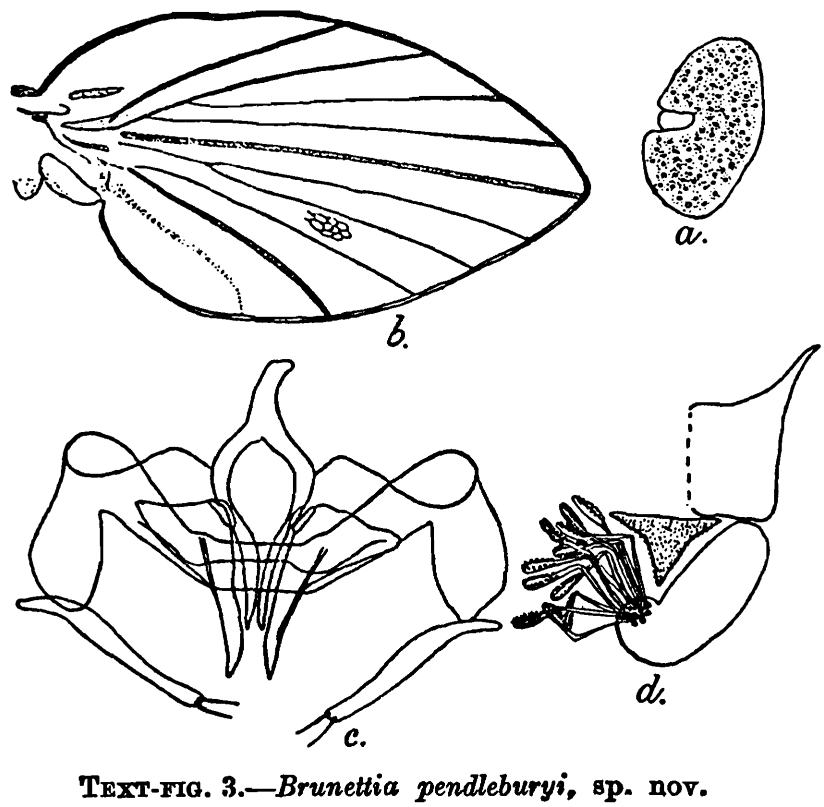
Type-specimen.—1♂ paratype ; Fraser's Hill, 4,200 feet, Pahang, and Malay Peninsula, 22.V.1932 and 4.VII.1931.

Remarks.—This species is one of a group of closely similar species, and the wing is identical to that figured for *B. atrisquamis* Brunetti. However, as the two sets of specimens of this species in the British Museum collections have different genitalia and as Brunetti made the description from a single ♂, it seems wisest to describe this species as new rather than to link it with such an inadequately known species

Brunettia pendleburyi, sp. nov.

A black species with white spots on the wing margin, very similar to *B. triangulata*, sp. nov. but with different genitalia and a less broadened wing.

Male.—Frons and clypeus with a black squamous covering; eye bridges touching. Antenna 15-segmented, scape bulging on inner side, twice as long as broad, flagellar segments eccentric, bearing paired strongly curved ascoids on segments 3-13. Palpal formula 1 : 5 : 5 : 6.



TEXT-FIG. 3.—*Brunettia pendleburyi*, sp. nov.
a. Allurement organ ; *b.* Wing ; *c.* Hypopygium ; *d.* Cercopod and anal valve

Thorax with a black vestiture of long squamous hairs. Allurement organ (text-fig. 3*a*) extensively developed, surrounding anterior spiracle so that portion below spiracle is equal to or greater than portion above it. Wing (text-fig. 3*b*) 2·3 mm long, 1·7 times as long as broad, humeral region enlarged so that anterior margin is broken into two separate regions of curvature ; R_5 slightly below wing tip, medial fork after radial, with a well developed pedicil ; Cu a very vaguely indicated vein ; upper surface of wing with a predominantly hairy vestiture, with scales intermixed over all but the apical sixth ; ventral surface evenly scaly ; on upper surface tufts of broad white scales present behind tips of R_1, R_2, R_3, M_2, M_3 and M_4 : tuft behind R_1 separated from it by a distance equal to half that between the tips of R_1 and R_2 ; a less conspicuous tuft at tip making 7 in all ; alula tuft broadening out from base to tip, extending beyond base of Cu.

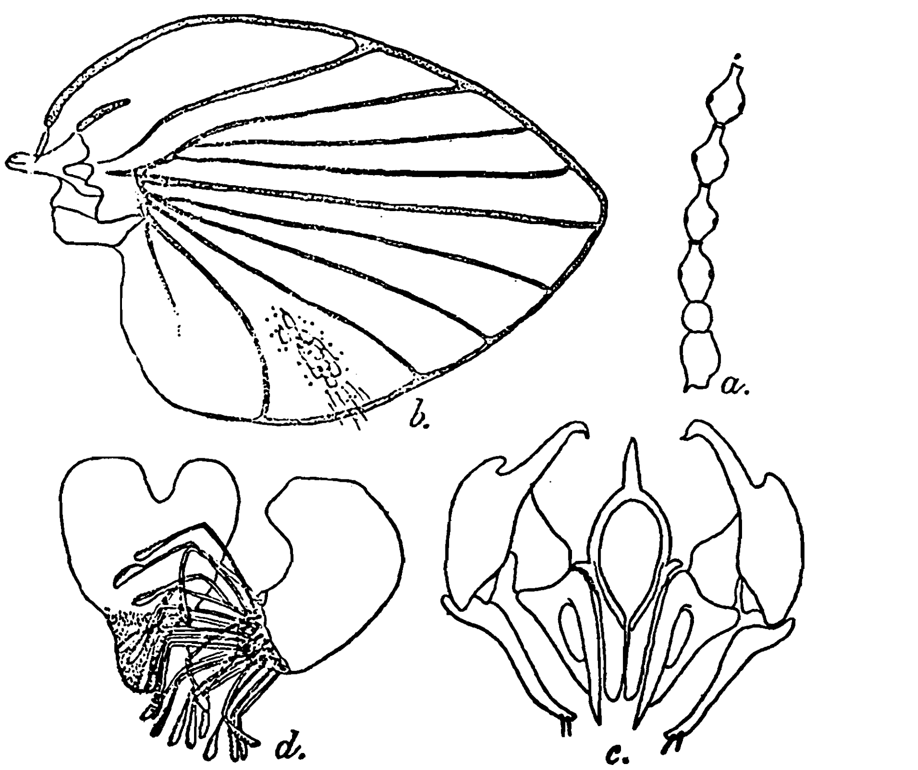
Hypopygium as in text-fig. 3c; the 9th sternite forming a rather broad transverse bar sclerotised noticeably on the anterior margin; 9th sternite not reaching beyond tip of aedeagus; style almost straight bluntly ended, the usual pair of preapical setae here at the very tip; aedeagus of two slender pointed valves; parameres with the spine as long again as the triangular base, sword-like and bent at an angle to the base; cercopods a little longer than the 9th tergite bearing apically (text-fig. 3d) a cluster of 14 or so angulated racket-shaped retinaculae; anal valve as in Fig. 3d.

Type-specimen.—Type and only specimen; Fraser's Hill, 4,200 feet, Pahang, Malay Peninsula, 5.VII.1931.

The species is named after Mr. H. M. Pendlebury who collected all the specimens in this collection of Psychodidae.

Brunettia brevifurca, sp. nov.

A black species with a particularly broad wing in which Cu has been rotated to a position almost at right angles to R_5.



TEXT-FIG. 4.—*Brunettia brevifurca*, sp. nov.

a. Base of antenna; *b.* Wing; *c.* Hypopygium; *d.* Cercopod and anal valve.

Male.—Eye bridges three facets wide, separated by a width of 3 facets but linked by a sclerotised band. Antennae broken off apically, scape (text-fig 4a) one and a half times as long as wide, broadest half way up, bearing a tuft of squamous hairs on inner side; flagellar segments with necks shorter than bulbs, ascoids apparently paired, Palpal formula 1 : 3·3 : 3 : 3·9.

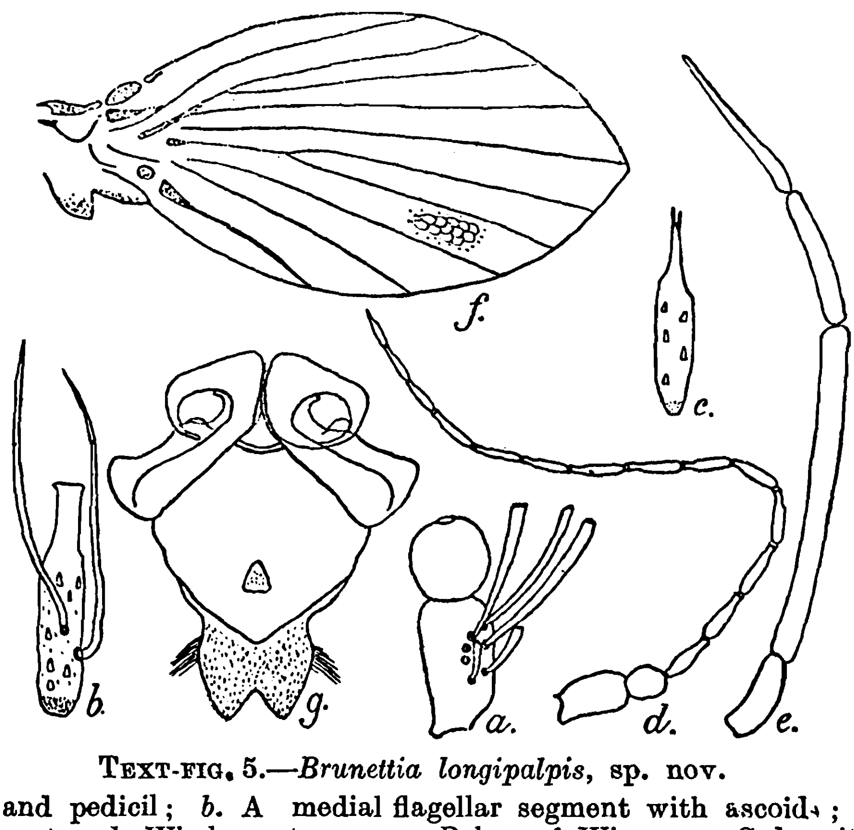
Thorax lacking any allurement organ. Wing very broad (text-fig. 4b), 3 mm long, 1·5 times as long as broad, radial fork very close to origin of R_{2+3} but after medial; medial fork so close to wing base that its pedicil is almost obliterated; R_5 below wing apex; anal part of wing so expanded that M_4 has the shape usually taken by Cu, bending posteriorly near the margin, and Cu, which is rotated into a position almost at right angles to R_5, is a very diffuse and indefinite vein that fades away before the margin; whole of wing membrane on both surfaces evenly covered with short scales, with a few hairs intermixed near the margin on the upper surface. Legs black, tibiae with a subapical ring of white scales; basal third and tip of metatarsi and whole of second tarsal joint white.

Hypopygium with style a little curved; aedeagus (text-fig. 4*c*) symmetrical, bifid, the two valves ending in rounded tips; paramere with the spine scarcely extending beyond the triangular basal piece and with its axis a continuation of the axis of the basal piece; paramere only a little longer than aedeagus; cercopod (fig. 4*d*) equal to 9th tergite, with a terminal cluster of 40 or so racket-shaped angulated retinaculae; anal valve with a rounded posterior margin (text-fig. 4*d*).

Type-specimen.—Type and only specimen; Mt. Kinabalu, 5,500 feet, Luma Luma, North Borneo, 17.IV.1924.

Brunettia longipalpis, sp. nov.

A species with very long palps and the wings evenly covered with iridescent scales.



TEXT-FIG. 5.—*Brunettia longipalpis*, sp. nov.

a. Scape and pedicil; *b.* A medial flagellar segment with ascoids; *c.* Terminal antennal segment; *d.* Whole antenna; *e.* Palp; *f.* Wing; *g.* Subgenital plate and spermathecae.

♀ Eyes with very short bridges, not extending beyond the medial edge of the antennal socket, separated by a width equal to $\frac{1}{4}$ of the head. Antenna (text-fig. 5*d*) 16-segmented, 1·25 times as long as wing width; scape (fig. 5*a*) 1·6 times as long as wide, some long squamous hairs present on inner side; flagellar segments (fig. 5*b*) like narrow flasks, the neck perfectly distinct, but not very much more narrow than the bulb; apical segment (fig. 5*c*) with a conical tip bearing two minute sensillae; ascoids very long, almost straight, in pairs on segments 4-14. Palpi very long (figs. 5*e* and *d* are drawn to the same scale), almost as long as antennae; formula 1 : 4 : 1·8 : 2.

Wing (text fig. 5*f*) 2·7 mm long, 2·3 times as long as broad, radial fork before medial, very close to origin of R_{2+3}, which is after apex of basal cell; R_5 very little above wing apex: Sc appearing as a triangular sclerotization; base of Cu much thickened; wing membrane above and below, evenly covered with small iridescent scales. Legs with a brown scaly covering. Apex of anterior and middle tibiae, base and tip of metatarsi and dorsum of 2nd tarsal joints with a white scaly covering; posterior leg with white scales on base and tip of metatarsi and most of 2nd tarsal joint.

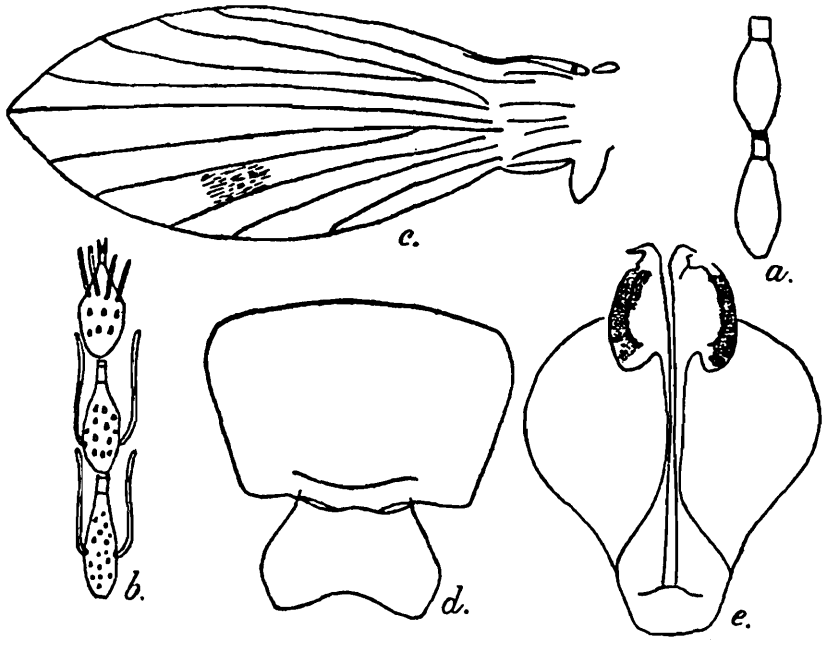
Abdomen with a brown scaly decumbent vestiture. Subgenital plate with a deep medial indentation, as seen in the text-fig. 5*g*. Spermathecae as in text-fig. 5*g*.

Type-specimen.—Type and only specimen; Samairan, near Sandakan, North Borneo, 15.VII.1927.

This species is very closely related to *B. splendens* Tonnoir (1936) of Central Africa.

Brunettia tormentosa, sp. nov.

Uniformly brown species with silvery-white tarsi and a brown hairy wing.



TEXT-FIG. 6.—*Brunettia tormentosa*, sp. nov.

a. Medial flagellar segments ; *b*. Terminal flagellar segments with ascoids ; *c*. Wing ; *d*. Subgenital plate ; *e*. Spermathecae.

Female.—Frons and clypeus with tufts of long brown squamous hairs. Eye bridges separated by width of 6 facets, their medial edges projecting distinctly beyond medial edge of antennal socket. Antenna 16-segmented, 1·2 times as long as wing width; scape 1·5 times as long as wide, bearing 20 or so strong squamous hairs on inner face; flagellar segments (text-fig. 6*a*) with slender basal bulbs and apical necks, the neck with a distinct, more sclerotized, collar-like band around it; terminal segments (text-fig. 6*b*) unreduced, the 16th with a sensory cone bearing two sensillae at the apex; ascoids paired, almost straight on segments 3-15, those on segment 16 replaced by a group of sensory rods. Palpal formula 1 : 1·9 : 2·1 : 1·9.

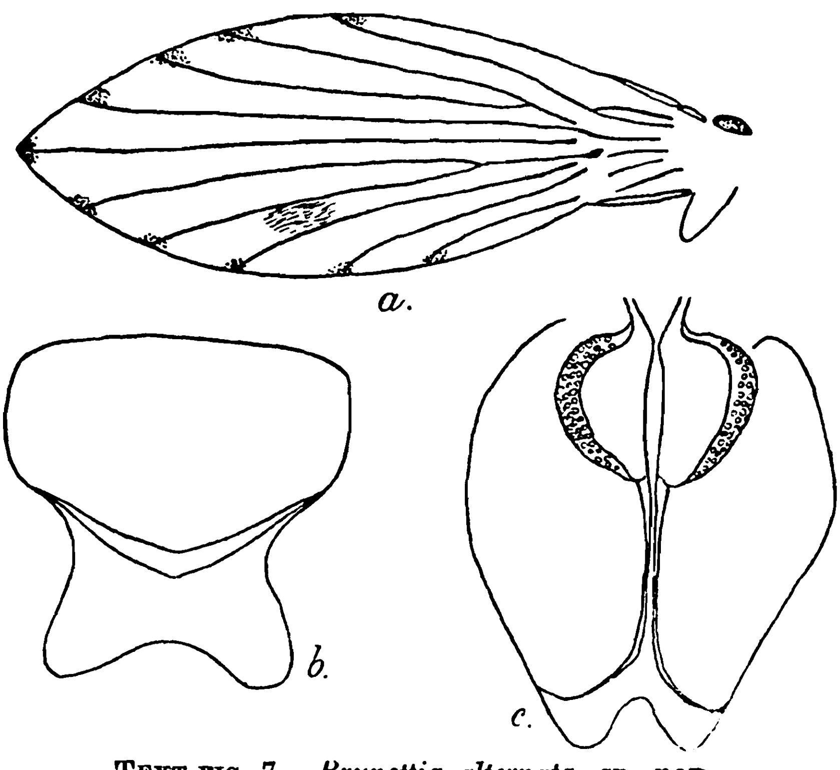
Thorax with a uniformly brown hairy vestiture. Wing (text-fig. 6*c*) 2·9 mm long, 2·5 times as long as broad, the area of wing lying below R_5 greater than that lying above it; R_5 at wing apex, origin of R_{2+3} at apex of basal cell, radial fork very little before medial, both near base of wing; wing membrane evenly covered on both surfaces by fine brown hairs; hairs on veins in the basal sixth of the undersurface rather squamous in character. Legs covered with scales with a silvery-white reflection, the apparent extent of the whiteness varying with the light; in diffuse light, apex of tibiae, metatarsi and all but last two tarsal joints appearing silvery white.

Subgenital plate not deeply cleft medially, its greatest width two-thirds of the distance from the anterior margin; spermathecae as in fig. 6*e*, the capsules with a finely reticulate sculptured pattern.

Type-specimen.—Type and only specimen; Fraser's Hill, 4,200 feet, Pahang, Malay Peninsula, 22.V.1926.

Brunettia alternata, sp. nov.

A brown species with white metatarsi and alternating black spots and white spaces in the wing margins; closely related to *B. tormentosa.*



TEXT-FIG. 7.—*Brunettia alternata*, sp. nov.
a. Wing ; *b.* Subgenital plate ; *c.* Spermathecae.

Female.—Eye bridges separated by width of 12 facets, their medial edges scarcely projecting beyond the medial edge of the antennal socket; antennae and palpi incomplete but very similar to those of *B. tormentosa*; the flagellar segments each with a distinct collar around the neck.

Thorax with a brown vestiture. Wing (text-fig. 7*a*) 2·2 mm long, 2·5 times as long as broad, divided more nearly into two symmetrical halves by R_5 than is the case with *B. tormentosa*; venation much as in that species but radial fork equidistant between base of R_{2+3} and level of medial fork; veins and membrane evenly covered with brown hairs; a cluster of darker brown to black squamous hairs at each vein tip, membrane between adjacent vein tips occupied by a clear patch bearing white hairs; similar patches present also behind the tips of R_1 and Cu; fringe unicolourous apart from a few white hairs around wing apex. Legs pale brown, metatarsi and first tarsal joint creamy white, the remaining tarsal joints brown.

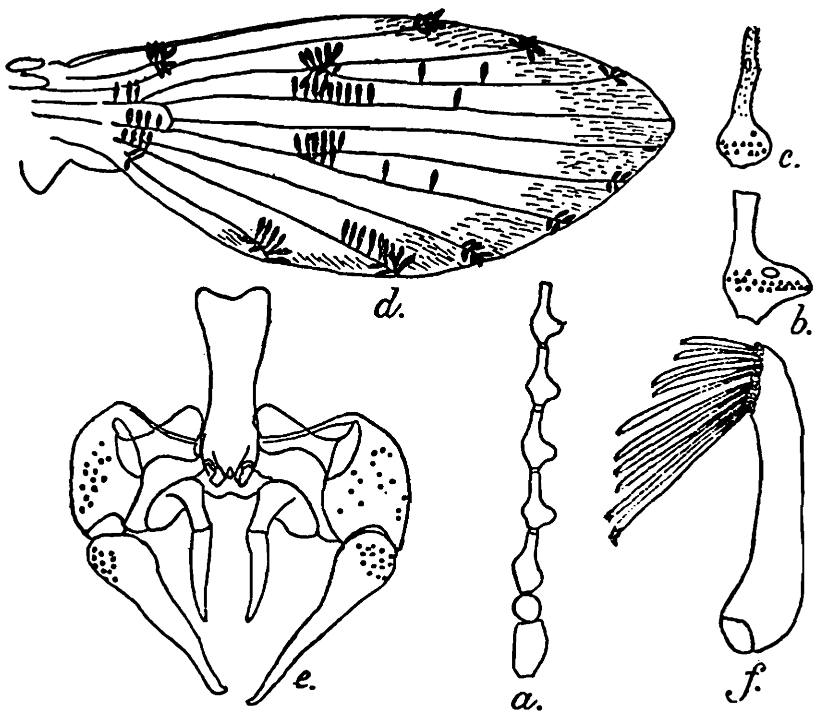
Subgenital plate as seen in the text-fig. 7*b*, the greatest width at the level of the tips of the lobes; spermathecae as in text-fig. 7*c*, the capsules bearing a sculptured pattern of minute circular pits.

Type-specimen.—Type and only specimen; Negri Sembilan, near Port Dickson, Malay Peninsula, 9.I.1935.

Brunettia anomala, sp. nov.

A pale brown species with long antennae and tufts of thick black scales on the forks and at the vein tips.

Male.—Eye bridges 5 facets wide, separated by a width of 1½ facets. Antenna 16-segmented, 2·3 times as long as wing width; scape 1·7 times as long as broad (fig. 8*a*), flagellar segments with eccentric bulbs (fig. 8*b*) and necks a little longer than bulbs in all except first flagellar segment; terminal segments with necks showing no reduction in length,



TEXT-FIG. 8.—*Brunettia anomala*, sp. nov.

a. Base of antenna; *b.* A medial flagellar segment; *c.* Terminal antennal segment; *d.* Wing, showing distribution of dark scales and hairs on wing membrane; *e.* Hypopygium; *f.* Cercopod.

16 with an elongate apiculus twice as long as the bulb; ascoids lost in type but visible as flat leaf-like structures in unprepared fly. Palpal formula 1 : 2 : 1·8 : 2·3.

Thorax without allurement organ. Wing (text-fig. 8*d*) 2·1 mm long, 2·4 times as long as broad, radial fork a little after medial, both after level of tip of Cu; R_5 well below wing tip; origin of R_{2+3} much before apex of first basal cell. Vestiture of wing mainly light brown and hairy; groups of black scales present over bases of veins, over forks, and at the tips of Sc, R_1, R_2, R_3, M_1, M_2, M_3, M_4 and Cu; a row of black scales on R_4 below fork and scattered odd scales amongst the normal hair on

R_3, R_4 and M_2; patches of rather paler hair present over each vein tip; underside with tufts of black scales over vein bases, forks, and tips of So, M_4 and Cu; a peripheral band of hairs on wing membrane close to margin, on both surfaces; remainder of wing membrane naked. Legs brown, white rings at bases of metatarsi and first two tarsal joints.

Hypopygium with 9th sternite a simple curved band; coxites (text-fig. 8*e*) a little longer than broad, style longer than coxite, tapered, almost straight, slightly hooked at tip; aedeagus bluntly ending, not projecting beyond the posterior margin of the 9th segment; parameres simple and pointed; cercopod twice as long as 9th tergite, cylindrical, little tapered, bearing a cluster of 14 or so retinaculae with fringed tips; anal valve an elongate triangle with a rounded tip.

Type-specimen.—Type and only specimen; Bukit kutu, 3,500 feet, Selangor, Malay Peninsula, 16.III.1931.

Genus **Telmatoscopus** Eaton

Of the four species of *Telmatoscopus* present, *T lanceolatus* is of interest as it is the first species of the subgenus *Mormia* Enderlein to be found outside the Palaearctic region. Of the various subgenera of *Telmatoscopus* that have been proposed, this is probably the most distinct and easily recognised. In the position of the origin of R_2+_3 and in the presence of port-hole organs on the ♂ antenna, *T lanceolatus* is a typical member of it. *T retrobarbus* is a curious species showing affinities with the European *T albomaculatus* Wahlg. though the retinaculae are unique in the genus. *T. fuscinervis* is quite the most ornately decorated species in the genus, specimens of it standing out in the cabinet even to naked eye inspection. The affinities of it, and of *T. candidus* can not be surmised as they are known only from ♀s.

Subgenus **Mormia** Enderlein

Telmatoscopus (Mormia) lanceolatus, sp. nov.

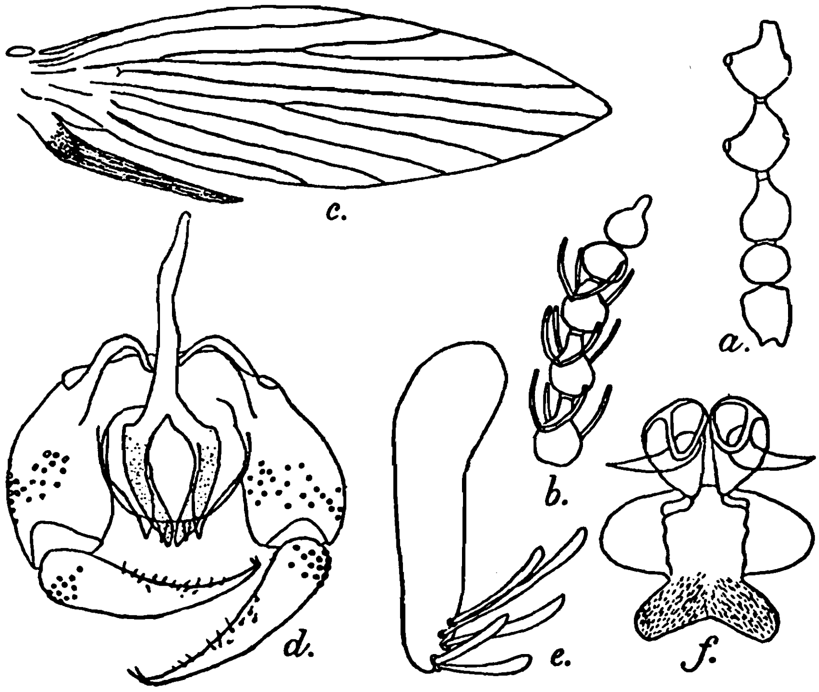
A small black species with lanceolate wings and a white space in the fringe at the wing apex.

Male.—Eye bridges 3 facets wide, touching. Antenna 16-segmented, broken at the 5th segment in type and only ♂, but calculated to be 2·6 times as long as wing width; scape (text-fig. 9*a*) only a little longer than wide, basal flagellar segments with very little neck, segments 3-5 (and probably some subsequent to 5) with port-hole organs: apical segments missing in type but probably similar to allotype. Palpi with a scaly vestiture; formula 1 : 1·3 : 1·4 : 2·3.

Thorax with a black vestiture, no allurement organ present. Wing (text-fig. 9*c*) lanceolate, 1·6 mm long, 3·3 times as long as broad; radial fork a little after medial, above tip of Cu; origin of R_2+_3 well after apex of 1st basal cell, R_5 below wing apex; alula tuft very long and pencil-like; lying parallel with hind margin of wing; wing vestiture blackish-brown apart from three tufts of decumbent hairs which are white basally and black apically, lying just before tips of Cu, M_3 and R_2 in each case terminating the rows of erect hairs on these veins; erect, hairs also present on R_3, R_4, M_1 and M_2 ; wing fringe black with a white space at the tip, extending from tip of R_3 to M_1, formed by hairs brown in proximal third and white in distal 2/3rd ; underside of wing with hairs replaced by broad scales in basal half. Legs unicolourous.

Hypopygium : coxite (text-fig. 9*d*) twice as long as wide, style as long as coxite, tapering, pointed, slightly curved; aedeagus symmetrical, bifid, flanked by pointed parameres the same length as the aedeagus; cercopod (text-fig. 9*e*) a little longer than 9th tergite, cylindrical, a little tapered, bearing 5 spatulate retinaculae; anal valve an equilateral triangle with rounded corners.

Female.—Similar to ♂ but scales on underside of wing not broad, and blending more gradually into normal hairs, the three white marks in the wing disc more pronounced, alula tuft not as long as in ♂. Antenna



TEXT-FIG. 9.—*Telmatoscopus* (*Mormia*) *lanceolatus*, sp. nov.

a. Base of antenna ; *b.* Tip of Antenna ; *c.* Wing ; *d.* Hypopygium ; *e.* Cercopod ; *f.* Subgenital plate and spermathecae.

as seen in text-fig. 9*b*, segment 13 with a well developed neck, 14 with a reduced neck, 15 sub-spherical, lacking a neck and 16 with a short terminal apiculus; ascoids V-shaped, in pairs on segments 3-14. Subgenital plate and spermathecae as seen in text-fig. 9*f*.

Type-specimens.—Type, allotype, 1♂ paratype ; Bukit kuti, 3,500 feet, Selangor, Malay Peninsula, 19—20.VI.1926. 1♂ Paratype. Fraser's Hill, 4,200 feet, Pahang, Malay Peninsula, 20.V.32.

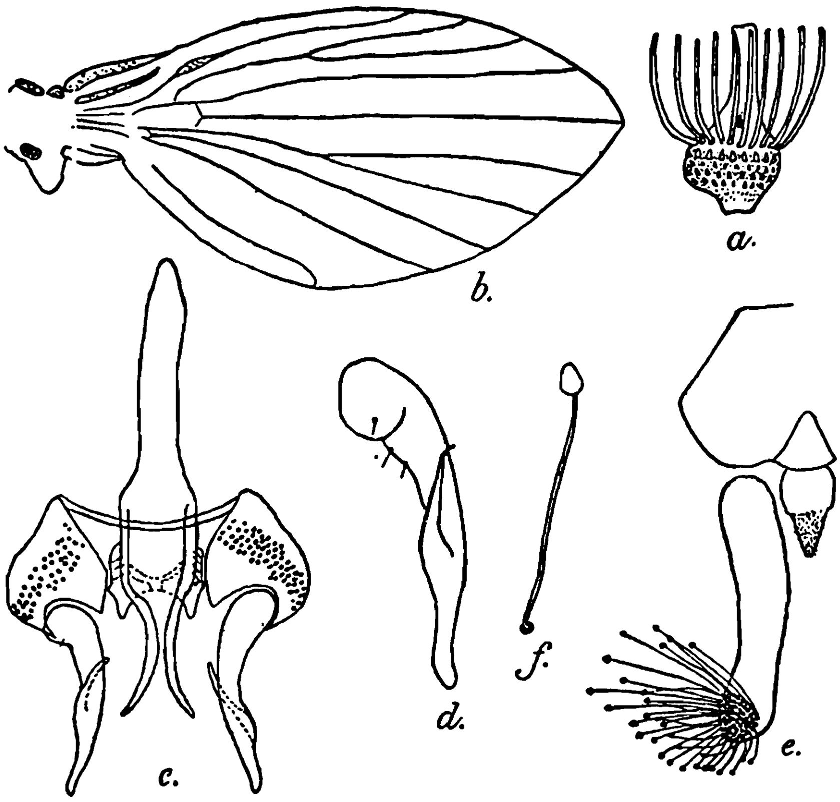
Subgenus **Telmatoscopus** Jung.

Telmatoscopus (Telmatoscopus) retrobarbus, sp. nov.

A brown species with white tufts on the wings and thorax.

Male.—Clypeus with a decumbent tuft of pale brown squamous hairs, frons with an erect snow-white tuft. Eye bridges 4 facets wide, separated by width of 3 facets. Antenna 16-segmented, 1·5 times as long as wing width, scape 1·6 times as long as wide, scape and pedicil with a covering of brown and white squamous hairs; flagellar segments with eccentric bulbs, necks shorter than bulbs in basal segments, longer than bulbs in more apical segments (text-fig. 10*a*); last segment with an elongate neck gradually decreasing in diameter and terminated by a short apiculus; ascoids numerous, simple, arranged in almost a complete circle (text-fig. 10*a*) of 18 or so in the basal segments to 12 or so in the apical ones, present on segments 3-16. Palpal formula 1 : 2·3 : 2·2 : 2·7

Thorax with a vestiture of white erect squamous hairs; a transverse band of brown hairs present in front of wing bases; no allurement organ. Wing (text-fig. 10*b*) 1·8 mm long, ovate, twice as long as broad, R_5 at wing tip, medial fork a little after radial and above tip of Cu, origin of R_{2+3} before apex of 1st basal cell, which is longer than the 2nd; vestiture of dark brown to black hair, with some white hairs present on R_2, R_3 and R_4, constituting a white tuft and again on M_1, M_2 and M_3,



TEXT-FIG. 10.—*Telmatoscopus retrobarbus*, sp. nov.
a. A medial flagellar segment; *b*. Wing; *c*. Hypopygium; *d*. Style, from below; *e*. Cercopod, anal valve and 9th tergite.

constituting a second white tuft, the two tufts at the level of the tip of R_1; ill-defined white tufts at vein tips; fringe rather rubbed, but unicolourous at least on anterior margin; hairs at wing base, particularly those on Sc, rather squamous. Tibiae with a broad white band in proximal half not quite reaching base, and an apical white ring; metatarsi with some apical white scales.

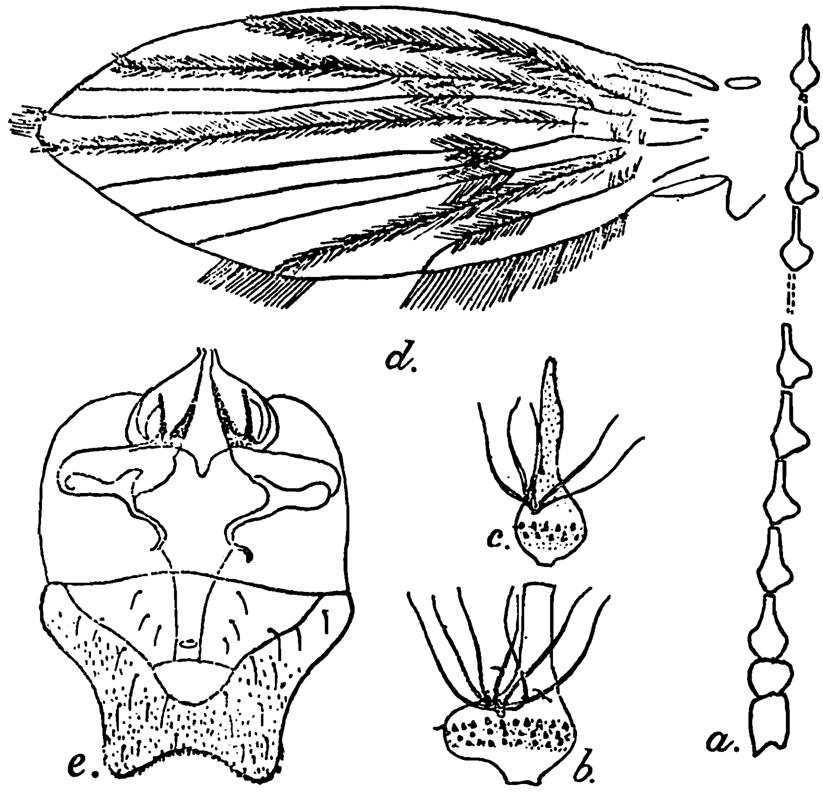
Abdomen with anterior dorsal vestiture of long brown decumbent hairs, flanked by uprising tufts of long squamous hairs that curl over the dorsal surface of the abdomen. Hypopygium with coxites (text-fig. 10*c*) broader than long. Style as seen in text-fig. 10*d* with a ventrally arising spine half way along, which points anteriorly; no tuft of deciduous hairs on style, but an extensive one on coxite; aedeagus ymmetrical and bifid, dividing into two outwardly curved pointed blades; cercopods (text-fig. 10*e*) cylindrical, not tapered, 1·7 times as long as 9th tergite, bearing an apical cluster of 60-70 thread-like retinaculae with minute bell-like tips (text-fig. 10*f*); anal valve triangular, longer than wide.

Type-specimens.—Type, and paratype ♂; Negri sembilan, near Port Dickson, Malay Peninsula, 9.I.1935 and 14.XII.1935.

Telmatoscopus fuscinervis, sp. nov.

A beautifully coloured species in which the creamy ground colour of the wing is dissected by radiating rows of chocolate-brown hairs along some of the veins.

Female.—Eye bridges 4 facets wide, separated by a width of 1 facet. Antenna (text-fig. 11*a*), 16-segmented, 1·8 times as long as wing width, scape 1·3 times as long as wide, flagellar segments (text-fig. 11*b*) with eccentric bulbs and long necks, terminal necks unreduced, the last



TEXT-FIG. 11.—*Telmatoscopus fuscinervis*, sp. nov.

a. Antenna ; *b.* A medial flagellar segment with ascoid ; *c.* Terminal flagellar segment ; *d.* Wing, showing distribution of brown hairs ; *e.* Subgenital plate and spermathecae.

(text-fig. 11*c*) with an apiculus twice as long as the bulb ; ascoids (text-fig. 11*b*) in pairs on segments 3-16, each consisting of a radiating bunch of 7-10 filaments. Palpal formula 1 : 2 : 2·3 : 2·2.

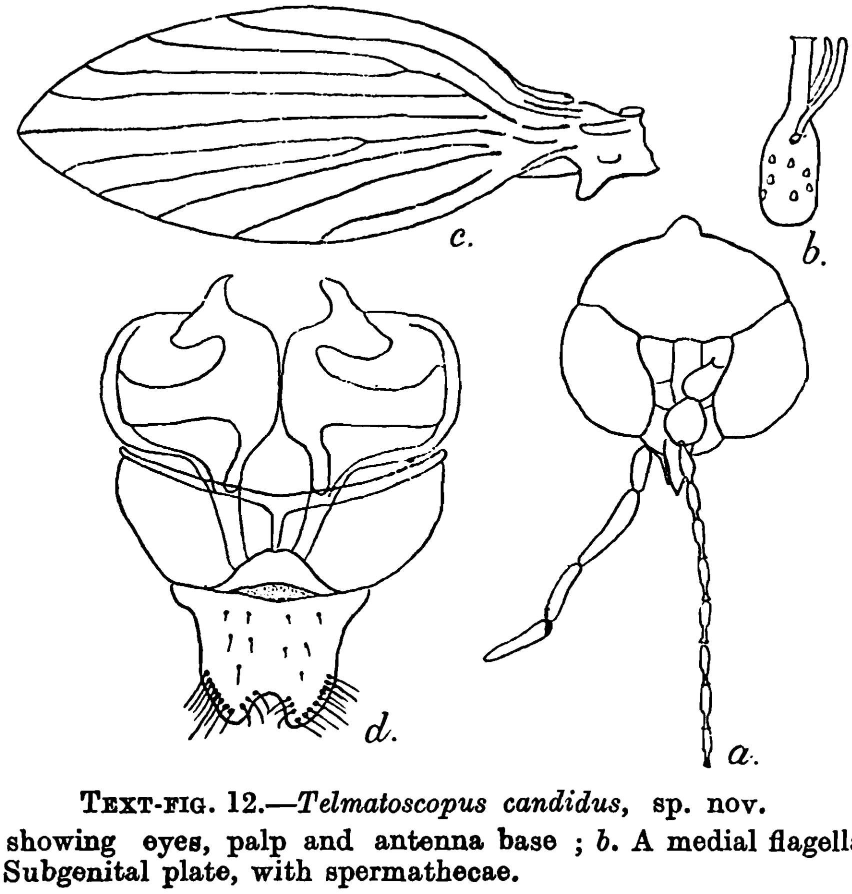
Thorax with a creamy vestiture, some of the long hairs between the wings faintly tipped with brown. Wing (text-fig. 11*d*) 2·5 mm long, lanceolate, 2·4 times as long as wide ; R_5 at wing tip ; radial fork after, medial fork before, level of tip of Cu ; origin of R_{2+3} before apex of 1st basal cell which is much longer than the second : erect hairs absent on R_1, R_5 and M_4, confined to the stem of the radial fork and to a little before this level on the other veins; wing vestiture creamy-yellow in colour ; some diffuse brown hairs over bases of veins, a distinct transverse, fascia of brown hairs at level of medial fork, four lines of brown hairs on R_1, R_2, R_5 and M_4, running across the distal half of the wing to the margin and constituting a pattern of great distinctness; fringe creamy with three brown spaces, a narrow one at wing apex, a broader one at tip of M_4, and a very broad one extending from tip of Cu to wing base; a faint infuscation at tips of longer hairs in anterior fringe. Legs light brown, the tarsi creamy white, a faint infuscation on the ventral surface of the 1st and 2nd tarsal joints of the hind leg.

Abdomen with subgenital plate as seen in text-fig. 11*e*, distally parallel sided and with an emargination of moderate depth; spermathecae lacking any sculptured patterning, strengthened by two heavily sclerotised ridges, ovipositor short.

Type-specimen.—Type and only specimen, Cameron's Highlands, Pahang, Malay Peninsula, 4,800 feet, 26.VI.1935.

Telmatoscopus candidus, sp. nov.

A black species with white tufts on the wing.



TEXT-FIG. 12.—*Telmatoscopus candidus*, sp. nov.
a. Head showing eyes, palp and antenna base; *b*. A medial flagellar segment; *c*. Wing; *d*. Subgenital plate, with spermathecae.

Female.—Eyes lacking all trace of eye bridges (text-fig. 12*a*), antenna broken off at 10th segment, but calculated to be 1·3 times as long as wing width; scape scarcely longer than wide, first flagellar segment with little neck, remaining segments with a neck equal to the narrow cylindrical bulb (text-fig. 11*b*); ascoids simple, paired, sinuate rods. Palpal formula 1 : 2·1 : 1·7 : 1·9.

Wing (text-fig. 11*c*) 1·7 mm long, 2·5 times as long as broad; radial fork before medial, both well before tip of Cu; origin of R_{2+3} on R_4 well after apex of basal cell, R_5 at wing tip. Wing vestiture mainly dark brownish-black, erect hairs present on R_1, and on all veins except R_5; some erect white squamous hairs scattered over bases of veins and others aggregated into two circular patches in wing disc at level of tip of Cu, one on R_2, R_3 and R_4, the other on M_1, M_2 and M_3; smaller erect white tufts a little before the tip of each vein except on R_5; fringe dark except for a white space from just before the tip of M_2, to the tip of M_1. Legs dark brownish-black, the tarsi creamy-white except for fore metatarsi, which are brown; a shadowy infuscation marring the whiteness of the 2nd-4th tarsal joints of the hind leg.

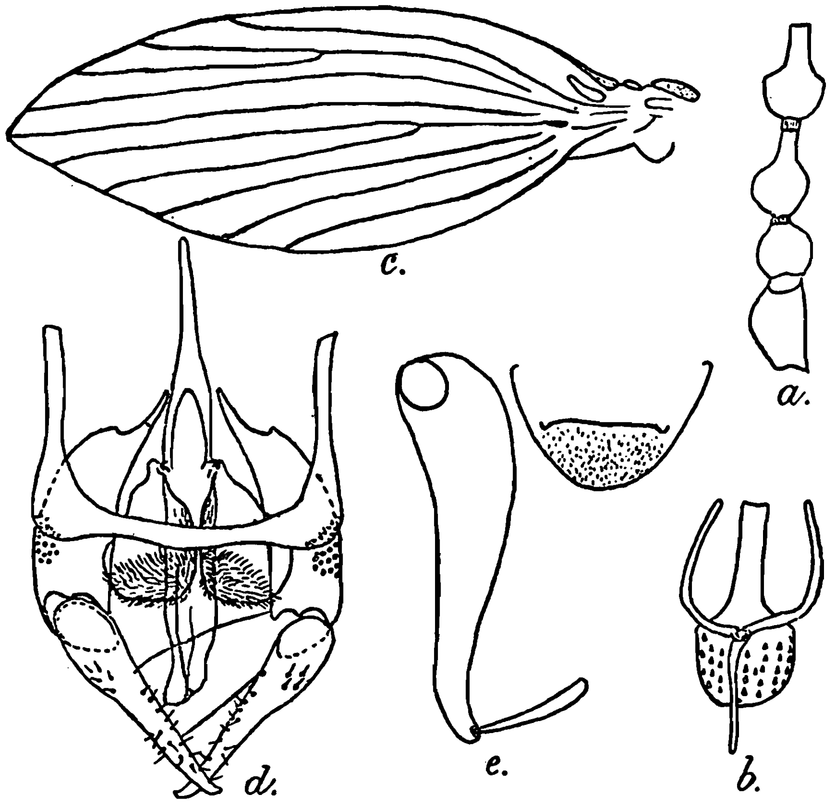
Subgenital plate as seen in text-fig. 12*d*, the lateral margins with a row of 8 or so, strong setae. Spermathecae as seen in text-fig. 12*d*, ovipositor of moderate length.

Type-specimen.—Type and only specimen, Fraser's Hill, 4,200 feet, Pahang, Malay Peninsula, 31.V.1932.

Genus **Psychoda** Latreille

Psychoda selangoriana, sp. nov.

An ochraceous-brown species with black spots at the vein tips.



TEXT-FIG. 13.—*Psychoda selangoriana*, sp. nov.

a. Base of antenna; *b.* A medial flagellar segment; *c.* Wing; *d.* Hypopygium; *e.* Cercopod and anal valve.

Male.—Eye bridges 4 facets wide, separated by width of 1 facet. Antenna broken off at 11th joint, but calculated to be twice as long as wing width: scape (text-fig. 13*a*) 1·4 times as long as wide, basal flagellar segments with necks shorter than bulbs; equal to bulbs in medial segments (text-fig. 13*b*); ascoids Y-shaped. Palpal formula 1 : 1·1 : 1·1 : 1·3.

Thorax with a rather dense vestiture of ochraceous-brown hair. Wing (text-fig. 13*c*) 2 mm long, 2·7 times as long as wide, radial fork after medial, but before tip of Cu; erect hairs to tips of usual veins (absent on R_5, M_2 and M_4), some rather long white squamous hairs scattered amongst the erect hairs; others with a dark bronzy reflection intermixed with them, the rows appearing as rather darker than the surrounding vestiture ; a tuft of decumbent blackish-brown hairs at each vein tip ; fringe unicolourous. Legs unicolourous.

Hypopygium (text-fig. 13*d*) with 9th sternite a rectangular transverse band rugose at the corners. Coxites twice as long as wide, tuft of usual deciduous hairs here very limited in its extent ; style subequal to coxite, straight, slightly hooked at tip ; a single long seta near the base and numerous small sensory setae along the length, but no lateral basal tuft of deciduous hairs. Aedeagus a simple median process with a flattened shelf-like extension on one side ; paired lobular parameres densely covered with recurved spiny hairs, articulating with aedeagus. Cercopods 1·2 times as long as 9th tergite, tapering and slightly curved (text-fig. 13*e*), bearing a single retinaculum one third as long as the cercopod ; anal valve (text-fig. 13*e*) rounded in outline.

Type-specimen.—Type and only specimen, Bukit Kutu, Selangor, 3,500 feet, Malay Peninsula, 20.IV.1926.

I am most grateful to Mr. Paul Freeman for permission to study the collections of Psychodidae in the British Museum. I am also most indebted to Dr. G. B. Fairchild of Panama for much helpful discussion.

ON SOME NEMATODES FROM INVERTEBRATES

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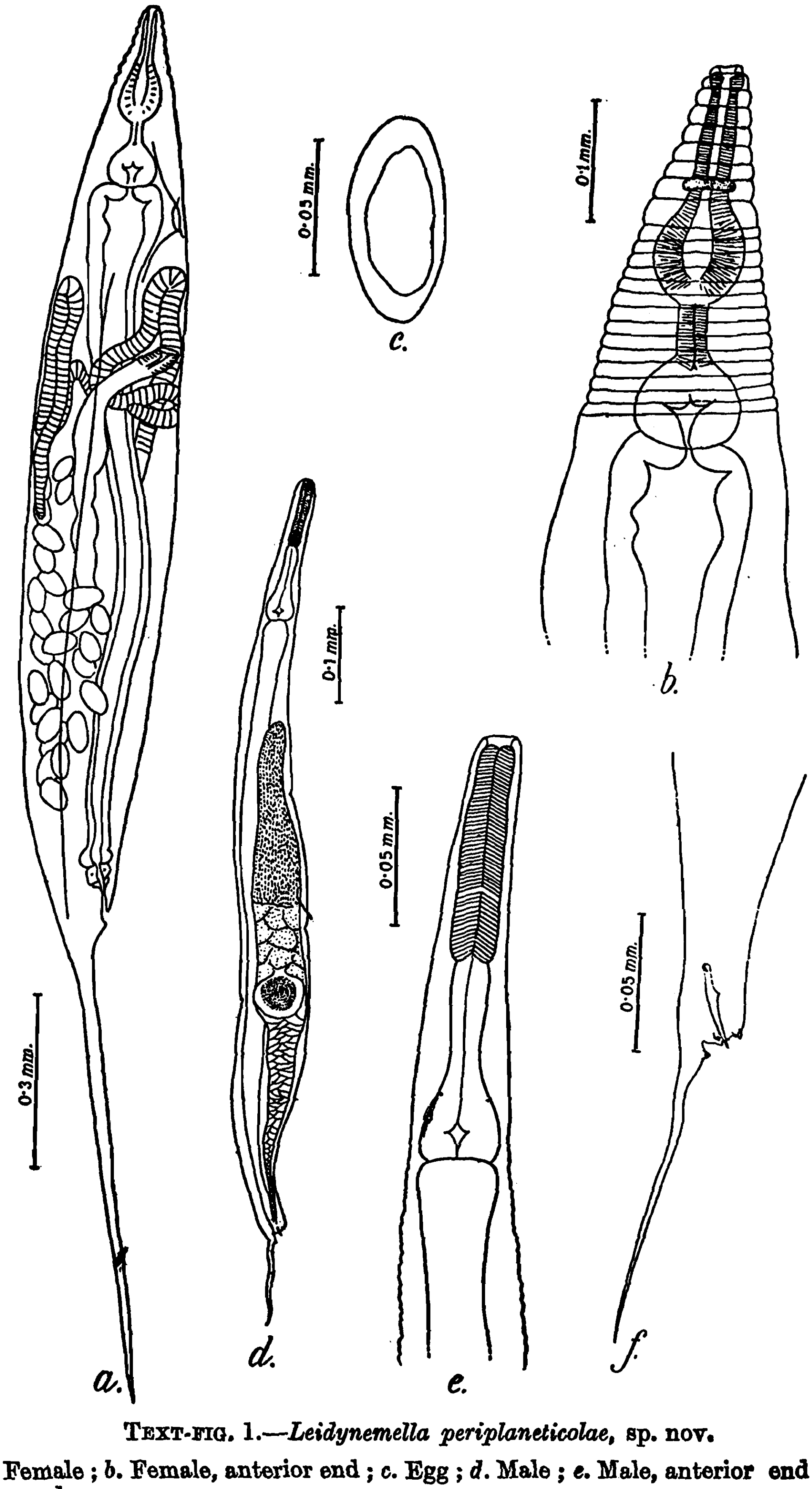
A large number of cockroaches and cricket moles were examined from various localities near Lucknow and two new species from the former host and three new and one already known species from the latter host were recovered which are being described here. The diagnosis of genus *Bulhoesia* (Schwenck, 1926) is emended, and genus *Mirzaiella* Basir, 1942 is considered a synonym of *Gryllocola* Basir, 1942 which is also emended.

Genus **Leidynemella** Chitwood & Chitwood, 1933

Leidynemella periplaneticolae, sp. nov.

Female.—(Text-fig. 1*a*, *b*). Length 2·13—2·945 mm., maximum breadth 0·245—0·295 mm. Lateral alae present from the base of the oesophagus upto the anus *i.e.* ⅘th of the posterior part of the body. The alae are about 0·026 mm. wide and well marked off. I-III annules are about 0·017 mm. wide, IV-VI annules are 0·025—0·026 mm. wide and the annules posterior to the base of the oesophageal bulb are about 0·022 mm. wide and correspond to the lateral alae. The cuticle in the region of the oesophageal bulb is rather smooth. Buccal cavity is prismoidal and possesses cuticular thickenings at the base. Oesophagus 0·305—0·34 mm. long, consisting of: a corpus 0·185—0·215 mm. long and the diameter of the anterior region (anterior corpus) is 0·026—0·028 mm. and that of the posterior region (posterior corpus) is 0·065—0·069 mm., an isthmus measuring 0·043—0·051 mm. long and 0·023—0·025 mm. broad; and a valvular bulb 0·077—0·078 mm. long and 0·082—0·086 mm. broad. The intestine is enlarged to form a cardia which has a greater diameter than the oesophageal bulb. The nerve ring is present just behind the posterior part of the corpus, 0·104—0·108 mm. from the anterior end. The anus is 0·912—1·06 mm. from the posterior end. The tail is elongated and filiform. The vulva is 0·485—0·618 mm. from the anterior end or anterior to the middle body exclusive of the tail. The excretory pore is 0·352 mm. from the anterior end and posterior to the base of the oesophageal bulb. The vagina is long and directed posteriorly. The two uteri are divergent. The eggs are oval (text-fig. 1*c*) and measure 0·073—0·082 × 0·034—0·039 mm. When deposited, the eggs are segmented. The two ovaries are present in the region of the vulva.

Male.—(Text-fig. 1 *d*, *e*, *f*). Length 0·931—1·08 mm., maximum breadth in the posterior third of the body is 0·068—0·071 mm. Lateral alae are absent. The cuticle is smooth anteriorly upto the valvular bulb, but it is present posteriorly where it is 0·007—0·008 mm. wide. The buccal cavity is small. The oesophagus is 0·14—0·149 mm. long, consisting of an anterior corpus measuring 0·050—0·053 mm. long and 0·009—0·012 mm. wide, a posterior corpus almost of the same diameter measuring 0·019—0·022 mm. long and 0·011—0·014 mm. wide, an isthmus



TEXT-FIG. 1.—*Leidynemella periplaneticolae*, sp. nov.

a. Female ; *b*. Female, anterior end ; *c*. Egg ; *d*. Male ; *e*. Male, anterior end ; *f*. Male, posterior end.

0·043—0·05 mm. long and 0·009—0·011 mm. wide, and a valvular bulb 0·026—0·031 mm. long and 0·025—0·027 mm. wide. The anus is sub-ventral. The tail appears to be attached as an elongated appendage, almost in the same plane as the body. When living, the worm is capable of moving the tail appendage to the dorsal side, in which position it was probably examined in the case of *Leidynemella fusiformis* Cobb, 1920. The single testis is well developed and extends almost upto the excretory pore, which is present much posterior to the base of the oesophageal bulb and 0·211—0·233 mm. from the anterior end. One single spicule, 0·027—0·03 mm. long. Caudal papillae are present: one pair preanal and subventral, one pair adanal and subventral, and one single papilla postanal and midventral on the tail appendage.

Host.—*Periplaneta americana* Linn.

Location.—Rectum.

Locality.—Lucknow, India.

Discussion.—The genus *Leidynemella* was created by Chitwood and Chitwood (1933) to accommodate a new species *L. paracranifera*, and the genus also included *L. fusiformis* Cobb, 1920, and *L. panesthiae* (Galeb, 1878). The present form differs from these three species in many of the characters and can be differentiated according to the following key:

KEY TO THE SPECIES OF THE GENUS *Leidynemella*

1.	Vulva posterior to the middle of the body (exclusive of tail)	*L. panesthiae.*
	Vulva anterior to the middle of the body (exclusive of tail)	2
2.	Lateral alae of female terminating as spinate process both anteriorly and posteriorly; annules not over 0·005 mm.	*L. fusiformis*
	Lateral alae of female not terminating in spinate processes; annules much more than 0·005 mm. wide.	3
3.	Annules 0·01 mm. wide near middle of body	*L. paracranifera.*
	Annules 0·02—0·022 mm. wide near middle of body	*L. periplaneticolae*, sp. nov.

The male of *Leidynemella periplaneticolae*, sp. nov. closely resembles that of *Hammerschmidtiella diesingi* (Hammerschmidt, 1838). The chief difference between *Hammerschmidtiella* Chitwood, 1932 and *Leidynemella* Chitwood & Chitwood, 1933, lies in the fact that the corpus in the latter genus possesses a distinct swelling in the posterior region. This distinction is, however, well marked only in female specimens and in the male specimens the distinction between the two is not so evident. Similar sexual dimorphism is also present in *H. diesingi.* In the other species of *Leidynemella* the corpus of the male is not well described: in *L. paracranifera* Chitwood & Chitwood, 1933, the male is unknown; in *L. fusiformis* Cobb, 1920, the " oesophagus is not described; presumably as in female "; and in *L. panesthiae* (Galeb, 1878) the corpus is not described and the male is " somewhat similar to that of *H. diesingi* " In the present form however, the posterior part of the corpus though of the same diameter as the anterior part, can easily be distinguished by a partition (text-fig 1*e*). The males of both *L. periplaneticolae*, sp. nov. and *H. diesingi* possess similar anal papillae and a single spicule.

Genus **Bulhoesia** Schwenck, 1926 emended

Bulhoesia thapari, sp. nov.

Female.—(Text-fig. 2 *a*, *b*). Length 2·323—2·53 mm., maximum breadth 0·176—0·217 mm. Lateral alae absent. The first cuticular annule is 0·017—0·018 mm. wide and the posterior annules are about 0·013 mm. wide. The mouth opening is triangular, surrounded by eight small labiopapillae and two circular amphids. The buccal cavity is almost square and 0·014—0·015 mm. deep. The oesophagus is 0·451—0·481 mm. long, consisting of a corpus measuring 0·335—0·388 mm. long and 0·034 mm. wide, an isthmus 0·030—0·031 mm. long and 0·030 mm. wide, and a valvular bulb 0·086 × 0·086 mm. The nerve ring is 0·215—0·217 mm. from the anterior end and in the posterior part of the corpus. The excretory pore is 0·559—0·575 mm. from the anterior end and posterior to the base of the oesophageal bulb. The intestine is slightly enlarged to form a cardia. The anus is 0·602 mm. from the posterior end. The tail is elongated and filiform. The vulva is 1·226—1·348 mm. from the anterior end or posterior to the midbody exclusive of tail. The vagina is short, muscular and anteriorly directed. The two uteri are divergent. The two ovaries are present anterior and posterior to the vulva. The eggs are oval, 0·069—0·074×0·043—0·049 mm. in size, and segmented when deposited.

Male.—(Text-fig. 2*c*, *d*). Length 0·874—1·264 mm., maximum breadth 0·077—0·112 mm. The lateral alae are absent. The cuticular annules are present near the anal region, about 0·004 mm. wide. The buccal cavity is small and about 0·005 mm. deep. The oesophagus is 0·108—0·168 mm. long. The corpus measures 0·108—0·138×0·014—0·017 mm. The isthmus is 0·022—0·026 mm. long and 0·011—0·012 mm. broad, and the valvular bulb is 0·035—0·04 mm. long and 0·036—0·042 mm. broad. The nerve ring could not be detected. The excretory pore is present much posterior to the base of the oesophageal bulb and in one specimen about 0·361 mm. from the anterior end. The anus is 0·146—0·155 mm. from the posterior end. The tail is much elongated and filiform. The single testis is reflexed and reaches almost upto the excretory pore. The anal papillae are distributed as follows: one pair preanal and subventral, one pair postanal and subventral and one single postanal and medial papilla. The spicule is single, 0·039—0·043 mm. long.

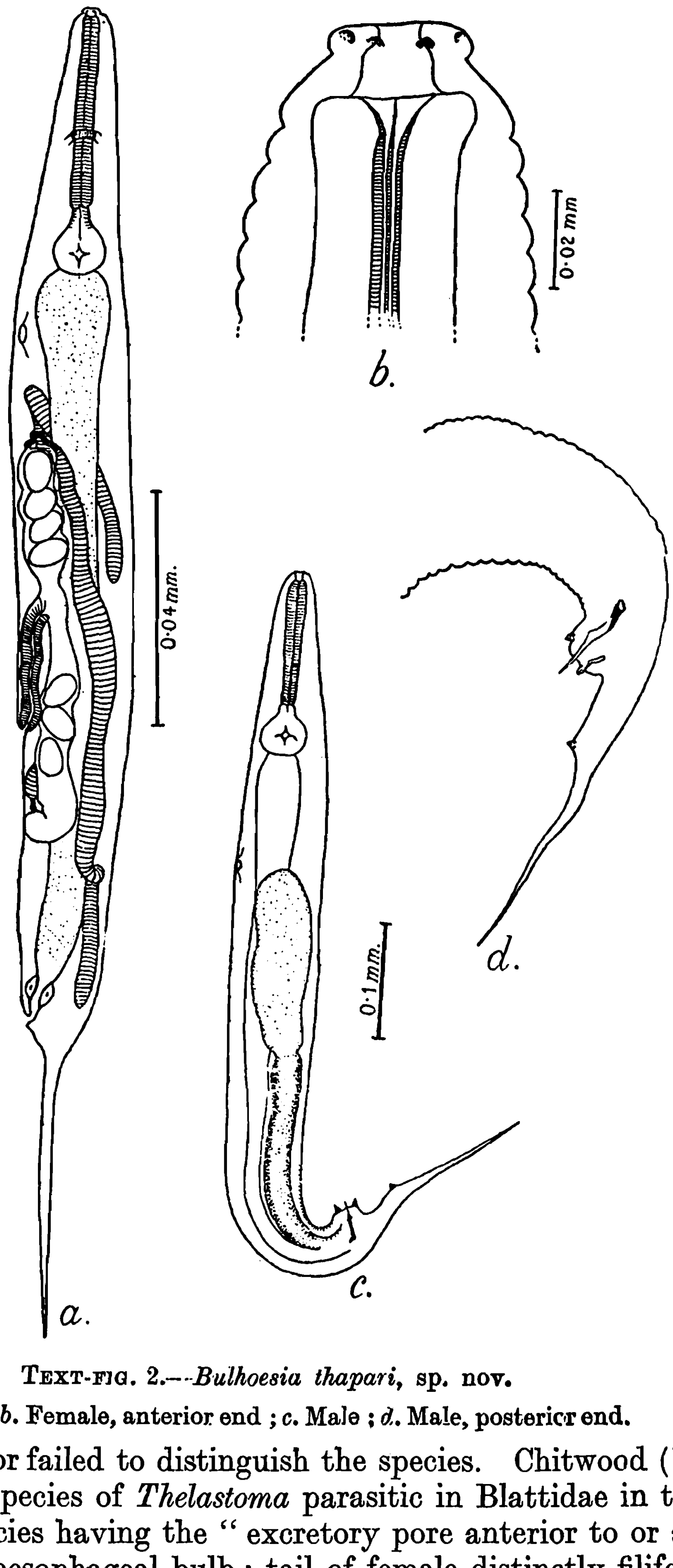
Host.—*Periplaneta americana* Linn.

Location.—Rectum.

Locality.—Lucknow, India.

Discussion.—The genus *Bulhoesia* was created by Schwenck (1926) but it was made a synonym of *Thelastoma* by Travassos (1929) and accepted by Chitwood (1932) and other workers.

A number of species of *Thelastoma* have been described from various posts but only two species *viz.*, *Thelastoma indiana* and *Thelastoma aligarhica* have been described from India. The species, which were described by Basir (1940), are respectively from *Leucophaea sp.* and *Periplaneta americana.* Unfortunately males were not found in either case and the description of the female specimens is not satisfactory and



TEXT-FIG. 2.—*Bulhoesia thapari*, sp. nov.

a. Female ; *b.* Female, anterior end ; *c.* Male ; *d.* Male, posterior end.

also the author failed to distinguish the species. Chitwood (1932, p. 20) divided the species of *Thelastoma* parasitic in Blattidae in two groups: (*a*) those species having the " excretory pore anterior to or at the same level as the oesophageal bulb ; tail of female distinctly filiform " under *Thelastoma sensu restricto* ; and (*b*) the rest of the species having the " excretory pore posterior to the base of the oesophagus, tail of female conical or attenuated " under *Thelastoma sensu lato.* To the latter group, to which the present species belongs, also belong *Bulhoesia icemi* Schwenck, 1926, *B. magalhaesi* Schwenck, 1926, and *Thelastoma aligarhica* Basir, 1940. The other species, *Thelastoma indiana* cannot, at present, be assigned to any of these groups as the excretory pore in the species was not observed and the male is unknown. The character of tail is not consistent with the position of the excretory pore as in *T aligarhica* Basir, 1940, the present form and, according to Todd (1943), in *B. icemi* Schwenck, 1926 (syn. *Thelastoma icemi* Schwenck, 1926) the tail is filiform though for the latter species the tail has also been described as attenuated (Chitwood, 1932). It therefore seems necessary that the character of tail be not used to distinguish between the two groups, *Thelastoma sensu restricto* and *lato*, as done by Chitwood (1932).

The group *Thelastoma sensu lato* of Chitwood includes three species and the male specimen was for the first time described by Todd (1943) for *B. icemi* Schwenck, 1926 and now in the present form.

The females of *Thelastoma aligarhica* Basir, 1940 and those of *Bulhoesia magalhaesi* Schwenck, 1926, resemble very closely and hence *T aligarhica* Basir 1940, must be considered a synonym of *B. magalhaesi* Schwenck, 1926.

In *Thelastoma*, according to Chitwood (1932), the male possesses four pairs of anal papillae, but in *B. icemi* Schwenck, 1926 (see Todd, 1943) and the present form (the only two species of *Thelastoma sensu lato* in which male is known) there are three pairs and two pairs and a single papilla respectively. This character of possessing less than four pairs of anal papillae and also having the excretory pore posterior to the base of the oesophageal bulb are in contrast with the characters of *Thelastoma sensu restricto* in which there are four pairs of anal papillae and also the excretory pore is anterior to the oesophageal bulb. The choice, therefore before us is, either to neglect the characters of the tail, position of the excretory pore and the number of the anal papillae and regard the species as belonging to *Thelastoma* with no reservation or to restore the genus *Bulhoesia* Schwenck, 1926. To the authors, the latter course seems to be more convenient for the sake of classification and hence the genus *Bulhoesia* Schwenck, 1926 is revived with the emended diagnosis as given below.

Generic diagnosis.—Thelastominae ; Mouth of female surrounded by eight submedian labiopapillae. Lips usually salient ; amphids as circular openings. Oesophagus simple, cylindrical (corpus), followed by a distinct isthmus and a valvular bulb. Excretory pore posterior to the base of the oesophageal bulb. Tail of female usually filiform, may be attenuated. Vulva near middle of body. Two ovaries ; uteri divergent. Eggs simple. Tail of male elongate and filiform, bearing less than four pairs of anal papillae : one pair preanal and ventral, one pair postanal and subventral and one pair postanal and ventral papillae present some distance from the cloaca. (The latter pair may be fused together to form a single median papilla as in *B. thapari*,* sp. nov.) One spicule.

* The species is named in honour of our teacher, Prof. G. S. Thapar.

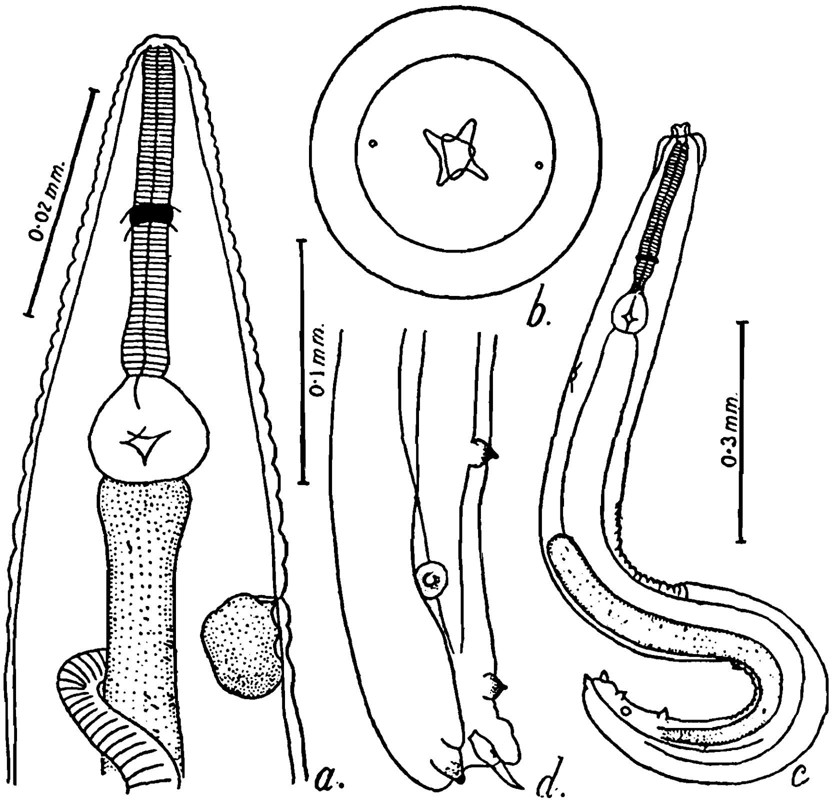
KEY TO THE SPECIES OF THE GENUS *Bulhoesia*

1. Females more than 3 mm. in length ; eggs almost spherical . .	*B. magalhaesi.*
Females 2—3 mm. in length ; eggs nearly oval . .	2
2. Oesophagus of female 0·37—0·42 mm. long ; excretory pore 0·380—0·47 mm. from anterior end ; eggs 0·065—0·070×0·050—0·057 mm., unsegmented when deposited	*B. icemi.*
Oesophagus of female 0·45—0·48 mm. long ; excretory pore 0·056—0·058 mm. from anterior end ; eggs 0·069—0·074×0·043—0·049 mm., segmented when deposited	*B. thapari,* sp. nov.

Genus **Gryllocola** Basir, 1942

Gryllocola gryllotalpae, sp. nov.

Female.—(Text-fig. 3*a*, *b*). Length 1·948—2·185 mm. ; maximum breadth 0·228—0·238 mm. Cuticle is striated in the anterior half, annules 0·012—0·014 mm. wide. Cervical and caudal alae are absent. Mouth



TEXT-FIG. 3.—*Gryllocola gryllotalpae,* sp. nov.

a. Female, anterior end ; *b.* Female, anterior end, end on view ; *c.* Male, *d.* Male, posterior end.

opening X-shaped, being surrounded by three slightly developed lips. The labiopapillae could not be detected even under high power. Two amphids present. Buccal cavity small and inconspicuous, about 0·016 mm. deep and broadly V-shaped. Oesophagus 0·026—0·031 mm. broad. The isthmus is almost absent and cannot be distinguished from the corpus. The oesophageal bulb is valvular and measures 0·093×0·093 mm. The nerve ring is 0·161 mm. from the anterior end. The excretory pore is

0·434—0·496 mm. from the anterior end, posterior to the base of the oesophageal bulb, and possesses a well developed excretory bag. The intestine is slightly enlarged to form a cardia, which is less broad than the valvular bulb. The anus is 0·211—0·217 mm. from the posterior end. The tail is short, conical and tapering. The vulva is 1·131—1·364 mm. from the anterior end *i.e.* approximately 12/20—14/23 from the anterior end. The vagina is short, muscular and directed anteriorly. The two uteri are divergent. The two ovaries are present—one anterior and the other posterior to the vulva. The eggs are oval, 0·053—0·056 × 0·030—0·031 mm. in size, segmented, and do not have any polar caps.

Male.—(Text-fig. 3 *c*, *d*). Length 1·071—1·397 mm., maximum breadth 0·093—0·112 mm. Cervical alae absent, caudal alae present. The cuticle is almost smooth. Buccal cavity comparatively large. The mouth opening appears to be surrounded by three well developed lips. Oesophagus 0·301—0·31 mm. long. Corpus 0·202 mm. long, isthmus 0·016 × 0·016 mm., and the valvular bulb 0·053—0·062 × 0·049—0·053 mm. Nerve ring 0·190—0·202 mm. from the anterior end. The excretory pore is 0·357—0·434 mm. from the anterior end, posterior to the base of the oesophageal bulb. Cloaca almost near the posterior end, on the ventral side. Tail truncated. Caudal papillae consisting of one pair of large ventral and preanals, one pair subventral preanals, one pair ventral and preanals immediately anterior to the cloaca and one pair of large subventral postanals. Testis single and reflexed. One spicule 0·025 mm long.

Host.—*Gryllotalpa africana* Beauv.

Location.—Rectum.

Locality.—Lucknow, India.

Discussion.—The genus *Gryllocola* was created by Basir in 1942 to accommodate *G. gryllocola* from *Gryllotalpa* sp. The present species differs from the type species, *G. gryllocola* Basir, 1942, in the size of the female and the male worms, absence of cervical alae in both the sexes, size of oesophagus in female, position of anus and vulva in the female, large eggs without polar caps; position of nerve ring in male, position of the anal papillae and size of the spicule.

In the male and female forms of the present species the lips are fairly well developed, though not much in the female but can be distinguished all the same. The lips in the type species, *G. gryllocola* cannot be distinguished though in the female it is described as " Oral opening prismoidal with three inner cuticular projections, surrounded by eight submedian labiopapillae " It seems that the " three inner projections " are nothing but the slightly developed lips as present in the present species. The labiopapillae could not be detected though examined very carefully under high magnification.

The genus *Mirzaiella* Basir, 1942, closely resembles the genus *Gryllocola* Basir 1942. According to Basir, however, the genus *Mirzaiella* differs from *Gryllocola* in having three well developed lips, intestine forms big cardia and the tail appendage is somewhat distinctly set off from the body, the rest of the characters, being strikingly similar. In

G. gryllocola, Basir could not observe the excretory pore, but in the form described above the excretory pore is posterior to the base of the oesophageal bulb whereas in *Mirzaiella* the excretory pore is anterior to the valvular bulb. In the present species, which closely resembles *G. gryllocola* Basir, 1942 in large number of characters, the lips are fairly well developed, a character it shares with *Mirzaiella.* Hence, the present form shows characters shared by *Gryllocola* and *Mirzaiella* as described by Basir, but it seems more probable that the genus *Mirzaiella* is a synonym of the genus *Gryllocola.* Unfortunately, no male of *Mirzaiella asiatica* was recovered which alone would decide the issue. In case the male of *M. asiatica* bears out the above conclusion, the genus *Mirzaiella* will be a synonym of *Gryllocola*, the latter genus having page precedence. The generic diagnosis of the genus will be as follows.

Genus **Gryllocola** Basir, 1942, emended

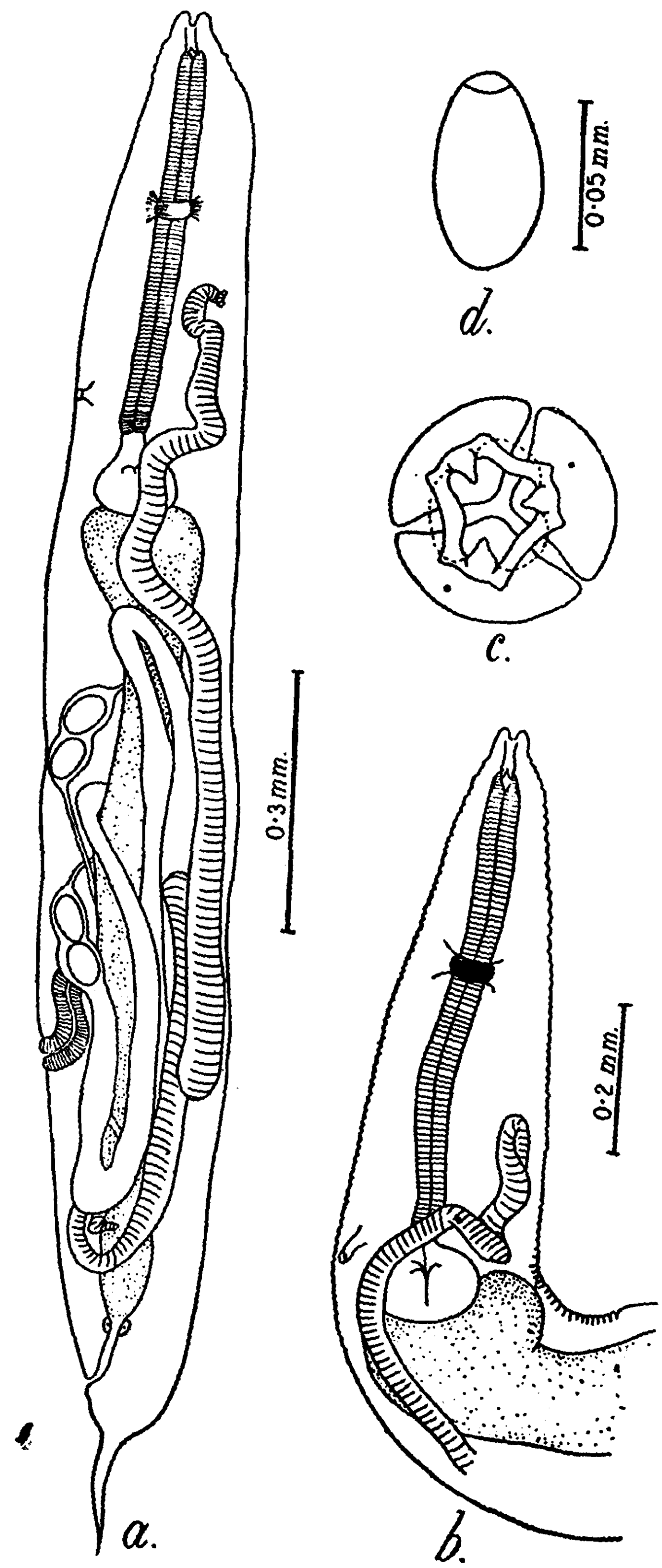
Synonym : **Mirzaiella** Basir, 1942

Thelastomatinae : Mouth opening prismoidal surrounded by three lips and eight submedian labiopapillae. Cervical and caudal alae may be present. Oesophagus consists of an anterior corpus, isthmus and a valvular bulb. Intestine enlarged to form a cardia. Vulva about 2/3 from the anterior end. Tail of female conical and tapering. Tail of male truncated bearing three pairs of preanal and one pair postanal papillae. Vagina directed anteriorly; ovaries two; uteri two, divergent. Eggs oval, with or without polar caps. Spicule single. Parasites of *Gryllotalpa* sp. Type species : *G. gryllocola* Basir, 1942.

Gryllocola indicus, sp. nov.

Female.—(Text-fig. 4*a*, *b*, *c*). Length 1·948—2·328 mm.; maximum breadth 0·226—0·248 mm. The cuticle is annulated upto the bulb, the first annule is 0·016 mm. in breadth, the rest of the annules upto the bulb are 0·006—0·009 mm. in breadth, decreasing in width posteriorly. The three lips are well developed and surround a triangular mouth opening. Two amphids present, the labiopapillae could not be detected even after careful examination. Buccal cavity 0·037—0·043 mm. deep and 0·025—0·028 wide, cylindrical. Three chitinous teeth present at the base of the buccal cavity. The oesophagus is 0·58—0·657 mm. long, consisting of a corpus measuring 0·543 × 0·037 mm.; an isthmus 0·019—0·022 × 0·02—0·025 mm.; and a valvular bulb 0·078—0·093 mm. Nerve ring 0·236—0·295 mm. from the anterior end, in the anterior half of the corpus. Excretory pore 0·496—0·558 mm. from the anterior end, anterior to the oesophageal bulb. Intestine dilated to form a big cardia, greater in diameter than that of the oesophageal bulb. Anus 0·226—0·233 mm. from the posterior end. Tail long and tapering appendage about 0·164 mm. in length. Vulva 1·311—1·473 mm. from the anterior end or approximately 60—66 per cent. posteriorly of the body. Vagina muscular and directed anteriorly. Ovaries two, the anterior one reaching anterior to the excretory pore and the posterior one posterior to the vulva.

The two uteri are divergent. The eggs (text-fig. 4*d*) measure 0·056—0·062×0·034 mm. They are segmented.



TEXT-FIG. 4.—*Gryllocola indicus*, sp. nov.
a. Female; *b.* Female, anterior end; *c.* Female, anterior end, end on view; *d.* Egg.

Host.—*Gryllotalpa africana* Beauv.

Location.—Rectum.

Locality.—Lucknow, India.

Discussion.—The present form closely resembles *Gryllocola asiatica* Basir, 1942 (syn. *Mirzaiella asiatica* Basir, 1942) in many points but differs mainly in having three cuticular teeth at the base of the buccal cavity, size of eggs, absence of labiopapillae (it seems improbable that they have been overlooked in the present form), small buccal cavity and position of the vulva. Unfortunately, the type specimen of *G. asiatica* is not available to us for study and hence it is difficult to decide the systematic position of the present form, more so because the measurements of *G. asiatica* available are apparently from one single female specimen, the males being unknown both in *G. asiatica* and the present form.

It so happened that a large number of hosts, *Gryllotalpa africana* Beauv. ere examined but in all the cases, mixed infection was found and there was some difficulty in classifying the male forms described here as *Gryllocola gryllotalpae*, sp. nov., since it could be described both with *Gryllocola gryllotalpae* sp. nov., as well as the present form. With the former species the male resembles in having the excretory pore posterior to the base of the oesophagus whereas it resembles the latter species, *G. indicus*, sp. nov., in having three well developed lips. But the male described under *Gryllocola gryllotalpae*, sp. nov. resembles very closely the male of *G. gryllocola* Basir, 1942, the authors feel inclined to classifying it under *G. gryllotalpae*, sp. nov. rather than with *G. indicus*, sp. nov.

Genus **Gryllophila** Basir, 1942

Gryllophila kheharlae, sp. nov.

Female.—(Text-fig. 5 *a, b, c*). Length 2·256—3·107 mm. ; maximum breadth 0·342—0·409 mm. The I and II annules are very prominent measuring 0·022 and 0·030 mm. respectively, rest of the annules anterior to the bulb are less prominent, measuring upto 0·045 mm., and in the rest of the body the annules are about 0·032 mm. Buccal cavity small. The oesophagus is 0·456—0·49 mm. long, consisting of a corpus 0·304—0·335 × 0·034—0·036 mm.; an isthmus 0·046—0·062 × 0·036—0·037 mm., and a valvular bulb 0·093—0·099 × 0·093—0·099 mm. The mouth opening is irregularly pentagonal and surrounded by eight labiopapillae and two amphids. The intestine is much enlarged to form a cardia, greater in diameter than the valvular bulb. Nerve ring 0·226—0·236 mm. from the anterior end, situated at the posterior end of the corpus. Excretory pore 1·054 mm. from the anterior end, much posterior to the base of the valvular bulb. Anus 0·31—0·34 mm. from the posterior end. Tail conical and tapering. Vulva 1·758—2·375 mm. from the anterior end or approximately 75 per cent. posterior to the body. Vagina directed anteriorly. Ovaries two. Uteri two, divergent. Eggs oval 0·140 × 0·099 mm., segmented before deposition.

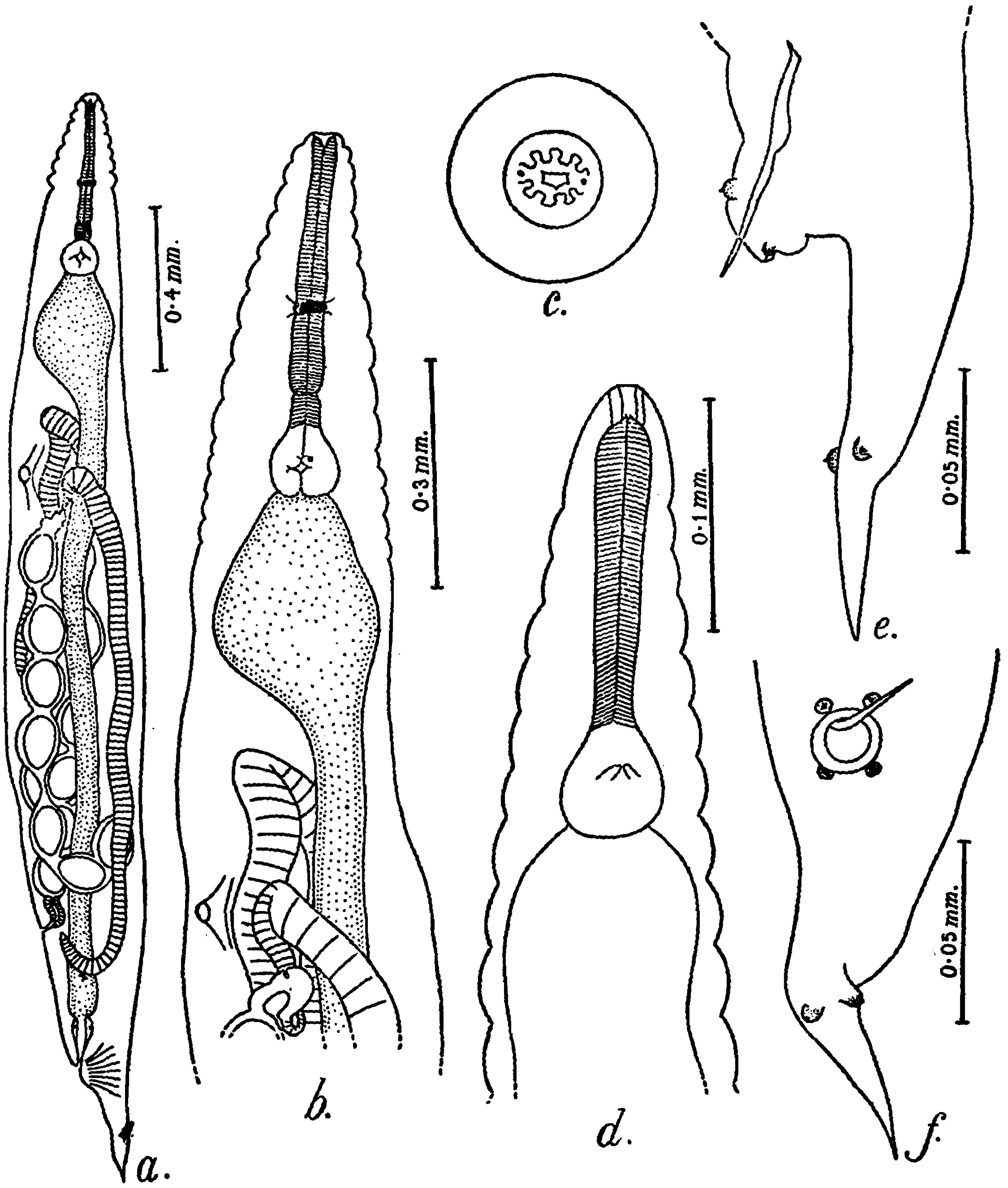
Male.—(Text-fig. 5 *d, e, f*). Length 1·378—1·38 mm., maximum breadth 0·133—0·146 mm. Body annulated prominently throughout the body length. First annule very big. Buccal cavity 0·021 mm. deep, cylindrical. Oesophagus 0·177—0·18 mm. long. Corpus 0·099 × 9·02 mm.; isthmus 0·037 × 0·015 mm., and valvular bulb 0·042—0·046 × 0·042—0·046 mm. The intestine is enlarged, having a greater diameter than that of the bulb. The nerve ring and the excretory pore could not be detected. Cloaca 0·115—0·118 mm. from the posterior end. Tail attenuated and tapering. Testis single, reflexed. Spicule

0·057—0·062 mm. long. Three pairs of caudal papillae present: one pair preanal and one pair postanal surrounding the cloacal opening and one pair of postanal papillae much posterior to the cloacal opening. All the papillae are ventral.

Host.—*Gryllotalpa africana* Beauv.

Location.—Rectum.

Locality.—Lucknow, India.



TEXT-FIG. 5.—*Gryllophila kheharíae*, sp. nov.

a. Female; *b.* Female, anterior end; *c.* Female, anterior end, end on view; *d.* Male anterior end; *e.* Male, posterior end, lateral view; *f.* Male, posterior end ventral view.

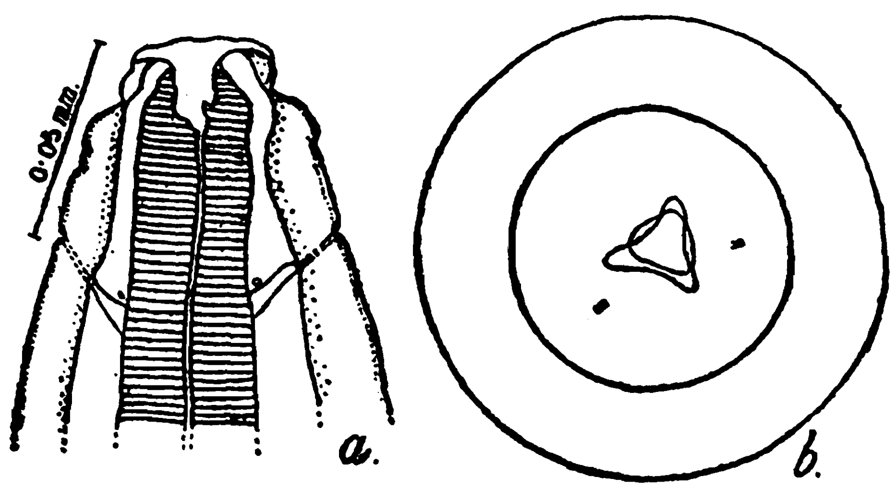
Discussion.—The genus *Gryllophila* was created by Basir in 1942 for a new species *G. gryllophila* from *Gryllotalpa* sp. The present form differs from the only species of the genus *G. gryllophila* Basir 1942, in the male having three pairs of anal papillae and a large spicule. It is interesting to note that the rest of the structures of both male and female of the present species closely resemble those of *G. gryllophila*. Since it is very improbable that such large anal papillae, as present in the present form, may have been completely overlooked by Basir, it seems necessary to create a new species for the present form, which shall be known as *Gryllophila khehariae*, sp. nov.

Basir (quoted by Theodorides (1953)) is of the opininon that *Gryllophila gryllophila* Basir, 1942 and *Neyraiella neyrae* Sanchez, 1946 are synonymous to *Thelastoma skrjabini* Serguiev. Since *G. gryllophila* Basir, 1942 was the type species of the genus, the new species, *G. khcehariae* becomes the type species by designation. Further, the generic diagnosis of *Gryllophila* should include : " Three pairs of anal papillae : one pair preanal, one pair adanal and one pair postanal papillae "

Genus **Talpicola** Basir, 1942

Talpicola talpicola Basir, 1942

Female.—(Text-fig. 6 *a, b*). Length 2·708—2·964 mm., maximum breadth 0·186—0·26 mm. The cuticle is very lightly annulated in the



TEXT-FIG. 6.—*Talpicola talpicola* Basir.
a. Female, anterior end, side view ; *b*. Female, anterior end, end on view.

first and second annules. Narrow cervical alae present. Mouth opening is tri-radiate. No labiopapillae could be seen, two amphids present. Buccal cavity 0·016—0·019 mm. deep and 0·006—0·009 mm. broad. Oesophagus 0·326—0·341 mm. long, consisting of : a corpus measuring 0·233—0·239 × 0·031—0·04 mm.; an isthmus 0·016—0·022 mm. long and 0·028—0·048 mm. broad and a valvular bulb 0·068—0·077 × 0·076—0·093 mm. The intestine is enlarged forming a cardia greater in diameter than the bulb. The nerve ring is almost in the middle of the corpus, 0·14—0·15 mm. from the anterior end. Excretory pore much posterior to the base of the oesophagus and 0·527—0·558 mm. from the anterior end. Anus 0·124—0·192 mm. from the posterior end. The tail is tapering and elongated. The vulva is 1·52—1·8 mm. from the anterior end or approximately 55 per cent. posterior of the body length. The vagina is muscular and anteriorly directed. Ovaries two, one reaching almost upto the excretory pore and the other posterior to the vulva. The two uteri are divergent. Eggs are oval, measuring 0·052—0·068 × 0·028—0·034 mm. They are segmented and do not possess any polar caps.

Host.—*Gryllotalpa africana* Beauv

Location.—Rectum.

Locality —Lucknow, India.

Note 1.—There seem to be two ducts coming out from the anterior, region of the corpus and opening to the outside through round apertures and narrow ducts. The opening is 0·052—0·056 mm. from the anterior end. The nature of these ducts and openings could not be ascertained.

Note 2.—The excretory pore and the tail is surrounded by small hair-like process in several specimens examined, which are probably fungi.

Discussion.—The present form though differing from *Talpicola talpicola* Basir, 1942 in the size of the buccal cavity, isthmus and eggs and the position of the nerve ring, must necessarily belong to the above species. The hair-like fungi and the opening of a duct of unknown nature are however being described for the first time for the genus. The nature of the ducts could not be ascertained.

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ON INDIAN AND BURMESE EARTHWORMS OF THE GENUS *GLYPHIDRILUS*

By G. E. Gates

This note reports results of study of material of Indian species of *Glyphidrilus* received for identification during the last fifteen or twenty years. Most of the lots were small but one fairly long series (from Saharanpur) provided an opportunity for obtaining much needed information as to variation in certain taxonomically important characteristics about which nothing had been previously recorded. A little Burmese material (8 specimens) received after completion of the original draft of the manuscript is also considered.

The author's thanks are tendered to the following : The officers of the Zoological Survey of India, who, at various times during the period of years, made available for study the material from the collections of the Indian Museum. Dr. S. L. Hora for examining certain specimens belonging to the Indian Museum in connection with the present contribution. Prof. C. R. N. Rao for the gift of several specimens as well as material of other genera. Miss Helen Benjamin for a grant to meet the cost of making the Saharanpur collection (as well as those from various other localities). Dr. N. Tebble for returning to the author Burmese material that had been sent to Professor Stephenson around 1931.

Genus **Glyphidrilus** Horst 1889

Definition.—Body wall protuberant, at maturity, in a longitudinal lamellar ridge ("wing") in *bc* on each side, across several clitellar segments. Polythecal, spermathecae behind testis segments, the pores in three or more intersegmental furrows beginning with 12/13, 13/14 or 14/15. Setae, eight per segment, in four pairs. Clitellum, annular (?), extending over a number of segments including all with reproductive apertures (?), intersegmental furrows not obliterated. (No dorsal pores.) Prostomium zygolobous. Anus dorsal, body nearly circular in cross section anteriorly, becoming more elliptical posteriorly, quadrangular after preservation, with setae at the four corners and *dd* only slightly larger than *aa*.

Gizzard oesophageal, in region of vii-viii (not strictly confined to one segment?). Typhlosole present, rather low and thickly lamelliform (?). (No calciferous glands). Vascular system with a subneural trunk, single dorsal trunk, and one or more pairs of latero-oesophageal hearts. Excretory system holonephric, nephridia lacking in first twelve (or so) segments. Holandric. Seminal vesicles four pairs, in ix-xii (?). Spermathecae adiverticulate, ducts at least confined to parietes.

Remarks.—Organs present only in one of the species scarcely merit mention in a generic definition and so reference to "prostates" has been omitted. Mention of male pores is also omitted as locations of those apertures have been recorded only for three species and also because of uncertainty as to the significance of the variation apparently indicated by some of those records.[1]

The definition above is tentative as we still are ignorant of important characteristics in a large proportion of the species. It is offered as one more contribution to a less artificial taxonomy of earthworms than that of the past which has been based on the so-called "phylogenetic" diagnoses.

A first attempt (below) at a key to any considerable section of the genus has succeeded only in pairing species that probably are morphologically and/or geographically distant. This may however be due only in part to the lack of information about internal organization.

Key to Oriental species of *Glyphidrilus*

1. a. Gizzard in vii or mainly so . . .	2
b. Gizzard in viii or mainly so .	3
2. a. Intestinal origin in xv	*tuberosus*
b. Intestinal origin behind xv . . .	*ceylonensis*
3. a. Intestinal origin in xv . . .	4
b. Intestinal origin behind xv .	6
4. a. Wings begin in region of xvii-xix	*papillatus**
b. Wings begin behind xx	5
5. a. No genital markings in *aa* . .	*birmanicus*
b. Unpaired, median markings in *aa*	*annandalei*
6. a. Intestinal origin in xvi, dorsal blood vessel ends in ix	*gangeticus*
b. Intestinal origin in xviii, dorsal blood vessel ends in ?	*malayanus*†

Glyphidrilus annandalei Michaelsen 1910

1925. *Criodrilus* sp. (? *lacuum*), Stephenson, *Proc. Zool. Soc. Lond.*, pp. 903-905.

Bangalore, Mysore State, 5 clitellate specimens. Prof. C. R. N. Rao.

Bhadravati, Shimoga district, Mysore State, December, 1 clitellate specimen. H. S. Rao. (Indian Mus.)

Mettupalayam, "from deep places along edge of Bhavani River", 16-9-25, 1 clitellate specimen. Dr. S. L. Hora. (Indian Mus.)

Bangalore, "dhobie ghat", May 12, 1 fragment. Miss Dorothy Pearson.

External characteristics.—Nephropores, on the *b* lines, are recognizable only from xiv or xv even though nephridia are present from ix posteriorly (small in xi-xiv). Female pores are on xiv, on *b* lines, nearer the setal equator than 13/14 (7 specimens). The wings are $1\frac{1}{4}$-$1\frac{1}{2}$ mm high. Genital markings are located as follows : unpaired medians, on xii-xxii (2), xiii-xv (2), xiii-xx (1), xiii-xxi (1), xiii-xxii (1) ; paired laterals, xiii-xxiv (7), xxxii-xxxiii (5), xxxiii-xxxv (1), xxxiv but on right side only (1). Rims of markings are conspicuously raised peripherally

(1) Male pores have been said to be on 21/22, 27/28, 29/30, in *annandalei*, on 21/22 in *quadrangulus*, on 27/28 in *weberi*.

**G. spelaeotes* Stephenson 1924 drops out here. It is not, at present, distinguishable from *papillatus*.

†*G. malayanus* Michaelsen 1903 is even more inadequately characterized than *spelaeotes* but may have (Gates, 1938, *Bull. Raffles Mus.*, Singapore, 14, p. 221) an intestinal origin in xviii.

(1 from Shimoga and 1 from Bangalore) so as to form deep cups within which the central tubercle is equally protuberant. The central tubercle of four markings, on xiv-xv, is doubled.

Remarks.—The three specimens from South Malabar of "*Criodrilus* sp.", in absence of wings, genital markings and spermathecae, must have been juvenile. The location of the gizzard muscularity and the ornamentation of the setae obviously are not as in the genus *Criodrilus*. Indeed, location of a gizzard in viii and vii not only rules out assignment to *Criodrilus* but invites consideration of reference to *Glyphidrilus*. *G. annandalei* is the only species of the genus that has been found in South India from whence the South Malabar specimens came. The zygolobous prostomium, ornamentation of the setae, location of gizzard, the segment of intestinal origin, the typhlosole, presence of hearts in vii-xi, and the presence of nephridia from xi posteriorly, all support an identification as *annandalei*.

Glyphidrilus gangeticus, sp. nov.

1909. *Glyphidrilus* sp. ?, Michaelsen, *Mem. Indian Mus.* I, p. 244. (Kichha near Naini Tal, Kumaon district, base of western Himalayas. 2 juveniles.)

1920. *Glyphidrilus papillatus*, Stephenson, *Mem. Indian Mus.* VII, pp. 258-260 (Lucknow.)

1923. *Glyphidrilus papillatus* (part), Stephenson, *Fauna Brit. India*, Oligochaeta, p. 493. (Excluding all but Lucknow worms.)

1947. *Glyphidrilus* sp., Gates, *Proc. nat. Acad. Sci. India*, (B), XVII, pp. 121-122. (Ahraura in Allahabad sector of the Indo-Gangetic plain, U. P.)

1948. *Glyphidrilus papillatus*, Gates, *Growth*, XII, pp. 175-176. (Location of anus in younger and older tail regenerates.)

1951. *Glyphidrilus papillatus*, Gates, *Proc. nat. Acad. Sci. India*, (B), XXI, p. 17. (Saharanpur.)

Glyphidrilus sp., Gates, (in press). (Sohagi.)

Saharanpur, United Provinces, October, 19 juvenile, 6 aclitellate and 110 clitellate specimens. M. Mathur. (Along banks of a river, at a depth of about eighteen inches.)

External characteristics.—Length, 85-140 mm (preserved in a strongly contracted state). Diameter, 4-5½ mm. The prostomium is zygolobous. Nephropores have not been definitely identified, *i.e.*, actual openings have not been seen, but they probably are located on the *b* lines. Spermathecal pores have not been recognizable (because of strong contraction) but are in 12/13-16/17 Female pores are on xiv, on *b* lines, about midway between 13/14 and the setal equator. Male pores were not found. Variation in segmental location of the wings is shown in the table below. Genital markings are postsetal and are differentiated into well marked rim and central portion. Variation in segmental locations of the markings is also shown in Table I.

Internal anatomy.—The gizzard is mainly in viii (30 specimens). The intestinal origin is in xvi (30). The typhlosole begins in xvii or xviii and is fairly well developed relative to the size of the gut, rather thick, not blade-like (lamelliform).

The dorsal blood vessel (single) ends exactly with the commissures of ix (28), with a left commissure of viii (1), or with a pair of commissures to the ventral trunk in viii (1). The ventral trunk bifurcates over the subpharyngeal ganglia or a little more posteriorly, the branches passing up around the gut and uniting under the brain so as to form a circum-pharyngeal ring. From this ring small vessels may pass back, in some specimens apparently, to join branches of the supra-oesophageal trunk. This trunk is large, disappearing from view in xiii-xiv, bifurcating anteriorly, each branch passing anterolaterally to join the anterior lateroparietal trunk in ii. The supra-oesophageal gives off in each of segments vi and vii a pair of asymmetrical vessels which pass to the anterior lateroparietal trunks. Because of the close crowding in a small space these asymmetrical branches and the supra-oesophageal trunk could easily be mistaken for segmental commissures and a continuation of the dorsal vessel. A pair of smaller vessels from the supra-oesophageal is occasionally recognizable in segment v. A pair of small vessels from the supra-oesophageal pass downward just behind septum 7/8 on the gizzard. These vessels either unite midventrally to form a short, median suboesophageal vessel or pass into two suboesophageals, or unite and then join one of the suboesophageals. Suboesophageal vessels, on the ventral face of the gut from which they can be dissected off, may be paired, unpaired and median, or large on one side and small on the other, or lacking on one side but present on the other, or the condition may vary from one segment to another. This suboesophageal complex may be connected by a pair of large vessels in each of viii to xiii and on the anterior faces of the septa with the anterior lateroparietal trunks, or the lateroparietal trunks may turn mesially on one or both sides of any of those segments to join the suboesophageal. In the latter case the segmental branches from the suboesophageal complex pass straight laterally in the more posterior segments behind the junction. The anterior lateroparietals, in a few specimens, bend mesially in xii, xiii or xiv and on the anterior face of the septum unite with the posterior lateroparietal, the united vessel then joining the suboesophageal complex. The subneural trunk is large, with a pair of branches passing laterally just behind each septum. Any one, or any pair, of those branches, in the region of xxiii-xxviii may be much enlarged. An enlarged branch in xxvii or xxviii after passing straight laterally for some distance, turns almost at a right angle and then continues forward as the posterior lateroparietal trunk. This vessel may be joined in any of segments xviii-xxiii by another large branch from the subneural or, if the subneural has disappeared in the meanwhile, the two lateroparietals may be connected by a large commissure on the ventral parietes. The posterior lateroparietal vessels either join the anterior lateroparietals or open into or become the suboesophageal vessels in xii (1), xiii (5), or xiv (8) or xii on one side and xiii on the other, or xiii on one side and xiv on the other. The relationships of these vessels appear to differ constantly from one worm to another. The subneural disappears without exception before reaching xvii and is never recognizable anteriorly as in species of *Perionyx*, *Drawida*, etc.

The last pair of hearts, in xi (30 specimens), is latero-oesophageal, the bifurcations to the dorsal trunk always small, and white, the bifurcations to the supra-oesophageal always large and filled with blood. Hearts of ix and x always appear to be lateral, opening directly into the dorsal trunk. If any bifurcation to the supra-oesophageal is present in segments ix and x it must be morphologically and physiologically different from that in xi. Segmental commissures of viii, when present, are lateral.

Seminal vesicles of xii are always elongated anteroposteriorly and push 12/13 back, into contact with 13/14. Small pseudovesicles are present in xiii and in one specimen are filled with dark brown granular debris such as is aggregated into the brown discs or bodies. Similar pseudovesicles are usually present in xiv where they presumably function as ovisacs. A pair of pseudovesicles is present in each of segments xiii, xiv, xv, and xvi, in one specimen, the size decreasing posteriorly.

Abnormality.—The left heart and both vesicles of ix are lacking in the worm in which the dorsal trunk ended with two commissures in viii (the specimen with post-alar unpaired median genital markings).

TABLE I

Variation in location and segmental length of the wings in one colony of *G. gangeticus*

Location.	Number of segments involved.	Number of specimens.
16/17-25/26	9	1
½xvii—½xxv	8	1
*17/18—½xxv	7½	51
*17/18-25/26	8	9
17/18—½xxvi	8½	2
17/18—26/27	9	1
½xvii—½xxv	7	32
½xviii—25/26	7½	1
½xviii—½xxvi	8	5
½xviii—26/27	8½	2
18/19—½xxv	6½	5
18/19—25/26	7	1
Not determinable because of condition		5
	Total	116

The " ½ " indicates that the wings extend onto the postsetal portion of the segment in case of the first figure of a pair, or onto the presetal portion in the case of a second figure. It does not indicate exact extent across a postsetal or presetal half, one quarter and three quarter (usually plus) extent being omitted to save space.

Asymmetry in extent of wings of an individual is slight but present in some specimens, though amounting only to one segment or less. In such cases, again to save space, only the greater extent is indicated, but by recording the more anterior beginning and the more posterior ending.

*The presetal portion of the wing, on the first segment, often is only about half the ight of the remainder of the wing.

TABLE II

Variation in number and segmental location of genital markings in one colony of *G. gangeticus*

Segment.	Median, unpaired markings.	Paired markings, in *bc*.
x	2	..
xi	12	..
xii	53	35
xiii	44	70
xiv	17	71
xv	2	92
xvi	6	107
xvii	52	107
xviii	67	1
xix	2	..
xxiv	..	9
xxv	..	94
xxvi	..	83
xxvii	..	8
xxviii	1	
xxix	1	1
xxx	1	..
xxxi	1	..
xxxii	1	..

Arabic numerals show the number of times a genital marking is found on a particular segment in 116 specimens, asymmetrical conditions disregarded, *i. e.*, occasional absence of one of a pair.

The markings on xxiv always are asymmetrical and present only when one wing ends at 23/24 or on the anterior portion of xxiv.

All the post-alar median markings (of xxviii to xxxii) are on one worm.

Remarks.—Spermatozoal iridescence was evident in the spermatheca ampullae of each of the dissected specimens.

Variation in number of segments crossed by the wings, in the Saharanpur specimens, is slight, 2½ ; 6½ segments (5 specimens), 7 (33), 7½ (52), 8 (15), 8½ (4), 9 (2). The wings, as Table I shows, begin on one of three segments, xvii, xviii or xix, and end on one of two segments, xxv or xxvi. Although much more variation was shown in the number of genital markings (Table II), none of the worms had paired markings in *aa* (as was also the case in the Lucknow specimens examined by Stephenson, 1920).

Variation in segments crossed by the wings in " a considerable number, (Stephenson, 1920, p. 259) of Lucknow worms was of about the same order, 6-8½, as in worms from Saharanpur. But the wings apparently always began on xviii though ending on any of several segments, xxiii, xxiv, xxv, or ½ xxvi. Unfortunately we do not know how many adult specimens were available to Stephenson nor the size of the sample on which wing locations were precisely determined.

Internal organization of the Saharanpur material was uniform and showed no variation that might be expected to be of taxonomic importance. Although the segment in which the dorsal blood vessel ends was not mentioned by Stephenson there is no good reason, at present, for suspecting that Lucknow worms differ in that respect alone from those obtained at Saharanpur.

Identification of five young worms from Ahraura (Gates, 1947) and others from Sohagi (Gates, in press) was not attempted. These juveniles, as well as the two from Kichha (Michaelsen, 1909) are assumed to be of *gangeticus* in absence of any reason for suspecting presence of another species of the genus in the western portion of the Gangetic plain.

G. gangeticus is very clearly distinguished from *G. papillatus* (Rosa) 1890, with which it has been confused, by the termination of the dorsal blood vessel with the hearts of ix, as well as by the intestinal origin in xvi.

Definition.—Wings begin on one of segments xvii-xix and end on one of xxiii-xxvi. Genital markings primarily postsetal : unpaired and median on (*x*), xi-xiv, (xv-xvi), xvii-xviii, (xix, xxviii-xxxii) ; paired, lateral to *aa*, xii-xviii, (xix, xxiii), xxiv-xxvii, (xxviii-xxx). Spermathecal pores on 12/13-16/17 Female pores on *b* lines midway between setal arc of xiv and 13/14. (Male pores ?) Clitellum on xiii or xiv to xxxiv or so (anterior and posterior limits rather indefinite). Segments, 202 (± ?). Length, 85-140 mm. Diameter, 3-5½ mm.

Gizzard mainly in viii. Intestinal origin in xvi. Dorsal blood vessel ends with hearts of ix. Last hearts in xi, only this pair latero-oesophageal.

Distribution.—Western portion of the Gangetic plain from Saharanpur to Lucknow, Ahraura and Sohagi. Replaced in the eastern portion of the plain by *G. tuberosus* ?

Glyphidrilus tuberosus Stephenson 1916

1914. ***Criodrilus lacuum*, Stephenson, *Rec. Indian Mus.* X, p. 256.**

Bayrani, near Kallikote, Ganjam district, Madras Presidency, 7. iv. 1924, 8 clitellate specimens. Dr. S. L. Hora. (Indian Mus.)

External characteristics.—Length, 70-118 mm. Nephropores are on the *b* lines and are recognizable only from xv posteriorly. Spermathecal pores are minute, on 13/14-14/15, 4-6 on each furrow, on the *a* and *b* lines and in *bc*. Females pores are minute, very slightly lateral to *b* lines and nearer to the setal equator than to 13/14. The wings are low and on xx-xxiv. Grooves from the wings may pass forward to xiv and back to xxvi, xxvii or xxviii. The genital markings are postsetal, small, circular to elliptical tubercles, slightly depressed peripherally, located on x-xiii, xvi-xix and xxiv-xxx, in *aa* (1, 2, or 3 markings), *ab* and *bc*. Each of these markings appears to be the equivalent of the central tubercle of an *annandalei* marking and without any indication of the wide marginal rim of *annandalei*.

Internal anatomy.—Gizzard small, apparently in vii (3 specimens). Intestinal origin in xv (3). Last hearts in xi (3).

Remarks.—The low height of the wings, the absence thereon of the tuberosities for which the species was named, and the lack of marginal rims on genital markings presumably cannot, be attributed to incomplete development as presence of spermatozoa in the spermathecal ampullae shows that these worms are mature enough to have completed copulation.

G. tuberosus has been known hitherto only from the original description. The present specimens are from a somewhat more southerly portion of the peninsula.

The specimens of "*Criodrilus lacuum*" from the shore at Satpara in Puri district of Orissa, in absence of wings, genital markings and spermathecae, must have been juvenile. The little information that was recorded with regard to these specimens is insufficient even for a generic identification but if the worms are actually of a species of *Glyphidrilus*, as now appears to be probable, they are more likely to be referable to *tuberosus* than to species from more distant regions.

(An attempt to determine the segment in which the dorsal blood vessel ends in this species was made by Dr. S. L. Hora. He states (*in lit.*) that the specimens are "too old and on opening they break in bits" and in the type "I could not possibly trace the vessels".)

Glyphidrilus papillatus (Rosa) 1890

Burma, 1 juvenile, 1 aclitellate and 2 clitellate specimens with label that had become illegible. (GEG/JS per N. Tebble.)

External characteristics.—Length of juvenile, *ca.* 57 mm. Diameter (adults) in clitellar region, *ca.* 5 mm, but less than 3 mm elsewhere. Anus wholly dorsal, with posterior lobe. The red clitellar coloration extends across xiv-xl at least.

Wings extend across xviii-xxvi and just onto xxvii (3). Unpaired, median genital markings are present in *aa* on xi-xviii and xxix-xxx, xii-xiv and xvii-xviii, xi-xiv and xviii. Paired genital markings, each in median part of *bc* are present on xiv-xvii (1) or xv-xvii (2). Markings are primarily postsetal.

Internal anatomy.—Gizzard in viii but apparently reaching well into vii (4). Intestinal origin in xv (4). Typhlosole begins about in xviii and is thickly lamelliform.

The dorsal blood vessel ends with the hearts of vii (4). Last hearts are in xi (4). Hearts of vii-ix are lateral, those of x-xi latero-oesophageal with the larger of the dorsal bifurcations passing to the supra-oesophageal trunk.

Spermathecae are mostly within the parietes, in xiv-xvii with pores on 13/14-16/17 (no spermatozoal iridescence).

Remarks.—A posterior portion of each specimen, except the juvenile, is lacking.

The red coloration, which may have been developed since preservation, gradually fades to disappearance both anteriorly and posteriorly so that recognition of definite clitellar boundaries is not possible from external inspection.

G. papillatus was erected for a single "mal conservato" specimen and Rosa made no mention of several characteristics on which information is now necessary. Records of the author's re-examination of the type were destroyed during the war. Attempts to arrange for determination of certain characteristics of digestive and vascular systems have been unsuccessful. The specimen may, after more than sixty years, have little or no value as a type.

The worms characterized above can be distinguished from the type only as follows: wings cover 9+ instead of 7 segments and end on an anterior portion of xxvii instead of at 24/25, presence of paired genital markings on xxiv-xxv. These differences certainly cannot be regarded, at present, as justification for erection of a new species. Since *papillatus* must now be defined as having an intestinal origin in xv, and a termination of the dorsal blood vessel in vii, the Indian forms from the western part of the Gangetic plain had to be placed in a different species (p. 55). This in turn makes it doubtful that identification of Hainan worms as *papillatus* [1] is correct. No information as to any taxonomically important characteristics of the Hainan material was supplied.

Glyphidrilus birmanicus, sp. nov.

Burma, 1 large juvenile, 1 clitellate specimen and anterior portions of 2 clitellate worms with label that had become illegible. (GEG/JS per N. Tebble).

External characteristics.—Length, 95-103 (+) mm. Diameter 6 mm. in clitellar region, as much as 5 mm. elsewhere. Prostomium zygolobous. Anus dorsal or dorsoterminal. Nephropores on *b* lines. Clitellar coloration, a deep red, extends across xii or xiii to xliii or xlvi but disappears gradually both anteriorly and posteriorly.

Wings are rather low, on xxi-xxix, in *bc*, just lateral to the genital markings (3). Genital markings are present only in a median portion of *bc*, and as usual are postsetal, on xii to xxi, xxii or xxiii, and xxx to xxxi, xxxiii or xxxiv.

Internal anatomy.—Gizzard in viii but apparently extending also through part of vii. Intestinal origin in xv (3). Typhlosole begins about in xviii and is rather thickly lamelliform.

The dorsal blood vessel ends exactly with the hearts of vii (4). The last hearts are in xi (4). Hearts of vii-ix are lateral, of x-xi, latero-oesophageal. A large vessel from the supra-oesophageal runs downwards on each side in vii.

[1] Chen, Y., *Cont. Biol. Lab. Sci. Soc. China*, (Zool.), xii, p. 426 (1938).

Nephridia, in these contracted specimens, fill the space between gut and body wall nearly to the mid-dorsal region. Nephridia lacking in first 11 or 12 segments.

Holandric, male funnels iridescent. Seminal vesicles in ix-xii. Pseudovesicles present in xiii and xiv, in the latter segment larger than in xiii. Spermathecae mostly concealed in the parietes but easily discovered by removal of superficial tissues. Number, 2 to 8 on each side in segments xiv-xviii, with pores on 13/14-17/18.

Remarks.—The juvenile is longer than the clitellate worm but even so had lost a posterior portion. Rudiments of wings and genital markings are unrecognizable in spite of the size.

Reproductive apertures, as in *G. papillatus*, were not identified definitely (specimens preserved in strongly contracted state).

Some internal organs had been removed from one of the anterior fragments. Exact site of insertion of septum 7/8 on the gut has not been determined, in these specimens as well as in those of *papillatus* and *gangeticus*. The septum, perhaps as a result of strong contraction, preservation or subsequent maceration, seems not to be attached to the gut. Two gizzards might have been said to be present in one worm (in vii and viii) if a more definite, non-muscular node had been recognizable,

G. birmanicus is distinguished from *papillatus* by the larger size, absence of genital markings in *aa*, location of wings on segments xxi-xxix.

Glyphidrilus sp.

Rangoon, Burma, 1 juvenile with label that is partly illegible. (GEG/JS per N. Tebble.)

Toungoo, Burma, 2 juveniles. (GEG/JS per N. Tebble.)

Remarks.—Internal organization is the same as in *G. papillatus* and *birmanicus*. The size of these juveniles is such as to indicate greater probability of being *birmanicus* than *papillatus*. Gizzard muscularity of the Rangoon worm is confined to viii.

Glyphidrilus sp.

1931. *Glyphilrilus papilatus* (part, Gates, *Rec. Indian Mus.* XXXIII, pp. 431-433.

Remarks.—A discontinuity in wing location is shown by data for Rangoon worms previously identified as *papillatus* (Gates, 1931, p. 431). The wings in 47 of a series of 71 worms crossed five to ten segments, beginning on xvii, xviii, or xix and ending on xxiii (once), xxiv, xxv, xxvi, xxvii (six times). Although this variation is greater than was found in *gangeticus* the identification, in each of these cases, presumably could have been correct. However, wings began on xxi in 19 and on xxiii in 5 specimens of the series and in each of them ended either on xxv or xxvi. These worms, with wings of four to six segments, may prove to be taxonomically separable from *papillatus*.

DISCUSSION

Species of Glyphidrilus have been erected in the past, on one to several specimens and characterized mainly or wholly by reference to external characteristrics though some, such as locations of male and female pores, were undetermined and ever since have remained unknown. By far the most important of the external structures have been the wings though some taxonomic value also has been attributed to genital markings. Intraspecific variation in number of segments and in the particular metameres crossed by the wings has now been demonstrated by a fairly long series from a single colony of one species (*gangeticus*). Genital markings, in the same series, varied in intrasegmental location and in number from eight to forty. Markings always were unpaired in the *aa* region of the body, but the value even of that characteristic is uncertain because of the presence on single individuals, of two or possibly three species, of paired and unpaired markings in *aa*. At present, use of genital markings in the taxonomy of *Glyphidrilus* appears to be limited to four pairs of + and — characteristics : presence or absence of markings, presence or absence in *aa*, presence or absence lateral to the *a* line, presence or absence of pairing in *aa*. The wings showed less variation in number of segments involved than the markings. When the range of variation can be anticipated these structures doubtless will continue, because of their immediate visibility, to have considerable taxonomic value.

Little or no variation was found in the same series with respect to five characteristics of internal organization which now appear to be of very considerable phylogenetic as well as taxonomic significance. These internal characteristics have shown that *gangeticus* is not even closely related to *papillatus* with which it had been confused because of similarity in the wings and the genital markings. One of the two remaining cases of discontinuous specific distributions, *papillatus* in Burma and Hainan, apparently rests on identification by external characteristics and information as to internal organization is lacking. In the other case *weberi* of Sumatra, Java, Flores and Celebes, even such facts as were recorded sixty years ago suggest failure to distinguish two or three distinct species. The genus *Glyphidrilus*, in spite then of past opinions to the contrary because of the semi-aquatic habitat of these worms, now promises to be of considerable zoogeographical interest.

The internal organization of the Burmese worms now appears to be more like that of *annandalei* from the southern tip of India than of the species in adjacent regions on either side of Burma. Anomalous distributions and morphological relationships of this same sort are being recognized in various other genera of earthworms. In these cases a sort of reversed phylogeny is attempted.

Specializations and conditions that can be regarded as derived are cancelled out from each species to obtain a primitive generic type. A "proto-glyphidrilus" so obtained is characterized in part only as follows : Digestive system with a single oesophageal gizzard in vi and an intestinal origin in xv. Circulatory system with a single, uninterrupted dorsal trunk, a pair of commissures connecting that trunk to the ventral vessel in each segment, the commissures of some segments anteriorly from xi enlarged and heart-like but lateral. Excretory system with a pair of holonephridia in each segment from ii posteriorly.

From the ancestral proto-glyphidrilus, *ceylonensis* is derived by tanslocation of the gizzard into vii and development of vessels connecting hearts of ix-xi to the supra-oesophageal trunk. Across the straits in southern India, *annandalei* is derived by translocation of the gizzard into viii, abortion of the dorsal blood vessel in i-vi and most of vii along with the commissures of i-vi, and the development of connectives between hearts of x-xi and the supra-oesophageal. Absence of such connectives in ix makes direct derivation from *ceylonensis*, which would otherwise be possible, inadvisable. Far to the north, *gangeticus* has its gizzard in viii, has inhibited development of intestinal characteristics by the gut in xv with resultant addition of one segment to the oesophagus and transfer of intestinal origin to xvi, but has developed connectives to the supra-oesophageal only for the hearts of xi. The latter characteristic contraindicates a direct derivation from *annandalei* that would otherwise be possible. In Burma, the derivation for both species involves the same changes as in *annandalei*. To the east, the gizzard has been transferred into viii in all Malaysian species. The oesophagus has been extended through xvii in one species from Malay Peninsula but only through xv in a Sumatran form. The one evolutionary change in the circulatory system that circumstances permit mentioning is the addition, in *malayanus* (Malay Peninsula), of a pair of hearts in xii that apparently have not yet been added elsewhere. To the far west, in Tanganyika, the derivation involves translocation of gizzard to vii, extension of oesoahagus through xvii and addition of two pairs of hearts, in xii-xiii (dorsal trunk?.)

The anterior nephridia probably have been aborted in all species and from the first 10 to 14 segments. Intraspecific variation, along with frequent reduction in size of the first few pairs, suggest that this evolutionary process is still going on. Spermathecae, likewise omitted from the preceding portion of this discussion, may also give evidence for present as well as past developments. The supposed rudiments of these organs in the testis segments of an African species provide a link to a stage with pregonadal locations. From that remote ancestor proto-glyphidrilus is derived by multiplication of the spermathecae, translocation of theca-producing capacity through the testis region into more posterior segments and development of the generically unique wings. The polythecal condition, like meronephry in other genera, may have arisen through early embryonic fragmentation of orginally paired segmental anlage.

Since establishment of those conditions there has been no uniformity in the evolution of the group. Though subsequent changes are few they appeared in various portions of the proto-glyphidrilus range, from Borneo to Africa, in independent order and at different times. One of these standard changes, foreshortening of the dorsal blood vessel, has taken placein other families of earthworms. Abortion of the trunk back to the commissures of vii, as in *annandalei*, has been found in *Eudrilus* (Eudrilidae) and *Eutyphoeus* (Megascolecidae). In the latter genus this change certainly has been brought about, in some cases, at one step. As such a drastic change can be attributed, in *Eutyphoeus,* to a mutation for histolysis of appropriate sections in the circulatory system during embryonic development, it seems unnecessary to assume a different origin in other genera.

Greater foreshortening, as in *gangeticus*, may have been due to repeated mutations as also seems required for the one, two, three step changes in connection with the latero-oesophageal hearts, the addition of hearts in xii and then in xiii, the extension of the oesophagus through xv, then xvi and finally xvii, as well as by the still continuing abortion of anterior nephridia. Although backward translocation of the gizzard in phylogeny is obvious, frequent records suggesting transgression of internal intersegmental boundaries makes this one alone of the evolutionary changes difficult to explain by single-step abrupt mutations.

In one portion of the *Glyphidrilus* range, Burma, two or more species are known to be present. One, *birmanicus*, is distinguished by absence of genital markings in *aa* and differences in location of the wings. A mutation for inhibition of genital markings in *aa*, already suggested by rare individuals of *papillatus*, provides for one of the changes. No evidence for abrupt mutational transfer of wings has been found and phylogenetic requirements can be met in this case by assuming varying reductions in size of wings that originally were much longer. This derivation again is indirect and from a common ancestor rather than from an existing form. If an anticipated third species is characterized by pairing of genital markings in *aa*, it may represent continuation of a local ancestral condition prior to establishment of a mutation for midventral union of anlage of paired markings.

SUMMARY

Internal organization, which now has been studied in three species enabled examination of the phylogeny of *Glyphidrilus* for the first time. Of the several major and standard evolutionary changes throughout the genus, one can be attributed to a mutation of drastic effect. Others are attributed to repetitions of one-step-at-a-time mutations. These mutations have become established in different sequences at various parts of the generic range which extends from Borneo to Tanganyika. Origin of closely related species in a single area is also attributed to establishment of mutations but this time affecting external characteristics.

ON THE OCCURRENCE OF *DERMESTES FRISCHII* KUGELANN (COLEOPTERA : DERMESTIDAE) IN INDIA, WITH A LIST OF SPECIES OF *DERMESTES* IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA

By G. MATHAI, *Entomological Assistant, Zoological Survey of India, Calcutta.*

In the course of examining the material of Dermestidae in the collection of the Zoological Survey of India, it was observed that a few specimens, representing one lot, that had been placed under *Dermestes vulpinus* Fabricius, were in fact referrable to *Dermestes frischii* Kugelann, a species hitherto not recorded from India. This new record is of further interest as the specimens were found to have damaged rubber sheets stocked in the godowns of the Bata Shoe Co., Batanagar, near Calcutta. A perusal of the literature showed that no species of *Dermestes* has been recorded as being harmful to rubber. Besides giving notes on *D. frischii*, a list of the species of *Dermestes* present in the collection is also added.

Dermestes frischii Kugelann

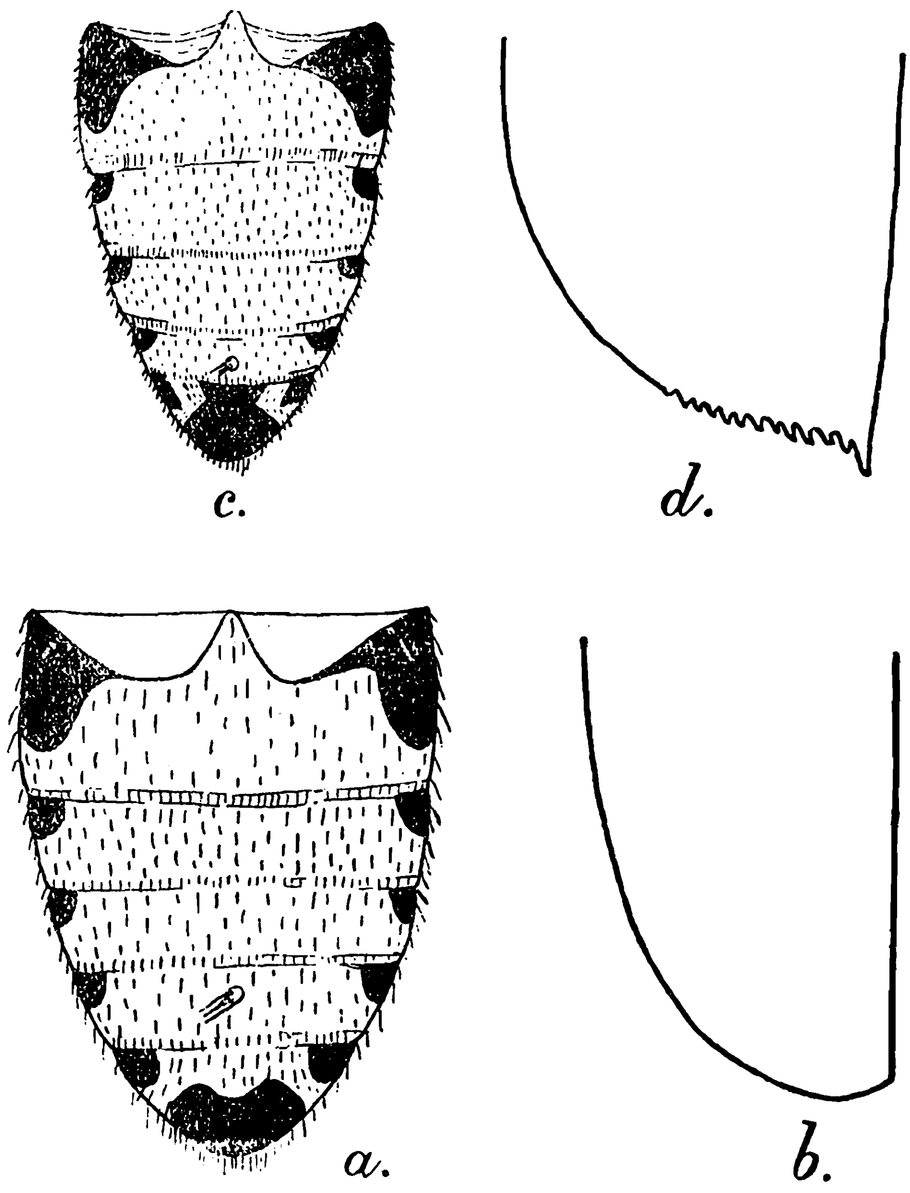
1792. *Dermestes frischii*, Kugelann, in Schneider, *N. Mag. Lieb. Ent.* IV, p. 478.
1834. *Dermestes pollinctus*, Hope, in Pettigrew, *Hist. Egypt. Mum.* p. 55, pl. 5, fig. 4-7.
1846. *Dermestes sibericus*, Erichson, *Nat. Ins. Deutschl.* III, p. 427.
1889. *Dermestes uniformis*, Rey, *Echange*, V, p. 56.
1911. *Dermestes frischi*, Torre, *Coleopt. Cat. Berlin*, XIV (33), pp. 43-44.
1945. *Dermestes frischii*, Hinton, *Beetles associated with stored products*, London, I, pp. 269-272.

The specimens under report were first brought to the notice of the Zoological Survey of India in August, 1939 by the Bata Shoe Co., Batanagar, Calcutta, where they were found causing damage to a consignment of rubber received from Travancore. The records made at the time indicated that the adults were gnawing at rubber, thereby making several perforations in the rubber sheets and causing consequent damage to the material. Under laboratory conditions the larvae and adults were found to show preference to animal matter and at occasions, probably owing to scarcity of food, they were also seen preying on each other.

In the collections made at the time the pupae were more abundant than either the larvae or the beetles. Early stages of the larvae were also absent and it seemed that probably the rubber sheets were being bored into by the larvae for the purpose of making their pupal chambers.

The damage caused by *D. frischii* to economically important products, such as, hide, dried fish, bath sponge, dog-biscuits, fungi, silkworm cocoons and other stored products is well known. Principally the larvae and adults feed on carcases, bones and carrion of various sorts, and the larvae are known to bore their pupal chambers in woodwork of warehouses, cork, cotton and mortar and stone work of walls.

According to Loir and Legangneux[1] workers engaged in unloading cargoes of bones at Havre, France, suffered severely from itching of the skin, conjuctivitis, irritation of the respiratory passages, and nausea due to the large quantity of larval hairs in the air in the holds of the ship.



c. d.

a. b.

TEXT-FIG. 1.—*a, b, Dermestes frischii*; *c, d, Dermestes maculatus*.
(*a*) ventral view of abdomen of male to show colour pattern; (*b*) apex of left elytron; (*c*) ventral view of abdomen of male to show colour pattern; (*d*) apex of left elytron; (*a, c, d*, After Hinton, 1945).

Distribution.—*D. frischii* was known earlier from Europe, Asia (Palearctic region), Africa, Madagascar and North America, but through the agency of commerce, it is becoming more and more cosmopolitan in distribution. Under the circumstances, it will not be surprising, if careful investigations show the occurrence of this species in several other parts of India also. In fact, in the course of preparation of this paper, two specimens of a species of Dermestidae collected from a bone-heap, near Agra Fort on 28.vii.1954, were received in the Zoological

[1] Loir, A., and Legangneux, H., *Bull. Acad. Med. Paris*, LXXVIII (29), pp. 68-72 (1922).

Survey of India from Prof. R. D. Saksena, Balwant Rajput College, Agra and they have been identified as *D. frischii.*

It is closely similar to D. *maculatus* Degeer (=*D. vulpinus* Fabricius) with which it could be easily confused as had happened in the present instance. *D. frischii* may, however, be distinguished from *D. maculatus* by the following characters : (1) apical margins of elytra are entire and not serrate and the inner apices are not produced to form acute spines in *frischii*, whereas in *maculatus* the apical margins of elytra are serrate and the inner apices are produced to form acute spines ; (2) sternites two to five of the abdomen are without impressed lines at the sides in *frischii*, whereas in *maculatus* the sternites are with impressed lines at sides ; (3) arrangements of the white hairs on the abdominal sternites of the two species are different (*cf.* text-fig. 1*a* and 1*c*), the chief distinction being in the pattern of apical patch of hairs on the fifth or last sternite. In *frischii* the apical patch is reddish brown and extends to about middle of the sternite, whereas in *maculatus* the apical patch is black or dark brown and extends fully to the entire length of the segment.

The specimens under report come close to the description of a variety of *D. frischii*, *viz.*, var *sibericur* Erischson (1846), and differ from the typical *frischii* in the following colour pattern and disposition of hairs ; (1) the white or yellowish white lateral band of the pronotum is without a patch of black hairs near base ; (2) the disc of the pronotum has the whitish or yellowish hairs much more numerous than the black so that the lateral and anterior bands of white hairs are not very sharply differentiated from the central region of the pronotum ; (3) the elytra have the whitish and brownish hairs much more numerous than the black so that the elytra appear much greyer than is the case in the typical *frischii.*

Material.—BENGAL : on rubber, Batanagar, near Calcutta, vii, 1933 (*Bata Shoe Co.*), (6 adults, pinned ; 2 adults, 4 larvae and 14 pupae in spirit). UNITED PROVINCES : from bone-heap, near Agra Fort, Agra, 28. viii. 1954 (*Prof. R. D. Saksena*) 1 ex.). EUROPE : No further data given, (1 specimen, pinned).

Dermestes maculatus Degger

1774. *Dermestes maculatus*, Degger, *Mem. Ins.* IV, p. 223.

1781. *Dermestes vulpinus*, Fabricius, *Spec. Ins.* 1. p. 64.

1911. *Dermestes vulpinus*, Torre, *Coleopt. Cat.* Berlin XIV (33), pp. 49-50.

1945. *Dermestes maculatus*, Hinton, *Beetles asssociated with stored products.* London 1, pp. 261-269.

Common name.—Leather beetle. In U. S. A., it is known as hide and tallow Dermestid ; in Canada, hide or leather beetles, and skin beetle in India and S. Africa.

In the Indian entomological literature this species is referred under *Dermestes vulpinus* Fabricius. As it is very widely distributed in India, collectors are liable to confuse other species with it. However, the white or yellowish white hairs of the sides of the pronotum together with the serrate and acutely produced apices of the elytra (text-fig. 1*c*, 1*d*) will serve to distinguish this from the remaining species of *Dermestes* occurring in India. The species breeds in animal matter, such as, stored hides and skins, carcases, meat, cheese, dried fish, mounted shikar trophies, silkworm cocoons, etc. It also attacks horn, feathers, fur, bristles and glue of brushes.

Distribution.—Cosmopolitan.

Material.—(*a*) *Dry collection*: KASHMIR: Kogyar, Yarkand Expedition (*Stoliczka*) (3 exs.). UNITED PROVINCES: Almora, Kumaon Hills, ii.1922 (*C. Paiva*) (1 ex.); Izatnagar, 23.iii.1949 (*P. K. Sinha*), (4 exs.). BIHAR: Madhupur, 23.iv-10.v.1911 (*C. Paiva*), (1 ex.). BENGAL: Calcutta, (4 exs.); Calcutta (*Museum Collector*) (2 exs.); Calcutta, 22.iv.1912 (*E. C. Dormieux*), (1 ex); on hide, Calcutta (*G. Watt*), (1 ex.); on skeleton of elephant, Calcutta, 5.ii.1907 (*J. Caunter*), (2 exs.); on bones of jackal, Calcutta Maidan, 13.iii.1912 (*F. H. Gravely*), (3 exs.); on carcases of vulture, Calcutta Maidan, iii.1912 (*F. H. Gravely*), (2 exs.). ASSAM: Naga Hills (*H. H, Godwin Austin*), (1 ex.); Manmluh, Khasi Hills, 13.v.1909 (*B. Warren*), (1 ex.). SOUTH INDIA: Madras (*East India Co., Museum*), (1 ex.); on board ship, 10 miles off Cocanada, Madras Coast, 16.v.1908 (*C. Paiva*), (2 exs.). SIKKIM: Sikkim (A. V. Knyvett), (1 ex.). NEPAL: Pipan, Nepal Terai, 28-29.iv.1907 (*Museum Collector*), (1 ex.). BURMA: Tavoy, Lower Burma (*Museum Collector*), (1 ex.); on semiputrid jerked beef, Rangoon (*H. H. Marshall*), (10 exs.). NEWZEALAND: (1 ex.).

(*b*) *Spirit collection.*—BENGAL: Calcutta (*Museum Collector*), (4 adults and 2 larvae); on hide, Rajshai, (4 larvae).

Dermestes ater Degeer

1774. *Dermestes ater*, Degeer, *Mem. Hist. Ins.* IV, p. 23, pl. 18, fig. 7.
1775. *Dermestes cadaverinus*, Fabricius, *Syst. Ent.* p. 55.
1911. *Dermestes cadaverinus*, Torre, *Coleopt. Cat.* Berlin XIV (33), pp. 41-42.
1939. *Dermestes ater*, Lepesme, *Bull. Soc. ent. Fr.* 44, p. 192.
1945. *Dermestes ater*, Hinton, *Beetles associated with stored products*, London I, pp. 296-299.

Originally referred to as *Dermestes cadaverinus* Fabricius, it was relegated to the synonymy of *Dermestes ater* Degeer by Lepesme (1939). It is generally found in carcases of dead birds and animals and is a pest of dried fish, skins and hides, leather goods, hog bristles, woollen tops, cheese, dead pupae and adults of silkworms, stored copra, poonac and dried mushrooms.

Distribution.—Cosmopolitan.

Material.—*Dry collection.*—BIHAR: on stored Tussar cocoons, Hazaribagh, 10.i.1887 (*J. Wood Mason*), (1 ex.). BENGAL: Calcutta (*Shureef* and *Lateef*), (2 exs.); on mulberry silkworms, Rajshai dist., (*J. C. Cleghorn*), (5 exs.). ANDAMANS: Nicobar Island, (1 ex.).

Dermestes coronatus Steven

1808. *Dermestes coronatus*, Steven, in Schonh, *Syn. Ins.* I (2), p. 85.
1911. *Dermestes coronatus*, Torre, *Coleopt. Cat.* Berlin XIV (33), p. 43.

A specimen with the label *Dermestes coronatus* Steven is present in the collection, but is not in a good state of preservation to warrant detailed observation. This species has not so far been recorded from India, and further material is necessary before its occurrence in India can be confirmed.

Distribution.—Sudrussland, ? India.

Material.—KASHMIR: Sirikol. Yarkand Expedition, (1 ex. pinned, damaged).

The following two species, though not represented in the collection of the Zoological Survey of India, are known from India.

Dermestes carnivorus Fabricius

1775. *Dermestes carniferus*, Fabricius, *Syst. Ent.* p. 55.
1911. *Dermestes carnivorus*, Torre, *Coleopt. Cat.* Berlin XIV (13), pp. 42-43,
1945. *Dermestes carnivorus*, Hinton, *Beetles associated with stored products*, London I, pp. 285-287.

This species is known to be a pest of hide and dried skin, raw tobacco and cacao.

Distribution.—North and South America, Europe, India.

Dermestes leechi Kȧlik

1952. *Dermestes leechi*, Kȧlik, *Pan-Pacif. Ent., San Francisco*, XXVIII, p. 45,

Distribution.—South India.

ACKNOWLEDGMENT

I take this opportunity to express my grateful thanks to Dr. A. P. Kapur, Officer-in-Charge of the Entomology Section, Zoological Survey of India for giving me facilities to undertake this work and for going through the manuscript and making helpful suggestion.

ON THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION IN RELATION TO THE MEAN ANNUAL ISOTHERMS

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In the " Check list of the Fishes of India, Burma and Ceylon, Part I. Elasmobranchii and Holocephali ", by one of us [1] the limits of the Indian region [2] have been indicated as " on the west, the Gulf of Oman and then from Ras-el-Haad southwards along Long. 60°E.; on the South, from Lat. 1°S., where it meets Long 60°E., eastwards to the coast of Sumatra ; on the East, the coast of Burma" Hundred and nine species were listed in it from within this area, 106 of Elasmobranchs and 3 of Chimaeras. Besides, a new species of Elasmobranch, *Proscyllium alcocki*, [3] has since been added to this list. A note on the geographical relationship of these 110 species of the Indian region with special reference to the isotherms is given below. It may also be mentioned here that other delimiting factors, both chemical and physical, such as salinity, currents, food, etc., in the distribution of these fishes, are left out of consideration in this note.

The *mean annual* isotherms of 6°C, 12°C and 20°C are shown by dotted lines in the accompanying map (Text-fig. 2). The 20°C isotherm north of the equator commences from a little above Florida (35°N. Lat. and 76°W Long.) on the eastern coast of N. America and traverses the Atlantic to reach the west coast of French West Africa (20°N. Lat. and 16°W Long.) and again extends from a little above Shanghai on the China coast (30°N. Lat. and 122°E. Long.) to California on the western coast of N. America (28°N. Lat. and 115°W Long.). The 20°C isotherm south of equator starts from about the middle of the eastern coast of S. America (28°S. Lat. and 52°W Long.) and gently curves to the western coast of S. Africa opposite to St. Helena (22°S. Lat. and 12°E. Long.) and is continued again from the Cape of Good Hope (35°S. Lat. and 20°E. Long.) traversing the Indian Ocean to the mid-western coast of Australia (28°S. Lat. and 115°E. Long.). From the mid-eastern coast of Australia (32°S. Lat. and 153°E. Long.) the isotherm smoothly curves across the Pacific to the coast of Ecuador in S. America (4°S. Lat. and 82°W Long.). The distribution of the pelagic Indian Elasmobranchs is remarkably correlated with the temperature of the sea water,

[1] Misra, K. S., *Rec. Indian Mus.* XLV, pp. 1-46 (1947).

[2] " Indian region " is not meant as a subfaunal area as such. We have tried only to show how far " Indian " elasmobranchs extend their distribution *vis a vis* the " Indian region " as defined by one of us in the check list.

[3] Misra, K. S., *J. zool. Soc. India*, II, pp. 87-89, pl. i, figs. 1-5 (1950); *Rec. Indian Mus.* XLIX [1951] ,pp. 101, 104 (1952).

they being found restricted mainly within the range of the 20°C isotherms north and south of the equator, and extending eastwards far into the Pacific, even to the western coasts of tropical N. & S. Americas but not far westwards into the Atlantic beyond the Cape of Good Hope.

For detailed and specific distribution of the fishes under discussion, reference may be made to the Appendix showing their longitudinal and latitudinal ranges as well as their depth records wherever available. A close study of the range of their distribution reveals the following facts :—

i. Out of 110 species listed, 3 Chimaeras (2 of which have been recorded only from their egg-capsules), and 6 Elasmobranchs, being bathypelagic [1], are not affected by such physical barriers as the isotherms from the distributional point of view.

ii. Out of the 3 Chimaeras, 1, and of the 107 Elasmobranchs 23 species are known from single records and may be taken as exclusively endemic (until otherwise proved as found elsewhere by future surveys) being restricted only in the Indian region north of the equator.

iii. Out of the total number of Elasmobranchs, 8 species are remarkably cosmopolitan, extending from the east coast of Africa eastwards through the Indo-Pacific to the islands of Polynesia and even to the tropical zones of the west coasts of N. and S. Americas within the latitudinal range 8°S. to 35°S. and 20°N. to 35°N.

iv. Eight species of the Indian Elasmobranchs have a wide range extending from the Indian region eastwards through the Indo-Pacific to the islands of Polynesia beyond 180°E. longitude within the latitudinal range of 12°S. to 30°S. and 20°N. to 35°N., but not to the west coasts of N and S. Americas.

v. Sixtyeight species of Elasmobranchs are not so cosmopolitan and are confined within the 180°E. longitude, their range of distribution being 35°S. to 35°N. Lat. and 20°E. to 180°E. Long. Six species out of this group, *viz.*, *Pentanchus indicus*, *Hypoprion hemiodon*, *Sphyrna mokarran*, *Physodon mulleri*, *Raja powelli* and *Narke dipterygia*, have, however, been recorded only from within a more restricted range of 2°N. to 35°N. and 40°E. to 130°E.

vi. Eleven species out of the 107 Elasmobranchs, *viz.*, *Rhincodon typus*, *Isurus glauca*, *Carcharhinus lamia*, *Carcharhinus limbatus*, *Galeocerdo arcticus*, *Sphyrna tudes*, *Sphyrna zygaena*, *Dasyatis* (*Dasyatis*) *pastinaca*, *Pristis microdon*, *Pristis pectinatus* and *Aetobatus narinari* extend their range of distribution into the Mediterranean and the tropical Atlantic between 5°S. to 35°N. Lat. and 15°E. to 89°W Long.

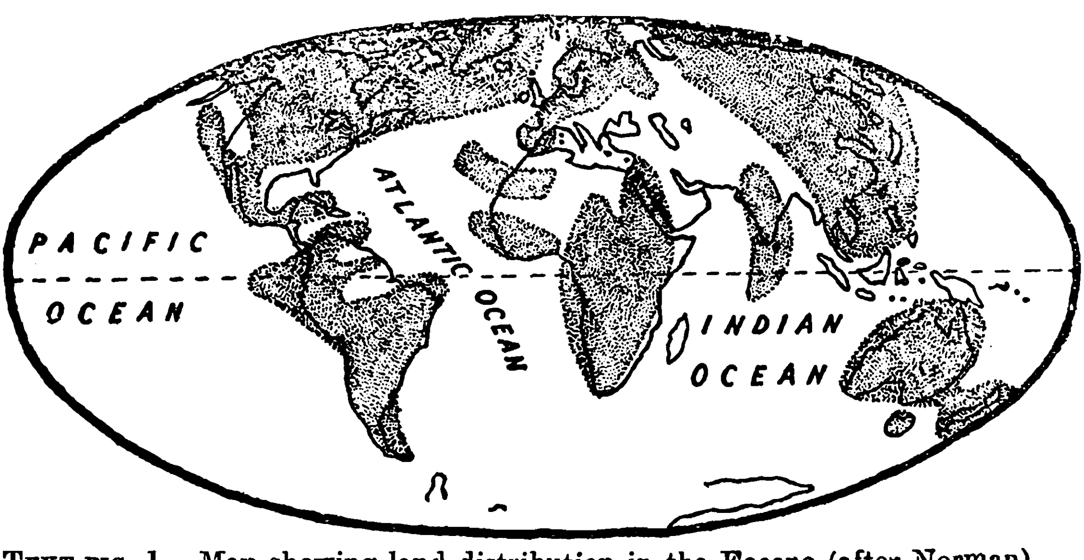
It can be seen from the above observations that the Elasmobranchs of the Indian waters are distributed widely from the Red Sea through the Indian and Pacific Oceans to the east coast of tropical N. and S. Americas, while their distribution towards the west is restricted, the Indian forms being hardly found beyond the west of the Cape of Good

[1] According to Norman, J. R., [*A History of Fishes*, p. 253 (1949)] bathypelagic fishes occur below 500 metres. Also see Myers, G. S., *Proc. 6th Pacific Science Congress*, III, p. 201 (1940).

Hope. The reason for this phenomenon is that the 12°C isotherm (Text-fig. 2), which borders the south-west coast of Africa beyond west of the Cape of Good Hope and extends upto 22°S. latitude, serves as a physical barrier for the free dispersal of the Indian species into the Atlantic. In this context it is worthwhile quoting Smith[1] who observes :

" The blanket of cold water along our west coast is so much a barrier to most warm water forms, that to a large extent it prevents the intermingling of the fishes of the tropical Atlantic with those of the Indianic shores of South Africa. Further, the Benguella current flowing northwards tends to limit the penetration of Cape waters by fishes from even the colder parts of the Atlantic, and in consequence the Cape represents a well-defined line of division between the Atlantic and the Indo-Pacific fishes ".

The occurrence of some of the Indian species, mentioned above, in the Mediterranean and the tropical Atlantic, however, requires explanation. " It is probable, " as suggested by Smith[2], " that these are the relics of earlier intermingling, for not very long ago in geological time, conditions were different, and there was almost certainly a warm water connection between the Indian and Atlantic Oceans ". It may also be explained by the configuration of the land masses during the Eocene period when the Mediterranean sea extended eastwards and opened into the Indian Ocean, and the isthmus of Panama was submerged under sea and the Atlantic and the Pacific Oceans were continuous (Text-fig. 1), thereby making it possible for a free dispersal of the species.



TEXT-FIG. 1.—Map showing land distribution in the Eocene (after Norman).

Besides, the recent and artificially constructed Panama [3] and Suez canals may have, to a certain degree, served as a connecting passage for the migration of these species.

Thus it is seen that temperature has a profound effect on the life of these pelagic fishes limiting their penetration into the colder waters of the Atlantic west of the Cape of Good Hope. It is also known that ecological

[1] Smith, J. L. B., *The Sea Fishes of Southern Africa*, p. 8 (1949).

[2] Smith, J. L. B., *The Sea Fishes of Southern Africa*, p. 7 (1949).

[3] Though the Panama canal is mostly freshwater, we feel, it may not be a real barrier at least to quite a few marine species that can live for sometime in freshwater. It is significant in this context to remember that one of the Indian marine elasmobranchs *Dasyatis* (*Pastinachus*) *sephen* is quite common in freshwater in the Ganges as high as Allahabad, while a few others occur all through the year in the Hooghly at Calcutta where the salinity is very low.

conditions of cold water zones of the ocean are bound to be so different from those of warmer water zones as to expect a certain degree of geographical raciation in many of the pelagic fishes. Scott[1] in his comparative study of the yellow tail flounder from three Atlantic fishing areas has recently established this truth beyond any doubt. Myers[2] also while discussing the distribution of the Californian sardine has observed that it is " extremely unlikely that a surface swimming, semipelagic fish inhabiting as cool water as does this sardine, could pass the equitorial regions ", thereby emphasising temperature as a major factor in the distribution of fishes. And taxonomists in dealing with the relationship of the species or sub-species in the species-complex may give due consideration to the ecology of these marine forms as indicated by the isotherm (temperature), for instance. Besides, a detailed study of the geographical distribution of marine fishes in relation to the isotherms may be of use to taxonomists in revealing which of these widely ranging species are in more urgent need of a revisionary study on world basis. To cite two examples : Fowler[3] in his " Contributions to the biology of the Philippine Archipelago and adjacent regions " has treated *Galeocerdo tigrinus* M. & H., whose type locality is Pondicherry in the 20°C isotherm, and *Squalus arcticus* Faber, whose type locality is Iceland in the 6°C isotherm, as synonyms of *Galeocerdo cuvier* (Lesueur) whose type locality is the northwest coast of New Holland in the 20°C isotherm. One of us[4] has synonymised *G. tigrinus* with *S. arcticus*, but agreeing with Whitley[5] separated *G. cuvier* from *G. arcticus*. Boulenger[6] considers *G. arcticus* as confined to the Arctic seas and *G. tigrinus* as restricted to all tropical and temperate seas. From a study of the isotherms it seems probable that *G. tigrinus* of the Indian waters which is synonymous with *G. cuvier* (Lesueur) of the N. W. Australian waters may, after proper taxonomic investigation, prove to be a subspecies of *Galeocerdo cuvier*.

Smith [7] in his work, " The Sea Fishes of Southern Africa ", as also Fowler [8] puts *Heptranchias platycephalus* (Tenore) of the 12°C isotherm in the synonymy of *Heptranchias cepedianus* (Peron) which has been recorded from S. Australia and New Zealand in the 12°C isotherm. They have also treated *Notidanus indicus* Agassiz of the 20°C isotherm as a synonym of *H. cepedianus*. Whitley [9] in his " Fishes of Australia " maintains that *H. cepedianus* is endemic in Australia. We feel that *Notidanus indicus* may, as a result of proper taxonomic studies, turn out to be a subspecies of *H. platycephalus* as it is found in the 20°C isotherm :

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[1] Scott, D. T., *J. Fish. Res. Board of Canada,* XI, No. 3, pp. 171-197 (1954).

[2] Myers, G .S., *Proc. 6th Pacific Sci. Congr.* III, pp. 201-210 (1940).

[3] Fowler, H. W., *Bull. U. S. nat. Mus.* (100) XIII, p. 186 (1941).

[4] Misra, K. S., *Rec. Indian. Mus.* XLV, p. 21 (1947).

[5] Whitley, G. P., *Fishes of Australia*, pt. 1, p. 114 (1940).

[6] Boulenger, G. A., *Cambr. nat. Hist.* VII, pp. 448, 449 (1932).

[7] Smith, J. B. L., *The Sea Fishes of S. Africa*, p. 38 (1949).

[8] Fowler H. W., *Bull. U.S. nat. Mus.* (100) XIII, p. 6, (1941).

[9] Whitley, G. P., *Fishes of Australia*, pt. 1, p. 70 (1940).

In order to study the distributional pattern of these fishes and to verify their nomenclatorial validity it will be necessary to conduct taxonomic investigations on an international basis as suggested by Horacio Rossa Jr.,[1] Fisheries Division, F. A. O. of the United Nations. But, these investigations involving the study of the species complex of the fishes have their own limitations in the present context of our knowledge of the Indian fishes.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION

Name of species	Range in Latitudes and Longitudes	Distribution[2]
	BATHYPELAGIC	
(1) *Chimaera monstrosa* L.	35°S.—0° and 20°E.—98°E.	Cape of Good Hope, Bay of Bengal in 820 metres, W. coast of Sumatra, North and Middle Atlantic and Mediterranean.
(2) *Harriotta indica* (Garman)	12°N.—13°N. and 45°E.—92°E.	Gulf of Aden, Bay of Bengal.
(3) *Rhinochimaera* sp.	90°N., 75°E.	Off Travancore coast, India.
(4) *Pentanchus indicus* (Br.) [=*Scyliorhinus* (*Halaelurus*) *indicus* Br.].	2°N.—23°N. and 47°E.—57°E.	E. Africa in 1289 metres, Gulf of Aden in 1840 metres, Gulf of Oman.
(5) *Benthobatis moresbyi* Alc.	15°N., 52°E.	Off Travancore coast, in 860 metres, India.
(6) *Raja andamanica* (Lloyd)	12°N., 92°E.	Andaman Sea in 558 metres India.
(7) *Raja mamillidens* Alc.	9°N., 79°E.	Gulf of Manaar, in 1194 metres.
(8) *Centrophorus rossi* Alc.	20°N., 76°E.	Travancore, in 430 fms., India.
(9) *Centroscyllium* (*Paracentroscyllium*) *ornatum* Alc.	20°N.—23°N. and 66°E.—89°E.	Arabian Sea, Bay of Bengal, in 285-405 fms.
	ENDEMIC	
(1) *Rhinochimaera* sp.	9°N., 75°E.	Off Travancore coast, India.
(2) *Isurus guntheri* (Murray)	20°N., 68°E.	Karachi, W. Pakistan.
(3) *Negogaleus balfouri* (Day) (=*Hemigaleus balfouri* Day)	18°N., 84°E.	Waltair, India.

[1] H. Rossa, *Trans. Amer. Fish. Soc.* LXX, pp. 110-118 (1950), 1951.

[2] Certain errors and omissions which occur in the "Check List of the Fishes of India, Burma and Ceylon. I. Elasmobranchi and Holocephali" (*Rec. Indian Mus.* XLV, pp. 1-46, 1947), have been rectified.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
	ENDEMIC—*contd.*	
(4) *Centrophorus rossi* Alc.	20°N., 76°E.	Travancore, in 430 fms., India.
(5) *Centroscyllium* (*Paracentroscyllium*) *ornatum* Alc.	20°N.—23°N. and 66°E.—89°E.	Arabian Sea, Bay of Bengal, in 285-405 fms.
(6) *Galeorhinus omanensis* Norman.	18°N., 64°E.	Gulf of Oman.
(7) *Zanobatus schoenleinii* (M. H.)	13°N., 80°E.	Madras, India.
(8) *Dasyatis* (*Himantura*) *alcockii* (Ann)	20°N., 85°E.	Puri coast, in 20-30 fms., India.
(9) *Dasyatis* (*Himantura*) *favus* (Ann.)	20°N., 85°E.	Orissa coast, India, in 20-30 fms.
(10) *Dasyatis* (*Amphotistius*) *jenkinsii* (Ann.)	19°N., 85°E.	Off Ganjam coast, in 46-54 metres, India.
(11) *Dasyatis* (*Amphotistius*) *microps* (Ann.)	18°N.—22°N. and 85°E.—92°E.	Off Orissa coast, India, Off Chittagong coast, in 34 metres, Pakistan.
(12) *Aetomylus nichofii cornigera* (Ann.)	21°N., 87°E.	Balasore, India, in 20-30 fms.
(13) *Rhinoptera jayakari* Boulenger.	23°N., 60°E.	Off Muscat coast, Arabia.
(14) *Rhinoptera sewelli* Misra	11°N., 76°E.	Off the coast of Calicut, India.
(15) *Narcine brunnea* Ann.	1°S.—22°N. and 80°E.—88°E.	India, in 20-30 fms., Ceylon.
(16) *Scyliorhinus* (*Halaelurus*) *quagga* (Alc.).	12°N., 75°E.	Malabar coast in 204 metres, India.
(17) *Bengalichthys impennis* Ann.	18°N., 85°E.	Orissa coast, India, in 20-30 fms.
(18) *Raja reversa* (Lloyd)	25°N., 65°E.	Arabian Sea, off the Baluchistan coast, in 820 fms., Pakistan.
(19) *Benthobatis moresbyi* Alc.	15°N., 52°E.	Off Travancore coast, in 860 metres, India.
(20) *Raja andamanica* (Lloyd)	12°N., 92°E.	Andaman sea, in 558 metres, India.
(21) *Raja mamillidens* Alc.	9°N., 79°E.	Gulf of Manaar, in 1194 metres.
(22) *Rhinobatos lionotus* (Norman)	21°N., 90°E.	East Channel, mouth of River Hooghli, India.
(23) *Proscyllium alcocki* Misra	5°S.—10°N. and 46°E.—95°E.	E. Africa, Andaman Islands, in 342-400 metres.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
COSMOPOLITAN, *extending from the east coast of Africa eastwards to the tropical zones of the west coasts of N. and S. Americas.*		
(1) *Aetobatus narinari* (Euphr.)	30°S.—20°N. and 32°E.—80°W. and 25°N., 80°W.	Natal, Madagascar, Seychelles, Red Sea, Arabia, India, in 20-30 fms., Burma, Ceylon, Malay Peninsula, Borneo, Celebes, Java, Siam, Cochin-China, Philippines, Melanesia, Micronesia. Polynesia, Hawaiin Group, along the American shores of the tropical eastern Pacific and tropical Atlantic (W. Indies, Cuba).
(2) *Sphyrna tudes* (V.)	10°S.—20°N. and 40°E.—80°W. and 10°N.—36°N. and 20°E.—40°W.	E. Africa, India, Indo-China, Philippines, Melanesia, Hawaii, Panama, N. Carolina, Brazil, Mediterranean, Atlantic (West Indies).
(3) *Alopias vulpinus* (Bonnaterre)	35°S.—35°N. and 20°E.—80°W.	S. Africa, Natal, Arabia, Ceylon, Philippines, China, Korea, Japan, California, Chile.
(4) *Isurus glauca* (M.H.)	35°S.—35°N. and 20°E.—80°W. and 20°N.—50°W.	Cape of Good Hope, Red Sea, Arabia, India, Ceylon, Indo-China, Japan, Chile, St. Helena in the tropical Atlantic.
(5) *Carcharhinus lamia* (Blainville).	8°S.—30°N. and 58°E.—80°W. and 35°N.—30°E.	Arabia, India, Burma, Malay Archipelago, China, Melanesia, also in California, tropical Atlantic Ocean and Mediterranean.
(6) *Carcharhinus menisorrah* (M.H.)	10°S.—20°N. and 40°E.—80°W.	Red Sea, Arabia, India, Burma, Malay Peninsula, Java, Indo-China, Philippines, Panama.
(7) *Galeocerdo arcticus* (Faber)	30°S.—30°N. and 32°E.—80°W. and 65°N.—20°W.	Natal, Red Sea, Arabia, India, Ceylon, Java, Indo-China, Philippines, China, Japan, Melanesia, Hawaii, the Galapagos, California and the Atlantic.
(8) *Rhincodon typus* Smith	35°S.—35°N. and 20°E.—80°W. and 30°N.—80°W.	S. Africa, Seychelles, India, Ceylon, Java, Siam, Phillippines, Japan, Australia, California, Panama, Chiio and the tropical Atlantic.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
WIDE RANGE, *extending from the Indian region eastwards beyond 180°E., but not reaching the tropical zones of the west coasts of N. and S. Americas.*		
(1) *Carcharhinus gangeticus* (M.H.)	16°S.—23°N. and 58°E.—155°W.	Arabia, India, Ceylon, Burma, Java, Indo-China, Philippines, China, Japan, Fiji, Hawaii.
(2) *Dasyatis (Amphotistius) kuhlii* (M.H.)	12°S.—35°N. and 40°E.—170°W.	Zanzibar, India, in 20-30 fms., Ceylon, Singapore, Java, Celebes, Siam, Cochin-China, Philippines, China, Japan, Australia, Melanesia, Polynesia.
(3) *Gymnura (Gymnura) poecilura* (Shaw)	15°S.—35°N. and 40°E.—155°W.	Red Sea, India, in 20-30 fms., Ceylon, Malay Peninsula Sumatra, Java, Siam, China, Japan, Polynesia.
(4) *Nebrius ferrugineum* (Lesson)	20°S.—20°N. and 40°E.—170°W.	Madagascar, Red Sea, India, Ceylon, Malay Peninsula, Malay Archipelago, Indo-China, Melanesia, Polynesia.
(5) *Carcharhinus limbatus* (M.H.)	30°S.—20°N. and 32°E.—170°W. and 20°N.—30°N. and 75°W. —80°W.	Natal, Seychelles, Red Sea, Arabia, India, Cochin-China, Polynesia, and also in tropical Atlantic (Mexico, Cuba, West Indies).
(6) *Carcharhinus melanopterus* (Q.G.)	30°S.—35°N. and 40°E.—155°W.	S. Africa, Red Sea, Arabia, India, Burma, Ceylon, Andamans, Malay Peninsula, Java, Amboinas, Siam, Indo-China, Philippines China, Japan, Australia, Melanesia, Polynesia, Hawaii.
(7) *Sphyrna zygaena* (L.)	25°S.—35°N. and 40°E.—155°W. and 30°S.—35°N. and 25°E. —45°W.	E. Africa, Madagascar, Zanzibar, Seychelles, Red Sea, Arabia, India, Ceylon, Malay Peninsula, Indo-China, Philippines, China, Japan, Polynesia, Hawaii, Eastern Pacific, tropical Atlantic (Brazil, Malta).
(8) *Triaenodon obesus* (Rupp.)	25°S.—20°N. and 40°E.—155°W.	Madagascar, Seychelles, Red Sea, India, Pakistan, Ceylon, Malay Archipelago, Melanesia, Polynesia, Hawaii.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
	NON-COSMOPOLITAN, *not extending eastwards beyond 180°E.*	
(1) *Heptranchias platycephalus* (Tenore)	35°S.—35°N. and 20°E.—130°E.	South Africa, India, Indian Ocean, China, Japan.
(2) *Chiloscyllium griseum* (M.H.)	35°S.—35°N. and 20°E.—130°E.	S. Africa, Red Sea, India Malay Peninsula, China, Japan.
(3) *Chiloscyllium indicus* (Gmelin)	35°S.—22°N. and 20°E.—160°E.	Cape of Good Hope, Red Sea, Arabian Sea, India, Burma, Ceylon, Malay Peninsula, Malay Archipelago, Siam, Indo-China, Formosa, China, Melanesia (Solomon Islands).
(4) *Chiloscyllium ocellatum* (Bonnaterre)	20°S.—9°N. and 80°E.—160°E.	India, Malay Archipelago, N. W. Australia, Queensland, Melanesia.
(5) *Chiloscyllium plagiosum* (Bennett)	35°S.—35°N. and 20°E.—130°E.	Cape Conoly, Madagascar, India, Burma, Malay Archipelago, Siam, China, Japan.
(6) *Nebrius concolor* (Rupp.)	20°S.—20°N. and 40°E.—160°E.	Madagascar, Red Sea, India, Ceylon, Malay Peninsula, Java, Philippines, Solomon Islands.
(7) *Stegostoma varium* (Seba)	25°S.—35°N. and 40°E.—152°E.	Zanzibar East Africa, Madagascar, Red Sea, India, Ceylon, Malay Peninsula, Malay Archipelago, Siam, Indo-China, Formosa, China, Japan, Austraila.
(8) *Seyliorhinus (Scyliorhinus) capensis* (M.H.)	35°S.—15°N. and 20°E.—75°E.	Cape of Good Hope, Natal, in 20-200 fms., India.
(9) *Scyliorhinus (Halaelurus) burgeri* (M.H.)	4°S.—25°N. and 30°E.—130°E.	India, Malay Archipelago, China, Japan.
(10) *Scyliorhinus (Halaelurus) hispidum* (Alc.)	5°S.—10°N. and 46°E.—95°E.	E. Africa, Andaman Islands, in 342-400 metres.
(11) *Atelomycterus marmoratus* (Bennett)	10°S.—5°N. and 80°E.—125°E.	Ceylon, India, Malay Peninsula, Singapore, Java, Sumatra, Amboina, Siam, Indo-China, China.
(12) *Physodon mulleri* (M.H.)	20°N.—22°N. and 85°E.—125°E.	India, Philippines, China.
(13) *Scoliodon palasorrah* (C.)	35°S.—35°N. and 20°E.—130°E.	S. Arfica, Red Sea, Arabia, India, Ceylon, Malay Peninsula, Java, Siam. Indo-China, Philippines, China, Japan.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
	NON-COSMOPOLITAN, *not extending eastward beyond 180°E.*—contd.	
(14) *Scoliodon sorrakowah* (C.)	10°S.—35°N. and 60°E.—130°E.	Mekran, India, Ceylon, Burma, Malay Peninsula, Java, Siam, Indo-China, Philippines, Japan.
(15) *Carcharias tricuspidatus* Day	35°S.—10°N. and 20°E.—115°W.	South Africa, India, Indo-China.
(16) *Scoliodon walbeehmi* Blkr.	29°S.—35°N. and 30°E.—130°E.	Natal, India, Ceylon, Malay Peninsula, Java, Indo-China, Philippines, Formosa, China, Japan.
(17) *Aprionodon acutidens* (Rupp.)	4°S.—20°N. and 55°E.—115°E.	Seychelles, Red Sea, Arabia, India, Indo-China.
(18) *Hypoprion hemiodon* (M.H.)	14°N.—23°N. and 58°E.—123°E.	Arabia, India, Indo-China, Philippines.
(19) *Hypoprion macloti* (M.H.)	5°S.—25°N. and 62°E.—70°W.	Mekran, India, Ceylon, Malay Peninsula, Philippines, Melanesia, Chile.
(20) *Carcharhinus bleekeri* Dumeril	4°S.—20°N. and 40°E.—79°E.	Seychelles, Red Sea, India, Pondicherry.
(21) *Carcharhinus dussumieri* (M.H.)	15°S.—23°N. and 44°E.—123°E.	E. Africa, Arabian Sea, India, Ceylon, Malay Peninsula, Java, Indo-China, Philippines.
(22) *Carcharhinus ellioti* (Day.)	1°S.—25°N. and 58°E.—80°E.	Arabia, Pakistan, Karachi. Ceylon.
(23) *Carcharhinus pleurotaenia* (Blkr.)	10°S.—18°N. and 40°E.—123°E.	India, Singapore, Java; Philippines.
(24) *Carcharhinus sorrah* (M.H.)	25°S.—22°N. and 40°E.—155°E.	Madagascar, Red Sea, India, Malay Peninsula, Malay Archipelago, Indo-China, China, Melanesia, Hawaii.
(25) *Carcharhinus temminckii* (M.H.)	5°S.—22°N. and 80°E.—118°E.	India, Burma, Malay Archipelago.
(26) *Mustelus manazo* Blkr.	30°S.—35°N. and 32°E.—130°E.	Natal, India, Pakistan, Ceylon, Indo-China, China, Korea, Japan.
(27) *Sphyrna blochii* (C.)	5°S.—22°N. and 72°E.—110°E.	Ceylon, India, Burma, Malay Peninsula, Malay Archipelago, Siam, Indo-Chin
(28) *Sphyrna mokarran* (Rupp.)	20°N.—24°N. and 40°E.—115°E.	Red Sea, India, Pakistan, China.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

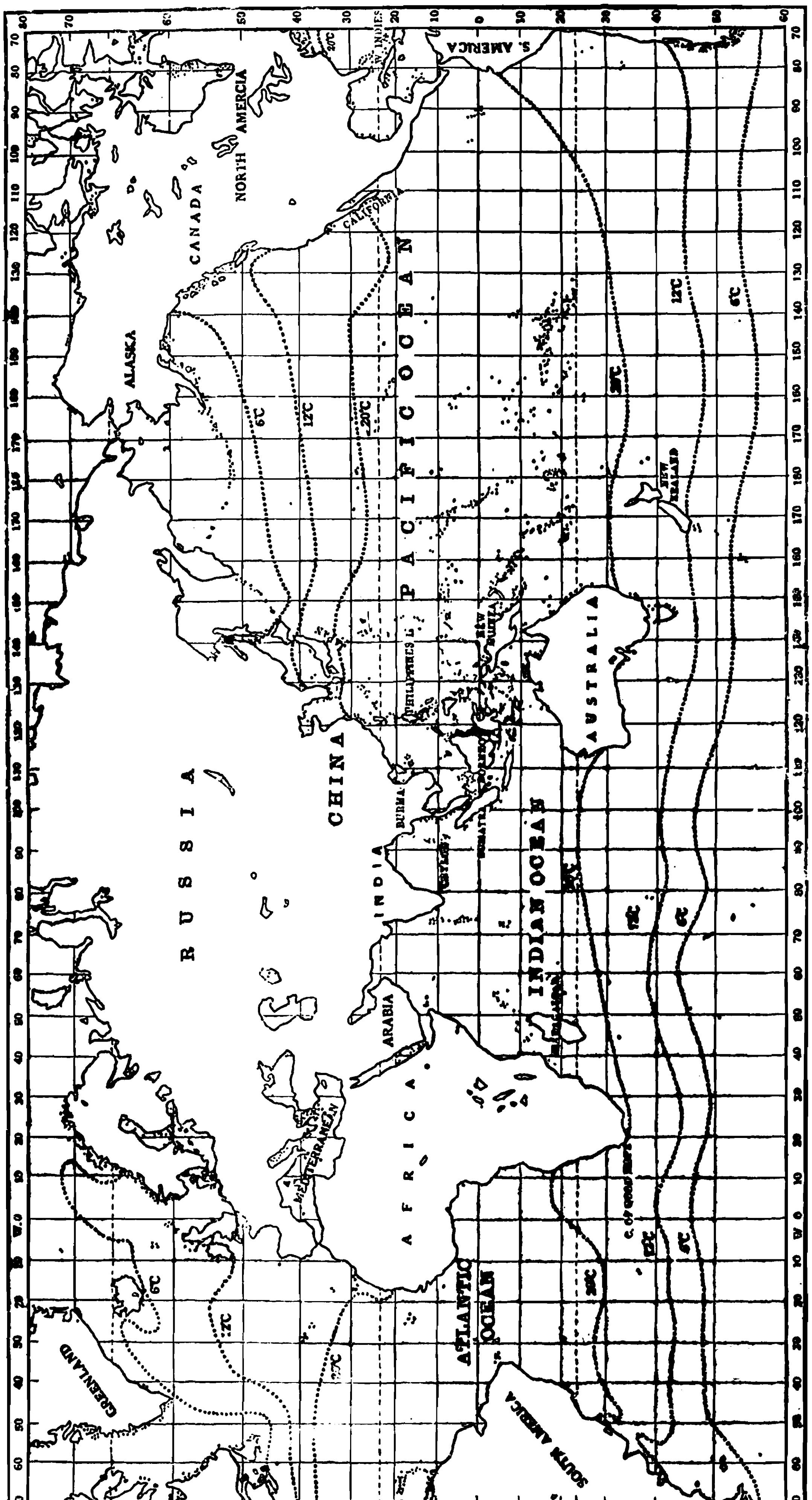
Name of species	Range in Latitudes and Longitudes	Distribution
NON-COSMOPOLITAN, *not extending eastwards beyond 180°E.*—contd.		
(29) *Manta ehrenbergii* (M.H.)	35°S.—25°N. and 40°E.—85°E.	Natal, S. Africa, Red Sea, Karachi, Pakistan, Puri, India.
(30) *Rhinobatos annandalei* (Norman)	5°S.—21°N. and 80°E.—100°E.	India, in 20-30 fms., Ceylon, Malay.
(31) *Rhinobatos armatus* (Gray)	5°S.—10°N. and 75°E.—116°E.	India, Malay Peninsula, Malay Archipelago.
(32) *Rhinobatos granulatus* (C.)	1°S.—29°N. and 75°E.—130°E.	India, in 20-30 fms., Ceylon, Andamans, Burma, Malay Peninsula, Malay Archipelago, Siam, Cochin-China, China.
(33) *Rhynchobatus djiddensis* (Forsk.)	25°S.—35°N. and 40°E.—180°E.	E. Africa, Madagascar, Seychelles, Zanzibar, Red Sea, Arabia, India, in 20-30 fms., Ceylon, Andamans, Malay Peninsula, Malay Archipelago, Cochin-China, Philippines, Japan, Melanesia.
(34) *Pristis cuspidatus* Latham	10°S.—20°N. and 40°E.—110°E.	Red Sea, India, in 20-30 fms., Ceylon, Andamans, Burma, Malay Peninsula, Cochin-China.
(35) *Pristis microdon* Latham	25°S.—20°N. and 40°E. — 125°E. and 5°S.—15°N. and 15°W.—50°W.	Zanzibar, Madagascar, India, in 20-30 fms., Ceylon, Malay Archipelago, Philippines, tropical Atlantic (Senegal, Amazon river).
(36) *Pristis pectinatus* Latham	35°S.—20°N. and 20°E. — 125°E. and 15°N.—25°N. and 75°W. —95°W.	S. Africa, Red Sea, India, in 20-30 fms., Burma, Philippines and tropical Atlantic (West Indies, Mexico).
(37) *Pristis zijsron* (Blkr.)	10°S.—25°N. and 62°E.—150°E.	India, in 20-30 fms., Ceylon East Indies, Queensland.
(38) *Rhinobatos obtusus* (M.H.)	30°S.—22°N. and 32°E.—110°E.	S. Africa, India, Malay Archipelago.
(39) *Rhinobatos thouiniana* (Shaw)	10°S.—20°N. and 40°E.—140°E.	Red Sea, India, Siam, Malay Archipelago, New Guinea.
(40) *Rhina ancylostoma* Schn.	4°S.—35°N. and 40°E.—125°E.	E. Africa, Red Sea, Seychelles, India, in 20-30 fms., Ceylon, Malay Peninsula, Cochin-China, Philippines, Japan, Australia.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES OF THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
NON-COSMOPOLITAN, *not extending eastwards beyond 180°E.*—contd.		
(41) *Raja powelli* Alc.	8°N.—12°N. and 40°E.—78°E.	Gulf of Aden, Arabian Sea, in 260 metres, Gulf of Martaban, Burma, in 194 metres.
(42) *Raja johannis-davisi* Alc.	10°S.—12°N. and 40°E.—78°E.	Zanzibar, Travancore coast, in 448-558 metres, Gulf of Aden.
(43) *Taeniura lymma* (Forsk.)	20°S.—20°N. and 40°E.—180°E.	Zanzibar, Mozambique, Mauritius, Red Sea, Arabia, India, Ceylon, Malay Peninsula, Malay Archipelago, Siam, Melanesia, Polynesia.
(44) *Dasyatis* (*Himantura*) *bleekeri* (Blyth)	1°S.—20°N. and 80°E.—110°E.	India, in 20-30 fms., Ceylon, Burma, Siam, Cochin-China.
(45) *Taeniura meyeni* (M.H.)	20°S.—5°N. and 59°E.—81°E.	Mauritius, Ceylon.
(46) *Dasyatis* (*Himantura*) *gerrardi* (Gray)	10°S.—35°N. and 40°E.—180°E.	Zanzibar, Red Sea, in 20-30 fms., India, Burma, Malay Archipelago, Japan, Polynesia.
(47) *Dasyatis* (*Himantura*) *uarnak* (Forsk.)	35°S.—20°N. and 20°E.—180°E.	Cape of Good Hope, Natal, Madagascar, Seychelles, Zanzibar, Red Sea, Arabia, India, in 20-30 fms., Ceylon, Andamans, Burma, Malay Peninsula, Malay Archipelago, Siam, Cochin-China, Philippines, M e l a n e si a, Polynesia.
(48) *Dasyatis* (*Pastinachus*) *bennett* (M.H.)	10°S.—17°N. and 80°E.—120°E.	India, Cochin-China, Philippines.
(49) *Dasyatis* (*Pastinachus*) *sephen* (Forsk.)	40°S.—20°N. and 40°E.—170°E.	Seychelles, Red Sea, Arabia ; India, in 3-30 fms., Ceylon, Burma, Singapore, Malay Archipelago, Siam, Indo-China, Micronesia.
(50) *Dasyatis* (*Dasyatis*) *pastinaca* (L.)	35°S.—8°N. and 20E. — 70°E. and 35 N— 15°E.	S. Africa, Natal, Madagascar, India, and also in the Atlantic (Mediterranean).
(51) *Dasyatis* (*Amphotistius*) *imbricata* (Schn.)	20°S.—20°N. and 40°E.—115°E.	Red Sea, Mauritius, Seychelles, India, in 20-30 fms.. Ceylon, Burma, Malay Peninsula, Java, Siam, Indo-China, China.
(52) *Dasyatis* (*Amphotistius*) *marginatus* (Blyth)	1°S.—22°N. and 80°E.—94 E.	India, in 20-30 fms., Ceylon, Burma.

LIST SHOWING THE LATITUDINAL AND LONGITUDINAL RANGES IN THE DISTRIBUTION OF THE ELASMOBRANCHS AND CHIMAERAS OF THE INDIAN REGION—*contd.*

Name of species	Range in Latitudes and Longitudes	Distribution
NON-COSMOPOLITAN, *not extending eastwards beyond 180°E.*—contd.		
(53) *Dasyatis* (*Amphotistius*) *zugei* (M.H.)	10°S.—35°N. and 73°E.—115°E.	India, in 20-30 fms., Burma, Ceylon, Malay Peninsula, Java, Cocein China, Japan.
(54) *Urogymnus africana* (Schn.)	10°S.—20°N. and 40°E.—180°E.	E. Africa, Seychelles, Red Sea, Arabia, India, in 20-30 fms., Ceylon, Malay Peninsula, Borneo, Java, Siam, Indo-China, Melanesia.
(55) *Gymnura* (*Aetoplatea*) *tentaculata* M.H.	30°S.—20°N. and 32°E.—85°E.	Natal, Red Sea, India, in 20-30 fms.
(56) *Gymnura* (*Aetoplatea*) *zonurus* Bleeker	10°S.—18°N. and 85°E.—115°E.	India, Singapore, Java.
(57) *Gymnura* (*Gymnura*) *micrura* (Schn.)	10°S.—17°N. and 62°E.—120°E.	Arabian Sea, India, in 20-30 fms., Ceylon, Burma, Malay Peninsula, Malay Archipelago.
(58) *Aetomylus maculatus* (Gray)	1°S.—20°N. and 80°E.—115°E.	India, in 20-30 fms., Ceylon, Malay Peninsula, Malay Archipelago, Siam, China.
(59) *Aetomylus milvus* (M.H.)	10°S.—20°N. and 40°E.—120°E.	Red Sea, India, Penang, Malay Archipelago, Philippines, China.
(60) *Aetomylus nichoffi* (Schn.)	10°S.—35°N. and 78°E.—115°E.	India, Ceylon, Burma, Malay Peninsula, Malay Archipelago, Cochin China, China, Japan.
(61) *Rhinoptera adspersa* (M.H.)	10°S.—13°N. and 80°E.—115°E.	India, Ceylon, Malay Archipelago.
(62) *Rhinoptera javanica* (M.H.)	25°S.—25°N. and 32°E.—120°E.	Delagoa Bay, India, Ceylon, Malay Peninsula, Malay Archipelago, Siam, Philippines, China.
(63) *Mobula diabolus* (Shaw)	20°S.—20°N. and 40°E.—150°E.	Red Sea, Arabia, India, Ceylon, Penang, Malay Archipelago, Queensland.
(64) *Narcine indica* Henle	10°S.—12°N. and 45°E.—115°E.	Gulf of Aden, India, Malay Archipelago.
(65) *Narcine timlei* (Schn.)	10°S.—35°N. and 78°E.—130°E.	India, in 20-30 fms., Ceylon, Malay Archipelago, China, Japan.
(66) *Torpedo marmoratus* Risso	35°S.—15°N. and 20°E.—120°E.	Cape of Good Hope, Madagascar, Mauritius, Seychelles, Red Sea, India, Philippines.
(67) *Torpedo sinsuspersici* Olfers.	35°S.—25°N. and 20°E.—52°E.	Cape of Good Hope, Madagascar, Persian Gulf, India.
(68) *Narke dipterygia* (Schn.)	5°N.—35°N. and 72°E.—130°E.	Arabian Sea, India, in 20-30 fms., Ceylon, Malay Peninsula, Indo-China, China, Japan.



TEXT FIG. 2.—Map showing the mean annual surface isotherms 6°C, 12°C and 20°C in the Indian Pecific and Atlantic Oceans.

ON THE LIFE HISTORY OF *PHILYRA GLOBOSA* (FABRICIUS), (DECAPODA : BRACHYURA)

By B F. CHHAPGAR, *M.Sc., Taraporevala Marine Biological Research Station, Bombay*

A serious lacuna in our knowledge of the Brachyuran fauna is the almost total lack of information about the life history of our crabs. Owing to the difficulty in rearing brachyuran eggs through successive larval stages up to the adult, under laboratory conditions, hardly any studies on this aspect of the problem have been made in India, except for a few notes by McCann[1], and Chacko and Thyagarajan[2] on fresh water crabs, and Menon[3], Naidu[4], and Prasad and Tampi[5] on marine Brachyura.

It is not difficult to secure the first zoaeae by hatching the eggs from a berried crab in the laboratory. The exigencies, however, of maintaining the zoaeae at proper conditions of temperature and aeration—and most difficult of all, the proper food—have precluded the success of most attempts to rear the zoaeae to the megalopa stage. An alternative method is to grow freshly collected larvae at least upto one moulting in a laboratory, and to connect such stages by further collection and nurture in the laboratory upto one stage each time. This method, though not most accurate, can be accepted as workable when the successive stages, both laboratory born and collected from the sea, are carefully examined and compared. This method has, therefore, been used in the present study.

Berried crabs were secured and their eggs hatched out in the laboratory to obtain the first zoaeal stages. At the same time, zoaeae were collected in plankton by the use of townets. A circular plankton net with a ring diameter of 20 inches, and made of fine Swiss organdy cloth was used, a large bottle being tied at the tip of the net. Towings were made just below the surface and varied from 8 to 15 minutes. Runs were made, weather and tide permitting, from opposite the Taraporevala Aquarium west to Malabar Hill and beyond. A smaller plankton net with a ring diameter of 10 inches and made of bolting silk was also used for making collections along the shore at Marine Drive. The contents of the bottles were immediately transferred to a large shallow jar, and the samples were examined alive in the laboratory and sorted out. They were then kept in aerated dishes or finger-bowls, and fed with diatoms

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[1] McCann, C., *J. Bombay nat. Hist. Soc.* XXXIX, pp. 531-542, pls. i, ii (1937).

[2] Chacko, P. I., and Thyagarajan, S., *J. Bombay nat. Hist. Soc.* (1) LI, pp. 289-291, figs. 1-4 (1952).

[3] Menon, M. K., *Bull. Madras Govt. Mus., Nat. Hist.* (n.s. (3) III, pp. 1-45, pls. i-x (1933); (5), pp. 11-56, pls. i-ix (1937).

[4] Naidu, K. G. Raja Bai, *Proc. Ind. Acad. Sci.* XXXIII, pp. 32-40, pls. i-iii, fig. 1-13 (1951).

[5] Prasad, R. R., and Tampi, P.R.S., *J. Bombay nat. Hist. Soc.*(3) 61, pp. 674-686, pl. i, figs. 1-58 (1953).

and mollusc larvae. The zoaeae were examined with the aid of a binocular microscope, in watch glasses and cavity slides. Appendages were cut off with a pair of entomological needles No. 20 mounted on holders. This was necessary in examining the details and making counts of the setae on the various appendages. Drawings were made with the aid of a camera lucida.

EGGS AND EARLY DEVELOPMENT

Starting with the observation of eggs from berried crabs, the different zoaeal stages obtained in plankton were identified and connected with the following stages by the number and size of the spines on the carapace and maxillipeds and the shape of the telson.

The characteristics that distinguish the zoaeae of *Philyra globosa* (Fabricius), are the presence of fairly long dorsal and rostral spines, and extremely short lateral spines, together with a flat, triangular, plate-like telson.

Unlike many other crabs, there proved to be three zoaeal stages in this crab. This is rather remarkable, considering that all other crabs have either two, four, or five stages. Another peculiarity, common to some species of *Ebalia* also, is the presence of six setae on the maxillipeds of the third zoaeal stage, most crabs having eight. All the stages are active, in which the individuals swim about by means of the maxillipeds and on occasion propel themselves backward by jerking motions of the abdomen. The first zoaeal stages swim at the surface and towards light. The second and third zoaeal stages also swim towards light but usually remain at the bottom. The megalopa stage avoids light, creeping underneath the aerating stones kept in the bowls. They also remain at the bottom.

Berried crabs were obtained from the beginning of December up to the first week of March and the first larval stages appeared in plankton in the last week of December.

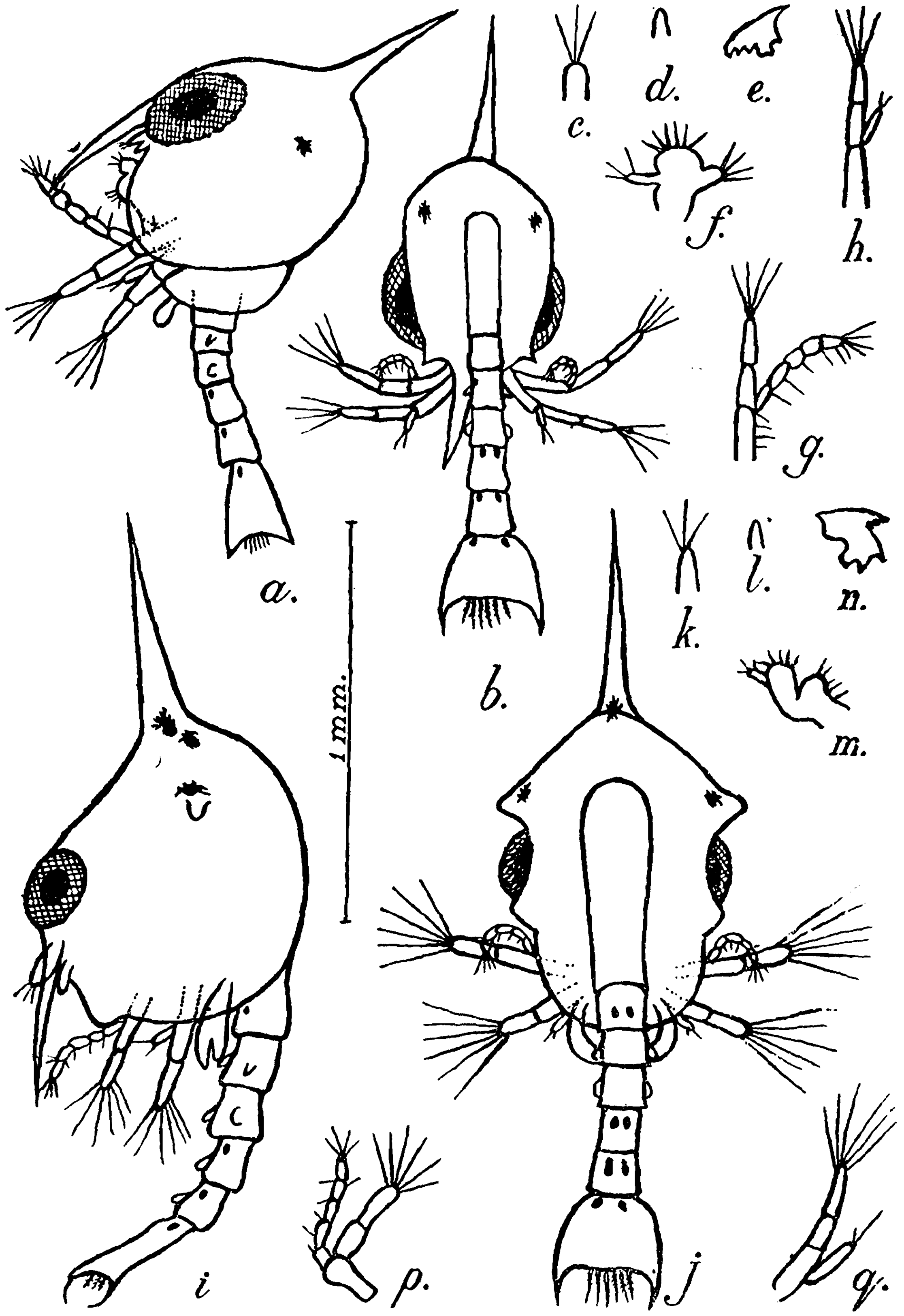
The body lengths were taken from the base of the dorsal spine to the extreme tip of the telson, using specimens which were as nearly straight as it was possible to find. All dimensions are in millimetres.

Eggs.—The berried female has its abdomen completely flexed as normally, the number of eggs being small and hidden from view. The eggs are circular, golden yellow or orange in colour, and measure 0·233 mm. Later they turn black due to the absorption of yolk and the pigmentation of the larvae inside the eggs. The later eggs are very slightly larger than the earlier ones.

First zoaea (text-fig. 1, *a* to *h*).—Measurements : Body length 1·26 ; eye width 0·5 ; body width 0·4 ; dorsal spine 0·33 ; rostral spine 0·26.

The carapace is rounded. The dorsal spine is slightly longer than the rostrum and is straight. There is no trace of the lateral spines. There is a long and narrow slit at the back where the abdomen comes out.

The antennule is an unjointed process with three aesthetes. The antenna is a rudimentary stump without any aesthetes. The mandible is heavy and bilobed. The maxillae are drawn closely up against the body. The first maxilla consists of a short, narrow, one-jointed exopodite bearing two setae distally and one in the middle; and two large, broad endites bearing six and four setae.



TEXT-FIG. 1.—*Philyra globosa* (Fabricius).
a. to *h.* 1st zoaea, and *i.* to *q.* 2nd zoaea.

a. Side view; *b.* Dorsal view; *c.* Antennule; *d.* Antenna; *e.* Mandible; *f.* 1st maxilla; *g.* 1st maxilliped; *h.* 2nd maxilliped; *i.* Side view; *j.* Dorsal view; *k.* Antennule; *l.* Antenna; *m.* 1st maxilla; *n.* Mandible; *p.* 1st maxilliped; *q.* 2nd maxilliped.

The first maxilliped consists of a short base with an exopodite of two segments bearing four long non-plumose setae, and an endopodite of five segments with four short hairs at the tip and several others along it.

The four hairs at the tip of the exopodite are constant and indicative of the first zoaea. The second maxilliped is similar to the first except that the endopodite has only one segment with two short hairs at the tip.

Rudiments of the chelipeds have appeared as buds.

The abdomen consists of five segments and a telson. It bears a pair of hook-like lateral knobs on the second segment, and a pair of rounded knobs on the third segment. There are also a pair of irregularly oval pigmented spots on the fourth and fifth segments, on the base the telson, and one below and behind the dorsal spine. These are the only colours in this zoaea, the rest of the body being colourless; the interior of the body is seen through the transparent colourless cuticle as a greenish or sometimes orange tinge.

The telson is in the form of a flat triangular plate, with six setae in the centre, and a lateral spine on each side. The setae are plumose in their basal half and naked distally. The fifth abdominal segment is slightly constricted where it joins the telson.

Second zoaea (text-fig. 1, *i* to *q*).—Measurements: Body length 1·53; eye width 0·56; body width 0·60; dorsal spine 0·46; rostral spine 0·43.

In general there is no great change in shape or appearance from the first zoaea except the increase in size and the fact that the lateral spines have appeared as rounded prominences. A branched chromatophore has appeared at the base of the dorsal spine. Both the maxillipeds are similar to those of the first zoaea, except that there are six hairs on the exopodites.

There is an additional pair of pigmented spots on the first abdominal segment, and the chelipeds have appeared. Buds of the pleopods can also be seen.

Third zoaea (text-fig. 2).—Measurements: Body length 2·0; dorsal spine 0·7; rostral spine 0·53.

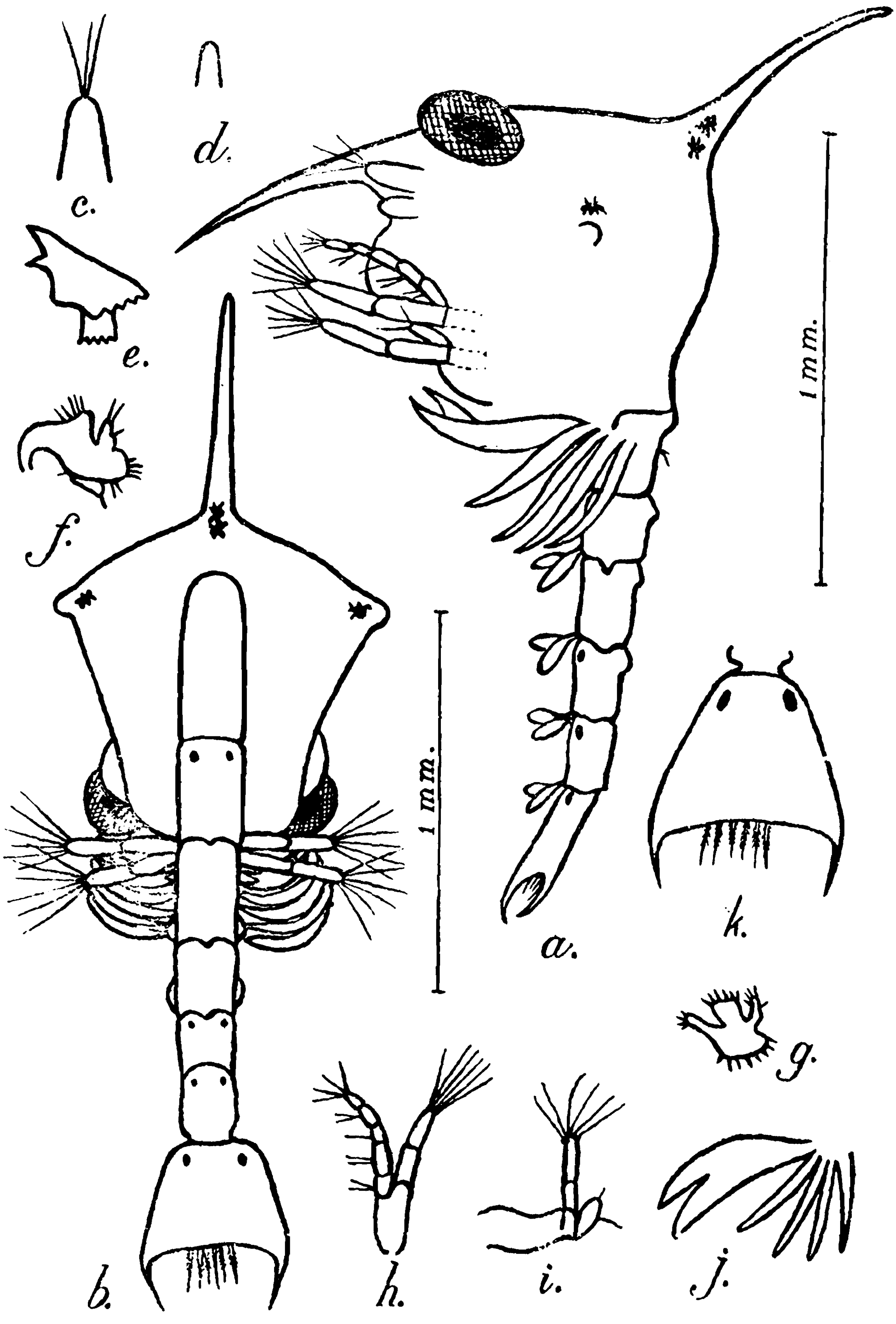
The general shape is the same as in the preceding stages. The eyes have begun to be stalked. The walking legs appear as long but still unjointed buds. The distal sides of the first, second and third abdominal segments are prolonged in the middle. The pleopods have lengthened, but still have no definite character. The maxillae remain the same except for an increase in number of setae. The exopodites of the maxillipeds have six hairs only. A pair of hairs have appeared on the first abdominal segment.

Megalopa (text-fig. 3).—Measurements: Body length from tip of rostrum to the termination of the telson 1·73; eye width 0·83; carapace width 1·16; carapace length from end of rostrum 1·16; length of dorsal spine 0·4.

The megalopa in this crab differs from those of others in having extremely well-developed spines. Thus there is a huge median dorsal spine; in front of this are two shorter spines, and at the same level, two lateral spinules which are sometimes very long. In front of these are two minute lateral spinules.

The rostrum consists of three short and blunt processes.

The chelipeds and four pairs of pereiopods are well develeped. The tips of the last pairs of pereiopods do not bear any curled setae. The ventral cornua are extremely long.



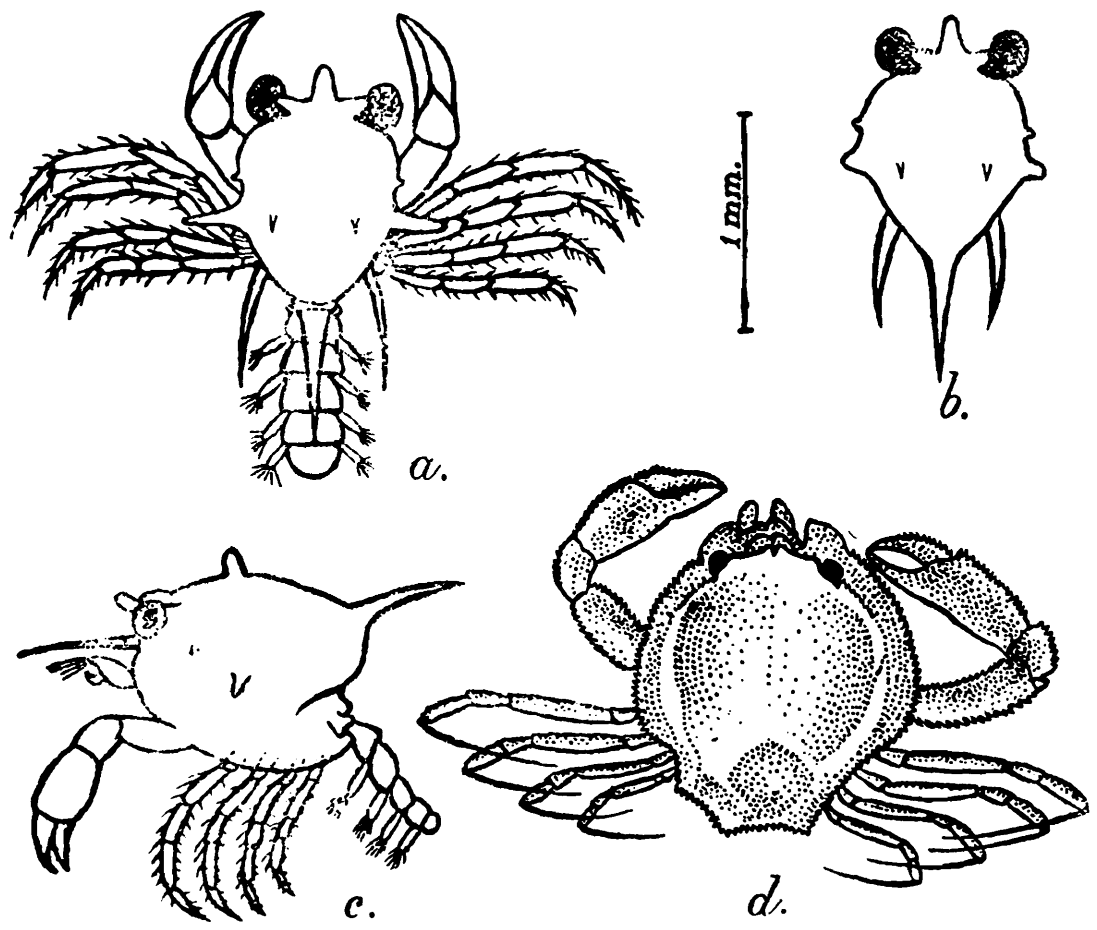
TEXT-FIG. 2.—*Philyra globosa* (Fabricius) 3rd zoaea.

a. Side view; *b*. Dorsal view; *c*. Antennule; *d*. Antenna; *e*. Mandible; *f*. 1st maxilla; *g*. 2nd maxilla; *h*. 1st maxilliped; *i*. 2nd maxilliped; *j*. Cheliped and legs; *k*. Telson.

The abdomen consists of five segments and the telson. The second, third, fourth and fifth segments bear pleopods with six setae each. The telson is a rounded plate without any setae. The megalopa uses its pleopods for swimming, the abdomen being held out horizontally, although it can now be curled under the body.

First instur (text-fig. 3*d*).—Measurements: Carapace length 1·66 ; carapace breadth 1·5 .

The carapace is subcircular, with the epistome projecting beyond the broad front. The lateral and posterior margins are serrulate. The merus of the external maxillipeds is narrow and acutely triangular.



TEXT FIG. 3.—*Philyra globosa* (Fabricius) Megalopa.

a. Dorsal view ; *b.* Dorsal view of variant with stunted spines ; *c.* Side view ; Ist instar.

The chelipeds are massive, with both borders of the arm, outer border of the wrist, outer border of the hand, and basal half of the hand spinulate. The legs diminish in length from the anterior to the posterior.

ACKNOWLEDGMENTS

The author takes this opportunity to express his grateful thanks to Dr. C. V Kulkarni, Director of Fisheries, Bombay, for his constant guidance and encouragement throughout the course of his studies.

THE EARTHWORMS OF BURMA. VII[1]

THE GENUS *EUTYPHOEUS*, WITH NOTES ON SEVERAL INDIAN SPECIES.

By G. E. GATES.

CONTENTS

Alphabetical list of species

[1]For the earlier parts I to VI of the series *vide* Gates, G. E., *Rec. Indian Mus.* XXXII, pp. 257-356 (1930); XXXIII, pp. 327-442 (1931); XXXIV, pp. 357-549 (1932); XXXV, pp. 413-606 (1933); XXXVIII, pp. 377-468 (1936); LII, pp. 55—93 (1954).

INTRODUCTION

The material with which this contribution is concerned was collected in Burma during the period from 1932 to the end of 1941, at which time the author's survey of the earthworms of that country was terminated by the Japanese invasion, and in India during the war. The Indian material comprised nearly ten thousand specimens, mostly from the Gangetic valley, all of which were identified. Locality records have been published elsewhere but a study of variation in the Gangetic forms had not been completed when return to Burma, as hostilities ceased, compelled abandonment of the project.

In this genus it was formerly thought (Stephenson, 1923, p. 428) that species are so much alike morphologically that their discrimination depended almost wholly on genital markings, penial setae and spermathecal diverticula, structures already known to be "extraordinarily variable" Many of the characteristics on which reliance had been placed were found, on examination of previous Indian material (Gates, 1938), to be of little or no taxonomic value. Even the dozen odd characteristics provided by the author's Burmese studies were inadequate for determining the status of several species. These, all still doubtful today, were represented in museum collections by a single worm, or several specimens and then usually from one locality, sometimes poorly preserved or even too immature to permit recognition of important specific characteristics. Short series of better preserved adult worms already had been found to be insufficient in Burma. Because of difficulties occasioned by absence of good criteria for specific distinction and by variation in the characteristics that had to be used—some of it of a nature regarded as "reversionary"—the genus *Eutyphoeus* was omitted from annual reports of progress on the survey of the earthworms of Burma after 1932. Meanwhile efforts were made to secure as much material from as many localities as possible. Abnormal or monstrous individuals, as well as juveniles that could be identified with some degree of certainty, were also studied for any light they might throw on some of the problems that were involved. Finally, types and most of the previous material of Burmese species were re-examined.

Gradually it became clear that species from widely separated portions of the generic range could not be as closely related as the similarity in their morphology might suggest. Independent attainment of a similar grade of morphological organization then required that ancestry be taken into consideration. Recognition of evolution now under way or recently completed led back through earlier stages of intrageneric developments to an examination of phylogenetic relationships in the oriental section of the subfamily to which *Eutyphoeus* belongs. Determination of the changes that had taken place in the evolution of that group then provided a basis for a preliminary consideration of the mechanism by which those changes had been brought about.

Certain modifications of long established conventions have become advisable in the interest of more concise topographical characterization. These, and additional abbreviations, as well as several of the less familiar special terms are explained in the next section.

Conventions and terminology.—The letters *a, b, c, d,* as in the past, designate the setae of a segment in order from the midventral level laterally. The same letters are now capitalized to indicate meridians of longitude passing across the follicle apertures of those setae. Combinations such as *AA*, *BC*, *CD*, etc., designate the interval between two meridians, usually on the ventral side, though *DD*, like *dd* previously, refers to the dorsum unless the context requires the contrary.

D, V, L, are abbreviations for dorsal, ventral, lateral, and mD, mL, mV, indicate mid-dorsal, mid-lateral, mid-ventral points, sites, or segmental meridians. C(=U in German publications), as in the past, stands for circumference.

Equatorial, in this genus, coincides with an arc or circle across apertures of setal follicles of a segment and aq or pq indicate in front of or behind the equator, *i.e.*, presetal or postsetal.

Battery, when not used in connection with spermathecae or prostates, includes all of the setae adjacent to a prostatic duct. In *Eutyphoeus* a battery comprises the *a* and *b* setae of a side with each of which there is often associated a rank of reserves of gradually decreasing size.

Vestibulum, an invagination restricted to the parietes or protuberant into the coelom, containing the portion of the body wall bearing the fissure. Not to be confused with fissure, as sometimes in the past.

Vestibulate, having a definite vestibulum. Avestibulate, without a vestibulum.

Fissure, a shallow, transversely slit-like depression in an outer portion of the parietes, usually in region of *AB*, containing apertures of the penisetal follicles, male deferent and prostatic ducts.

Arsenosomphic, with male genital terminalia.

Anarsenosomphic, without male genital terminalia *i.e.*, male pores, and associated structures such as porophores, prostates, prostatic ducts, other glands, penes, fissures, vestibula, copulatory chambers, etc.

Holonephric, with one pair of funnelled (stomate) nephridia per segment, each nephridium with a parietal nephropore.

Meronephric, with more than two nephridia per segment.

Exonephric, with parietal nephropores.

Enteronephric, opening into the gut.

Stomate, with a funnel (nephrostome), with reference to nephridia.
Astomate, without a funnel.

Thecal, provided with spermathecae.

Athecal, without spermathecae.

ACKNOWLEDGMENTS

Collection of Burmese material was financed by annual grants from the University of Rangoon, of Indian material by gifts from Miss Helen Benjamin. A special grant from the same university enabled measurements, by Miss Chapman under the author's supervision, of penial setae in most Burmese species. Compilation and tabulation of data, interpretation of results and preparation of the manuscript were completed during a portion of tenure of a John Simon Guggenheim fellowship.

SYSTEMATICS

The classification herein followed is that of Stephenson (1930). This has been obsolete for some time, so far as the Megascolecidae is concerned, but the only alternative available, that of Michaelsen (1928), gives even greater taxonomic value to a character now known to be acquired independently in different evolutionary lines (cf. p. 221).

Family MEGASCOLECIDAE

Subfamily *OCTOCHAETINAE*

Genus **Eutyphoeus** Michaelsen 1900

Certain characteristics no longer need mention in specific descriptions though they were recorded in the laboratory during dissection to prove this very statement. Among them is an intestinal origin in (xv) (some data in, Gates, 1933, p. 561). Deviation has been found only in association with metameric anomaly and each case is recorded below in the appropriate section on abnormality. A pair of hearts is almost always present in xiii (*loc. cit.* p. 561) and any deviation therefrom likewise has been mentioned below. No variation was found, in any of the numerous dissections that were made during some twenty odd years, as to presence or absence of: gizzard, calciferous glands (or in their basic structure), ventral intestinal caeca, typhlosole, supra-intestinal glands, or pharyngeal nephridia. Nor was any variation found as to number of gizzards, calciferous glands and bands of pharyngeal nephridia. The location of those organs always was the same, except in rare monstrosities. Variation as to absence of septa 6/7-7/8, and as to posterior displacement of subsequent septa, again was associated only with metameric anomalies.

The typhlosole always seems to be folded in a regularly zigzagged manner, with ventral margins of folds united. The folding is less obvious in small species and gradually disappears in all of them as the ridge becomes more translucent posteriorly. The typhlosole always terminates with supra-intestinal glands, supposedly hepatopancreatic in function. These glands are two pairs per segment with slight antero-posterior increase in size recognizable in each individual. Occasionally only two glands are present in the first gland segment (posterior half) and they may be so small as to be concealed from view beneath the distended dorsal blood vessel. Openings from gut lumen into the glands rarely were seen. When recognizable they were quite obvious and in a single longitudinal row at mD (ten noted in several specimens of *bifovis*).

The medianmost nephridium on each side in posterior segments of the body always appears to be stomate. The number of segments in which such funnels are present seems to be variable. All nephridia of the anterior segments and the lateral ones posteriorly always appear to be astomate. The pharyngeal nephridia usually have been said to be in an annular or horse-shoe-shaped parietal band. With relaxation a shortly and closely zigzagged arrangement of the cord (duct) to which the tubules are attached becomes recognizable. Although so noted only in a few species below this arrangement may be generically characteristic. The material available usually has not been in satisfactory condition for study of these minute organs and especially those in the region of *BC* where tubules usually are closely crowded together in strongly contracted specimens. Reference to number of longitudinal ranks in the posterior portion of the body accordingly has been omitted in the specific accounts. Several sample determinations are as follows: six ranks, one at *A*, *C*, and lateral to *C* on each side (*pusillulus*); three (?) in *BC*, one at *D*, two laterally (*compositus*); three (?) in *BC*, one at *D*, five laterally (*cochlearis*); several in *BC*, six lateral to *D*, with an occasional seventh tubule (*foveatus*), but only three to six ranks in mutant forms (Thanbula and Laboo); twenty ranks (*rarus*); 24 ranks, 12 on each side, several closely crowded in *BC* (*gigas*). Variation in the excretory system now appears to be of a minor nature and limited to inter-and intra-specific differences in number of times paired embryonic anlage are transversely split.

Data as to variation that is, or promises to be, of some taxonomic value has been included in accounts of the various species. Segment number, however, had not yet been studied when the work was ended.

A bulbus ejaculatorius always is present but variation as to size, muscularity and extent of concealment in the parietes appears to be about the same in a number of species. Similar variation may be shown in length of the prostatic ducts (8-21 mm in *rarus*). Number of seminal chambers in a spermathecal diverticulum may vary from one to twelve differences noted on opposite sides of the same spermatheca as well as between spermathecae of the same individual. When chambers are numerous they may be in a single row or in a some or less compact and berry-shaped mass

Additional general observations are as follows. Pigmentation refers hereinafter to a dark deposit responsible for a characteristic velvety brown appearance of the dorsum in certain species. A green color has been noted in *bifovis* (living and preserved) and *gammiei* (after preservation). No corresponding deposit in the ventrum has been found and the color disappears regardless of preservative. A blueish grey coloration in several batches of unpigmented worms also disappeared after preservation. Pigment is only slowly bleached out in formalin but does disappear, in certain conditions, after some years.

The cuticle turns in at the anterior end of the body and is continued through the buccal cavity, pharynx and gizzard where it is thickened and much tougher. Behind the gizzard the cuticle usually is unrecognizable but in macerated specimens (*annulatus*, *compositus*, etc.) a complete layer has been recognized back into xi.

Calcareous material between the lamellae of the calciferous gland always has been finely granular though larger aggregates have been found just dorsal to the lamellae.

Species are arranged below in groups for the first time but for easy reference an alphabetical list is provided on pp. 93, 94.

Frequent reference is made hereinafter to a hypothetical ancestral form from which all species of the genus can be derived. As certain structural details irrelevant to the particular discussions were omitted therein, a more complete characterization of this form, as it is now visualized, is subjoined.

The proto-eutyphoeus stage

Biprostatic, ducts of tubular glands opening to exterior in or close to *AB* (probably aq), on segment xvii. Male pores, external apertures of united male deferent ducts of a side, in *AB*/pq, on xvii. Bithecal, each spermatheca with a simple median and lateral diverticulum and opening to the exterior in the region of *AB* on intersegmental furrow 7/8. Female pores on xiv/aq at or near A, each pore at ectal end of a short oviduct with funnel in xiii. Setae four pairs per segment, in eight regular longitudinal ranks all within the ventrum. Septa between vi-vii and vii-viii aborated during embryonic development. Digestive system with one large gizzard formed by thickening of the muscular layer of that portion of the oesophagus belonging to vi, one pair of intramural calciferous glands in xii, intestinal origin in xv, a medium typhlosole ending with a short series of doubly paired supra-intestinal (hepatopancreatic?) glands, short lateral typhlosoles anteriorly, a midventral rank of small anteriorly directed, intestinal caeca one in each of several consecutive segments. Circulatory system with a single dorsal vessel, paired lateroparietal trunks instead of one subneural, paired lateroesophageal hearts in x-xiii. Excretory system meronephric, nephridia all small, exonephric except in iii, astomate except for the medianmost on each side in posterior segments, nephridia of iii opening into the pharynx. Reproductive system with testes in x and xi, seminal vesicles in ix and xii, ovaries in xiii.

The soma may well have comprised 150 or more segments, for all spcies of *Eutyphoeus*, as well as those of the two most closely related genera, do have that number.

THE *hastatus* GROUP

Eutyphoeus hastatus Gates 1929

1

Thayetmyo, August, 0-2-37. K. John.

Magwe, August, 0-1-21. K. John.

External characteristics.—Length, 80-180 mm. Diameter, 3-5½ mm. Unpigmented, as also in case of all material considered below. The *b* setae of xix, ornamented with transverse rows of fine teeth, are 0·35 mm long, 30μ thick (Magwe), 33μ (Thayetmyo). First dorsal pore on 10/11 or 11/12 and then often with a pore-like but apparently imperforate marking on 10/11. Clitellum reddish but not protuberant.

Spermathecal pores small slits in lateral half of *BC* or with centers at or just median to *C* (half of the Thayetmyo worms). Female pores both present (50), on or very slightly median to *A* and in a single, transversely placed, whitened area of rather indistinct outline that reaches into *AB*.

Male porophores distinctly demarcated, elliptical areas of slight parietal thickening and convex surface, extending from about *mBC* into a lateral portion of *AA*, transverse or slightly diagonal and then convergent anteriorly. A lateral portion may be widened and slightly more protuberant. The transversely slit-like fissure containing male and penisetal follicle pores is just lateral to *B* and is so small as to be practically filled by the thickened tip of one penial seta. Margin of the slit very rarely whitened and slightly protuberant but the tumescence scarcely deserves characterization as an annulus.

Genital markings primarily presetal but may include ventral setae, extending laterally to *A*, into *AB*, to or very rarely slightly beyond *B*, separated midventrally by a narrow median strip of unmodified epidermis, in contact but not united midventrally, margins united but greyish translucent central portions discrete, or central areas also united when only evidence of union (occasionally lacking) is provided by slight incisions at mV of anterior and posterior margins. An extra marking on xix (7 Thayetmyo, in 3 of which marking is rudimentary). Extra markings on xix and xx (2 Thayetmyo).

Internal anatomy.—Typhlosole begins in xxvii (1), xxvii (13), xxix 25) or xxx (4). Lateral typhlosoles always present (60), in caecal segment and that next behind. Caecal aperture only slightly smaller than caecal lumen. Ventral caeca in xxxii-lvi (1 Magwe), xxxii-lviii (1 Thayetmyo), xxxiii-lvii (2 Magwe), xxxiii-lviii (1 Magwe).

Location of supra-intestinal glands

Segments	Number of specimens from Thayetmyo	Magwe
76—80	..	2
77—80	1	
77—81	7	7
78—81	5	1
78—82	8	5
79—82	5	..
79—83	6	2
80—84	..	2
81—85	2	..

Circulatory system as in *gigas*, as also in case of all material considered below, except that the extraoesophageals are connected by a transverse vessel just behind 5/6, and the dorsal trunk is uninterrupted (60). Commissures of v almost always large and filled with blood.

Holandric, male funnels of x iridescent, testis sac annular (60) and when much distended by testicular coagulum often opened even by a cautious mid-dorsal incision. Seminal vesicles of ix, always present, reach up to or nearly to dorsal trunk and often bulge 8/9 anteriorly, especially ventrally. Vasa deferentia of a side usually come into contact in xii but do not unite until xvii. Bulbus ejaculatorius white, firm, elongate, coelomic, occasionally with slight sheen.

Spermathecal duct short, soft, white, lumen irregularly slit-like in cross section due to presence of vertical ridges, one on posterior wall often higher than the others and with a vertical groove, a similar ridge occasionally also on anterior wall. Diverticula median and lateral (119 spermathecae), elongate, widened entally, sperm marked off (especially entally) by fine greyish lines into spheroidal to shortly ellipsoidal masses. Each diverticulum of one worm has a slender stalk with several small, ellipsoidal seminal chambers entally. Median diverticulum of left spermatheca lacking (1 Magwe). An extra diverticulum on posterior or anterior face of duct of one spermatheca (2 Magwe). Lateral diverticulum in two discrete portions (1 Magwe).

Soft (glandular?) material in white cords somewhat similar in appearance to nephridial tubules passes downwards between strands of longitudinal musculature over sites of lateral portions of genital markings.

Penial setae (36 Thayetmyo and Magwe) 2·40-3·55 mm long, 45-75μ thick at base, 30-48 at neck, 42-75 at blade, 25-40 at tip. Shaft straight except for a slight curve at ectal end, yellow to neck, red ectally. Tip with widened blade tapering to a point. Ornamentation of transverse rows, of three or more fine spines, closely crowded ectally, more widely spaced entally and with more variation in size and shape of spines, in two worms in regular circles. Number 8-11 (36 batteries).

Abnormality.—(No. 1) Left spermatheca lacking (Magwe). (No. 2) An extra normal spermatheca on right side, opening to exterior on 6/7(1).

Remarks.—Genital markings, male porophores and locations of spermathecal pores are, in this material, as in the types for which the species was erected.

This species is rare at Prome, only one specimen having been obtained there since 1927.

2

Spermathecal pores, in types of *hamatus* (Kalewa), center about at *B*.

Male porophores transversely elliptical areas of greyish translucence and convex surface, extending from *A* nearly to *mBC*. The fissure approximately central, immediate margin whitened and very slightly tumescent.

Typhlosole begins in xxvi. Lateral typhlosoles in xxvi-xxvii. Supra-intestinal glands in lxxiii-lxxvi.

Remarks.—*E. hamatus* was erected for worms with a more median location of spermathecal pores, with genital markings in *A* to *mBC* on xx that crossed whole length of the segment, with male porophores having centrally located fissures, and with penial setae having a terminal spine recurved into a hook shape (Gates, 1930, p. 330, fig. 19*b*). The hooked tip of the penial setae seemed especially characteristic as such a conformation had not previously been recorded from the genus. Prostates were looped in a regularly zigzagged manner that had not previously been seen.

3

Typhlosole, of the types of *montanus* (Pegu yomas east of Letpadan), begins posteriorly in xxvii or in xxviii. Lateral typhlosoles low lamellae in xxviii. Supra-intestinal glands in lxxxiii-lxxxvi (1).

Spermathecal duct about one mm long, slightly bulbous, with muscular sheen, lumen irregularly slit-like in cross section due to presence of several low vertical ridges on anterior and posterior walls.

Body wall thickened in region of male porophores and slightly protuberant into coelomic cavity, penisetal follicle passing into apex of protuberance.

Remarks.—*E. montanus* was erected for holandric worms with spermathecal pores in the *hastatus* location but with circular male porophores and centrally located fissures, with genital markings in *A* to *mBC* of intersegmental and more posterior location, and having unusually large seminal vesicles penetrating through several septa. Such posterior extension of seminal vesicles has been even used in generic definition (Glossoscolecidae).

Three worms with foreshortened dorsal blood vessel indicate that abortion of an anterior part of that trunk in ontogenetic development can be accomplished as a result of a single mutation, and possibly for the first seven (1 specimen) as well as for the first six (2) segments.

4

Taungdwingyi (Magwe), August, 0-5-76. K. John.

Taungdwingyi, hills to the east, August, 0-0-2. K. John.

External characteristics.—Length, 55-110 mm. Diameter, 3-5 mm. Clitellum reddish, not or only very slightly protuberant. Seta *a* of xx ornamented by short transverse rows of fine spines. First dorsal pore on 11/12 (37), 11/12 but with a pore-like though apparently imperforate marking on 10/11 (32), 12/13 (3, of which two have a pore-like but apparently imperforate marking on 11/12).

Spermathecal pores usually centered at or median to *B*, occasionally just lateral to B. Female pores both present (82) and within a single, transverse white area in *AA*.

Male porophores greyish translucent, usually indistinctly delimited, occasionally with rather indefinite but opaque, white rim, slightly concave, extending from just median to *A* to or nearly to m*BC* and anteroposteriorly to or nearly to 16/17 and 17/18. A portion about in *AB* of the posteromedian quadrant containing the fissure is slightly raised and bears, around the fissure, an annulus that is delimited from the protuberance by a slight furrow and that is slightly notched mesially and laterally. The posterior lip thus indicated is often slightly enlarged and occasionally bilobed.

Genital markings circular, extending from just median to *A* to slightly lateral to *B* and anteroposteriorly to intersegmental furrows, symmetrical with reference to equator of segment, occasionally displacing *a* mesially and *b* laterally : on xx (77), on xx and right side of xix (3), or left side (2), on right side of xix and left side of xx (1). A small white transversely elliptical to spindle-shaped marking with convex surface present in *AB* on postsetal portion of xvi. Male porophores may be depressed so that these markings are on anterior walls of the concavity.

Internal anatomy.—Typhlosole begins in xxvii (23), xxviii (9). Lateral typhlosoles, always present, in xxvii-xxviii or xxviii-xxix, usually blade-like, occasionally thickened and then with rounded ventral margins or flattened and band-like, rarely divided into two portions separated from each other by an interval of nearly equal length, dark red (6) or white. Ventral caeca in xxxi-xxxvi (1), xxxi-xxxvii (2), xxxi-xxxviii (4), xxxi-xxxix (2), xxxii-xxxix (1), xxxii-xl (1). These caeca are large, with patent apertures into gut lumen, often containing soil. Several rudimentary caeca, apparently without apertures into gut lumen, were noted in one specimen and may have been present but unrecognized in others.

Location of supra-intestinal glands

Segments	Number of specimens
69-72	1
69-73	1
69-74	1
70-73	1
70-74	7
71-74	5
71-75	12
72-75	2
72-76	7
73-76	1

Dorsal blood vessel uninterrupted (72). Commissures of vi and v always present and filled with blood.

Seminal vesicles of ix fairly large (11), medium-sized (11), medium-sized on one side and small on the other (5), small on both sides (36). Small vesicles are acinous, rather translucent, with numerous flecks of black pigment. Medium-sized and large vesicles soft, opaque, with only slight traces of marginal lobulation. Male funnels always present in x (72), iridescent in 19. Iridescent funnels usually associated with medium-sized or large seminal vesicles in ix, but in one case with almost rudimentary vesicles (soft, opaque, no black flecks). Testis sac annular (72), distended with coagulum and in contact or almost so with parietes both dorsally and laterally. Vasa deferentia of a side come into contact in xii but unite only in xvii (22). Bulbus ejaculatorius small, soft, white, coelomic. Prostatic duct 1-2 mm long.

Spermathecal duct short, soft, thin-walled, no sheen, lumen irregularly crescentic in cross section due to presence of a high ridge with vertical groove on posterior wall and several lower ridges. Diverticula median and lateral (144 spermathecae), usually elongate and slightly widened entally. Spermatozoal iridescence confined to a shortly ellipsoidal and terminal seminal chamber or visible clear to duct. In the latter case sperm mass spirally coiled like a corkscrew, looped in a regularly zigzagged fashion with all loops short and in the same plane, or otherwise twisted.

Longitudinal musculature uninterrupted over genital markings.

Penial setae (37) 1·85-2·62 mm long, 40-65μ thick at base, 29-40 at neck, 40-70 at blade, 25-45 at tip. Shaft straight except for ectal curve. Tip widened, slightly flattened on one side, narrowing to a spine which is recurved as in types of *hamatus*. Ornamentation of fine spines in irregularly broken circles on blade, in short transverse rows further ectally and entally. Number, 6-9 (19 batteries), 12 (2 batteries of 1 worm). Tips, in two of the 70 functional setae examined in this connection, concave as in a spoon bowl, and in four other setae ending in a straight spine. Only one functional seta was present in one battery.

Abnormality.—Left spermatheca with no ampulla, duct spheroidal and distended by the sort of material usually present in ampulla, on dorsomedian and dorsolateral margins a small spheroidal diverticulum.

5

Pyinmana (Yamethin), October, 0-0-2. K. John.

External characteristics.—Length, 80-90 mm. Diameter, 3-4 mm. Clitellum yellowish.

Spermathecal pores in *AB*.

Margin of fissure of male porophores slightly tumescent but not definitely marked off by a groove as in the Taungdwingyi worms.

Genital markings present only on xvi, extending from *MBC* into *AA*, larger and more protuberant than on Taungdwingyi worms.

Internal anatomy.—Ventral intestinal caeca in xxxii-liii (1). Supra-intestinal glands in lxxvi-lxxix and lxxvi-lxxx.

Seminal vesicles of ix large and bulging 8/9 anteriorly, most markedly ventrally.

Penial setae (4) 2·6-2·74 mm long, 34-40μ thick at base, 40-44 at midshaft, 39-40 at neck, 58-59 at blade. Blade slightly flattened on both convex and concave sides of curve, ectal margin rounded and without spine or hook. Number, 6-9 (4 batteries). Color changes gradually from yellow to red as length decreases in a battery. Short reserve setae thicker near base than the functional setae.

6

Remarks.—Except as noted above these worms are like those from Taungdwingyi.

Magwe, vicinity of, August, 0-2-16. K. John.

External characteristics.—Length, 80-130 mm. Diameter, 4-6 mm. Clitellum reddish. Seta *b* of xix 0·37 mm long, 30μ thick at nodulus, an associated reserve seta 0·335 mm. and 28μ thick, tips of both ornamented with short transverse ridges of very fine teeth. First dorsal pore on 11/12 (16) but with a pore-like though apparently functionless marking on 10/11 (8).

Spermathecal pores in median portion of *BC* (8), with centers on or just lateral to *B* (8). Female pores both present (16). Male porophores circular areas of slight parietal thickening, extending from or slightly median to *A* to or nearly to *C*. A small lateral portion of each porophore grey translucent, depressed, the remainder white and markedly convex. Fissure, with protuberant setae, at center of convexity. Margin soft, tumscent, usually flattened but with an appearance of an indistinctly marked off annulus. Male pore on a small spheroidal protuberance from the anterior face of the posterior lip.

Genital markings of about the same size as the male porophores, in *AC*, on xxi (9), with an additional marking on right (2) or left side of xxii (2), right marking of xxi lacking (2), left lacking (2), paired on xxii (1).

Internal anatomy.—Typhlosole begins in xxviii (2), xxix (3), xxx (1). Lateral typhlosoles in first two typhlosolar segments (12, not found in 2). No lateral intestinal caeca (14). First ventral caecum in xxxii (1), xxxiii (6), xxxiv (3), caeca in xxxii-li (1), xxxiv-lv (1), xxxiv-lx (1).

Location of supra-intestinal glands

Segments	Number of pecimens
95-101	2
96-101	4
96-102	1
97-101	2
97-102	2
98-103	1

Dorsal blood vessel uninterrupted (14), but commissures of v may have been functionless in three of the worms.

Testis sac annular (13, including 1 aclitellate), above dorsal blood vessel. Seminal vesicles of ix white, soft, anteroposteriorly flattened, reaching up to or nearly to dorsal blood vessel (14), but not as large as the posterior vesicles. Male funnels of x always large, crenellated (14), usually (12, including one aclitellate) iridescent. Fan-shaped or button-shaped testes recognizable in x (9). Vassa deferentia of a side unite only in xvii. Bulbus ejaculatorius soft, white, covered by transparent tissue. Prostatic duct 2-4 mm long.

Spermathecal diverticula median and lateral (28 spermathecae).

Longitudinal musculature uninterrupted over genital markings.

Penial setae (20) 1·0-1·7 mm long, 20-60μ thick at base, 25-45 at neck, 28-60 at blade, 12-20 at tip. Shaft practically straight. Tip red, widened, slightly flattened, tapering to a point. Ornamentation of thorn-like spines in short transverse rows ectally, in circles entally. Number, 6-9 (10 batteries).

7

Eutyphoeus sp., Gates, 1933, *Rec. Indian Mus.* 35, p. 601.

External characteristics.—An annular tumescence around the fissure containing the penisetal follicle pores is slightly more protuberant posteriorly. A vertical opaque line on the anterior face of that protuberance is associated with the male pore.

Internal anatomy.—Typhlosole begins in xxix. Lateral typhlosoles low, simple lamellae reaching slightly into xxviii and xxx. Supra-intestinal glands in lxxxii-lxxxiv.

Spermathecal diverticula median and lateral.

Remarks.—This Tiddim specimen differs from all others that have been assigned to *hastatus* in the dislocation of *d* setae in posteriormost segments to a position dorsal to mL, and the smaller number of supra-intestinal glands, in three segments. Penial setae lack a terminal hook and have no blade-like widening of the tip. Absence of genital markings is also noteworthy as these structures have been present in all clitellate individuals of *hastatus*.

The worm cannot be referred to any holandric species now known from the Arakan Yomas. Identification as *hastatus*, because of the differences just mentioned, must be tentative.

VARIATION IN *E. hastatus*

Genital markings, in that portion of the *hastatus* range closely bordering the Irrawaddy and Chindwin rivers, do not vary with respect to presetal origin and postclitellar location. Always present on xviii, an occasional worm may have an extra pair, or more rarely two extra pairs, on the next one or two segments. Intrasegmental location apparently is restricted to *AA*. Increase in size of the markings would then be possible only by anteroposterior extension, approximation or even union at mV, all of which seem to be indicated by the material that has been available. Union midventrally of originally paired embyonic anlage may explain those cases in which no indication of double origin is recognizable in adults.

Passing up from the river bank to the eastern boundary of the range in the Pegu Yomas, as well as in a more northern portion of the Chindwin valley, the markings show no tendency to become united midventrally but rather one for greater midventral separation and lateral expansion. Only in one locality at the southern border of the range have markings become intersegmental, or more accurately bisegmental, and of symmetrical location with reference to the intersegmental furrow between the two segments concerned. Markings still are postclitellar except in the vicinity of Pyinmana where they are on a clitellar segment (xvi) as are the markings of *constrictus* from the same locality. A similar parallelism in location of markings, though on a different segment (xxi), is demonstrated by worms of the two species collected in a region extending from Natmauk down towards Magwe.

The rank of ventral intestinal caeca extends through xxxi-lx but the number, in the vicinity of Taungdwingyi, may be restricted to 6-9. Supra-intestinal glands are in lxix-lxxxvi and xcv-ciii, the discontinuity of eight segments due to the location of the glands of certain Magwe district worms in the same segments as in *constrictus* from the same area. The number of segments involved in an individual is 5-7, in those Magwe specimens of *hastatus*, rather than 4-5 or occasionally 6 as in the rest of the range.

Lateral intestinal caeca may be present or absent in a local population. An annular thickening of the gut wall such as may be present around the aperture into a definite caecum has been noted, in a number of specimens which, prior to opening and cleaning out gut contents had been tallied as acaecal. The opening through the annulus in these cases apparently leads only into a slight pocket without any constriction which is scarcely distinguishable, except for the annulus at an appropriate site for a caecum, from fortuitous bulges and sacculations in other intestinal regions.

Penial setae always have a blade-like local thickening near the ectal end but only in the populations from two widely separated areas has the blade narrowed to a terminal and recurved spine. Reserve penial setae always have been present in each battery.

Spermathecae have shown little variation as to number of diverticula. Of the 308 that were examined this time, one did lack a median diverticulum, two had an extra discrete diverticulum, and one diverticulum was completely bifid. The aberration, in each of these cases, characterized only one of a pair of lateral organs, and four individuals were involved.

The testis sac is annular throughout the range. A sort of penis, in the form of an annulus, seems to be developing, in some populations, around the fissure containing the male, prostatic and penisetal follicle pores. Whether this delicate structure is a permanent organ or temporary and then resulting from outrolling of the lining of the fissure or from tumescence of the margin of the fissure aperture is not yet clear.

Variation in *hastatus*, in general, does not appear to be continuous, in a north-south direction, throughout the eastern portion of the range. Evolutionary processes that now appear to be under way presumably would result eventually in a number of small-range species in the Pegu Yomas.

E. hastatus is now defined as holandric. Any individual that varied in the number of testes, regardless of similarity in other characteristics would be referred to another species.

Holandry, *i.e.*, presence of a pair of testes in each of segments x-xi is basic throughout families of the megadrilous oligochaeta. Equally archaic are : arrangement of setae in eight regular longitudinal ranks within the ventrum, absence of interruption in the single dorsal blood vessel and presence of paired female pores. One-seventh of the species of *Eutyphoeus* share all of these primitive characteristics and are collectively designated for the first time, as above, by the name of the least specialized.

In young juveniles of these as well as of other species, somatic generic characteristics were already established in digestive and excretory systems but reproductive organs always were unrecognizable under the binocular. Presumably only microscopic anlage of gonads, and possibly of deferent duct funnels, are present in this early period of post-hatching existence. From the female funnel rudiments, which are on the anterior face of septum 13/14, deferent ducts later grow back through the septum down towards and then deep into the musculature of the body wall but usually not until maturity are patent external openings, the female pores, recognizable in the epidermis. After the breeding season and as the clitellum regresses, these pores, according to the evidence now available, are occluded and the epidermal section (at least) of the oviduct aborted. The male deferent ducts likewise grow back, from funnel rudiments on anterior faces of 10/11-11/12 but on reaching the parietes instead of penetrating deeply into the musculature continue to grow posteriorly. The ducts of a side, normally come into contact shortly and grow back together through six or seven segments but in xvii, after passing by, on the lateral side, sites of emergence of prostates into the coelom, unite, abruptly turn mesially and then bore down through the body wall. A portion of the united duct usually becomes more or less thickened to form an ejaculatory bulb that seems to be characteristic of this genus. Long before maturity the ducts acquire externally recognizable openings through the epidermis in *AB* and *behind the* equator of xvii. The apertures of the *a* and *b* follicles of that segment gradually become more closely approximated than in other segments, mostly it seems, by lateral migration of the *a* pore. The region immediately surrounding the follicle apertures then becomes depressed so as to be on the roof of a shallow fissure with a transversely slit-like superficial opening. These "fissures", to which frequent reference is necessary throughout this contribution, are developed in most species and now appear to be one of the basic innovations in the genus. Meanwhile the male pores have migrated forward to a site on the posterior wall of the fissure, and the sigmoid setae of the ventral follicles of xvii have been replaced by specialized shafts called penial. The prostatic pore rarely is recognizable even in adults but is located on the lateral or anterior wall of the fissure. The body wall adjacent to each fissure is thickened and demarcated more or less definitely to form a male "porophore" presumably with some function at time of copulation. The roof of the fissure around the follicle apertures may acquire, in some species, the appearance of a tough glistening transverse tubercle or of two circular tubercles. Prior to maturity genital markings, areas of parietal modification, and the spermathecae begin to develop but the period in which the coelomic cavity of xi is reduced to the lumen of a testis sac cannot now be mentioned.

In aberrant individuals without prostates the male deferent ducts ceased to grow before reaching xvii, or in xvii or occasionally not until several segments behind, and always failed to penetrate deeply into the parietes. When, however, prostates developed in a wrong segment, whether anteriorly (xv or xvi) or posteriorly (xviii), the male ducts acquired external openings in the prostatic metamere and in normal topographical relationships to the prostatic and follicle apertures. Presence of but one prostate resulted in normal development only on its own side of the body, the male ducts of the other side ending blindly as in aprostatic individuals. Male porophores and penial setae were not developed in absence of prostates but did develop in wrong segments where prostates were present. In worms with prostates in different segments on opposite sides of the body, penial setae and porophores developed normally but in association with each prostate.

An extra prostate (very rare) was associated, in each case, with penial setae and an imperfectly developed male porophore without a male pore. These relationships permit an assumption that prostate anlage induce a series of changes that includes approximation of ventral follicles of xvii, development of the fissures, male porophores and penial setae, an abrupt change in direction of growth and then penetration of male deferent ducts into the parietes, as well as subsequent migration of the male pore into the fissure. The induction apparently becomes effective on male deferent ducts just as they are growing beyond level of the prostate anlage. When, however, the inducing influence is not exerted a duct may continue to grow straight posteriorly for ten segments more. In vestibulate species a vestibular invagination is induced also.

Male funnels had not developed in the usual segments, in certain aberrant individuals, when testes were lacking there but were present in wrong segments with testes. A similar relationship, also unilateral as in case of male funnels and male pores, was shown by the seminal vesicles. Here also an induction effect, this time by the testis anlage is assumed.

The prostate induction, in *hastatus*, so affects the associated setal follicles as to result in production of a battery of 6-12 shafts. Two of these assume the characteristics of functional setae and can be protruded through follicle apertures long before sexual maturity. Most of the "reserve" setae never will have any use in the way penial setae are supposed to function. Whether their production is one way of getting rid of certain wastes or whether they have some sort of a skeletal function, as suggested by Miss Chapman, the battery does represent one important specialization in a primitive species. Bends and wrinklings of ectal portions of reserve setae occasionally noted in worms that had not copulated may have resulted from violent muscular contractions at preservation.

Eutyphoeus manipurensis Stephenson 1921

External characteristics.—Clitellum extends on specimens from Tiddim and Falam to 16/17 or just onto xvii. Spermathecal pores centered at or close to m*BC*.

Male pore in a circular area of opacity in, or on a spheroidal tubercle on, the tumescence at posterior margin of fissure. Prostatic pore anterolateral to male pore and between the two tumescences.

One genital marking on each side in lateral portion of *BC*, presetal, close to margin of male porophore (3 Tiddim). A median area of greyish translucence in presetal portion of xii (3) may be only a region of epidermal thinness but on two of the worms looks like a genital marking though no gland was found internally.

Internal anatomy.—Typhlosole begins in xxvi but has a low protuberance into posterior portion of xxv. Lateral typhlosoles well developed, in xxvi (5). Lateral caeca in xxvi (5). Ventral caeca in xxxi-xxxiv (1), xxxi-xxxvi (1). Supra-intestinal glands in lxv-lxviii (2), but rudimentary in lxv in (1), lxv-lxix (1 Falam), lxviii-lxxi (1 Falam).

Circulatory system as in *gigas* except that extraoesophageals are connected by a transverse vessel just behind 5/6 and the dorsal vessel is uninterrupted and with commissures in v and vi.

Testis sac annular, dorsal trunk not included. Male funnels of x with spermatozoal iridescence (5). Testes of x, when recognizable, fan-shaped. Seminal vesicles of ix large (5). Bulbus ejaculatorius small, whitish, in parietes.

Spermathecal duct about one mm. long, with muscular sheen, not bulbous, lumen irregularly slit-like in section due to presence of several low ridges, one on the posterior wall often slightly larger.

Genital marking glands small, acinous, sessile on parietes, covered dorsally by a very delicate, transparent membrane which may be peritoneal. Parietal portion of gland tougher, narrower and of slightly different colour.

Penial setae (12) 1·04-2·0 mm. long, 33-62μ thick at base, 26-41 at midshaft. Ornamentation variable, clearly visible or almost unrecognizable under low power of microscope, scattered single triangular teeth, or smaller spines in transverse rows of seven to eleven or in irregular circles rarely or frequently broken. Number, 2 (6 batteries), 2 functional and 1 reserve (2 batteries), 2 functional and three reserve (1).

Remarks.—The tag-like tumescences on the male porophores are regarded as equivalents of separated anterior and posterior halves of "annular" penes. Constant presence of the four tags indicates they may be permanent structures rather than temporary eversions or outrollings from the fissure. Slight depression of male porophores obviates protuberance beyond general level of body surface. However, tags of similar appearance in a species of *Toroscolex* appear to be independently retractile.

Sufficient material for estimation of extent and significance of variation with regard to taxonomically important structures has not been available in this species. The samples that have been studied are thought to indicate that the Burmese populations have become stable with reference to development and location of the lateral intestinal caeca but not with regard to number and location of genital markings. Apertures of the spermathecae have migrated laterally in the Burmese population but apparently have been retained, in the Manipur population, in a site that must be regarded as primitive. The Indian worms seem to have become more specialized with reference to the capsule around the genital marking glands but all are primitive in so far as modification and number of penial setae are concerned. Distribution presumably is continuous in a north-south direction through the Arakan mountain arc.

The difference in segmental location of the lateral intestinal caeca, in view of the evidence provided by various species (below), is thought to have resulted from independent evolution of those structures in different portions of the range rather than by a transfer of organ developing capacity from one segment to another. To call attention taxonomically to the differences while at the same time indicating a very close relationship, two subspecies are erected, *manipurensis* (n. subsp.) for the northern worms of India, *chinensis* (n. subsp.) for the Burmese worms in a southern part of the range.

By cancelling out obvious specializations, such as the fissure tags in *manipurensis*, modifications in penial setae and battery as well of course as the penial annulus in *hastatus*, together with genital markings and associated glands, lateral intestinal caeca, and parietal modifications around the fissures on xvii of both of those species, a stage of organization is obtained that may well have characterized a form ancestral to both of those species. This hypothetical form is referred to hereinafter as proto-eutyphoeus for from it there can be derived additionally not only all species of *Eutyphoeus* but even a closely related genus.

The most important morphological difference between *hastatus* and *manipurensis* is the absence in the latter of a median spermathecal diverticulum. This condition, in the genus *Eutyphoeus*, now appears not to be primitive and so proto-eutyphoeus is credited with bidiverticulate spermathecae. The unidiverticulate condition with which we are here concerned occasionally appears in individuals of species with bidiverticulate spermathecae. A single step, abrupt change of this sort suggests intervention of a mutation for inhibition of development of the median diverticulum. Establishment of this particular mutation, "unidiverticulate", is proposed as an important stage in the evolution of *manipurensis* from the proto-eutyphoeus.

Eutyphoeus marmoreus Gates 1933

Internal anatomy.—Typhlosole begins, in the types, in xxix. Lateral typhlosoles low simple lamellae in xxix, reaching slightly into xxx. Lateral intestinal caeca in xxviii (2). Ventral caeca in xii—lx(1). Supra intestinal glands in lxxxv-lxxxviii (1), lxxxvi-lxxxviii (1).

Circulatory system as in *gigas* except that the extra-oesophageals are connected by a transverse vessel behind 5/6 and the dorsal trunk is uninterrupted.

Left posterior seminal vesicle of one worm passes back into xxiii. Vestibulum, when completely retracted, conspicuously protuberant into coelomic cavity and with a more or less pointed apex about two mm. above level of ventral parietes. Penisetal follicle and prostatic duct pass into apex of vestibular bulb, the bulbus ejaculatorius into the posterior wall and more ventrally. With partial eversion vestibular bulb is dorso-ventrally flattened and the externally protuberant portion is elongate and with a soft, wrinkled, greyish translucent surface.

Spermathecal duct slightly more than two mm. long and nearly two mm. thick. Lumen irregularly slit-like in cross section ectally, becoming rather crescentic entally, due to presence of several ridges ectally and of a high and thick posterior ridge ectally.

Penial setae 1·8-1·95 mm. long, 40-45μ thick at base, 23-40 at neck, 29-45 at blade. Tip flattened and slightly widened, narrowed to a spine. Ornamentation of fine thornlike teeth in regular circles, continued to 0·9 mm. level down the shaft. Number, 2-4. Reserve setae pink, tip with terminal hook.

Remarks.—Three worms from the type locality of *marmoreus* and *bullatus*, with a complete dorsal trunk and no genital markings, have been difficult to place. Because of apparent absence of testes in x and lack of any iridescence on male funnels indicating those gonads had been present, the specimens, in spite of the presence of seminal vesicles in ix, were regarded as metandric and referred to *bullatus*. Conditions since found in other species apparently indicate that testes of x may mature or at least cease functioning earlier than those of xi, and that discharged testes may regress so as to become macroscopically unrecognizable. The seminal vesicles of ix may then be expected to regress earlier than those of xii thus explaining the flattening against the anterior face of 9/10 (not 8/9). Accordingly, the three trouble ome worms are now considered to be *marmoreus*. If, however, as was firs thought, the three worms were unable to produce sperm in x, the condition would now be attributable to a mutation for metandry (p.128) unless of course, a third species closely related to the other two is present in the same locality.

E. marmoreus has penial setae of a more advanced type than does *manipurensis* and a battery that is more primitive than that of *hastatus*, but like the latter is distinguished from *manipurensis* by the primitive bidiverticulate spermathecae. Intestinal caeca, as in case of *manipurensis*, indicate a more advanced stage of evolutionary development and stability than has been attained by *hastatus*. Morphological specializations and geographical distribution rule out close relationship with all other holandric species. All that is needed, however, to derive *marmoreus* from the proto-eutyphoeus is to bring about the invagination into the coelomic cavity of that same portion of the body wall that become modified in the rest of the holandric species into a tough and sometimes thickened, disc-like male porophore. The slightly concave depression in the male porophore of *manipurensis*, that seems to be necessary to prevent erosion of the delicate fissure tags, is suggestive of a very early stage of such an invagination.

The tag which bears the male pore (as in *manipurensis*) is now removed far away from the surface and at the same time a structure is obtained which can function as a temporary intromittent organ for direct transfer of sperm into a spermathecal duct. This eversible vestibulum with its muscular bulb is certainly an advanced sort of specialization and one that is lacking in many species of the derived groups that are next to be considered.

Eutyphoeus bullatus Gates 1933

Penial setae (6 from Tiddim types) are 1·62-2·58 mm. long, 33-50μ thick at base, 27-36 at midshaft, 10-15 at tip. Shaft straight except for ectal curvature. Tip flattened and tapering to a point. Ornamentation of thorn-like spines scattered single or in short transverse rows. Number, 2-4 (3 batteries). Reserve setae red, 0·45-0·52 mm. long, 55-59μ thick at midshaft. Tip more markedly flattened than in functional setae which are yellow.

Remarks.—Three of the types having been transferred to another species *bullatus* is now defined as metandric and with a foreshortened dorsal blood vessel. These two characteristics distinguish the species from those of the *hastatus* group. Absence of the testes of x (metandry), in organisms that have no more than two pairs of these gonads, long has been considered taxonomically important, often requiring generic distinction. Absence of an anterior portion of the dorsal blood vessel together with associated portions of the circulatory system, in animals of a relatively simple sort, has been thought to have taxonomic value at the species level. However, these two characteristics, in the case of *bullatus*, would indicate relationships to species that are geographically distant and isolated from it. The specialized and presumably eversible vestibula, on the contrary, suggest relationship to *marmoreus* which is present in the same area. The latter species, except for the intestinal caeca, is primitive enough to serve as an ancestor for *bullatus*.

Whether phyletic derivation is to be direct or from a common ancestor with *marmoreus*, or from an ancestor common to morphologically similar but geographically isolated species, it does require the two drastic modifications in reproductive and circulatory systems. Foreshortening of the dorsal trunk may have taken place earlier as presence of anterior seminal vesicles, structures usually eliminated long before the anterior male funnels and their deferent ducts, indicates quite recent acquisition of metandry. Phyletic origin from a common ancestor with *marmoreus* now seems to be the one required. This derivation justifies appending an otherwise isolated species to a fairly homogenous group of such different morphological organization.

THE *constrictus* GROUP

Eutyphoeus constrictus Gates 1929

1

Meiktila (the type locality), September, 1-0-22. K. John.

External characteristics.—Length, 110-150 mm. Diameter, 5-7 mm. Setae small, often recognizable only with difficulty : one *b* seta of xix 0·32 mm. long and 30μ thick at nodulus, ventral setae at least of viii-x ornamented with short transverse ridges of very fine teeth. First dorsal pore on 10/11 (4), ?11/12 (8), 11/12 (11). Clitellum reddish.

Spermathecal pores with centers at or median to *B*, often reaching to or nearly to *A*. Female pores both present (22). Male porophores areas of slight parietal thickening, nearly circular extending from or slightly median to *A* (rarely just lateral to mV) to or nearly to *C*.

The external male aperture represented by the transversely slit-like opening in the parietes through which penial setae may project, in *AB* and on the median half of a male porophore, occasionally close to the median margin. The portion of the porophore immediately adjacent to the slit is soft, whitish and often slightly tumescent, usually especially marked anteriorly and posteriorly but never with an appearance of a complete annulus. The primary male pore is minute and on the posterior wall of the shallow fissure into which the external aperture leads, occasionally on a hemispheroidal tubercle. On the anterior wall of the fissure is the prostatic pore. Two pits on the roof of the fissure apparently represent apertures of two discrete penisetal follicles. (No genital markings.)

Internal anatomy.—Typhlosole begins in xxvii (2), xxviii (7) or xxix (5). Lateral typhlosoles present in the first two typhlosolar segments (22). Lateral intestinal caeca lacking (6), or when present in xxvii (3), xxviii (10), xxix (1), two pairs, one each in xxviii-xxix (1). Caeca are slightly protuberant anteroposteriorly flattened flaps, definitely constricted off only dorsally (8). First ventral caecum in xxxiii (1) or xxxiv (5).

Location of supra-intestinal glands

Segments	Specimens
96-102	1
97-101	2
97-102	1
97-103	1
98-103	4*
99-144	3
99-105	1
100-104	1

* Including the juvenile.

Circulatory system as in *gigas* except as follows: Dorsal blood vessel uninterrupted (22), commissures unrecognizable in v (5) or present but slender, translucent or opaque and then white and without blood (possibly functionless ? 5), with blood (12). Extra-oesophageal trunks connected by a transverse commissure just behind 5/6.

Testis sac ventral (1), annular (21) and above dorsal vessel. Male funnels present in x (22), usually only small and rounded knobs, larger and crenellated (3). Vasa deferentia of a side separate to xvii. Bulbus ejaculatorius small, soft, whitish, coelomic but covered by delicate tissues.

Spermathecal duct short, lumen rather large, irregularly slit-like in cross section due to presence of several low vertical ridges. Diverticula elongate, always paired (44 spermathecae), sperm mass usually twisted in a slightly spiral or shortly zigzag fashion.

Abnormality.—Right prostate unusually short, 2 mm. long, but of normal thickness.

Remarks.—Locations of supra-intestinal glands in the other eight worms were indeterminable because of condition. Location of these glands enables identification of the juvenile even though male porophores had not yet developed as there is no other unpigmented metandric species with uninterrupted dorsal vessel in the Meiktila area.

The lumen of the fissure in the male porophore now appears to be the equivalent of that within a penis and so should not be considered a rudimentary vestibular invagination. Location of the male pore on the tumescence at posterior margin of fissure aperture, when that tumescence is most pronounced, apparently indicates that the lining of the fissure can be pulled outwards.

2

E. constrictus has been found to the north of Meiktila only at Mansum presumably in Myitkyina district, 12 to 14 miles from Gora, at *ca.* 3,200 feet, in dense, rain-forest bamboo.

The single specimen secured has no genital markings, spermathecal pores slightly lateral to *B*, rudimentary lateral intestinal caeca in region of xxv, ventral caeca in xxxv-xxxvi (+?), and supra-intestinal glands in lxxxi-lxxxiv. The typhlosole begins in region of xxv-xxvii and there are rudiments of lateral typholosoles in xxv.

3

Myingyan, September 0-0-1. K. John.

Length, 83 mm. Diameter, $3\frac{1}{2}$ mm.

Lateral intestinal caeca lacking. First ventral caecum in xxxii. Supra-intestinal glands in lxxxv-lxxxix.

Worms from other Myingyan localities, Chappea and Kyaukpadaung, also hadno genital markings.

Penial setae (25, Myingyan district localities) 1·4-1·77 mm. long, 40-55μ thick at base, 30-50 at neck, 60-82 through blade. Shaft nearly straight occasionally with circular constrictions in neck or blade regions, Tip thickened, flattened on one side, red, tapering to a point. Ornamentation of scattered rows of four or more thorn-like teeth. Number, 5-8 (13 batteries), 14 (1 battery). Functional setae, the two longest of a battery, yellow except for tip which is red. Three functional, *i.e.*, yellow setae, present in the 14-shaft battery. Reserve setae thicker than functional setae and with entire shaft red. One functional seta only in each battery of several juveniles (75×2 mm.), all setae of other juvenile batteries entirely red. The largest setae of these juvenile batteries 0·4-0·41 mm. long.

4

South of Meiktila *E. constrictus* was found at Ywadaw and Pyinmana (Yamethin). Paired, triangular genital markings in *AC* are present on xvi of each of the 46 specimens from those two localities.

5

Further south in the Sittang valley *E. constrictus* was obtained at two different localities so near the town of Toungoo that no other information was recorded.

Genital markings were lacking in eight specimens from one of those colonies. Reproductive organs were juvenile in spite of marked clitellar tumescence and retardation in development may have been due to parasites present in huge numbers.

6

Spermathecal pores were centered at *C* in worms from the other Toungoo colony. Genital markings present on each of the five specimens were in *BC* on xiii. Markings were rather large and depressed so as to have a somewhat sucker-like appearance.

7

Daylo stream, Karen Hills (Toungoo,) 0-0-1.

External characteristics.—Length, 125 mm. Diameter, 4 mm. First dorsal pore on 11/12. Spermathecal pores with centers at or slightly lateral to *C*. Male porophores small, circular, indistinctly demarcated, slightly concave. Fissure containing male pore at center of porophore. Genital markings larger than porophores, in *AB*, on xv, between sites of 14/15 and 15/16.

Internal anatomy.—Typhlosole begins in xxvii. Lateral typhlosoles in xxvii. Lateral intestinal caeca in xxviii. Ventral caeca in xxxii-l, the first much larger and the only one with a recognizable aperture into intestinal lumen. Supra-intestinal glands in lxxix-lxxxii. Dorsal trunk uninterrupted, commissures of v blood-filled.

Testis sac annular. Male funnels present in x. Right anterior deferent duct comes into contact with posterior duct in xii, separates, in contact again from xv.

Over site of each genital marking there is a conspicuous protuberance into coelomic cavity with smooth, white, firm surface, probably with a thin but transparent layer of muscle continued across it.

8

Pa Taw Lo, between Sat Der and Chaung Na Kwa, Karen Hills (Toungoo), September, 0-0-1 (in poor condition). Dr. H. I. Marshall.

Male porophores raised in a rather mound-like manner. Spermathecal pores lateral to m*BC*. Genital markings extending slightly beyond *A* and *B*, on xix.

Lateral intestinal caeca in xxviii, but retracted into intestinal lumen. Supra-intestinal glands in lxxxii-lxxxvi. Male funnels of x small but slightly crenellated.

9

Pegu Yomas (Toungoo), September. Site No. 1, 0-15-14. Site No. 2, 0-0-1. Site No. 3, 0-0-1. Site No. 4, 0-1-5. Site No. 5, 0-0-1. G. E. Blackwell.

External characteristics.—Length, 120-230 mm. Diameter, 4-6 mm. Unpigmented, clitellum reddish but not protuberant. Setae begin on ii, fairly large, readily visible; a *b* seta of xix 0·43 mm. long and 37μ thick at nodulus, tip ornamented with transverse rows of very fine teeth. First dorsal pore on 11/12 but with an obviously imperforate, dark, greyish translucent marking on 10/11 (2), marking on 10/11 more pore-like but probably non-functional (5), no marking on 10/11 (30), on 12/13 (1).

Spermathecal pores small, in lateral portion of *BC* and usually nearer *C* than m*BC*, or with centers at or just lateral to *C* or more rarely with the whole pore lateral to *C*. Female pores both present (24). Male porophores small, unprotuberant, transversely elliptical to spindle-shaped, greyish translucent, with centers at or just median to *B*. Porophores on several specimens have a narrow, opaque, whitish, slightly raised rim, sharply demarcated both peripherally and from the grey portion by slight though definite grooves. The fissure is central, completely filled by tips of penial setae, margin of fissure aperture quite without tumescence or protuberance. A longitudinal crescentic area of grey translucence, concave on lateral side, is median to each male porophore and may have a clearly demarcated opaque rim. These areas may be slightly separate from, in contact with, or united with the male porophores; in latter case the grey portions of the areas and of the porophores continuous.

Genital markings reach to or nearly to intersegmental furrows, slightly beyond *B*, and mesially are in contact (8), or with rims united at mV (1), or with rims separated midventrally by a strip of unmodified epidermis of variable width (29). Locations: on xv (10, 9 from site 1), xviii (16, 9 from site 1), xix (12, 7 from site 1), left side only (1, site 5).

Internal anatomy.—Typhlosole begins in xxvii (1), xxviii (11), or xxix (10). Lateral typhlosoles always present (38), in first two typhlosolar segments Lateral intestinal caeca small, occasionally clearly constricted from gut all around the periphery but usually so marked off only dorsally, laterally, or anteriorly: in xxviii (24), left side only and retracted into intestinal lumen (1), xxix (3), left side of xxviii and right side of xxix (1), lacking (1). Ventral caeca in xxxii-xl (1), xxxiii-lx (1); first caecum in xxx (1), xxxii (2), xxxiii (14), xxxiv (1), in worms in which entire range was not determinable.

Location of supra-intestinal glands

Segments	Number of specimens from site 1	2	3	4	5
83-87	—	—	—	—	1
84-88	1	—	—	—	—
85-88	—	—	—	1	—
85-89	—	—	—	1	—
86-89	5	—	—	2	—
86-90	1	—	—	—	—
87-90	3	—	—	—	—
87-91	1	1	—	1	—
88-98	2	—	1	1	—
88-92	1	—	—	—	—
89-92	1	—	—	—	—

Dorsal blood vessel uninterrupted (38), commissures of v usually large and red. Lateroparietal trunks may be clearly visible as far back as lxxxv.

Testis sac annular (38). Seminal vesicles extend into xiii (2), xiv (3), xv (9), xvi (2), xxii and constricted by septa (1, from site 5). Male funnels of x small (38), usually rounded rather than crenellated. Anterior male ducts always smaller, usually much smaller. Bulbus ejaculatorius fairly large, whitish, and in a worm from site 5 two mm. long.

Spermathecal duct short, lumen crescentic in cross section due to presence of a vertical ridge (with vertical groove) on posterior wall. Diverticula median and lateral (76 spermathecae), usually elongate.

Penial setae (34, various localities) 1·45-2·88 mm. long, 30-50μ thick at base, 28-50 (58-65, worm from site 5), at neck, 50-85 (100-125, worm from site 5) at blade. Shaft straight. Tip pink, slightly flattened on one side, tapering rapidly. Ornamentation of fine thorn-like teeth. Number, 8-11 (17 batteries). Reserve setae entirely red.

Abnormality.—(No. 1) Right male funnel of xi herniated through 10/11 into x. (No. 2) An extra diverticulum on anterior face of one spermathecal duct. (No. 3) An extra diverticulum on posterior face of one spermathecal duct. (No. 4) One diverticulum almost completely bifid.

10

Twante (Hanthawaddy), September, 0-0-64. K. John.
Hlegu (Insein), September, 0-0-2. K. John.

External characteristics.—Length, 150-230 mm. Diameter, 5-6 mm. Unpigmented, clitellum yellowish, yellowish brown or brownish. Setae usually begin on ii but may be wholly or in part lacking on that segment: on xx, $AB<CD<BC<AA$, DD *ca.*$=\frac{1}{2}C$. First dorsal pore on

9/10 (1), 10/11 (86, a small pore-like but imperforate marking on 9/10 on several), 11/12 (1).

Spermathecal apertures small, in lateral half of *BC* or with centers at or very close to *C*. Female pores both present (67, sites not determinable on others), usually at or just median to *A*, occasionally one or both just lateral to *A*.

Male porophores shortly elliptical (and then transverse) to circular, from a lateral portion of *AA* to or nearly to m*BC* and anteroposteriorly to or almost to 16/17 and 17/18, each with a slightly protuberant, white, narrow rim quite distinct from remaining portion in which epidermis is greish translucent. A completely circumferential annulus, at or just lateral to *B* around aperture of the fissure on each specimen except several from Twante (and then collapsed or retracted?). Two discrete penisetal pits present on roof of fissure which is very slightly dorsal to level of porophore surface. Male pore minute and on a rounded tubercle on posterior wall of fissure.

Genital markings shortly and transversely elliptical, with a narrow, raised,white marginal rim and a greyish translucent central portion, usually slightly smaller than the male porophores with which they are in line, on xx right side only (15), left side (13), both sides (8 Twante and 1 Hlegu), lacking (23 Twante and 1 Hlegu).

Internal anatomy.—Typhlosole begins abruptly in xxviii-xxix. Small lateral typhlosoles always present in first two or three typhosolar segments (85). Lateral intestinal caeca usually lacking or represented only by slight bulges without distinct demarcation, definitely constricted off and ventrally directed caeca in xxviii (9), xxix (2, in one retracted into gut lumen). Ventral caeca in xxxiv-lix (2), xxxiv-lx (1), xxxiv-lvii (1), xxxvii-lix (1).

Location of supra-intestinal glands

Segments	Twante: without genital markings	Twante: with genital markings	Hlegu
85-88	4	2	—
85-89	2	1	1
86-89	3	2	—
86-90	—	2	—
87-90	—	2	—
87-91	2	3	—
88-91	1	3	—
88-93	—	—	
89-92	—	1	—

Dorsal blood vessel uninterrupted (85), commissures of v large and red 82).

Testis sac annular (80), U-shaped (3), or ventral (2). Male funnels present in x, usually crenellated, rarely (5) more rudimentary and knob-like. Anterior deferent ducts lacking on both sides (4 Twante and 1 Hlegu), present on one side only (2 Twante), present on both sides (48 Twante), occasionally recognizably smaller than the posterior ducts.

Spermathecal duct short, lumen rather crescentic in cross section due to presence of a high vertical ridge with vertical groove on posterior wall (lower and less definite ridges laterally and anteriorly). Diverticula median and lateral (165 spermathecae), short and thick, bilobed, trilobed or multilobed distally, occasionally digitiform.

Penial setae (4 Hlegu and 16 Twante) 2·4-3·06 mm. long, 40-65μ thick at base, 42-56 at neck, 65-90 at widest part of blade-like ectal portion. Major portion of shaft nearly straight, a terminal portion beginning just ental to blade curved to one side. Blade thickened and flattened on inner and outer sides of curve, narrowing gradually to an apparent point as viewed from side as seta lies on slide but when rolled over end is rounded or truncate. Ornamentation, ental to blade, of short, transverse rows of a few fine spines. Number, 10-14 (10 batteries).

Abnormality.—(No. 1) Right spermatheca adiverticulate (Twante). No. 2-3) Athecal, even rudiments of pores lacking.

Remarks.—Parietal protuberances into coelomic cavity of xvii, such as are present in Bassein worms, are either lacking here or so indefinite as not to be certainly recognizable.

11

Padaukchaung (Bassein), jungle, October, 0-0-36. K. John.

External characteristics.—Length, 96-135 mm. Diameter, 3-4 mm Setae may be wholly or in part lacking on iii or iii-iv as well as on ii.

On each male porophore of each specimen there are two slightly raised and fairly distinctly delimited areas, one median and the other lateral to the penial annulus. These areas may be circular or triangular and then with apices towards annulus and bases at rim of porophore.

Genital markings on xviii (1), xix (10), xx (26), lacking on none.

Internal anatomy.—

Location of supra-intestinal glands

Segments	In worms with genital markings	
	on ix	on xx
81-84	—	1
82-85	2	3
83-86	2	6
83-87	1	—
84-87	4	1

Male funnels and anterior deferent ducts lacking on both sides (30). Bulbus ejaculatorius rather small, with no muscular sheen, concealed from view and bound to parietes by delicate tissues. The body wall is protuberant into coelomic cavity of xvii on each side, the protuberance of a rather hemispheroidal shape and soft. The prostatic duct passes into the anterior face, the penisetal follicle into the dorsal face, and the bulbus into the posterior face.

Penial setae (6) 2·48-2·76 mm. long, 42-50μ thick at base, 42-48 at neck, 70-76 at widest part of blade-like ectal portion. Number, 6-9 (3 batteries).

Remarks.—The organization of these worms, except as otherwise indicated above, is as in those from Twante and Hlegu.

12

Labu (Prome), August, 9-0-7, K. John.

External characteristics.—Length, to 195 mm. Diameter, 5-6 mm. Clitellum reddish. Setae large, one *b* of xix 0·5 mm. long, 50μ thick at nodulus. First dorsal pore on 10/11 (15, including 9 juveniles), 11/12 (1).

Spermathecal pores with centers at or lateral to *C*, in latter case pores entirely in *CD*. Female pores both present (6). Male porophores small, protuberant, shortly elliptical opaque areas, transversely or anterolaterally directed. Median half of porophore occupied by a small but definite annulus usually centered at *B*. A fairly clearly demarcated area of grey translucence just anteromedian to each porophore and with a narrow, opaque marginal band.

Genital markings lacking (5), paired but with margins united at mV, primarily presetal, in *BB* on xvi (1). A single marking on right side of a presetal portion of xviii of the other worm extends from m*BC* to *A*. An indistinct area of grey translucence on left side of xviii may represent a rudiment of the other marking of a pair.

Internal anatomy.—Typhlosole begins in xxix (3). Lateral typhlosoles present in xxviii-xxix (5). Lateral intestinal caeca rudimentary and marked off dorsally, in xxviii (4), marked off ventrally, in xxix (3). Ventral caeca in xxxv-liii (1), first ventral caecum in xxxiii (1), xxxiv (2), xxxv (5).

Location of supra-intestinal glands

Segments	Number of juveniles	Number of adults
81-86	1	
82-86	1	
82-87	..	1
83-87	..	1
83-88	1	...
84-88	1	..
84-90	..	1
85-89	2	1
85-90	..	[illegible]
86-89	1	..
86-90		2
86-91	1	..

Dorsal vessel uninterrupted, segmental commissures present in v (5). Testis sac annular (5). Male funnels present in x (5), deferent ducts of a side unite in xvii. Bulbus ejaculatorius more than one mm. long, coelomic.

Spermathecal *duct* short, *lumen* irregularly crescentic in cross section, due to presence of several small and one large vertical ridges, latter with a vertical groove at least ventrally. Diverticula median and lateral (10 spermathecae), usually elongate, sperm occasionally in a zigzag looped or spirally coiled mass.

Remarks.—These worms were collected near a cluster of several houses that is too unimportant to be on any of the maps but which is located not far from the river bank, across the Irrawaddy from the town of Prome.

13

Prome, August, 4-17-14. K. John.

Paukkaung (Prome), August 0-0-14. K. John.

Thanbula (Thayetmyo), August, 0-1-14. K. John.

External characteristics.—Length, 80-160 mm. Diameter, 3-5 mm. Clitellum reddish. First dorsal pore on 10/11 but with an imperforate marking on 9/10 (Thanbula a-b), on 11/12, occasionally with a pore-like but imperforate marking on 10/11 (Thanbula c and several others).

Measurements of b setae of xix

Length in mm	Thickness in micra at nodulus*	
0·43	40	Prome
0·47	40	..
0·39	40	Paukkaung
0·31	33	Thanbula
0·31	25	..
0·32	30	..
0·25	20	Thanbula a
0·26	26	b
0·48	38	c

Spermathecal pores in lateral portion of *BC*. Female pores both present (53). Male porophores circular or nearly so, or transversely elliptical and then occasionally approximating to size and shape of porophores of *hastatus*. The fissure, at or close to *B*, usually central, occasionally slightly lateral.

General markings in contact mesially or nearly so, on xiv (2 Paukkaung), xv (1 Thanbula), xviii (11), xix (5), xx (1), xxi (4).

*Ornamentation of transverse rows of fine teeth near tip.

Internal anatomy.—Typhlosole begins in xxviii-xxix. Lateral typhlosoles present in first one or two typhlosolar segments (63). Lateral intestinal caeca unrecognizable in some but present though rudimentary in others, in xxviii. Ventral caeca in xxxi-xliv (1 Prome), xxxii-li (1 Prome), xxxii-liv (1 Prome), xxxii-lv (1 Prome), xxxiii-l (Thanbula b) xxxiv-lvii (Thanbula c).

Location of supra-intestinal glands

Segments	Number of specimens from		
	Prome	Paukkaung	Thanbula
73-76	..	1	..
75-77	..	1	..
75-78	..	1	
76-80	..	1	..
77-80	..	6	.
77-81	2	1	2
78-81	1	1	..
78-82	3	1	1
79-82	1	1	..
79-83	2	..	3 (including a)
80-83	1	..	..
80-84	5	..	5
80-85	1	..	..
81-84	2	..	..
81-85	4	..	1
81-86	1	..	1
82-86	4	..	..
82-87	3	..	..
83-87	3	..	..
84-88	1	..	..
84-89	1	..	..
85-89	1	..	1 (b)
89-93	..	..	1 (c)

Dorsal vessel uninterrupted (63), segmental commissures of vi and v always present (63), usually large and blood filled.

Testis sac annular (63). Male funnels of x present (63), usually small, with no ducts (6 Prome), ducts present but slenderer than the posterior ducts (57).

Spermathecal diverticua median and lateral (126 spermathecae). Occasionally with a double widening distally to produce a rathercruciform shape (8 diverticula).

Penial setae (20 from Prome) 1·49-2·51 mm· long, 42-70μ thick at base 35-50 at neck (just ental to blade), 51-75 at widened blade. Shaft nearly straight except for curvature ectal to neck. Ornamentation, from neck entally, of transverse rows of 3-12 spine-like teeth, or occasionally teeth in somewhat irregular circles. Number, 7-9 (10 batteries), 10-11 (2 batteries), 7-13 (8 batteries of aprostatic juveniles). All setae usually yellow, functional setae of a deeper color, or functional setae with pink tips, or reserve setae pink and functional yellow (3 batteries from Thanbula a-b-c).

Remarks.—Aprostatic juveniles, in which prostates are not yet recognizable internally, are 53-62 mm. long and 3 mm. thick. Rudiments of seminal vesicles are recognizable and ental ends of spermathecae just protrude through the parietes. Rudiments of genital markings are recognizable on a slightly larger juvenile, 87×3·8 mm.

Spermathecal pores of Thanbula a and b are in median half of *BC*. Genital markings are on xi in *BC* (Thanbula a), on xii-xiii in *BC* (Thanbula b), and those of Thanbula c are in *AB*, on xix, postsetal with *a* and *b* in anterior margin.

14

Natmauk (Magwe), on the road from Magwe, August, 5-0-5. K. John.

External characteristics.—Length, to 110 mm. Diameter, to 5 mm. Clitellum yellowish. Setae small, one *b* of xix 0·32 mm. long and 32μ thick at nodulus, a reserve associated therewith being 0·25 mm. and 25μ. First dorsal pore on 11/12 (5).

Spermathecal pores with centers at or slightly lateral to *B* and reaching m*BC*. Female pores both present (5). Male porophores as on topotypical material (1), or slightly elongated so as to dislocate 16/17 and 17/18 (3), larger and circular and extending from *A* to *C* (worm with markings on xix). Fissure just lateral to *B*, margin of fissure aperture usually slightly tumescent, annular (1) and distinctly marked off by a completely circumferential furrow.

Genital markings, of about the size of porophores (3) or slightly smaller, in *BC* or *AC*, on xv, right side (1), both sides (3), xix (1).

Internal anatomy.—Typhlosole begins in xxvii (1) or xxviii (4). Lateral typhlosoles always present in first two typhlosolar segments. Lateral intestinal caeca lacking (1), represented by small trilobed flaps in xxvii(1), or by slightly protuberant, anteroposteriorly or lateromesially flattened flaps, definitely constricted off only dorsally, in xxviii (3). First ventral caecum in xxxiii (1), xxxiv (1) or xxxv (3).

Location of supra-intestinal glands

Segments	Number of specimens	
101-105 .	1	Markings+on xix
102-106 . .	2	Including 1 juvenile
103-109 . .	1	Juvenile
104-109 . . .	2	

Dorsal blood vessel uninterrupted, commissures of v present and red (7, including 2 juveniles).

Testis sac annular (5), above dorsal vessel. Male funnels of x larger than in topotypical worms and crenellated. Bulbus ejaculatorius small, soft, whitish, covered by delicate tissues.

Spermathecal duct so short as to be almost unrecognizable in coelomic cavity. Diverticula median and lateral (14 spermathecae).

15

Magwe, vicinity of, August, 0-0-9. K. John.

Male porophores and genital markings (on xxi) appear to be the same as in *hastatus* from the same locality. Supra-intestinal glands are in xcv-ciii, the same segments as are involved in *hastatus* from the same locality.

Remarks.—Other portions of the records and the specimens were destroyed during the war.

16

Pegu Yomas, opposite Letpadan (Tharrawaddy), August, 0-0-2. G. R. Anderson.

Genital markings on 21/22. Markings and male porophores as in *hastatus* from the same locality. Seminal vesicles of xii reach into xvii.

Remarks.—Other records as well as the specimens were destroyed during the war.

Intersegmental markings have not been found, in this species, at any other locality. Similarly, such markings have been found, in *hastatus*, only at this locality. Both holandric and metandric individuals were characterized by unusually long seminal vesicles. Accordingly it appears that worms which must be referred to *constrictus* have arisen, *in situ*, from *hastatus* by the metandric mutation.

17

Mt. Victoria (Pakokku), at 3,000 feet, in teak forest and grass land on east side near path from Kanpetlet to summit, July, 7-0-0. Dr. G. Heinrich.

External characteristics.—Length, 70-100 mm. Diameter, 3-5 mm. Setae begin on ii on which all are present though almost unrecognizable except with brilliant illumination because of small size and deep retraction; on xx, $AB<CD<BC<AA$, BC quite definitely $< AA$ throughout the rest of the axis. A *b* seta of xix of the most mature specimen is 0·32 mm. long and 22μ thick and without recognizable ornamentation. A reserve seta from same follicle 0·085 mm. long and 25μ thick at base. First dorsal pore on 11/12 (3) or 12/13 (1).

Spermathecal pores in median half of BC. Female pores both present. A penial annulus centered about at B in a slight convacity extending from A to mBC and no deeper than that of the genital markings. Posterior part of the annulus slightly thickened.

Genital markings paired, depressed, greyish translucent, from A to mBC, on xx (3).

Internal anatomy.—Typhlosole begins in xxix (6). Lateral typhlosoles in first one or two typhlosolar segments (6). Lateral intestinal caeca represented by small, vertical protuberances without definite demarcation, in xxviii (6), apertures into gut lumen in anteriormost portion of xxix clearly marked off on inner wall of intestine. Ventral caeca present. Supraintestinal glands in lxxv-lxxviii (2), lxxvi-lxxix (2), lxxvii-lxxix (1), lxxvii-lxxx (1), lxxviii-lxxxi (1).

Dorsal blood vessel uninterrupted (7), segmental commissures of v blood filled (7). A transverse vessel connects the extra-oesophageals just behind 5/6.

Testis sac annular (3). Seminal vesicles restricted to xii (6), including most mature worm extending into xiv (1), a slender posterior lobe directed dorsally (6), posteriorly directed and in a rather closely zigzagged series of loops (1). Male funnels of x only slightly smaller than the posterior funnels.

Spermathecal diverticula median and lateral (2 spermathecae).

Penial setae (12) 0·36-1·23 mm long, 13-28μ thick at base, 15-47 at midshaft, 5-15 at tip. Shaft slightly bowed, gradually widened to a blade-like region ectally and then tapering to a blunt point, tip slightly curved in opposite direction to that of the other part of the shaft. Ornamentation of fine teeth in broken circles. Number, 9-15 (6 batteries). Two longest setae in each follicle, otherwise indistinguishable, from the reserves were measured. Reserve setae are thicker than the others.

Remarks.—Most mature worm is only 85 mm long. The penial annulus seems to be unusually well developed in comparison with other sex organs.

Gut of several worms is filled with a black "vegetable mould"

Identification of small juveniles of *Eutyphoeus* from a region of unknown fauna at present can be only tentative. In their present stage the worms are indistinguishable from *constrictus*. If the penial annulus represents an early rudiment of an elongate penis, development of some sort of an invagination to contain it is to be expected. Unpigmented worms with elongate penes and uninterrupted dorsal blood vessel, whether uni- or bi-vestibulate, cannot be referred to any species now known.

18

Mt. Victoria (Pakokku), in pine forest and evergreen jungle on east side near path from Kanpetlet to summit, at 7,800 feet, May 10 to June 10, 27-0-0. Dr. G. Heinrich.

External characteristics.—Length, 47,90 mm, Diameter, 3-4 mm. Setae begin on ii on which all are present ; on xx, $AB<CD<BC$, BC *ca.*- or slightly<or slightly$<AA$. A *b* seta from xx of the most mature specimen 0·43 mm long and 36μ thick at nodules, 0·34μ and 32μ from opposite side of same segment, an ectal portion lacking in both cases, ornamented with transverse rows of fine teeth. A reserve setae 0·04 mm long and nearly 20μ thick at base (ental end). First dorsal pore on 11/12 but with a pore-like though imperforate marking on 10/11 (9), 12/13 (1).

Spermathecal pores just lateral to *B*. Punctate depressions mark sites of both female pores. The male porophore is represented by an area of slight epidermal thickening, extending from just median to *A* to a slightly greater distance lateral to *B*, on which are two minute apertures. The anterior is a (combined ?) opening of penisetal follicles, the posterior a male pore. The margin of the male pore is very slightly tumescent on one of the worms.

Genital markings on xviii and xix, with centers about on *A* and reaching laterally to *B* (1, the largest specimen).

Internal anatomy.—The typhlosole begins in xxix (10). Lateral typhlosoles present in first one or two typhlosolar segments. Lateral intestinal caeca small, clearly marked off from gut, usually directed ventrally, in xxviii (10) but opening into gut in anteriormost portion of xxix. Ventral caeca in xxxi-lii (1), first caecum in xxxiii (3). Supra-intestinal glands in lxvii-lxix (1), lxviii-lxx (4), lxix-lxxi (2), lxx-lxxii (2), lxxi-lxxiii (1).

Dorsal blood vessel uninterrupted (10), commissures of v filled with blood (10).

Testis sac annular (10). Seminal vesicles reach posteriorly into xvii or even further back (1), xv (1), confined to xii (8). Each vesicle, in the latter case, in two distinct portions, an anterior which reaches only part way up the gut, and a posterior that is longer, usually narrower, reaching up to dorsal vessel or even across it to opposite side. Male funnels of x rudimentary, posterior funnels much larger but still button-shaped and of course without spermatozoal iridescence.

Spermathecal diverticula median and lateral (20 spermathecae).

Penial setae (18) 0·78-1·92 mm long, 16-27μ thick at base, 23-35 at midshaft, 9-15 at tip. Shaft straight except for a slight curve at ectal end and there widened but not flattened. Tip rather pointed or ending in a slight spine (4 setae). Ornamentation of fine spines in closely crowded, broken circles. Number, 10-15 (19 batteries). (The longest seta of each follicle considered as "functional" and measured. Other setae, reserves, thicker and yellower.)

Remarks.—Some of these worms were found crawling around on the ground after only two days of rain, according to Dr. Heinrich, though earthworms had not been found prior to that time. Others were found on trees, under bark and in holes made by beetles at about five feet from the ground. Intestines of such worms were filled with a black "vegetable mould" while the guts of others were filled with a yellowish or brownish soil.

These worms are distinguished from those of the 3,000 foot level by the smaller number of supra-intestinal glands (in 3 instead of 4 segments), the more anterior location of those glands (a slight discontinuity in segments involved in the two localities), better development of lateral intestinal caeca, larger setae, more anterior location of the genital markings, and absence of a penial annulus. In their present stage of development these worms, like those from the lower level, cannot be specifically distinguished from *constrictus*.

VARIATION IN *E. constrictus*

A functional dorsal pore on 10/11, presumably primitive, characterizes worms from the extreme southern part of the range (Hanthawaddy, Insein and Bassein districts), and from the west bank of the Irrawaddy in Prome but is occasionally still found in other localities (as Prome, Myitkyina). Location of spermathecal pores at or close to *B*, also primitive, characterizes worms from a central part of the range (Meiktila, Myingyan, Yamethin districts) and occasional individuals from Toungoo. Pores are in a median portion of *BC* in material from Natmauk (also in the dry zone), Mt. Victoria and Myitkyina but elsewhere have been shifted still further, to lateral part of *BC* or even into *CD*.

Genital markings have been lacking in all material from Myingyan, Meiktila and Myitkyina districts, in nearly a half of the worms from Hanthawaddy and Insein districts, as well as on occasional individuals elsewhere. Markings are segmental, paired, present only in clitellar and postclitellar (xviii-xxi) regions but vary in size, shape, intrasegmental location and number. Intraclitellar locations have been found only in worms from a middle portion of the southern half of the range (Magwe, Yamethin, Toungoo, Prome districts). Male porophores also vary as to size, shape and appearance. A distinct annulus around aperture into the fissure of the male porophore is generally present only in southern material (Hanthawaddy, Insein, Bassein, Labu), but even here it is not yet certain whether this annulus is a permanent structure or formed perhaps by rolling outwards of the wall of the fissure.

Variation as to segment in which the typhlosole begins is slight and there was none as to presence or absence of lateral typhlosoles. Lateral intestinal caeca are frequently lacking, often quite rudimentary, and at most not constricted off from gut all around the circumference. Caeca are usually in xxviii rarely in xxv (Myitkyina), xxvii (Meiktila) or xxix (several localities).

Number of segments with supra-intestinal glands, in an individual, varies, 3-7 ; 3-5 at Paukkaung, 4-5 at Padaukchaung and Pegu Yomas, 4-6 at Thanbula, Prome, Twante, 4-7 at Labu, 5-7 at Natmauk and Meiktila. Number of segments in which glands have been found, in a local population, is greater ; 7 at Mt. Victoria (7 and 10 specimen samples), Bassein (20) ; 9 at Natmauk (6), Hanthawaddy (53), Insein (2), Pegu Yomas (15), and Meiktila (14) ; 10 at Paukkaung (14) ; 11 at Labu (15) ; 13 at Prome (36) ; 17 at Thanbula (15). The number for the species is still larger, 37, the segments lxxiii-cix. The most anterior locations were in Prome material and the most posterior in that from Natmauk, the former locality well within and the other near the dry zone.

Male funnels usually are present in x most everywhere but apparently have disappeared in the Bassein population. There is no variation in termination of the dorsal vessel, any specimen with a foreshortened trunk would be identified as another species. Variation in taxonomically significant characteristics of the spermathecae is almost nil. Of the 406 (+)

spermathecae of 302 + specimens of *constrictus* that were examined in this connection, 603 were bidiverticulate. One lacked both diverticula. Several worms have had an extra diverticulum on anterior or posterior face of the duct. Only two athecal individuals of this species were ever found.

The range of *constrictus* includes all of the Pegu Yomas and their northern continuation between the Chindwin and Irrawaddy rivers as well as the western lowlands down to the latter between the bend and Prome. In recent alluvium the species has been found across the river from Prome once, at one locality in Bassein district, and near the yomas in Insein district but probably is present in older alluvium of the Sittang Valley north of Toungoo as it has been found occasionally in the Toungoo hills at the western margin of the Shan plateau. Included is all of the *hastatus* range that is east of the Chindwin and the Irrawaddy.

Morphologically about all that seems to be needed to derive *constrictus* directly from *hastatus* is elimination of the testes in x. The similarity of male porophores, identical location of similar genital markings in worms of the two species from each of several localities, in particular the very unusual intersegmental locations found at one Yoma site, seem to indicate that such a change may even now be taking place. The location of supra-intestinal glands in the same segments of both species through the Magwe-Natmauk section, in view of the marked discontinuity from the rest of *hastatus*, is also of interest in this connection.

The change required for the local phyletic derivation suggests appearance of a mutation, "metandric", for abortion of the anterior testes. Indeed, the lessened importance of the gonads of x in reproduction apparently evidenced by many specimens of *hastatus*, especially in an eastern portion of the range, may indicate that the mutation is already fairly well established in various populations of that species though its expression is masked or delayed until late in life of the individual. Persistence of functionless male funnels in x throughout most of the *constrictus* range has been regarded as evidence of recent origin. Occasional presence of rudimentary seminal vesicles in certain Yoma localities should then require a still more recent origin as vesicles certainly have disappeared in most metandric species long before the funnels of x. Retention of these useless organs, the funnels and vesicles, in *bullatus* as well as *constrictus*, and their eventual disappearance pose a problem with Lamarckian implications. The solution proposed is delay in penetrance till after gonads have induced development of the other organs, the delay greater in individuals with vesicles. Disappearance of the male funnels of x in certain isolated populations of *constrictus* would then indicate a fourth and still earlier stage of penetrance.

No geographically feasible alternative to phyletic derivation of *constrictus* from *hastatus* is available. The name of the former is now given to a group of species with ranges contiguous to or overlapping that of *constrictus*.

Two specimens of *constrictus* without spermathecae are to be explained as the result of appearance of a mutation, for inhibition of development of spermathecae. This mutation, "athecal", appears very much more rarely in *Eutyphoeus*, where only these two cases are known, than in various Burmese species of *Pheretima*. Athecal mutants cannot receive sperm in copulation. In absence of parthenogenetic capacity, as apparently in *Eutyphoeus*, there will be no offspring to perpetuate the mutation at least insofar as the female side of the hermaphroditic animal is concerned.

Eutyphoeus peguanus Gates 1925

1

Rangoon and immediate vicinity maHthawaddy), July-August, 0-0-69. K John.

Syriam (Hanthawaddy), August, 0-10-50. K. John.

Kyauktan (Hanthawaddy). August, 0-12-22. K. John.

Hmawbi (Insein), September, 0-0-34. K. John.

Taukkyan (Insein), September, 0-11-54. K. John.

Wanetchaung (Insein), September, 0-3-54. K. John.

Wakema (Myaungmya), October, 0-0-1. Maung Ohn Maung.

Pantenaw (Maubin), October, 3-0-0. Maung Ohn Maung.

External characteristics.—Unpigmented, as all material considered below. Clitellum reddish, at most only slightly tumescent. Ventral setae of viii-x ornamented as in *constrictus*, a *b* seta of xix from an aclitellate Rangoon worm 0·5 mm long and 44μ thick at nodulus. First dorsal pore on ?11/12 (2), 11/12 (52, of which 15 have an imperforate marking on 10/11).

Spermathecal pores large, in *BC*, occasionally reaching both *B* and *C*, usually centered at or near m*BC*, occasionally just median to *C*, rarely median to m*BC*. Female pores both present (63).

Male porophores large, circular or slightly extended longitudinally (never transversely), on large worms about 2 mm wide or 2 + 2½ mm, extending from or just median to *A* to m*BC*, often less distinctly demarcated mesially, body wall often slightly raised just beyond lateral margins. The small, shallow transverse fissure just lateral to *B*, usually on posterolateral quadrant, or near middle of posterior half (Kyauktan, Hlegu, Taukkyan). Two distinct penisetal follicle apertures present on roof of fissure but definite tubercles have not been recognized. Male pore on a small protuberance from posterior portion of fissure and may be nearly spheroidal, or depressed centrally so as to have a ring shape or in addition narrowed proximally so as to have more or less of a funnel-shape. Prostatic pore on anterior wall of fissure.

Genital markings lacking or paired and segmental, extending from just median to *A* to m*BC* or even further laterally, slightly dislocating intersegmental furrows both anteriorly and posteriorly, nearly circular or slightly extended longitudinally (never transversely), and of about the same size as the porophores. Markings may be slightly or markedly concave, level or nearly so, or a lateral portion may be elevated.

Location of genital markings

Locality	Number of specimens with markings on				No markings
	xix	xx	xxi	xxii	
Rangoon	7	..	50	..	12
Syriam	..	3	..	51	1
Kyauktan	6	19	1	4	2
Hlegu	..	32	..	..	..
Hmawbi	24	10	..	..	..
Taukkyan	..	32	..	..	2
Wanetchaung	1	17	..	3	28
Wakema	..	..	1	..	..

Syriam : Rxx and xxii (1), Lxxi and Rxxii (2), Rxxi (1), xx and Rxxii (1).
Kyauktan : Rxx and Lxxi (1).
Hlegu : Rxx (1).
Taukkyan : Rxx and Lxxi (1), Lxx (1).
Wanetchaung: Lxx (7), Lxix and Rxx (1).

Genital markings present on three consecutive segments, xx, xxi and xxii (1 Kyauktan) are smaller than the male porophores.

Internal anatomy.—Typhlosole begins in xxviii or xxix (as in other material below). Lateral typhlosoles present in xxviii-xxix (247 unrecognized in 3 worms), just median to caecal apertures. Lateral intestinal caeca are usually present. They may be slight lateral protuberances not clearly marked off from gut. When more distinctly constricted they may be bluntly rounded or pointed and then anteriorly, posteriorly, dorsally or ventrally directed. Occasionally they are completely retracted into gut lumen (4). In xxvii (2), xxviii (65), xxix but opening into gut at 28/29 or in xxviii (2).

Circulatory system, as in material considered below, as in *gigas* except that extra-oesophageal trunks are connected just behind 5/6 by a transverse vessel. Dorsal blood vessel ends with segmental commissures of vii (2), continued anteriorly (all others), usually ending with commissures of vi but at 5/6 (many Wanetchaung, some Syriam, several from other localities), at 4/5 (3 Syriam, several Wanetchaung). The portion anterior to commissures of vi may be white and slender (functionless?) or nearly as thick as posteriorly and then red but transparent even to 4/5 and with a pair of slender (functionless?) commissures just anterior to 5/6 (3).

Location of supra-intestinal glands and ventral caeca

Segments	Number of specimens from							
	1	2	3	4	5	6	7	8
3—96	..	1	..	..	..	..	..	..
94—98	..	1	1	3	..	..	..	..
94—99	..	2	1	1	..	..	..	..
95—99	4	2	6	4	..	..	..	
95—100	..	2	..	4	..	..	..	..

Location of supra-intestinal glands and ventral caeca—contd.

	Number of specimens from 1	2	3	4	5	6	7	8	
96—99	1	..	..	..	..	..	..	..	
96—100	4	..	1	3	..	..	..	..	
96—101	1	2	..	1	..	..	..	..	
97—101	2	..	3	2	..	..	..	..	
97—102	3	1	..	..	..	..	1	..	
98—102	5	1	..	..	..	..	..	..	
98—103	..	..	..	..	1	..	1	..	
99—103	1	..	..	..	..	..	2	..	
99—104	..	..	..	..	..	1	7	..	
99—106	..	..	..	..	..	..	1	..	
100—104	..	..	..	..	..	1	2	..	
100—105	..	..	..	..	1	..	9	..	
100—106	..	..	..	..	..	..	2	..	
101—105	..	..	..	..	1	..	4	..	
101—106	..	..	..	..	..	..	13	..	
101—107	..	..	..	..	..	..	2	..	
102—106	..	..	..	..	..	2	2	1	
102—107	..	..	..	..	1	..	8	..	
103—106	..	..	..	..	2	..	..	..	
103—107	..	..	..	..	1	..	..	..	
103—108	..	..	..	..	2	2	7		
104—108	..	..	..	..	..	3	..	..	
104—109	..	..	..	..	1	1	4	..	
104—111	..	..	..	..	..	..	1	..	
105—109	..	..	..	..	..	1	..	..	
105—110	..	..	..	..	..	..	1	.	
106—110	..	..	..	..	..	..		..	
107—112	..	..	..	..	..	..	1	..	
34—66							1	..	Left column worms with genital markings on xxi, right column those with markings on xix.
34—67							2	..	
34—68							..	1	
34—72							1	..	

Location of supra-intestinal glands and ventral caeca—contd.

Segments	Number of specimens from 1	2	3	4	5	6	7	8	Left column worms with genital marking on xxi, right column those with marking on xix.
34—73							..	1	
35—70							..	1	

1 Syriam. 2 Kyauktan. 3 Hmawbi.
4 Wanetchaung. 5 Hlegu. 6 Taukkyan.
7 Rangoon. 8 Wakema.

The first supra-intestinal gland is at 98 and 127 mm (from anterior end) in worms 200 and 250 mm long respectively.

Testis sac annular (almost always). Male funnels of x and their deferent ducts almost always present. The funnels may be as large and of same shape and appearance as those of xi, little more than small rounded knobs, or variously intermediate between those two extremes, the several conditions shown by worms from each of the localities. Deferent ducts are almost always smaller, occasionally much smaller, than those of the posterior funnels. Ducts of a side usually come into contact in xii and run side by side to xvii where they unite, but they may separate from each other at irregular intervals between xii and xvii, be twisted around each other, or (very rarely) be widely separated until xvii.

Spermathecal duct short, with thick wall, lumen irregularly slit-like in cross section due to presence of vertical ridges. One on the posterior wall often enlarged and with a slight vertical groove. A similar ridge occasionally present on anterior wall. Ampulla usually rather longitudinally sausage-shaped, often asymmetrical with relation to duct. Diverticula lateral and median (498 spermathecae), right spermatheca lacks median diverticulum (1 Syriam), both diverticula lacking (1 Syriam, Abn. No. 2). An additional one or two small diverticula present on posterior faces of ducts (1 Hlegu). Diverticula may be ovoidal, ellipsoidal, digitiform and in latter case bent, twisted or with very slight marginal indentations as if indicating a very slight zigzag looping. Sperm in each diverticulum usually in one continuous mass. A pyriform sperm mass with head embedded in granular contents of ampulla very frequently resting on aperture into duct, a narrowed ectal continuation translucent to transparent and occasionally protuberant to exterior through spermathecal pore.

Longitudinal musculature uninterrupted over genital markings though body wall may be bulged more or less conspicuously into coelomic cavities according to the depression of the markings.

Penial setae (60 Rangoon) 1·0-1·88 mm long, 33-55μ thick at base, 30-40 at neck, 37-50 at blade, 11-20 at tip.* Shaft usually straight, occasionally with a slight ectal curve. Tip widened and flattened, tapering to a point, or a short spine (once) or to a knob (4) or with rounded ectal margin. Ornamentation of thorn-like teeth in short transverse rows. Number, 6-10; 6 (2 batteries), 7 (5), 8 (9), 9 (12), 10 (2). Functional setae yellow. Reserve setae pink with widened, oar-like blade

* Measurements at tip made at a level 10μ down from ectal margin.

usually tapering to a point. The blade-like widening of the tip is lacking on 20 setae from five Rangoon earthworms that have no genital markings, the setae 35-40μ thick at midshaft. Ornamentation of these setae is restricted to a region between levels 0·3 and 0·4 mm down the shaft. Ornamentation continued further ectally on setae of worms with genital markings, occasionally even to very ectal margin.

Penial setae may lack a blade-like widening of tip in inornate worms from other localities, but outside of Rangoon absence of blade may also characterize setae from worms that do have genital markings. Measurements of smaller penisetal samples are included in the table below.

Length in mm	Thickness in μ at base	neck	blade	tip	Number measured	Number per battery	Genital markings on segment	Locality
1·8—2·0	53—60	31—32	38—39	15—17	2	7	xix	Kyauktan
1·6—1·9	31—40	34—38	41—46	12—13	4	6—7	xxii	Syriam
1·82—1·87	36—38	39—41		11—15	4	7—8	xx	Hmawbi
1·7—1·82	33—38	36—38		10—11	4	8	xix	Hmawbi
1·6—1·81	42—50	38—48		11—14	6	8—13*	xx	Taukkyan
1·5—1·79	47—70	47—50		12—15	6	8—9	xx	Hlegu
1·78—1·96	40—47	38—45		11—15	6	6—8	0	Wanetchaung

Juveniles.—Genital markings and male porophores are still lacking on the three Pantenaw worms. Supra-intestinal glands in ciii-cviii.

Abnormality.—(No. 1) An extra, median suboesophageal testis sac in xii, containing a male funnel on left side from which a deferent duct runs posteriorly to unite with other two deferent ducts of same side in xvii.

(No. 2) Right spermatheca represented only by two spheroidal vesicles sessile on parietes (Syriam).

Remarks.—The funnel-shaped protuberances bearing the male pores are so fragile as to be easily eroded and occasionally little evidence of their former presence is recognizable (erosion subsequent to preservation?).

Aclitellate specimens with a brownish or greyish discoloration of clitellar segments appear to be postsexual. Testis sacs are empty, testes large and fan-shaped, male funnels and spermathecae without iridescence, spermathecal ampullae filled with granular material. Genital markings are unrecognizable though their sites are discolored in the same way as clitellar segments.

Lateral typhlosoles (as in other species) are often unrecognizable even when intestinal contents have been carefully washed out and then become recognizable only after a firmly adherent, coagulated slime has been scraped off. In cases when coagulum was especially refractory the typhlosoles may also have been scraped off.

A slight sheen indicative of presence of muscle fibres is recognizable on the nerve cord under careful scrutiny. The cord breaks readily, usually close to level at which tension was exerted.

*Includes several very small reserve setae, scarcely more than the apices.

The worms characterized above are topotypical and, in addition, include those similar to topotypes in absence of clitellar genital markings, in size of postclitellar markings as well as of male porophores, and in eccentric location of fissures in posterior halves of male porophores. Localities from which these worms were obtained are all in the Irrawaddy Delta region

The size of the male porophores, together with an ability to depress them in a concave manner, is thought to indicate a sucker-like function at time of copulation. Genital markings, of similar size and capacity, lacking coelomic glands, may have the same function.

2

Duyinzeik (Thaton), September, 0-1-2. K. John.
Kyaikto (Thaton), August, 0-3-22. September, 0-6-48. K. John.
Kinmunsakhan (Thaton), September, 0-1-3. K. John.
Mupun (Amherst), October, 0-0-2. K. John.
Kawkareik (Amherst), 0-0-1.

External characteristics.—Length, to 160 mm. Diameter, to 7 mm. First dorsal pore on 11/12 (46, 14 of which have a more or less pore-like marking on 10/11 that is almost certainly imperforate in 12), 12/13 (3).

Spermathecal pores in median portion of *BC*, or with centers occasionally just lateral to *B*. Female pores both present (60). Male porophores small, circular, reaching from or about *A* into *BC*, nearly all of the porophore raised in a rounded, mound-like fashion, fissure central and about at *B*.

Genital markings slightly larger than male porophores, circular or nearly so, or transversely extended, from slightly lateral to mV into *BC*, or to or beyond *mBC*.

Location of genital markings

Locality	Number of specimens with genital markings on				
	xvi	xix	xx	xxi	xxii
Kyaikto	69	65	4		..
Kinmunsakhan	4	4	..	..	..
Duyinzeik	3	..	..	2	1
Mupun	2		..	2	..
Moulmein	35	..	..	35	..
Chaungson	10	..	..	10	..
Kya In	18		..	18	..
Ye	5	..	..	5	..

Kyaikto: Rxv, xvi and xix (3); Lxv, xvi and xix (1); xvi, Rxx, Rxxi (1); xvi, xix, Lxx (1); xvi, Rxx Lxxi (1); Lxvi, xx (1); xix (1); Rxx, Rxxi (1).

Internal anatomy.—Lateral typhlosoles always present (88). Lateral intestinal caeca usually present, in xxviii (29), dorsally directed (7), ventrally directed (8), laterally directed (5). Ventral caeca: in xxxiv-lvi (2 Kyaikto), xxxiv-lviii (1 Kyaikto), xxxiv-lxi (1 Kinmunsakhan), xxxv-lii (1 Kyaikto), xxxv-lxii (1 Mupun), xxxv-lxv (1 Duyinzeik).

Location of supra-intestinal glands

Segments	Number of specimens from 1	2	3	4	5	6	7	8	9
84—87	3	..	..	..	..	..	..	..	..
85—88	3	..	..	..	..	..		..	..
85—89	7	..	..	..	..	..	..		
86—89	5	..	..	..	..				
86—90	3	..	..	..		..	.	..	
87—90	4	..	..	..	..	..	..	..	
87—91	3	..	..	..	..	.	..		..
88—92	..	..	1	..	..	..	..		..
89—93	..	1	..	..	..	..	..	..	
90—93	..	..		1	..	..	..	..	
90—94	..		1	..			..	..	
91—95	..			2	..		..		..
92—96	..	..	..	1	..	1		..	
93—97	..			..	1	..			..
94—98	..	..	..	..	1	1			..
95—98	..	..	..		1				.
95—99	..	..	..		..		1	1	3
95—100	..	..	..		..				1
96—100	..	..	..	..	..		1	2	5+1
97—101	..	..		..	..		2	..	12+3
97—102	..	..	..	..	..	..	2	..	2
98—101	..	..	..		..	..		1	..
98—102	..	..	..	..	..	..	3	..	13+3
99—102	..	..	..	..	..	..	1	..	..
99—103	..	..	..	..	..	..	3	..	4+1
99—104	..	..	..	..	..	..	2		1+1
100—104	..	..	..	..	..		4	..	..
102—106	..	..	..	..	..		..	..	1

1 Kyaikto. 2 Kawkareik. 3 Mupun. 4 Kinmunsakhan.
5 Duyinzeik. 6 Kyaiktiyo. 7 Taungzun. 8 Naunggala.
9 Thaton.

Numbers to right of + indicate specimens with genital markings on xvi.

Dorsal blood vessel ends, with, or as a triangular tag just in front of, commissures of vi (usually), rarely continued as a slender (and functionless ?) filament to posterior face of 5/6.

Testis sac u- or U-shaped, rarely annular (2 Mupun and several Kyaikto).

Spermathecal diverticula median and lateral (174 spermathecae), median diverticulum lacking on left (1 Kyaikto) or right (1 Kinmunsakhan) spermatheca.

Penial setae (16 Kinmunsakhan) 1·35—1·99 mm long, 45—65μ thick at base, 32—42 at neck, 36—53 at blade, 20—35 at tip, 6—7 per battery (8 batteries); (16 Kyaikto) 1·73—1·96 mm long, 42—60μ thick at base, 33—43 at neck, 33—50 at blade, 20—30 at tip, 7—8 (8 batteries); (6 Duyinzeik) 1·72—1·98 mm long, 40—60μ thick at base, 37—45 at neck, 42—58 at blade, 22—30 at tip, 7—8 per battery (3 batteries).

Remarks.—These worms are distinguished from those of the delta region by the presence of clitellar genital markings, smaller size of male porophores, central location on porophores of the penisetal fissure, smaller size of the genital markings which are however larger than the porophores, and more anterior location of the supra-intestinal glands. They are distinguished from the worms of section 3 by the anterior location of the supra-intestinal glands and usually by the presence of intraclitellar markings. Location of the glands in the other Thaton district worms (below) is more nearly as in the delta region.

3

Kyaiktiyo (Thaton), September, 0-0-2. K. John.

Taungzun (Thaton), September, 0-2-24. K. John.

Naunggala (Thaton), September, 0-0-4. K. John.

Thaton, September, 0-76-33. K. John.

External characteristics.—First dorsal pore on 10/11 (4), 11/12 (53, on several of which a pore-like but obviously imperforate marking is present on 10/11).

Spermathecal pores in median or lateral halves of *BC*, or with centers at m*BC*. Female pores both present (31).

Male porophores small, circular, about as wide as *AB* but centered at *B*, flat or raised in a more or less mound-like fashion, definitely demarcated by a completely circumferential furrow, with central fissure (Thaton). Circular, distinctly demarcated, about twice width of *AB*, flat, fissure central (Naunggala). Fissure on a mound-like protuberance, possibly in the posterior portion of an indistinctly demarcated porophore of variable size (Taungzun, Kyaiktiyo).

Genital markings circular or nearly so, occasionally transversely or more rarely longitudinally extended, reaching from near mV or nearer *A* to m*BC* or further laterally. Slightly larger than male porophores (Taungzun) or smaller (Kyaiktiyo). A longitudinally elliptical or crescentic (and then concave laterally) marking just median to each male porophore (Thaton, others ?).

Location of genital markings

Locality	Number of specimens with markings on			
	xvi and xx	xix and xx	xx	xxi
Taungzun .		1	25	..
Naunggala .	..	..	4	
Thaton .	11	..	98	..
Kyaiktiyo			..	2

Internal anatomy.—Lateral typhlosoles always present (141). Lateral intestinal caeca in xxviii (30), or xxxix (5), ventrally directed (9), dorsally directed (11), posteriorly directed (10), scarcely constricted off from gut (4). Ventral caeca in xxxv-lxiv (1), xxxv-lxv (1), xxxv-lxviii (1), xxxvi-lxiv (2), all from Thaton.

Dorsal blood vessel usually ends with hearts of vi.

Testis sac u- or U-shaped and in latter case often reaching to or nearly to dorsal vessel, rarely annular (1 Naunggala, 8 Thaton). Annular sacs present in some aclitellate individuals, aclitellate ventral sacs present in some clitellate worms. Anterior male funnels and their ducts lacking in one Kyaiktiyo worm.

Spermathecal diverticula median and lateral (282 spermathecae).

Penial setae (12 Naunggala), 1·6—1·93 mm long, 37—65μ thick at base, 35—48 at neck, 42—62 at blade, 20—30 at tip, 8—12 per battery (6 batteries); (2 Taungzun) 1·75—2·05 mm long, 45—50μ thick at base, 41—43 at neck, 50 at blade, 22—30 at tip, 7 (1 battery); (4 Kayiktiyo) 1·51—1·91 mm long, 38—42μ thick at base, 40—45 at neck, 44—58 at blade, 20—25 at tip, 8—9 (2 batteries).

4

Kamaungthwe River, east (Tavoy), August, 0-1-3. W. D. Sutton.

Tavoy district (Site No. 9), August, 0-0-3. W. D. Sutton.

External characteristics.—Spermathecal pores centered at m*BC* or mesially. Male porophores large and like those of topotypical worms. Genital markings lacking as on all previous specimens from Tavoy and Mergui districts.

Internal anatomy.—Supra-intestinal glands in lxxxviii-xci (2), lxxxviii-xcii (4), lxxxix-xcii (1), xc-xciii (1). Dorsal blood vessel ends with commissures of vi (8). Testis sac annular (8). Anterior male funnels and deferent ducts lacking (1 Kamaungthwe), funnels well developed but ducts lacking (2 Kamaungthwe), funnels and ducts present (5).

Penial setae (14) 1·63—1·92 mm long, 40—60μ thick at base, 30—38 at neck, 32—40 at blade, 20—30 at tip, 6—8 per battery (7 batteries).

5

Shwegyin (Toungoo), October, 0-0-15. Saw Marshall Shwin.

Kyaukkyi (Toungoo), October, 0-0-3. Saw Marshall Shwin.

External characteristics.—Length, to 310 mm. Diameter, to 10 mm. First dorsal pore on 11/12 (15, of which 4 have a pore-like but imperforate marking on 10/11).

Spermathecal pores in lateral portion of *BC*, occasionally reaching beyond C, or centered about at m*BC*. Female pores both present (17). Male porophores mound-like protuberances or flat discs with one portion (posterior, median or central) bearing the fissure protruded in a mound-like manner.

Genital markings of about the same size as male porophores or larger, median margins about at *A* or just lateral to mV, on xvi and xx (18).

Internal anatomy.—Lateral typhlosoles always present (19). Intestinal caeca in xxvii (1), xxviii (12), or in xxviii but opening into gut through 28/29 (3), posteriorly directed (1), anteriorly directed (1), dorsally directed (6), ventrally directed (1), Ventral caeca in xxxv-lxix (1 Shwegyin). Supra-intestinal glands as shown in table below.

Dorsal blood vessel ends with commissures of vi (17), continued into v where it bifurcates, the branches passing ventrally just in front of 5/6 (1 Shwegyin).

Testis sac ventral (8 Shwegyin, 1 Kyaukkyi), U-shaped and reaching to or nearly to dorsal vessel, or annular (2 Shwegyin). Anterior male funnels and their ducts present or lacking (1 Shwegyin).

Spermathecal diverticula median and lateral (36 spermathecae).

6

Toungoo, October, 0-0-40. K. John.

Toungoo district, September, 0-0-8. G. E. Blackwell.

External characteristics.—Spermathecal pores centered at or just lateral to *B* or near m*BC* (8 district).

Male porophores small, about as wide as *AB* but centered at *B*, clearly demarcated, mound-like, fissures central (40 Toungoo and 2 district), porophores large, disc-shaped, fissures on local mound-like protuberances from median portions (6 district).

Genital markings extending from or just median to *A* to m*BC* or nearly to *C*, usually longitudinally extended, occasionally transversely; on xix (40 Toungoo), xx (2 district, with small porophores), xxi (1), Rxix and Rxx (1), Rxx (1), Lxx and Rxxi (1), Lxix and Lxx (1), xix and Rxx (1). A transverse greyish translucent area with distinctly demarcated and slightly raised rim and each of its four sides slightly concave is present in *AA* on xvii (most Toungoo). A more or less clearly demarcated, rather crescentic area (concave mesially) may be marked off just lateral to each male porophore (14 Toungoo).

Internal anatomy.—Lateral typhlosoles always present (48). Ventral caeca in xxxiv-lxvii (1 district). Supra-intestinal glands as in table.

Location of supra-intestinal glands

Segments	Number of specimens from 1	2	3	4	5
92—96	1	..		1a	
93—96	.	1			..
93—97		1		1a	..
94—98		1	..		..
94—99	2				..
95--99			4		..
96—100	..	..	1	1	..
96—101		..	1	1	
97—101		..	3	2	..
97—102	..	.	..	1	..
98—102		..	2	..	..
99—103	1	..	1		..
99—104	2				3
99—104, 106			1		..
100—104	2		..	..	2
100—105	3		1	..	2
101—104	1		..	..	..
101—105	2		..	..	2
101—106			..		4
102—106		..		..	1
102—107	1	.	..		5
103—108	..	..	..	..	1

1 Shwegyin. 2 Kyaukkyi. 3 Toungoo.

4 Toungoo district. 5 Pyinmana.

(a) Specimen with small male porophores. Others with larger porophores.

The dorsal blood vessel usually ends with the hearts of vi but may be continued very shortly as a tag or to 5/6 as a slender (functionless ?) filament (4 Toungoo, 2 district with small porophores) or even to 4/5 and with thread-like commissures in v (6 district with larger porophores).

Testis sac ventral, U-shaped or annular.

Spermathecal diverticula median and lateral (96 spermathecae).

Penial setae (8, from one of the localities) 1·76—1·91 mm long, 45—65μ thick at base, 40—50 at neck, 55—75 at blade, 20—30 at tip, 6—7 (4 batteries); (12 from the other locality) 1·86—2·09 mm long, 43—65μ thick at base, 40—47 at neck, 40—47 at blade, 22—30 at tip, 6—8 (6 batteries).

7

Pyinmana (Yamethin), August, 0-2-19. K. John.

External characteristics.—Length, 180—250 mm. Diameter, 6—8 mm. First dorsal pore on 11/12 (19, of which one has a pore-like but imperforate marking at 10/11).

Spermathecal pores large, reaching nearly to *B* and *C*, centers usually slightly nearer *C*. Female pores both present (18).

Male porophores distinctly demarcated, reaching from region of *A* nearly to *C*, nearly circular, the fissure at center of ventral face of a fairly large, mound-like protuberance from a median portion. The prostatic pore is minute and located on a small spheroidal protuberance from the anterior margin of the fissure, the male pore on a larger protuberance from the posterior margin.

Genital markings of about the same size as the porophores, nearly circular, transversely or longitudinally extended, always slightly nearer posterior than anterior intersegmental furrow: on xx (9), and Lxxi (1), xxi (1), Lxx and Rxxii (1), Rxxi (1), xix (2), Lxiv, xix and xx (1), Lxiii, xx and xxi (1), Lxx and Rxxi (1), Rxii, xiii, xxi and xxii (1), none (1).

Internal anatomy.—Lateral typhlosoles always present (20). Lateral intestinal caeca lacking (1), in xxviii (10), xxix (10, but opening anteriorly through 28/29 into gut of xxviii in 3), retracted into gut (1). Ventral caeca in xxxiv-lxx (1). Supra-intestinal glands as in table above (p. 139).

Dorsal blood vessel usually continued anterior to commissures of vi, often filled with blood to 5/6, in v slender to filamentous (functionless ?), colorless, no commissures in v (5), or thicker and red to 4/5 with red commissures just anterior to 5/6 (6, in two of which commissures have been traced to ventral trunk), or ending with commissures of v (2).

Testis sac annular (20).

Spermathecal diverticula median and lateral (39 spermathecae), lateral diverticulum of left spermatheca lacking (1).

Penial setae (28), 1·85—2·32 mm long, 55—75μ thick at base, 48—60 at neck, 49—75 at blade, 20—40 at tip. Shaft straight except for a slight ectal curve, tip pink, flattened on one side, widened, tapering to a blunt point (7 of 40 setae), spoon-shaped (2), wrinkled, bent, cracked or broken off and missing (31). Number, 6—9 (14 batteries). Reserve setae red, tapering to a blunt point ectally, the smaller straight, the longer ones bent at tip. Two batteries had three functional (yellow) setae. Ornamentation of thorn-like teeth, scattered or ental to neck in irregular circles.

Remarks.—Occasional continuation of the dorsal blood vessel anterior to its usual level of termination, in this and several other species, and association therewith of the various segmental commissures that are ordinarily absent, indicates that the vascular system is laid down during embryonic development as in most earthworms. Later on, the appropriate portions, according to the species, together with the associated segmental commissures to the ventral trunk, are histolyzed.

E. peguanus apparently can be derived directly from *E. constrictus* by a mutation ("foreshortening") for abortion of an anterior portion of the dorsal trunk during ontogenetic development. Occasional presence in adults of a posterior section of the usually aborted portion, together with the appropriate segmental commissures, presumably results from incomplete or delayed penetrance of the mutation. Presence of the useless male funnels of x, and usually also of their ducts, suggests rapid establishment of the foreshortening mutation soon after the metandric mutation that gave rise to *constrictus.* Support for this belief is also provided by the distributions of the two species. The annular tumescence around the fissure of the male porophore, which seems to be developing now in both *hastatus* and *constrictus* has never been found in *peguanus.*

The *peguanus* genotype expresses itself, throughout the recent alluvium of the deltas region, in a phenotype characterized by large genital markings, equally large male porophores and the postclitellar and intrasegmental situation of the markings. Markings and porophores are of such similarity that the fissures almost appear to have been accidentally included. Both markings and porophores may have a sucker-like function at copulation. Equally characteristic seems to be the funnel-shaped, male pore bearing protuberance from the anterior wall of the fissure.

Segmental location of the genital markings is however variable and they may be on xix (f. *promotus*), xx (f. *intermedius*), xxi (f. *typicus*), or xxii (f. *postremus*). Occasionally both markings may be lacking (f. *simplex*).

Worms from Tavoy and Mergui districts always have lacked genital markings which seems to indicate that f. *simplex* is a true breeding type. Almost equal uniformity has characterized the material (f. *postremus*) secured at Syriam over a period of years. A similar uniformity is shown by the collections (f. *intermedius*) at Hlegu, Taukkyan, and to a less extent at Wanetchaung. If *simplex*, *intermedius* and *postremus* are true breeding types then the same may also be true of *typicus*. Rare cases of asymmetry (each marking on a different segment), perhaps also still rare cases of markings on two different segments, may result from hybridization of two of the true breeding forms. At one time it was thought that f. *promotus* might be a hybrid between *simplex* and *typicus* but the materials and records are no longer available. However, it can be stated that during all the years of collecting in Rangoon and immediate vicinity only three forms, *simplex*, *typicus* and *promotus*, were secured.

Worms from isolated colonies at Mandalay, Nyaungyo (Arakan Yomas) and Chaukma (Chindwin Valley), were all of f. *simplex* but the Myitkyina colony comprised *simplex*, *typicus* and *promotus*. Persistence of isolated remnants at the periphery of a once greater range scarcely seems possible in these cases. Of the alternatives, independent origin *in situ* from *constrictus*, or transportation from the deltas region, the latter now seems more probable. Monsoon flood waters, which may have been an agency of distribution in some of the deltas region, cannot be invoked in the cases of these colonies. Of the agents that are known, or have been postulated, to be responsible for transport of earthworms, man seems to be the most likely. Although *peguanus* has not been found in Rangoon in earth around roots of potted plants, it is frequently present in flowerbeds around houses and in gardens from whence soil containing cocoons or small juveniles could easily have been taken on many occasions. Admittedly however, Mergui and Tavoy distributions, except for Tavoy town itself, seem much less obviously attributable to agency of man than the above-mentioned isolated colonies.

With the deltas forms thus geographically limited it will be convenient to treat them all collectively as a subspecies, *peguanus* n. subsp. The other forms also can be treated as a geographical subspecies which takes the name *similis* (n. subsp.) of one originally thought to be of species status.

In subspecies *similis* male porophores are small, usually smaller than the genital markings and with no sucker-like appearance. Instead they are raised (after preservation) *in toto* so that the fissure is on the rounded apex of a rather mound-like tough protuberance which presumably functions as a sort of intromittent organ in copulation. At greatest protuberance the organs appear to be the equivalent, in larger size, of the firm cone-like penis of *compositus* and closely related species.

Genital markings, in a region from the southern border of Amherst district north to Shwegyin and Kyaukkyi (Toungoo) usually are two pairs, one of which is intraclitellar and on xvi. The second pair, in Amherst district worms from the sea to the Siamese border as well as in various localities of Thaton district, is on xxi (f. *similis*) but in some Thaton localities and in the southern part of Toungoo district is on xx (f. *praecox*). Intraclitellar markings are omitted in some of the Thaton district localities and from Toungoo town north to the end of the range at Pyinmana. The remaining pair may be on xx (Thaton) or xix (Toungoo, f. *tumidus*) or in the north may occasionally be omitted. A peripheral region of the body wall around the mound-like protuberance has a tendency, in the older alluvium from Toungoo north, to assume an appearance of the *peguanus* male porophore. The testis sac, in the Shwegyin region and certain Thaton localities appears to be undergoing a further reduction to a suboesophageal chamber.

E. peguanus is quite common in the southern half of the Pegu Yomas which is part of the *constrictus* range but consideration of the very interesting material from that area has now become impossible.

Eutyphoeus plenus, sp. nov.

Pyinmana (Yamethin) and vicinity, August, 73-26-239. K. John.

External characteristics.—Length, 210-335 (clitellate specimens only). Diameter, 7—10 mm. First dorsal pore on 10/11 (2), 11/12 (203, of which 88 have a pore-like but imperforate marking on 10/11, 12/13 (5, of which 1 has pore-like markings on 10/11—11/12 and 2 have a marking 11/12).

Spermathecal pores in *BC*, occasionally with centers close to or rarely actually at *C*. Female pores both present (147).

Male porophores rather small, slightly wider than *AB*, circular or transversely elliptical, flat or protuberant in a mound-like fashion, not reaching intersegmental furrows, with central fissure. A crescentic area concave towards male porophore, partly or largely greyish translucent, with a more or less definite, opaque, white rim often recognizable just median to each male porophore. A similar area but concave mesially may be visible just lateral to each male porophore.

Genital markings reach from or close to *A* to or nearly to *C* and are usually longitudinally elliptical, touching or dislocating intersegmental furrows.

Location and number of genital markings

Segments	Number of specimens
15, 16	1
15, 16, R19	1
15, 16, 19	1
15, 16, 19, L20	1
15, 16, L19, 20	1
15, 16, L19, R20	8
15, 16, R19, L20	5
15, 16, R19, 20	4
15, 16, 19, 20	2
15, 16, 20	219
R15, 16, 20	1
15, 16, 20, R21	2
15, 16, 20, L21	3
15, 16, 20, 21	2
15, 16, R18, 20	1
15, 16, R20, L21	1
15, 16, 21	1
15, 16, L19, 20, R21	1
15, 16, R19, 20, R21	1
15, 16, L18, 19, R20	1
16, L20	1
16, 20	3
16, R20, L21	1
R14, 15, 16, 20	1
L14, 15, 16, 20	1

R a marking present on right side only.
L a marking present on left side only.

Internal anatomy.—Typhlosole begins in region of xxviii (?). Lateral typhlosoles always present, often small. Lateral intestinal caeca in xxvii (5), xxviii (25), xxix (8), about equally in xxviii and xxix (8), in different segments on opposite sides (a number); dorsally directed (28), ventrally directed (40), anteriorly directed (25), posteriorly directed (51), completely retracted into gut lumen (10), lacking (1). Ventral caeca and supra-intestinal glands located as shown in table below.

Location of ventral intestinal caeca and supra-intestinal glands

Segments	Number of specimens	Segments	Number of specimens
34—73	1	106—110	4
35—72	2	106—111	8
35—73	1	107—111	5
35—75	2	107—112	16
35—76	2	108—112	1
35—77	1	108—113	16
35—78	2	108—114	1
35—79	1	109—113	4
		109—114	7
		110—114	2
		110—115	5
	12		69

Circulatory system as in *gigas* except that the extra-oesophageals are connected by a transverse vessel just behind 5/6. The dorsal vessel ends with or just in front of the hearts of vii (286) or is represented anteriorly by a functionless translucent strand (1) or a white and apparently solid cord (3) passing forward to 5/6, or by a slender white strand ending at 4/5.

Testis sac annular (all aclitellate and clitellate worms). Anterior male funnels and ducts lacking (1), the funnels of x rudimentary (14 in 5 of which both ducts are lacking, right duct lacking in 5, left duct in 4). Three deferent ducts on left side (1), from xv to bulbus ejaculatorius, the third duct passing laterally in xiv nearly to *D* and then into xiii where it disappears.

Spermathecal diverticula median and lateral (580 spermathecae), the sperm within often looped or twisted in a somewhat spiral manner.

Nerve cord with a markedly pink sheen due to presence of a strong muscular sheath. This sheath is 130—190μ thick in region of 5/6 and gradually becomes thinner posteriorly but even in xx may still be 100μ thick.

Penial setae (20) 2·09—2·99 mm long, 36—75μ thick at base, 40—70 at neck, 60—115 at blade, 25—45 at tip. Shaft straight except for an ectal curve, yellow except at the ends which are red, with dark segments, tip widened and flattened. Ornamentation of fine thorn-like spines so closely crowded as to have an appearance of fur or in distinct and irregularly interrupted circles and in this case disappearing at a greater distance from the ectal margin. Number, 8—15 (30 batteries), usually 11-15, Reserve setae entirely red, with oar like blade, bent terminally and usually wrinkled in region of bend (softened ?).

Juveniles.—Identified by the thick muscular sheath on nerve cord anteriorly. Genital markings and male porophores still lacking on specimens that had reached a size of 150—230 × 5—7 mm Spermathecal pores represented only by greyish translucent, slight puckerings of the epidermis. Fissures are present in *AB* but usually slightly nearer to *B*. Minute male pore behind the fissure and about half way between equator of xvii and 17/18. Penial setae may protrude slightly from the fissure through a cuticular aperture but in some of the worms the cuticle apparently has no aperture and is continuous across the fissure though tips of penial setae are recognizable therein.

Supra-intestinal glands in civ-cxiii (10). Dorsal blood vessel ends with hearts of vii (9) or on 5/6 (1) and then continued from hearts of vii as a slender transparent thread without blood and presumably functionless.

Abnormality.—(No. 1) A wedge-shaped half segment with four setae intercalated behind vii on right side only. Right male porophore on xvi, left on xvii (disregarding the half segment in the present enumeration). Genital markings on Rxiv, xv, Lxvi, Rxix, Lxx.

An extra half septum on right side inserted on gut just in front of gizzard and on parietes just in front of spermatheca. Three commissures from dorsal trunk on the right side anterior to 8/9. The dorsal trunk is continued anteriorly to level of half septum and then passes ventrally as a left commissure of vi (none on right side). Right male funnel of xi large, left rudimentary. A rudimentary seminal vesicle in xi on right side, the right vesicle in xii. Right heart of xiii lacking. Intestinal origin in xiv on right and in xv on left side. Right ovary and female funnel in xii, left in xiii.

Remarks.—The region of the body wall peripheral to the small male porophore that would be part of a sucker-like area if in subsp. *peguanus* seems here to be developing, as in some populations of subsp. *similis* and of *constrictus*, into two genital markings with some other function.

The anterior migration, during late juvenile growth, of male pores from their earlier postequatorial site to one nearer the prostatic pores appears to recapitulate part of one of the evolutionary changes of the classical megascolecid phylogeny. The union of male deferent and prostatic ducts to open by a single pore that was assumed by the proponents of that scheme is not achieved in this case. Nor has it been found in any other species of *Eutyphoeus*.

Absence of pigment, superficial fissures, an annular testis sac, the long series of midventral intestinal caeca, location of the supra-intestinal glands, bidiverticulate spermathecae and a blade-like thickening of the penisetal shaft all indicate close relationships to *E. hastatus*, *constrictus* and *peguanus*. To the last two, closer relationship is indicated by the metandry. *E. plenus* is distinguished from *constrictus* by the ontogenetic abortion of an anterior portion of the dorsal blood vessel and associated segmental commissures, from *peguanus* by abortion of another section of the dorsal trunk along with the commissures of vi. Additionally *plenus* is distinguished from subsp. *peguanus* by the small male porophores and the intra-clitellar genital markings, from subsp. *similis* by a second pair of intraclitellar markings and location of the postclitellar markings on xix. The thickness of the muscular sheath around the anterior end of the nerve cord appears to be unique in the genus but no information is available as to this sheath in other species.

Lateral intestinal caeca, absent only in one of 290 specimens, are more frequently developed than in the related species but here also show variation in site and method of growth.

A "foreshortening" mutation such as has been invoked (pp. 141 and 112) to explain phylogenetic origin of *peguanus* and *bullatus* also can be postulated in the ancestry of *plenus*. Distributions are such that *plenus* can be derived from *constrictus* or *peguanus*. The first alternative involves abortion, in a single step, of more of the circulatory system than in the cases previously considered. This may not be impossible. Incidence of complete penetrance in *plenus* is high, unhistolyzed portions of the dorsal trunk having persisted only in 4 of 293 specimens (*ca.* 1·4 per cent). The second alternative, involving a second foreshortening mutation or some sort of an intensification or extension factor, requires retention of male funnels of x, even though their ducts are disappearing in *plenus*, during the time required for establishment of three consecutive species stages. *E. plenus* is known only from the vicinity of Pyinmana where it presumably arose too recently to have achieved a greater distribution.

Eutyphoeus ferinus, sp. nov.

Myitkyina, September, 0-9-5. K. John.

External characteristics.—Length, of largest clitellate specimen, 230mm. (all clitellate worms posterior amputees), of longest complete aclitellate specimens, 270 mm. Diameter, 7 mm. Unpigmented. Setae begin on ii, on xx AB=or slightly $<BC<AA$, $DD>\frac{1}{2}$C. Tips of *a* and *b* setae of xiii ornamented by short transverse rows of fine teeth. First dorsal pore on 11/12 but with a non-functional porelike marking on 10/11 (4), without marking on 10/11 (10). Clitellum dark blueish, annular, from 12/13 or just behind equator of xii to 17/18, functional dorsal pores on 12/13 and 17/18 only, intersegmental furrows lacking, setae present.

Spermathecal pores small transverse slits in *CD* or with centers on or just median to *C*. Female pore on left side (most clitellate specimens), a rudimentary (?) right pore present on one clitellate and a punctated depression at site of pore on aclitellate specimens. Male porophores small, firm, with slightly convex surface, circular to shortly elliptical (transversely placed) in *BC*, usually well lateral to *B*. A very small slit, through which tips of penial setae may protrude, is the only aperture that has been recognizable. A crescentic whitened area with concave side laterally may be present median to each porophore or replaced by two smaller, shortly elliptical and slightly diagonal areas.

Genital markings paired, transversely elliptical to circular areas of epidermal thickening, postsetal on xiv-xvi and on 18/19-20/21 as follows : on xvi (1 clitellate), on xiv, xv, xvi (1 clitellate, 6 aclitellate), on xvi and 19/20-20/21 (1 clitellate, 1 aclitellate), on xvi and 18/19,19-/20 (1 clitellate), on xvi and on 19/20 (1 clitellate). Markings of xiv almost meet at mV, the interval between increasing posteriorly. Postclitellar markings extend from *A* or just lateral to mV to m*BC*, or nearly to *C*, *a* and *b* included in anterior marking.

Internal anatomy. Typhlosole begins in xxvii. Lateral typhlosoles unusually well developed and folded like the main typhlosole, in xxvii-xxx. Lateral intestinal caeca apparently lacking. Ventral caeca in xxxvii-xxxix (2), xxxvii-xxxviii (1). Supra-intestinal glands in xciv-xcvii (3), c-ciii (1).

Circulatory system as in *gigas* except that extra-oesophageals are connected by a transverse vessel just behind 5/6. Dorsal trunk, ending with commissures of vi, abruptly just in front of the commissures of vi, or continued as a fine white thread to posterior face of 5/6.

Metandric, testis sac ventral. Seminal vesicles push 12/13-13/14 into contact with 14/15. Funnels of x very small club-shaped rudiments (recognized only in aclitellate specimens). Prostatic ducts 15-17 mm. long. Bulbus ejaculatorius fairly large and coelomic.

Spermathecal duct short, stout, lumen irregularly crescentic in cross section due to presence of a high vertical ridge (with vertical groove) on posterior wall and several smaller ridges laterally and anteriorly. Ampulla flattened, anteriorly directed. Diverticulum a bi- or tri-lobed horizontal ridge on posterior face of duct near ampulla. Two apertures (at least?) are present on inner wall of duct from the diverticulum, one just lateral and one just median to the large vertical ridge.

Penial setae (functional) 1·6-2 mm long. Shaft nearly straight except for an ectal curvature, tapering slowly to a rounded tip without terminal spine. Ornamentation of numerous short transverse rows of fine spines. Number, 7 (1 battery of five pink to red reserve and two light yellow functional setae).

No glandular material recognizable over sites of genital markings.

Remarks.—In aclitellate specimens seminal vesicles are well developed testis sac filled with coagulum, spermathecae fairly well developed but anteriorly directed ampullae are short and flattened, genital markings indistinctly delimited or (2) primordia unrecognizable.

Morphologically *E. ferinus* appears to be related to *constrictus*, *peguanus* and *plenus* and is distinguished from each of them only by the single functional female pore and the single spermathecal diverticulum perhaps also though with less certainty by the intersegmental location of the postclitellar genital markings.

The morphology of the circulatory system in particular indicates closer relationship to *peguanus* than to *constrictus* or *plenus* but the distributions imply a much closer relationship to *constrictus*. This apparent anomaly seems capable of resolution by a phylogeny in the same manner as for *peguanus*, *plenus*, *bullatus*, and other species. Here again a foreshortening mutation is required but in order to derive *ferinus* from *constrictus* two additional mutations must be assumed. The first of these ("oviductless") is for abortion during ontogenetic development of the right oviduct. The right oviducal or female funnel is retained and seems to be of normal size but the duct is rudimentary or lacking distally. Once again, incomplete or delayed penetrance of a mutation is indicated, here by presence of a rudimentary right female pore on several individuals. The second additional mutation (stalk-less 1) is for abortion of the stalks of the spermathecal diverticula so that the seminal chambers are developed in a single horizontal row on the posterior face of the spermathecal duct. An ancestral bidiverticulate conditon is still indicated, in *ferinus*, by the two openings into duct lumen, or the two groups of openings, one on each side of the large vertical ridge on the posterior wall of the duct. This stage may well have been preceded by one in which the two diverticula, instead of growing straight out from the duct in a median and lateral direction, were turned posteriorly and more or less closely approximated. Such a stage is shown today by the spermathecae of *E. macer*.

E. ferinus seems not to have initiated development of the lateral intestinal caeca that are now becoming established in *peguanus* and *constrictus*. Reduction of the testis sac to a suboesophageal chamber, which has been found only rarely in *peguanus*, appears to have become customary in *ferinus*.

THE *levis* GROUP

Eutyphoeus levis (Rosa) 1890

Kyaiktiyo Hill (Thaton), September, 0-0-1 K. John.

Kyaiktiyo (Thaton), September, 0-0-5. K. John.

Thaton, September, 0-5-4. K. John.

External characteristics.—Length, to 62 mm. Diameter, to 3 mm. Unpigmented. The *d* setae definitely dorsal (10) in a posterior portion of the body, about at mL or very slightly dorsal (2 posterior amputees). First dorsal pore on 11/12 (12), 12/13 (2), 13/14 (1). Clitellum lacking at mV (10) and between male porophores where body wall is so thin that nerve cord is visible externally.

Spermathecal pores with centers on or close to *B* (15). Female pores both present (10). Male porophores slightly protuberant, transversely and shortly elliptical, rather sharply demarcated areas, with centers at or slightly median to *B* and reaching mesially to or nearly to *A*. At the center of each porophore a very shallow, transversely slit-like depression contains two pits from which penial setae may protrude, discrete apertures apparently of two penisetal follicles. The marginal region around the slit is slightly tumescent, distinctly demarcated peripherally by a slight, completely circumferential and circular groove. On the tumescence, which looks like a rudimentary penial annulus there is occasionally visible a minute pore, smaller than the penisetal pits, and presumably the aperture of male deferent ducts.

Definite genital markings lacking but in *AB* and on a presetal portion of xvii there may be visible (7) a slightly raised circular area but which has no grey translucent central portion.

Internal anatomy.—Typhlosole begins in xxi (4) or xxii (4). Lateral typhlosoles, in first two typhlosolar segments, low, continuous, simple lamellae. Ventral caeca in xxviii-xix (3), xxix (1), xxix-xxx (1). Supra-intestinal glands in lvii-lix (5), lviii-lx (3).

Dorsal blood vessel though unrecognizable in front of vii must be uninterrupted as hearts of vi are always present and blood-filled segmental commissures are recognizable in v (4) or even in iv (1).

Male funnels present in x (8), anterior ducts passing posteriorly for some distance before coming into contact with posterior deferent ducts. Testis sac annular (8), hearts of xi apparently imbedded in the testicular coagulum but dorsal blood vessel probably not included. Prostates confined to xvii-xviii (8), prostatic ducts *ca.* two mm long. Bulbus small, white, soft, confined to parietes or only slightly protuberant into coelomic cavity.

Spermathecal duct with thick wall, lumen small and slit-like in cross section. Diverticulum (single) always lateral (16), digitiform to pyriform and with a single seminal chamber (14), or bifid and with two shortly ellipsoidal seminal chambers (2 spermathecae from the same worm). Penial setae (20) are (according to Miss Chapman's measurements) 1·0-1·13 mm long, 10-15μ thick at tip, 24-30 at midshaft, 29-49 at base. Shaft slightly curved as in blade of a scythe. Tip tapering and bluntly rounded or, occasionally, slightly widened and spoon-shaped, deformed only in 5 of 50 setae. Ornamentation of long spines in practically unbroken circles between 0·01 and 0·2 mm levels down the shaft. Number, 2 (24 batteries), 3 (2), 1 (2, from one worm).

Remarks.—*E. levis* was erected for a single specimen that was considered, even in 1890, to be in too poor condition for study of internal anatomy. The type is broken just behind the prostatic region and intestinal characteristics are not determinable. Spermathecae are however clearly unidiverticulate and the diverticulum is lateral. No positive contraindications against identity with *E. falcifer* Gates 1933 were found. Type localities of the two forms probably are very near each other. The only solution to the problem posed by *levis*, in absence of adequate collections from the region of the type locality, is to supress *falcifer* and define the former as the latter.

Eutyphoeus pusillulus Gates 1931

Body wall of the type opaque at mV.

Typhlosole begins in xxii. Lateral typhlosoles low, continuous, simple lamellae in xxii-xxiii. Supra-intestinal glands in lvi-lviii.

Remarks.—Sexual maturity is indicated by spermatozoal iridescence on the male funnels but there is no iridescence in the spermathecae to show that copulation had taken place.

E. pusillulus is close to *E. levis* from which it can be distinguished at present by the proandry and, of course associated therewith, absence of posterior male funnels, deferent ducts and seminal vesicles.

No evidence of production of sperm in x by *levis* has been found, nor other support for a suggestion previously made that the type of *pusillulus* might be an aberrant individual of *falcifer* (= *levis*).

Ye, the type locality of this species, is at the southern border of Amherst district which must also be considered the southern boundary of the *Eutyphoeus* range. The jungles and uncultivated areas of the southern part of Amherst district to the Siamese border scarcely have been entered by collectors.

Eutyphoeus pius, sp. nov.

Kyaiktiyo (Thaton), September, 0-0-2. K. John.

External characteristics.—Length, 40 (incomplete posteriorly) to 42 mm. Diameter, 2½-3 mm. Unpigmented. Setae begin on ii (2), *a* and *b* more closely paired than *c* and *d*, *d* setae posteriorly at or only very slightly dorsal to mL. First dorsal pore on 11/12(2). Clitellum annular (?), the body wall though with clitellar coloration so thin near mV that nerve cord is visible externally, definitely lacking near mV on xiii and xvii, extending dorsally from equator of xiii to 17/18 ; dorsal pores and intersegmental furrows lacking, setae present.

Spermathecal pores transverse slits, in lateral half of *BC* but reaching very slightly beyond *C* (1), or with centers about at *C* (1). Both female pores present (2). Penes annular, each in a slight, rather regularly concave depression, the latter in an indistinctly delimited area of slight tumescence (and possible parietal thickening), the annulus just lateral to *B*, the male porophore probably reaching from *A* to or beyond m*BC*.

Genital markings paired, in *AB* but reaching slightly lateral to *B*, apparently postsetal on xiii, xiv and xv (2) as anterior margins quite definitely are nearer segmental equators than the posterior margins (but sites of intersegmental furrows crossed ?).

Internal anatomy.—Septa, digestive, circulatory and excretory systems as usual in the genus (2). Lateral intestinal caeca in xxv but opening to gut in xxvi (2). Typhlosole begins in xxvi. Lateral typhlosoles low, simple lamellae in xxvi. Ventral caeca in xxxi-xxxiv (2). Supra-intestinal glands in lxv-lxvi or lxv-lxvii. Dorsal blood vessel continued certainly to 4/5 with commissures in v (1, doubtful in the other).

Testis sac U-shaped (2), reaching up only slightly at sides of gut, ventral portions of hearts of xi apparently imbedded in coagulum. Anterior wall of sac in region of mV bulged forward half way through segment x. Semimal vesicles extend back to 13/14. No male funnels in x. Bulbus ejaculatorius soft, bound loosely to parietes. Prostates in xvii-xx, ducts 2-3 mm long, slender, white.

Spermathecal duct short, lumen slit-like in cross section, without posterior vertical ridge. Diverticula median and lateral (4 spermathecae), simple, rather elongate and looped in a shortly zigzag fashion.

Genital marking glands (soft) sessile on parietes.

Penial setae 1·45-1·5 mm long (measured along straight line from tip to base), 29-30μ thick at neck (just ental to bowl or widened part of tip), 40μ at midshaft, 51-70 at base. Shaft curved in a rather spiral fashion but when flattened by cover glass has a bow or crescent shape. Tip spoon-shaped (1), thickened but without concavity (1). Ornamentation of slightly irregular, closely crowded circles of very fine spines, frequently and irregularly broken entally. Number, 2 (2 batteries).

Remarks.—Clitellar thickening of the epidermis is slight in the smaller worm though intersegmental furrows are unrecognizable, dorsal pores not only present but actually open. As spermatozoal iridescence in the spermathecal diverticula proves that copulation had taken place, condition of the clitellum may be due to postsexual regression.

The penial annulus appears to be a permanent structure seated on a discoidal region of parietal thickening that is slightly depressed, on the types, in a regularly concave manner so as to bring the annulus below general level of body surface. Better protection still for the soft annulus would be provided by apposing anterior and posterior (or median and lateral) margins of the porophore, if that is possible. A vestibulum, eversible as in *macer*, certainly is lacking but a somewhat similar sort of intromittent organ might be attainable, during copulation, by raising the male porophores in a mound-like fashion, as in *constrictus*, with penes at distal extremities.

E. pius is morphologically similar to *E. lippus* Gates 1934 from Ramechap district of Nepal in various ways. Differences have to do with : First dorsal pore, on 11/12 instead of 10/11 or anteriorly. Spermathecal pores, centered lateral to m*BC* rather than mesially. Genital markings, several pairs on clitellar segments rather than one pair on x. Lateral intestinal caeca, in xxv rather than xxiv. Ventral caeca, in 3 consecutive segments of xxxi-xxxiv rather than in 4-7 of xxx-xxxvii. Supra-intestinal glands, in 2-3 segments of lxv-lxvii rather than 3-5 of lxvi-lxx.

E. pius is distinguished from *E. macer*, present in the same Burmese district, as follows. By absence of eversible vestibula, presence of three pairs of intra-clitellar genital markings instead of one and with a more anterior location (on xiii-xv instead of xvi), lateral intestinal caeca in xxv instead of xxiv, typhlosolar origin and lateral typhlosoles in xxvi instead of xxv, ventral caeca in 3 segments of xxxi-xxxiv rather than 4-6 of xxviii-xxxiv, supra-intestinal glands in 2-3 segments of lxv-lxvii instead of 3 in lxiii-lxvi. Except the vestibula, these differences are of about the same order as those distinguishing *lippus* and *pius*. In these circumstances geographical relationship must be given greater weight than the structural similarities. The latter then, insofar as *lippus* and *pius* are concerned, are indicative only of similar stages in independent lines of evolutionary development.

Eutyphoeus macer Gates 1933

Thaton, September, 0-0-21. K. John.

Bilin (Thaton), September, 0-0-1. K. John.

Kyaikto (Thaton), August, 0-0-1. K. John.

External characteristics.—The *d* setae are not noticeably dorsal on any of these specimens. First dorsal pores on 11/12 (15), 12/13 (2).

Spermathecal pores usually in lateral half of *BC*, just reaching to *C*, rarely (1) reaching into *CD* and then with centers at or close to *C*. Female pores both present (23). Vestibular apertures small, centers about at *B*. Vestibula small, practically filled by annular penes. Posterior half of annulus slightly thickened and continued ventrally into two pointed flaps usually bent anteriorly. Penes may be withdrawn into vestibula so that only tip of a single flap is visible (7), or both flaps of each penis may be slightly protuberant to exterior (2), or vestibula may be completely everted (14). Penis and everted vestibulum have a columnar appearance and rather like that of a tubular penis but a more or less definite circular furrow marks off the ventral and penial portion of the column from a dorsal part representing everted vestibulum.

Genital markings postsetal, on xvi (19), in *AB*, usually continued slightly beyond both *A* and *B*. Right marking (2) or both (2 specimens) lacking.

Internal anatomy.—Lateral intestinal caeca in xxiv (13) but opening into gut in xxv. Typhlosole begins in xxv (10) but may be slightly protuberant into xxiv. Lateral typhlosoles simple, low lamellae in xxv. Ventral caeca in xxviii-xxxii (2), xxviii-xxxiii (1), xxix-xxxii (4), xxix-xxxiii (2), xxix-xxxiv (2). Supra-intestinal glands in lxiii-lxv (3), lxiv-lxvi (9).

Dorsal vessel empty in front of commissures of vi and unrecognizable in front of 4/5 probably because of absence of blood. Segmental commissures of v usually recognizable though small and white. Transverse connectives between extra-oesophageal trunks are present just behind 5/6 and just in front of 8/9.

Testis sacs U-shaped, limbs not quite reaching to dorsal trunk (10), limbs possibly united above dorsal trunk to form an annular sac (1).

Spermathecal duct short, rather soft, lumen slit-like ectally, crescentic entally due to presence on posterior wall of a high vertical ridge. Diverticula always median and lateral (20 spermathecae), usually more or less digitiform but may be bilobed (4) or trilobed (6). Ampulla usually bent anteriorly as in types.

Penial setae (22 Thaton) are 2·03-2·53 mm long, 11-16μ thick at tip widening to 16-22, 13-18 at neck, 19-27 at base. Shaft with slight spiral curve ectally. Tip flattened, only slightly widened, usually bent and wrinkled, occasionally narrowing to a sharp point or a short spine.

Ornamentation of irregular rows of spine-like teeth, between levels of 0·05 and 0·3 mm down the shaft. Number, 2 (25 batteries), 3 (1).

Genital marking glands small, soft, sessile on parietes.

Remarks.—The penial annulus, in absence of immature worms for growth stages, is assumed to develop around a fissure of the usual sort and in this species to be a permanent structure. The pointed projections from the thickened posterior portion of the annulus presumably are inserted into spermathecal pores of a copulatory partner and in absence of any contraindication likewise appear to be permanent. On more complete retraction of the penes than has characterized any of the material hitherto available, some protrusion is expected of the vestibular roof into the coelomic cavity.

No variation as to male terminalia, presence or absence, shape or site of lateral intestinal caeca, number of supra-intestinal gland segments, or as to segment of origin and intrasegmental situation of genital markings, has been found, though four specimens suggest a trend in some populations towards elimination of the markings. A variation of but one segment in axial location of the supra-intestinal glands, with regard to size of the sample, also is unusual. Even as to number and axial location of ventral caeca, variation is slight.

Posterior direction and approximation, in this species, of spermathecal diverticula originally more anterior and directed laterally or mesially, appears now to be in a line of development that ends in a unidiverticulate condition characteristic of *ferinus*.

Male funnels of x and their ducts, as in *pius* and the remaining species of this group, apparently have disappeared.

Eutyphoeus sejunctus Gates 1930

Pelachi (Toungoo), on road to Thandaung, September, 0-0-4. G. I. Marshall.

Shwenyaungbin (Toungoo), on road to Thandaung, September, 0-0-1. H. I. Marshall.

Dawpakho, Thandaung Reserve, (Toungoo), September, 0-0-5. H. I. Marshall.

External characteristics.—First dorsal pore on 11/12 (10). The *d* setae are dorsal (10) posteriorly. Clitellum thinner or lacking (?) at mV(10).

Spermathecal pores with centers on or close to *B* (10). Female pores both present (10). Vestibular apertures always open, nearly circular, in *AB*, occasionally reaching just beyond *B*. Vestibula small, practically filled by small, firm, smooth-surfaced, conical penes, less than ½ mm long.

Genital markings postsetal, on xi, in *AB* (10). Indistinctly demarcated, translucent areas with centers at or near *A* occasionally recognizaable on sites of 16/17 and 17/18, a transverse strip between those patches with unusually thin epidermis.

Internal anatomy.—Typhlosole begins in xxvii (or just reaches into xxvi). Lateral typhlosoles low simple lamellae, in xxvii (5). Ventral caeca in xxxii-xxxviii (1), xxxii-xl (1), xxxii-xli (1), xxxii-xlii (1), xxxii-xliv (1). Supra-intestinal glands in lxiii-lxv (1), lxiv-lxv (1), lxiv-lxvi (2) lxvi-lxviii (1).

Testis sac slightly U-shaped, lower portions of hearts of xi apparently imbedded in testicular coagulum. Bulbus ejaculatorius firm, with slight pink sheen, bound to parietes, Vestibular roof conspicuously protuberant into coelomic cavity as a columnar, bluntly conical or rather ovoidal, solid body with muscular sheen, into which prostatic duct, penisetal follicle and bulbus pass ectally.

Spermathecal duct *ca.* one mm long (including parietal portion), lumen small, slit-like in cross section. Diverticula median and lateral (20 spermathecae), usually with a single seminal chamber, or, occasionally, with one or two additional and much smaller chambers. Ampulla bound down around ental portion of duct.

Genital marking glands conspicuously protuberant into coelomic cavity. The gland though soft is sufficiently coherent, in this material to be pulled out from parietes taking away the marking on its ventral face.

Penial setae (according to Miss Chapman's measurements) are 2·46—2·48 mm. long, 38-40μ thick at tip, 45 at midshaft, 48-50 at base. Ornamentation, extending 150μ down the shaft, of small spine-like teeth, in regular unbroken circles ectally, in scattered rows of two or three entally. Number, 9 (1 battery of a Thandaung worm). Functional setae yellow, reserve setae red.

Remarks.—Fissures, in absence of immature specimens, are assumed to develop as usual in the genus though here always small and with a definite smooth margin that has been lacking in previous species of the present group. The margin of the fissure, as in subsequent species of the *levis* group, instead of becoming soft and tumescent, is firm and glistening. The penis formed as the vestibular invagination developed is tough and somewhat resembles the hard, mound-like protuberance from the male porophore of *peguanus*. The thickened vestibular roof in the coelomic cavity suggests a muscular bulb to evert the vestibulum as a temporary intromittent organ with the conical penis at its distal extremity. The testis sac which has been annular in previous species of this group has now been reduced to a suboesophageal chamber occasionally with a u—or even a U-shape. The secondary nature of these distentions, in comparison with an earlier U-shaped stage in the reduction, is shown by exclusion therefrom of the hearts of xi.

No variation, even as to presence or absence of genital markings and lateral intestinal caeca, has been found in any of the localities. Variation in number and axial location of ventral caeca is greater than in some of the previous species but, as also in case of supra-intestinal glands, is less than that prevailing in *hastatus*, *constrictus* and *peguanus*.

Development of a battery of reserve setae and the dorsal dislocation of the *d* setae are innovations in this group.

Eutyphoeus strigosus Gates 1933

External characteristics.—Penes firm, shortly conical. The pore at apex of the penis is small, with firm smooth margin and is slit-like to circular.

Internal anatomy.—Typhlosole begins posteriorly in xxvii but is higher from xxviii. Lateral typhlosoles low, simple lamellae in xxvii. Ventral caeca in xxxiv-xlvii (1). Supra-intestinal glands in lxix-lxxi (2), lxx-lxxii (2).

Circulatory system as in *gigas*, except for anterior continuation of dorsal trunk. Extra-oesophageals almost come into contact behind 5/6 so that the commissure between is very short.

Testis sac u - or U-shaped, limbs not adherent to gut, hearts of xi entering sac only beneath gut.

Spermathecal duct *ca.* one mm long, lumen slit-like in cross section. Diverticula median and lateral, simple, bent at right angles, or slightly looped as in *pius*, or bi- or tri-lobed.

Genital marking gland sessile on parietes, soft, but not easily scraped away from body wall.

Remarks.—The oval papilla with follicle apertures, inside the penis, shows that the smooth-margined pore at apex of the organ is a fissure and, despite appearances, of the same nature as throughout most of the genus. Discrete male and prostatic pores may then be expected. Only slight protrusion of the penis has been shown but eversion of the vestibula is anticipated in view of the presence of vestibular bulbs.

The worms from three localities showed no variation as to : site and method of development of lateral intestinal caeca, secondary typhlosoles origin of main typhlosole, axial and intrasegmental location of the genital marking. Incidence of absence of markings was 11·5 per cent as compared with 8 per cent in *macer*. Variation as to ventral caeca and supra-intestinal glands appears to be greater than in previous species except *sejunctus*. With those two species the most posterior location of lateral intestinal caeca has been attained, the axial location being anteriorly in species both to the north and to the south. Typhlosolar origin and lateral typhlosoles, as in general throughout the genus, are closely associated with the lateral caeca.

The genital marking showed no evidence of the union of paired anlage that seems to be required phylogenetically.

As in *sejunctus* the dorsally directed limbs of a U-shaped testis sac appear to be secondary distentions.

Eutyphoeus compositus Gates 1933

External characteristics.—Spermathecal pores may be just lateral to C. Vestibular apertures small, circular to elliptical, at or close to *B*, each in a flat, slightly protuberant, distinctly demarcated, circular field extending from *A* into *BC*. Vestibula small, well-like, almost completely filled by rather conical penes which are less than ½ mm long. A small greyish translucent, transversely elliptical area, with boundaries recognizable only in brilliant illumination, is present just anterior and just posterior to each vestibular aperture.

Internal anatomy.—Typhlosole begins abruptly in xxiv (9) or xxv (1) but is not as high as in xxv or xxvi. A small secondary typhlosole which may be also folded slightly is present laterally on each side in xxiv-xxv and reaching into xxvi. A slight protuberance that looks like a rudimentary caecum is present on each side of the gut, in nine of the ten dissected specimens, in the first typhlosolar segment. Each protuberance is slightly constricted off from the gut, dorsally (8) or ventrally (1). The dorsal constriction is continued ventrally, in one case, on the anterior side of the protuberance.

Location of supra-intestinal glands

Segments	Specimens
58—60	1
58—61	5
59—62	2
59—63	1
60—63	1

Circulatory system as in *gigas* except that dorsal trunk is continued anteriorly and extra-oesophageals are connected by a transverse commissure just behind 5/6.

Testis sac ventral (1), u-shaped (3), U-shaped (6), reaching nearly (1) or actually to dorsal trunk (1). Hearts of xi pass into testis sac ventrally.

Spermathecal duct *ca.* ½ mm long, slightly bulbous, slenderer than in *annulatus*, a vertical ridge not certainly recognizable on posterior wall of lumen. Diverticula median and lateral (20 spermathecae), digitiform, usually bent anteriorly or anteriorly and then ventrally.

Glands of the small genital markings on male porophores are usually (6 specimens) recognizable in coelomic cavity after removal of concealing nephridia, but the glands of three specimens appear to be entirely within the parietes.

Penial setae (36, mostly from Kyauk-kyone worms) are 1·2—1·65 mm. long, 10—18μ thick at tip, 24—33 at midshaft, 28—43 at base. Shaft bowed. Tip softened, wrinkled or cracked. Ornamentation of very fine spines in closely crowded circles. Number, 5-7 (18 batteries). Functional setae yellow, reserve setae red.

Remarks.—Vestibula may be eversible in this form in spite of apparent absence of thickening of roofs sufficient to be recognizable in the coelomic cavity.

Ventral intestinal caeca were 3-6 (usually 4) in xxviii-xxxiv (25 specimens). Reduction of the testis sac to a ventral chamber either has been completed or is under way, brown pigment has been acquired, but the lateral intestinal caeca appear to be in an early stage of evolutionary development though site seems to have been fixed. Incidence of absence of genital markings, and the variation as to axial and intrasegmental location, in 142 worms from two localities, was zero. In view of such uniformity, as also characterizes related species to the south, this taxon is treated for the present as a species in spite of similarities to *annulatus* and the geographical contiguity.

E. compositus is distinguished from *sejunctus* by the lateral position of the spermathecal pores, lateral position of the *d* setae posteriorly, presence of genital markings on x and xvii, rudimentary condition and more anterior location of lateral intestinal caeca, more anterior location of supra-intestinal glands and absence of vestibular bulbs. From *annulatus*, *compositus* is distinguished by the smaller vestibula, presence of genital markings on the circular areas bearing the vestibular pores, restriction of genital markings to x-xi and xvii, presence of rudimentary lateral intestinal caeca in xxiv, and a slightly more anterior location of supra-intestinal glands.

Eutyphoeus annulatus Gates 1931

Kin-U (Shwebo), September, 0-0-4. Saw San Thwe.

Kyaukmyaung (Shwebo), September, 0-1-3. Saw San Thwe.

External characteristics.—Length, to 55 mm. Diameter, to 3 mm. Pigmentation sparse behind clitellum, dense anteriorly. First dorsal pore on ?11/12(4), 11/12 (4). Clitellum reddish, protuberant, lacking at mV except on a portion of xiv and from 16/17 posteriorly where the musculature is no longer visible externally through the epidermis.

Spermathecal pores nearer to *C* than *B* or close to *C* (Kin-U), slightly nearer *B* (Kyaukmyaung), at m*BC*, just median to, at or just lateral to *C* (Sagaing, Kaungmudaw). Female pores both present (7). Vestibular apertures, in *AB* but usually reaching into *BC*, rather slit-shaped, transverse or slightly diagonal. Body wall somewhat thickened around the apertures, slightly less so mesially. Penes small, less than ½ mm. long, rather conical, invisible until vestibula are cut open.

Genital markings postsetal: On vii, in *BC* (1-Sagaing, 3-Kaungmudaw) ; on x, in BC (7) ; on xviii (6) ; on xix and xx (1, Kyaukmyaung), Postclitellar markings extend from *A* or slightly lateral to *A* into *BC*. Opaque rims of preclitellar markings, when recognizable, may cross intersegmental furrows but the greyish translucent central area appears to be strictly segmental.

Internal anatomy.—Typhlosole begins abruptly in xxiv (3) or xxv (5). A smaller secondary typhlosole, also slightly folded (16), is present laterally on each side in first two typhlosolar segments. Lateral intestinal caeca lacking (16). Ventral intestinal caeca in xxix-xxxi (2 Kyaukmyaung), xxix-xxxii (1 Kaungmudaw), xxix-xxxiii (1 Kaungmudaw).

Location of supra-intestinal glands

Segments	1	2	3	4
62—66	1		..	..
63—66		1		1
63—67	1	..	..	..
64—68	..	..	2	1
65—68		..	1	1
65—69	..	..	..	1

1 Kyaukmyaung. 2 Kin-U. 3 Sagaing.
4 Kaungmudaw.

Testis sac ventral (Kin-U and Kyaukmyaung), u-shaped(4-Sagaing 1-Kaungmudaw) or U-shaped (3 Kaungmudaw) and then reaching to or almost to dorsal blood vessel. Hearts of xi not included in dorsal limbs. Bulbus ejaculatorius white or with pink muscular sheen, protuberant into coelomic cavity but sometimes covered over by transparent tissue. Vestibular roof slightly protuberant into coelomic cavity.

Spermathecal duct (coelomic portion) nearly or actually one mm long, bulbous, narrowed at parietes. Lumen slightly eccentric due to presence on posterior wall of a high vertical ridge on which there is usually a slight vertical furrow. Ectally this furrow widens and deepens so that ridge appears to bifurcate. Diverticula median and lateral (32 spermathecae), usually directed anteriorly and then ventrally.

Glandular material (soft) protrudes slightly into coelomic cavity just over each genital marking including those on vii.

Penial setae (22 from Kyaukmyaung and Kin-U worms) are 1·95-2·98 mm long, 12-25μ thick at tip, 27-39 at midshaft, 30-50 at base. Shaft bowed, *i.e.*, curved in a semicircle. Tip pink, usually cracked or softened, otherwise tapering to a point. Ornamentation of closely crowded, unbroken circles of spines, extending 0·5 mm down the shaft. Number, 6-8 (22 batteries). Functional setae yellow except for tip, reserve setae red.

Remarks.—Circumferential constrictions on the penial setae, as well as the dark and light segments, now have been found occasionally in other species and have been lacking in some of the recent specimens of *annulatus*.

Complete protrusion of the penes has been recognized, perhaps all that is permitted by the small vestibular bulbs (proximal portion of the temporary intromittent organ of *macer* lacking here ?).

Ventral intestinal caeca have varied in number (29 specimens) from 3-7 (usually 4-6) in xxviii-xxxv and supra-intestinal glands have been in 4-5 of eight segments, lxii-lxix. Lateral intestinal caeca have not begun to develop though the typhlosolar correlation indicates they may be anticipated in xxiv or xxv. Brown pigment has been acquired and is more dense in a postclitellar region of the body than in *compositus.* The testis sac has been reduced to a suboesophageal sac but secondary dorsal distentions may be present. Male funnels of x almost have disappeared, a pair without ducts having been found only in one of 25 worms. The genital markings, though always restricted as to pairing and postsetal location, have been on any of segments vii-xxi except viii, xiii and xvii. Incidence of absence of the markings, in the type series of 22 specimens, was 4·5 per cent and certainly has been low in subsequent lots though definite percentages cannot be mentioned.

THE PHYLOGENY OF THE *levis* GROUP

The dorsal blood vessel has been retained in its primitive uninterrupted condition in each species of this group. Both female pores have been retained and also without variation. The first dorsal pore is on 11/12 and with equal uniformity the clitellum is thin or lacking just at mV. Genital markings have been restricted throughout the group to a postsetal location and always are associated with coelomic glands of unknown function but possibly for production of an adhesive substance at time of copulation.

The history of the supra-intestinal glands and of the ventral intestinal caeca apparently can be read from the available data in either of two directions but for the present it is assumed, in each case, to involve reduction in number.

Interspecific variation as to the lateral intestinal caeca, male genital terminalia, axial location of the genital markings, supra-intestinal glands and ventral caeca, is such as to indicate segregation in a common ancestral form of local populations into a number of small-range species, as now seems to be under way in the Pegu Yomas populations of *hastatus* and *constrictus* that are not mutating to other species. The small size of these *levis* group species and the infrequency with which they have been found, in comparison with somatic size and frequency of individuals of species just to the west, may indicate that morphological stabilization has been attained at cost of adaptability. The numbers and size of *peguanus* individuals in Thaton and Amherst districts rules out the explanation once advanced that "the mighty genus *Pheretima* has crushed all competitors" (Stephenson, 1923, Fauna British India, p. 30), in its westward advance.

The range in which segregation took place extends from Ye, at the southern border of Amherst district as well as of the *Eutyphoeus* domain, to Mandalay and then, west of the Irrawaddy river, north through Sagaing district and well into Shwebo. Extensions of this range may perhaps be anticipated as the fauna of the east bank of the Irrawaddy above Mandalay is largely unknown and not much more has been learned about that of the opposite side above Shwebo.

From the common ancestral form, which would have to be close to the proto-eutyphoeus, *pusillulus* has been segregated at the southern frontier, by establishment of the unidiverticulate mutation along with reduction in number of ventral caeca and supra-intestinal glands (as in the other seven species), elimination of genital markings as well as posterior testes and male ducts though not before evolution of an annular testis sac had taken place. In the rest of the range holandry was also completely eliminated but by establishment of the metandric mutation.

To the north *levis* has been derived by establishment of the unidiverticulate mutation, elimination of genital markings and by dorsal dislocation of the *d* setae posteriorly. If retained male funnels of x indicate recent origin, *levis* is the youngest species of the group. *E. pius* has been derived by a restriction of genital markings to xiii-xv, development of intestinal caeca in xxv and of a sucker-like male porophore with a penial annulus. *E. macer* has been derived by restriction of markings to xvi, development of intestinal caeca in xxiv and of eversible vestibula into which the penial annulus, now with posterior protuberances, has been withdrawn. *E. strigosus* is derived by restriction of genital markings to xii and their union at mV, development of intestinal caeca in xxvii and of vestibula so invaginated as to leave the fissure at apex of a tough conical penis without annulus. *E. sejunctus* has been derived by restriction of genital markings to xi, reduction of the annular testis sac to a suboesophageal chamber, development of intestinal caeca in xxvi, of batteries of reserve penial setae along with *strigosus* terminalia, and by dorsal dislocation of the *d* setae posteriorly. *E. compositus* has been derived by restriction of genital markings to x-xi and development of *sejunctus* terminalia but only now is in process of developing lateral caeca in xxiv. *E. annulatus* has been derived by development of *sejunctus* terminalia and like *compositus* has acquired brown pigment. Though the species still shows the presumed primitive variation in location of genital markings some populations have an obvious tendency for restriction to xv.

A mutation seems to be required to explain appearance of individuals without genital markings in the "marked" species of this group, as well as in *peguanus*, *constrictus* and *marmoreus*. Such a mutation has become established in the northern part of the *constrictus* range and in *peguanus* has given f. *simplex* which breeds true in isolation. This mutation, "inornate", for inhibition of development of genital markings, characterizes the holotype of *pusillulus* and is assumed in the phylogeny of *levis*.

Though anterior testes have been eliminated in genera of more than one family, proandry is rare and no evidence of the usual sort can be adduced as to its origin. Since the posterior testes can be aborted mutationally a similar cause for abortion of the anterior gonads is assumed in the phylogeny of *pusillulus*.

Approximation of diverticula on the posterior side of the spermathecal duct in *macer* provides just the stage on which stalkless subscript 1 can operate most easily to bring about the unidiverticulate condition reached in *E. ferinus*. Slight dorsal dislocation posteriorly of *d* setae to or just above mL (*pius*, *macer*, *strigosus*) similarly seems preliminary to the more marked dislocation of *levis* and *sejunctus*. If there is involved in this case a single mutation, it has become established in the southern half of the range though its effect has been partially masked, or its penetrance delayed, in three of the five species.

THE *foveatus* GROUP

Eutyphoeus foveatus (Rosa) 1890

1

Mupun (Amherst), October, 0-0-3. K. John.
Moulmein (Amherst), October, 0-0-58. K. John.
Kyaikto town (Thaton), August, 0-0-6. October, 0-0-30. K. John.
Boyagyi (Thaton), October, 0-0-2. K. John.
Syriam (Hanthawaddy), August, 0-0-9. K. John.
Kyauktan (Hanthawaddy), September, 0-0-1. K. John.
Twante (Hanthawaddy), September, 0-0-72. K. John.
Taikkyi (Insein), September, 0-2-26. K. John.
Wanetchaung (Insein), September, 0-0-31. K. John.
Taukkyan (Insein), September, 0-0-22. K. John.
Hmawbi (Insein), September, 0-0-16. K. John.
Hlegu (Insein), September, 0-0-20. K. John.
Dam site, M5-6 (Insein), September, 0-0-17. K. John.
Hlawga (Insein), September, 0-0-9. K. John.
Maubin, October, 0-0-17. Maung Ohn Maung.
Danubyu (Maubin), October, 0-0-4. Maung Ohn Maung.
Pantanaw (Maubin), October, 0-0-3. Maung Ohn Maung.
Pegu, August, 0-1-5. K. John.
Pegu, jungles to the east, August, 0-0-4. K. John.
Thanatpin (Pegu), August, 0-2-3. K. John.
Ingabu (Henzada), October, 0-0-2. Maung Ohn Maung.
Zalun (Henzada), October, 0-0-1. Maung Ohn Maung.
Henzada, October, 0-0-2. Maung Ohn Maung.
Pyu (Toungoo), hills to the west, September, 0-0-32. H. I. Marshall.
Toungoo, October, 0-0-1. K. John.
Paukkaung (Prome), September, 0-0-28. K. John.
Prome, September, 0-0-25. K. John.
Allanmyo (Thayetmyo), September, 0-0-5. K. John.
Thayetmyo, September, 0-0-5. K. John.
Naba (Katha), September, 0-0-25. Saw San Thwe.

External characteristics.—A size of 380×9 mm is reached by some of the Paukkaung worms. First dorsal pore on 10/11 (1), 11/12 (38), 12/13 (1).

Spermathecal pores small slits, usually centered at *B*, rarely slightly median or very rarely slightly lateral to *B*. Female pore on left side (59), on right side also (3), represented by a punctate but possibly functionless marking on right side (4). Vestibular aperture, always open usually nearly circular, rarely hexagonal, square, longitudinally elliptical or rectangular, usually restricted to *AA*, occasionally reaching slightly beyond *B*. Vestibulum deep, body wall around vestibular aperture thickened in an annular fashion, roof thin, never showing indications of eversion. Penes slenderly tubular, one mm or more long or, lateralmost portion of vestibular roof, directed ventrally or ventromesially, invisible from rexterio

Genital marking reaches *A*, into *AB*, to or rarely very slightly beyond *B*, almost to equator of xvi and to site of 14/15 or onto posterior portion of xiv, usually indented at equator of xv, *a* within or outside. The following variations were found in present material : Portion of marking in front of equator of xv much reduced (3 Paukkaung, 1 Prome, 5 Pyu), or lacking (1 Paukkaung), or separated from the equisized posterior part by an unmodified transverse band of epidermis containing ventral setae of xv (1 Paukkaung, 1 Thayetmyo, 1 Syriam, 1 Twante, in the latter case anterior marking about twice size of posterior). No genital marking, epidermis wrinkled and whitish ventrally on xv-xvi (1 Pyu). An additional small marking in *AA* on 13/14 (1 Thayetmyo).

Internal anatomy.—Typhlosole begins in xxvii (3) or xxviii (25). Longitudinal rows of small patches, as in *excavatus*, always present in first one or two typhlosolar segments ; one patch on each side (1), two (5), three (20), four (25), five (1). The anteriormost usually is slightly median to caecal aperture. Protuberances that look like unconstricted lateral caeca may be recognizable (34) but in some other worms were not certainly distinguishable from sacculations present in neighbouring segments, in nine specimens even sacculations lacking. Small incompletely constricted caeca present in xxviii or xxix. Two pairs of caeca in two successive segments xxvii-xxviii (1), xxviii-xxix (3), or smaller but both pairs in the same segment and one dorsal to the other (1).

Circulatory system as in *gigas* except that the extra-oesophageals are connected by a transverse vessel just behind 5/6. The dorsal trunk (1 Pyu) is continued well onto gizzard where it bifurcates, the branches disappearing ventrally at sides of the gizzard, or continued further and nearly to 5/6 where it passes ventrally on left side as a heart-like commissure (1 Pyu).

Testis sac suboesophageal (64). Bulbus ejaculatorius firm, with muscular sheen, conspicuously protuberant into coelomic cavity (64), sometimes more than two mm long.

Location of supra-intestinal glands and ventral caeca

Segments	Number of specimens from										
	1	2	3	4	5	6	7	8	9	10	11
85-91		..	..	..		..	..	1	..		
86-90		..	..		..			1			..
86-91	..	..	1	1				1	..		.
87-91		..	2	..		..		..	..	..	..
87-92			2	1	..	..		1		1	..
87-93		..		1	..	1	..	..		..	..
88-92	1		5	2	..	..		..	..	1	1
88-93	..		2	1	..	..		.		2	1
88-94	1		..	1	1	..		..		..	..

Location of supra-intestinal glands and ventral caeca—contd.

Segments	Number of specimens from										
	1	2	3	4	5	6	7	8	9	10	11
89-93	2	..	6	2	..	..	..	..	..	1	5
89-94	1	4	4	1	1	..	1	..	2	8	..
89-95	1	2	1	..	..	1	1	..	..	1	..
90-94	2	2	4	..	1	..	..	..	..	2	2
90-95	..	2	5	2	1	2	1	1*	..	2	
90-96	..	1	..		..	..	4	..	1	..	..
91-95	2		1	2			..	..	..	..	..
91-96	1	1	..	1		1	1	..	1	1	..
91-97	1	3	..				2	..	1	..	..
92-96				1		..	..	..	..	..	..
92-97		2	..	2	1		2	..	..	..	..
92-98	1	1	..		..	..	..	..	..	..	..
93-98	..	1		1		..	..	..	..	..	.
93-99			..	1	..	..	..	..	..	..	..
94-100		1		..			..	..	..	..	..
95-99	..			..	..		1	..		..	..
95-100		2			..	..	..	..	..	..	..
95-101		2					..			..	..

33-53	..	..		1				..	..	..	..
34-53	..	..	..	1	..	..	..	..	..	..	..
34-56	..	..	..	3		..	..	..	..	..	..
34-57	..		..	1	..		..		..	..	..
34-58	..	..	..			..	..	1	..	..	..
34-59	..	..	..	1	..	1	..	..	..	..	.
35-54	..		..	1			..	..	..	..	..
35-55				1			..	..	..	..	..
35-56			..	2	..	..		..	..	.	..
35-57	..			4			..	1	..	..	..
35-58	..		..	1	..		..	..		..	..
35-59	..			2		..	..		..		..

*Abnormal or mutant.

Location of supra-intestinal glands and ventral caeca—contd.

Segments	Number of specimens from										
	1	2	3	4	5	6	7	8	9	10	11
35-60	..	..	..	1	..	..	..	..	..	..	..
36-54	..	..	..	..	..	..	..	2	..	..	..
36-57	..	..	..	1	..	..	..	..	..	..	..

1 Rangoon and vicinity. 2 Naba. 3 Pyu.
4 Paukkaung. 5 Kyaikto. 6 Allanmyo.
7 Prome. 8 Thayetmyo. 9 Laboo.
10 Thanbula. 11 Moulmein.

Spermathecal duct 2-3 mm long, with brilliant muscular sheen markedly bulbus, ampulla bound down around entalmost portion, wall thick. Lumen small except in region of diverticular junctions where it may be slitlike or widened horizontally and then on floor of widened portion two, three or four lobes with high and regularly rounded surfaces. Diverticula median and lateral on each spermatheca except as noted below. Seminal chambers in a diverticulum usually five or less.

Median diverticulum of right spermatheca lacking (1 Pyu, 1 Thanatpin, 1 Allanmyo). Median diverticulum of left spermatheca lacking (1 Henzada, 1 Taukkyan). Median diverticulum of each spermatheca lacking, duct abnormally short and without sheen (3 Taikkyi, 1 Dam site). An extra small diverticulum of about same height as the other two but on anterior face of duct (1 spermatheca, each of 2 Naba worms).

Body wall occasionally rather conspicuously protuberant into coelomic cavity over genital marking as a result of depression of the marking, the longitudinal musculature uninterrupted over site of marking.

Penial setae (60 from 6 localities), 3·0-4·6 mm long, 30-51μ thick at base, 22-46 at midshaft, 11-30 at tip. Shaft with spiral curves ectally, assuming under pressure of cover glass a question-mark shape. Tip flattened but not widened, tapering to a point, thin and almost transparent. Ornamentation of spine-like teeth in irregular transverse grooves ectally, more or less regular and possibly unbroken circles entally. Number, 8-16 (30 batteries). Reserve setae may be pink. Functional setae of 130 additional specimens from the various localities have the spiral curvature ectally, unless otherwise indicated.

Penial setae of four Taikkyi and Damsite worms with unidiverticulate spermathecae, 11-16 per battery, 3·05-3·44 mm long, 41-52μ thick at base, 31-39 at neck, 44-47 at blade, 13-18 at tip. Shaft practically straight except for slight curve at ectal end. Tip flattened, widened, occasionally with a longitudinal ridge at middle of blade. Tips of smaller reserve setae only slightly widened and very similar to those from worms with bidiverticulate spermathecae.

Abnormality.—(No. 1) An extra half vestibulum on left side of xviii, containing a penis and penial setae. A prostate and duct of about same size as those in xvii, and a penisetal follicle present in xviii on left side. Left male deferent duct passes into parietes normally in xvii, no bulbus ejaculatorius in xviii (Moulmein).

(No. 2) Right spermathecal pore on 8/9. Genital marking extending to equator of xvi on left side, to equator of xvii on right side. A half vestibulum present on left side of xvii, another on right side of xviii. Clitellum on xiii-xviii on left side, xiv-xix on right side. Septum 11/12 thickly muscular but present only on right side. Intestinal origin in xvi and last heart in xiv on right side. No testis sac, a rudimentary male funnel in xi on right side, a large male funnel in xii on right side but none on left side, rudimentary seminal vesicles in xii (left side) and xiii (right side). No ovary on right side (Taikkyi).

Remarks.—Types are softened. One is aclitellate, avestibulate penes represented only by very small rudiments, and without a genital marking. Vestibulum and penes are recognizable on another but the genital marking is incompletely developed or abnormal. Penes are visible on a third but the vestibulum is scarcely recognizable presumably as a result of relaxation associated with maceration.

The penes almost completely protrude in anesthetics but eversion of the vestibulum has never been observed.

The genital marking has been lacking only once, in the entire range, and an extra genital marking has been present only twice, once each on 13/14 and 18/19, the three worms from or near the northern boundary. The anterior portion of the marking, between equators of xiv and xv, has been lacking on three specimens from two localities, one of which is at the northern periphery, the posterior half absent on but one worm also from near the northern limit. The marking has been separated into two parts by an unmodified strip of epidermis at equator of xv in one worm from each of seven localities. This variation may result from premature cessation of growth in separate anlage thereby resulting in reversion to an ancestral state characterized by two discrete intersegmental markings such as still prevails in *excavatus.*

The dorsal blood vessel usually ends with or as a short stump just in front of the hearts of vii. Continuation, in 3 of 104 specimens examined in this connection, onto gizzard (2) and then bifurcating or turning ventrally on one side or passing on nearly to 5/6 (1) before turning ventrally, represents partial reversion to an ancestral condition in which the trunk was uninterrupted and with paired commissures to ventral vessel in each segment. The reversion is attributable to inhibition, during development, of the reorganization process that eliminates the segmental commissures and produces the foreshortening.

Variation in number of segments provided with supra-intestinal glands appears to be about the same throughout the range, glands having been found only in 5, 6, 7 segments. Number of segments in which glands have been found, in a local population, is 8-14, and in the species, 17.

Number of segments in which glands have been found	Number of specimens in sample	Segments involved	Locality
8	10	88—95	Moulmein
9	5	89—97	Laboo
10	33	86—95	Pyu
10	5	88—97	Kyaikto
10	5	87—96	Allanmyo
10	14	87—96	Thanbula
11	5	85—95	Thayetmyo
11	13	89—99	Prome
13	24	89—101	Naba
14	13	85—98	Rangoon
14	20	86—99	Paukkaung

Glands in five segments, 49 worms.
Glands in six segments, 66 worms.
Glands in seven segments, 31 worms.

Variation as to presence or absence of lateral intestinal caeca, degree of constriction from gut wall, shape and direction as well as number, throughout the range, indicate the species has been found in an early stage of evolution of a new organ. In marked contrast is the constancy of the seemingly insignificant red patches at sites of lateral typhlosoles. Variation in number of spermathecal diverticula is considered below.

The abnormal specimen (No. 1) shows that development of the vestibulum also is induced by the prostate but only unilaterally. Further, development of the penis likewise is prostate induced and that development may be perfectly normal in absence of a male deferent duct.

Mandalay and Naba populations now appear to be local colonies established after accidental transport from the proper range well to the south. Small individuals of this species occasionally have been found in earth around roots of the potted plants that have been carried around Burma for many years. Locations of supra-intestinal glands in the Naba worms are almost exactly the same as in those from Prome. Several attempts to find the species again at Mandalay, to secure data on location of supra-intestinal glands, were all unsuccessful. The colony at Mandalay probably was not large and may have become extinct. The distribution in Amherst and Thaton districts now appears to be marked by significant discontinuities and at least in part by isolation from the main range. The Moulmein-Mupun colony, which is well established is thought to be a result of accidental transportation by man. Although the same agent can have responsibility for the introductions into Thato district, transport by flood waters from across the Sittang, either directly or indirectly, may require consideration.

With these deletions the *foveatus* range is limited to the southern hills of the Arakan Yomas, the recent alluvium of the Irrawaddy-Sittang rivers and adjacent higher land. The species has not been found as yet in Myaungmya and Pyapon districts where the alluvium presumably is of latest deposition.

2

Laboo (Prome), September, 0-0-6. K. John.
Thanbula (Thayetmyo), September, 0-0-14. K. John.
Thayetmyo, September, 0-0-1. K. John.

External characteristics.—Spermathecal pores small, almost without exception in *AB*, often nearer *A* than *B*, occasionally just lateral to *A*. (Genital marking normal.)

Internal anatomy.—Typhlosole begins in xxvii (2), xxviii (14), xxix (4). Red patches always present in first one or two typhlosolar segments, two in a row (4), three (12), four (4). Lateral intestinal caeca rudimentary, in xxviii (3 Laboo) or lacking. Ventral intestinal caeca in ; xxxiv-lviii (1), xxxiv-lx (1), xxxv-liv (2), xxxvi-li (1), xxxvi-liii (1).

Spermathecal duct slightly more than one mm long, lumen small with several fairly high vertical ridges on the wall. Median diverticulum lacking (42 spermathecae). Lateral diverticulum usually a horizontal ridge of five to nine seminal chambers, rarely a vertical ridge (2). Seminal chambers occasionally few, five to two or even one and then more protuberant and ovoidal to spheroidal.

Penial setae have no blade-like widening of tips and are spirally curved ectally.

Abnormality.—(No. 1) A very small vestibular invagination containing a rudiment of a penis present on right side of xv. A prostatic duct about one mm long passes into wall of vestibular invagination but entally duct ends abruptly without a gland. A follicle containing three penial setae associated with the prostatic duct. Penial setae 1·34-1·6 mm long, 45-46μ thick at base, 39-40 at midshaft, 25-26 at tip. (Right male deferent duct passes into parietes of xvii normally.)

Remarks.—These worms have normal *foveatus* genital markings and penial setae. Spermathecae also are as usual except for absence of the median diverticulum. No other species is present in or near the region with which the worms could be confused so no question arises as to their identification or their mutant nature. Each individual of the sample of the populations at Laboo and Thanbula is a mutant (unidiverticulate). At Thayetmyo, where the species is not common, only one individual, 16·6 per cent., of the small sample secured, is a mutant. Thanbula and Thayetmyo are at or near the northern border of the *foveatus* range. Laboo though well inside is near the foothills of the southern Arakan Yomas.

Three specimens of the Taikkyi and one of the Damsite samples, 10·7 per cent. and 5·8 per cent., with normal genital markings, show the unidiverticulate mutation which presumably has appeared *in situ.* The spermathecal duct in these worms is abnormally short. Penial setae are like those of *spinulosus* and have a neck of the same width though the blade is not quite as thick and does not narrow to a spin. Younger reserve setae are more like those of *foveatus* than similar stages in *spinulosus.* Identification of these worms would have to be *spinulosus*, though genital markings are quite normal, if the localities were unknown.

Eutyphoeus spinulosus Gates 1926

Padaukchaung (Bassein), nearby jungle, October, 0-4-46. K. John.
Bassein, October, 0-4-28. K. John.

External characteristics.—Spermathecal pores centered at or just median to *B*. Female pore on left side (48), a pore also present on right side but like area around it smaller than that of left side (10 Bassein, 3 Padaukchaung).

Genital marking with a deep V-shaped incision at equator of xv on each side, *a* and *b* of xv in the incision rather than in the marking (60), the portion in front of equator of xv definitely smaller (53). Genital marking nearly reaching equators of xv and xvi only (4 Padaukchaung, 2 Bassein). Two distinct markings, the smaller on 14/15 (6 Padaukchaung, 1 Bassein).

Internal anatomy.—Typhlosole begins in xxviii (3), or just in front of 28/29 (2). Small patches at sites of lateral typhlosoles in longitudinal rows of three (2) or four (3), in first one or two typhlosolar segments. No lateral intestinal caeca. Ventral caeca in xxxv-lxii (1), xxxv-ixiii (1), xxxv-lxv (1), xxxvi-lxiv (1), xxxvi-lxvi (1).

Location of supra-intestinal glands

Segments	Number of specimens
87—91	2
88—92	6
89—93	7
90—93	1
90—94	1
90—95	?
91—96	1*

*The only pair of glands in xcvi of this worm is smaller than those of preceding segment

Circulatory system as in *foveatus*.

Testis sac suboesophageal (82). Bulbus ejaculatorius protuberant into coelomic cavity though covered with transparent tissue (Bassein), in parietes, or covered over by opaque tissue (Padaukchaung).

Spermathecal duct usually about one mm long, abruptly narrowed in parietes, with marked sheen. Lumen irregularly slit-like in cross section, with several fairly high vertical ridges on wall. Diverticulum a low ridge rather diagonally placed with anterior end ventrally, always lateral (164 spermathecae). Definite seminal chambers not marked off externally but five to nine spheroidal masses of spermatozoa may be visible through outer tissues. Only one opening into duct lumen was found from diverticulum (8 spermathecae).

Penial setae (10 each from Bassein and Padaukchaung), 3·5-4·37 mm long, 32-45μ thick at base, 31-40 at neck, 45-59 at blade. Shaft practically straight except for a slight curve ectally. Tip flattened, widened (also in functional setae of 71 other specimens), tapering to a sharp point or a spine. Ornamentation of small thorn-like teeth in regular circles about 5 micra apart. Number, 6-8 (10 batteries). Reserve setae red, thick basally, tip often slightly concave like a spoon bowl.

Abnormality.—(No. 1) No male genital terminalia on right side, right deferent duct dwindling to disappearance before reaching xvii (Bassein). (No. 2) Spermatheca lacking on left side (Bassein).

Remarks.—This species is distinguished from *foveatus* by absence of the median spermathecal diverticulum, absence of spiral coiling of an ectal portion of the penial setae and by the shape of the thickened ectal portion of the penisetal shaft. The anterior portion of the *foveatus* genital marking here seems to be gradually disappearing. Incidence of inornate individuals certainly is much higher than in *foveatus* though statement of percentages now has become impossible.

E. spinulosus has been found only in the recent alluvium of Bassein district. It must have arrived there recently, perhaps from the southern hills of the Arakan Yomas the fauna of which is entirely unknown south of the Taungup pass.

Eutyphoeus planatus Gates 1929

Allanmyo (Thayetmyo), August, 0-0-45. K. John.
Thayetmyo, August, 0-0-15. K. John.
Magwe and vicinity, August, 1-0-44. K. John.
Minbu and vicinity, August, 3-0-120. K. John.

External characteristics.—Length, 100-240 mm. Diameter, 5-9 mm. Pigmentation dense anterior to, in and just behind clitellum, sparse posteriorly. First dorsal pore on 10/11 (4), 11/12 (86).

Spermathecal pores centered at or close to *B*, more often slightly lateral, or pores in median half of *BC* (Allanmyo). Female pore on left side (79), a smaller pore present on right side (5) or represented by an imperforate punctation (10).

Vestibular aperture (Allanmyo-Thayetmyo), in *BB*, usually transverse, often slightly wider anteriorly as in types (fig. 20*a*, Gates 1929,

p. 36), occasionally rectangular, nearly square (2), longitudinally rectangular (2), wide open except when longitudinally rectangular. Tow pairs of slightly raised, longitudinal areas with somewhat of an appearance of genital markings present on vestibular roof mesially, close to mV (epidermis between opaque) or slightly more lateral (epidermis between so thin that fibres of longitudinal musculature beneath are visible).

Vestibular aperture Y-shaped (Minbu-Magwe), limbs of about the same length, one median and posterior, the others directed anterolaterally. The Y-shape due to presence of a ridge on anterior wall of vestibulum that may almost touch posterior wall in which case vestibular aperture is almost V-shaped (2 Minbu). Vestibular aperture closed, by apposition of margins of limbs of Y, or open. The wider the opening the less prominent the anterior ridge which is however always distinct even in relaxation so complete that vestibular lumen is almost obliterated (1 macerated Minbu worm). Two pairs of slightly raised areas present on vestibular roof mesially but the two anterior areas are here on lateral sides of the anteromedian ridge.

Penes small, soft, annular, or quite unrecognizable (specimens from each of the four localities) in which case two penial setae usually protuberant from the transverse fissure.

Genital marking (single, 208) transverse, in *BB*, rarely extending slightly into *BC*, on postsetal portion of xiii, occasionally (?) reaching slightly across site of 13/14. Asymmetrical, from mV to *A* on left side (1 Allanmyo). An additional marking on xiv (14 Allanmyo, 1 Thayetmyo), usually in AA (13), reaching into *AB* (1) or to *B* (1), possibly crossing site of 14/15 in some cases, but always smaller than the anterior marking. A rather indefinite rudiment of an extra marking on xiv (4 Minbu).

Internal anatomy.—Typhlosole begins in xxvii (1), xxviii (13), xxix (1, Thayetmyo), xxvii (3), xxviii (19, Allanmyo), xxviii (1), xxix (15, Minbu), xxviii (1), xxix (16), xxx (1, Magwe). Lateral typhlosoles represented by small, dark red, transversely elliptical patches in longitudinal rows of one (4), two (14), three (21), four (27), five (1). Lateral intestinal caeca lacking, a slight lateral bulge occasionally recognizable in xxviii, xxix or even xxx (1). Ventral caeca rather large, often bent backwards or coiled when length is greater than that of its segment. The largest caecum (each of several worms) may have one, two or three small, shortly ellipsoidal, whitish swellings posteriorly on the widened proximal portion. Ventral caeca and supra-intestinal glands as in table (p. 171).

Circulatory system as in *gigas* except that extra-oesophageals are connected by a transverse vessel just behind 5/6 and the supra-oesophageal occasionally is continued forward to hearts of xi. Dorsal trunk continued onto gizzard as a colorless (functionless ?) filament (1), ending with commissures of vii, or just in front of them as a bluntly rounded or a conical protuberance (225). Right heart of xiii lacking (1 Minbu).

Testis sac apparently suboesophageal (Thayetmyo-Allanmyo), a small cord apparently of testicular coagulum continued up to or nearly to dorsal blood vessel on anterior face of each heart of xi (1 Thayetmyo), dorsal halves of hearts of xi recognizable without opening the sac. Testis sac annular (Minbu-Magwe), passing over dorsal trunk, usually conspicuously distended dorsally as well as laterally by coagulum. When there is little or no coagulum dorsally and laterally, lumen of sac can still be traced to or nearly to dorsal vessel though the upper portion of the sac appears to be strongly contracted. Hearts of xi are invisible in distended sacs but attached to posterior wall and within a delicate tube.

Location of supra-intestinal glands and of ventral caeca

Segments	Number of specimens from			
	1	2	3	4
85—90		6		..
86—90		1		..
86—91	1	8	..	..
87—91		2	..	..
87—92	3	4	..	..
87—93	1	1		
88—92	3	1	..	..
88—93	5	2		..
88—94	1	..		
90—95	..	1	1*a*	..
91—96	..		1*a*	..
91—97	..		2*a*	..
92—97	..	..	1	..
92—98	..	..	2*a*	
93—97	..	..	..	1
93—98	..	..	3*a*	2*b*
93—99	..	..	1*a*	1
94—98	..	..	..	2
94—99	..	..	2	2
94—100	..	..	2	3
95—100	..	..	..	6
95—101	..	..	2	..
95—102		..	1	..

Location of supra-intestinal glands and ventral caeca—contd.

Segments	Number of specimens from 1	2	3	4
96—101	..	..	2	2
96—102	..	..	3	..
96—103		..	1	..
97—101	..	..		1
97—103	..	..	4*c*	..
97—105	..	..	1	..
98—102	..	..	..	1
98—103	..	..	1	..
99—104	..	..	1	..
33—36	..	2	..	..
33—37	1	2		..
33—38	1	..	..	..
33—39	1+1	..	..	..
34—37	1+2	11	..	..
34—38	6+7	5	3*a*	..
34—39	3+7	..	..	2
34—40	..	..	1	1
35—38	..	..	3	3
35—39	1	..	5	3
35—40	..		2	1
36—38			1	..
36—39	..	..	3	2
36—40			5	3
36—41	..		1	2
37—40	..	..	1	1
37—41	..	..		1

1 Thayetmyo. 2 Allanmyo. 3 Minbu. 4 Magwe.

a All unusually small worms, 100-130 × 5-6 mm.

b Including one juvenile. *c* Including one small worm.

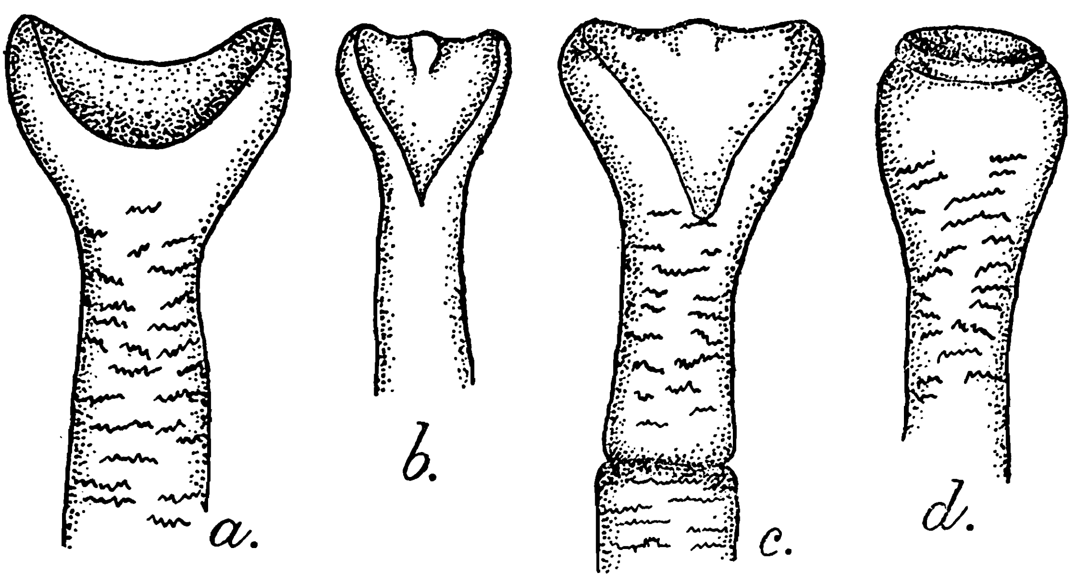
+ Previous records (Gates, 1933, p. 593).

Vestibular roof somewhat protuberant into coelomic cavity, somewhat thinner, especially in Thayetmyo-Allenmyo worms, mesially. Bulbus ejaculatorius small, rather soft, white, in posterior wall of vestibulum.

Spermathecal duct (Minbu-Magwe) bulbous, flask-shaped, constricted at or within parietes, with narrow but definite neck entally, two or slightly more mm long, with marked pink sheen. Lumen irregularly slit-like in cross section due to presence of vertical ridges on anterior and posterior walls. Number of ridges variable but twelve in several spermathecae, all of about the same height and quite regularly placed. Duct (Allanmye-Thayetmyo) less than two mm long, white, no sheen recognizable, constricted in parietes but without a definite neck region entally. Lumen crescentic in cross section due to presence of a fairly high and thick ridge with a slight vertical groove on posterior wall. Diverticula small, often with but one shortly ellipsoidal seminal chamber or with ental end marked off into two to seven (rarely) lobes, median and lateral (449 spermathecae). Lateral diverticulum lacking on right spermatheca (1 Minbu, 1 Thayetmyo), on left spermatheca (1 Minbu, 1 Thayetmyo). An extra diverticulum on posterior face of one spermatheca (1 Magwe), on anterior face of each spermatheca (1 Thayetmyo).

Body wall bulged slightly into coelomic cavity over genital marking but not thickened (Allanmyo-Thayetmyo). Coelomic surface of protuberance firm, longitudinal musculature uninterrupted. A slight layer of soft (glandular ?) material on coelomic face of protuberance in Minbu-Magwe worms. This layer is easily scraped off to display small, circular greyish translucent spots (ends of glandular cords ?) between longitudinal muscle fibres.

Penial setae (40 Allanmyo-Thayetmyo) 1·9-2·7 mm long, 30-45μ thick at base, 20-60 at neck, 30-57 at blade. Shaft nearly straight except for a slight ectal curve, occasionally with one or more circumferential constrictions. Tip widened, flattened, rather spade-shaped, truncate



TEXT-FIG. 1.—*E. planatus.* Tips of penial setae, x *ca.* 560.
a. From clitellate worm (Magwe) ; *b.* From juvenile (Magwe) ; *c.* From clitellate worm (Minbu) ; *d.* Tip abnormal. From clitellate worm (Minbu).
[Camera lucida sketches by Miss Chapman. (Other sketches of penial setae, vestibula, and genital markings were destroyed during world war ii)].

or ectal margin with central protuberance rarely tapering to a point. Ornamentation of small triangular teeth in transverse rows ectally, in circles entally, 3-4 circles in 10 micra. Number, 4-8 (20 batteries). Width of blade, 32-42μ in Allanmyo, 35-57 in Thayetmyo worms.

Penial setae (68 Magwe-Minbu) 1·0-2·3 mm long, 25-50μ thick at base, 12-30 at neck, 28-60 at blade. Shaft curved in half parabola. Tip widened, scoop-shaped, ectal margin concave, ending in annulus (4, fig. 1). Ornamentation of thorn-like teeth in rows or circles as before. Number, 5-11 (34 batteries). Functional setae yellow, reserve setae pink and usually with central protuberance of ectal margin (Magwe) quite obvious. Four functional setae, from juveniles with batteries of 10-11, are 1·34-1·8 mm long, 30-47μ thick at base, 15-21 at neck, 34-45 at blade.

Juveniles.—Anlage of vestibular invaginations are represented in these Magwe-Minbu worms, 65-100$\times$4 mm, by a greyish translucence of body wall in diagonal, anterolaterally directed areas within each of which is a transverse fissure through which penial setae project. A median region on presetal half of xvii, of triangular shape with apex posteriorly, is more or less markedly tumescent. Grey areas are slightly depressed (1) or, in largest juvenile, depressed, enlarged and united at mV posteriorly on xvii. Margins of fissures very slightly tumescent on one of the juveniles. The rudiment of the genital marking is postsetal on xiii. Spermathecal pores exactly centered at *B*. Testis sac annular, with delicate coagulum extending dorsally through sac and above dorsal trunk. Spermathecal duct bulbous and even at this stage with a definite though short neck. Ampulla shorter than duct, rudiments of diverticula recognizable.

Parasites.—Gregarines are present in numbers, in coelomic cavities of postprostatic segments of three of the juveniles.

Remarks.—The genital marking according to evidence provided by juveniles belongs to xiii though it may cross site of 13/14 in its growth. The marking has been absent only twice. Additional markings have been present on xii (or 12/13 ?) thrice, on xiv (or 14/15 ?) in a score of cases. The latter location is the same as that of the anterior marking of *excavatus*.

Populations from opposite sides of the Irrawaddy River have similar characteristics but those at northern and southern limits of the unusually small range differ with respect to shape of vestibular aperture and lumen, shape of testis sac, shape and length as well as muscularity of spermathecal duct and the ridging of its inner wall, curvature and shape of tip of functional penial setae, color of reserve setae, segment in which typhlosole begins, segmental location of supra-intestinal glands, and possibly in development of glandular material associated with genital marking.

Penial annuli, on the contrary have been recognized in individuals from each of the localities though absent in others from the same populations. The variation here, as in other species, may be due merely to degree of outrolling of lining of fissure at time of preservation rather than in development of a permanent structure.

Eutyphoeus excavatus Gates 1929

Meiktila, September, 0-0-33. K. John.
Taungtha (Myingyan), September, 0-0-1. K. John.
Myingyan, September, 0-0-21. K. John.
Kyaukse, hills to the west, September, 0-5-50. K. John.
Kyaukse, two miles to the west, September, 4-1-49. K. John.
Dwehla (Kyaukse), September, 0-4-29. K. John.
Myotha (Sagaing), September, 0-0-10. K. John.
Tada-U (Sagaing), September, 0-0-2. K. John.

External characteristics.—Smallest clitellate specimen 110 mm long and 4 mm thick. First dorsal pore on 10/11 (2), 11/12 (58), 12/13 (3).

Spermathecal pores small, with centers on or median to *B*, rarely in median half of *AB*. Female pore on left side only (149), paired (11, but both functional?). An imperforate punctation at approximate site of right pore on nine specimens.

Vestibular aperture transversely slit-like, extending into lateral half of *BC*, margin especially strengthened from *A* laterally. Vestibular lumen transversely dumbbell-shaped in horizontal section (full contraction), often much shallower in region of *AA* than laterally and then lips usually in contact with each other in region of *AB* on each side. Vestibulum may be relaxed so that there is no trace of an aperture recognizable in *AA*, the worms then apparently bivestibulate. A slightly raised, circular to shortly elliptical area is present, about in *AB*, on each side of the anterior and posterior vestibular walls, and on these areas occasionally are distinguishable an opaque whitish rim and greyish translucent central portion. Penes are represented only by small, low, whitish annuli on the vestibular roof at or slightly lateral to *B*. The annulus may be anteroposteriorly flattened (many Myingyan specimens) and even slightly extended so as to appear tubular but is still less than one half mm long. The annulus is unusually small in some of the Meiktila specimens and in worms from other localities appears to be entirely lacking though the rim of the aperture into the fissure is slightly softer than the rest of the vestibular roof. Median to the annulus and centered at *A* there is often a slightly raised circular patch.

Genital markings (median) reach laterally to *A*, into *AB*, to or just lateral to *B* and may nearly meet or actually be in contact at equator of xv. Markings are sharply demarcated by a slight, (usually) completely circumferential groove. Just internal to this groove the marking is slightly raised and whitish but this margin is not clearly marked off from the greyish translucent portion which is usually depressed in a regularly concave fashion. The usual two markings are present (199) except as follows : Anterior marking lacking (1 Kyaukse, 1 Dwehla). Posterior marking lacking, a marking on 13/14 (1 Myingyan). An extra marking on 13/14 (2 Myingyan, 1 Meiktila). An anterior half portion of a marking present on the posterior part of xvi (1 Dwehla) in addition to the usual markings.

Internal anatomy.—Typhlosole begins in xxvi (1), xxvii (7), xxvii (10), xxix (1). A very slight but definite white ridge, continuous or variously interrupted, often present forward into xv. A short intermediate zone less than one segment in length usually present but pressed against front end of typhlosole and unrecognizable unless gut wall is stretched. Lateral typhlosoles represented only by longitudinal rows of patches, two in a row (3), three (10), four (9), five (3). Patches shortly oval to elliptical or spindle-shaped thickenings of wall gorged with blood, usually unrecognizable externally. Location of ventral caeca and supra-intestinal glands as shown in table. Two ventral caeca, both median and with apertures close together have been found in a single segment (of four specimens).

Circulatory system as in *gigas* except that the extra-oesophageals are connected by a transverse vessel just behind 5/6 and the dorsal trunk ends with hearts of vii (209).

Testis sac annular (209). Hearts of xi at first appear to be within the sac and adherent to its posterior wall but each heart is within a tube of delicate tissue which can be dissected off as also in case of hearts of xii. The dorsal trunk also at first appears to be included in the sac but delicate longitudinal mesenteries pass down from the vessel to dorsal surface of gut shutting off a small space that contains no testicular coagulum.

Location of ventral caeca and of supra-intestinal glands

Segments	Number of specimens from		
	1	2	3
33-38	1	—	—
33-42	1	—	—
33-43	1	—	—
34-38	2	—	—
34-39	1	—	1
34-40	—	1	—
35-39	2	—	—
35 40	2	—	—
35-41	2	2	—
36-38	3	—	—
36-39	2	—	—
36-40	1	2*	2
36-41	1	1	—
36-42	1	—	—
37-38	1	—	—
37-42	1	—	—

* Including the only record of caeca for a Taungtha worm.

Location of ventral caeca and of supra-intestinal glands—contd.

Segments	Number of specimens from 1	2	3
92-97	1	—	—
92-98	2	—	—
93-97	2	—	—
93-98	7	—	—
93-99	3	—	—
94-98	2	—	—
94-99	2	—	—
94-100	1	—	—
95-99	1	—	—
95-100	3	—	—
95-101	2	—	—
96-100	1	2	—
96-101	2	3	—
96-102	—	1	—
97-101	1	1	—
97-102	—	3	2
97-103	—	3	3
98-102	—	3	1
98-103	—	—	5
98-104	—	—	1
99-103	—	—	1
99-104	—	1	1
99-105	—	—	1
100-105	1	—	
101-105	—	—	1

1. Kyaukse and Dwehla. 2. Myingyan and Taungtha. 3. Meiktila.

Bulbus ejaculatorius markedly protuberant into coelomic cavity bound down to parietes, or within body wall, rather soft or firm, without muscular sheen. Vestibular roof thin in *AA*, thickened laterally and there slightly protuberant into coelomic cavity.

Body wall often conspicuously protuberant into coelomic cavity over each genital marking due to depression of a central portion of marking. Longitudinal musculature though thin, continued across the protuberances.

Spermathecal duct short, abruptly narrowed deep in parietes, lumen slit-like in cross section. The diverticulum, always single (418 spermathecae), lateral, rarely with an appearance of being more anterior than lateral (3 Myingyan specimens), usually manicate, with 6-8 finger-like lobes. Only one aperture in duct lumen (8 spermathecae) has been found.

Penial setae (36 Myingyan and Meiktila) 2·95-4·95 mm long, 40-75μ thick at base, 20-38 at neck, 27-63 at tip ; 3·2-4·05 (40 Dwehla), 40-75μ thick at base, 30-50 at neck, 30-50 tip. Shaft straight except for curvature from neck ectally. Tip widened, flattened tapering to a point or, occasionally, slightly concave like a bowl of a spoon. Ornamentation of spine-like teeth irregularly scattered ectally, in broken circles entally. Number, 8-16 (20 batteries, Dwehla), 5-17 (18 batteries, Myingyan and Meiktila). Reserve setae, paler than yellow functional setae, bowed slightly (quarter of a circle), with widened spoon-shaped tip.

Remarks.—The patches at sites of lateral typhlosoles are not always present in the same number on both sides of a worm. Counts were recorded for a single side only as the difference between the two sides usually was but one.

A female pore has been present on the right side in 11 of 149 specimens examined in this connection. Range of spermathecal pore location is even smaller than in *bifovis*.

At least one genital marking has been present in every worm, that of 14/15 lacking on two, that of 15/16 on one. An extra marking has been present on 13/14 of five specimens.

Each of 468 (+) spermathecae examined in this connection was unidiverticulate, the diverticulum lateral except in three worms where it had the appearance of being more anterior.

Number of segments with supra-intestinal glands in an individual was 5-7. Number of segments in local populations 9 (16 and 17 specimen samples from Meiktila and Myingyan respectively), 14 (31 specimen sample from Kyaukse-Dwehla). Number for the species, only 14.

Greater variation was found in number of ventral intestinal caeca 211. The number of segments involved in this species is the same as the maximum for a single individual.

All degrees between extremes of variation as to condition of margin of fissure containing penisetal follicle pores have been found in a single population, annulus lacking, doubtfully indicated, small, anteroposteriorly flattened and in a slightly longer tubular form.

Eutyphoeus cochlearis Gates 1951

Internal anatomy.—Typhlosole begins abruptly in posterior portion of xxvii (2), or xxviii (1), but reaches maximum height only in xxvii or xxix. Lateral typhlosoles represented only by longitudinal rows of

3-6 small, oval reddish patches in first typhlosolar segment. Ventral intestinal caeca in xxxiv-xxxix (1), xxxvi-xxxix (2). Supra-intestinal glands in xciii-xcviii (1), xciv-xcviii (1), xcv-xcix (1). Circulatory system, in these types, as in *gigas* except that extra-oesophageal trunks are connected by a transverse vessel just behind 5/6.

Testis sac annular and above dorsal trunk (1), or U-shaped, limbs reaching up to dorsal vessel (2). Vestibular roof thin midventrally. Penial setae (reserve) in two longitudinal ranks with the largest setae anteriorly and the smallest posteriorly, one rank in median, other in lateral wall of an entally closed cylinder, the two ranks almost meeting posteriorly. The two functional setae in softer tissue at anterior face of cylinder.

Spermathecal duct (coelomic portion) about 2 mm long, not bulbous. with fairly thick muscular wall, lumen rather crescentic in cross section due to presence on posterior wall of a fairly high ridge with a vertical groove at least ventrally.

Penial setae (6 Pakokku), 3-4·4 mm long, 40-50μ thick at base 30-40 at midshaft, 20-25 at neck, 35-39 at tip. Shaft curved into an S-shape. Tip slightly flattened, truncate, more or less spoon-shaped. Ornamentation of circles of spines that become smaller ectally. Number, 11-13 (3 batteries). Reserve setae shorter but thicker, tips more markedly spoon-shaped, bowl of spoon of smaller reserve setae occasionally ending in a slight protuberance.

Eutyphoeus bifovis Gates 1929

Taungdwingyi (Magwe), August, 1-1-14, K. John.
Taungdwingyi, hills to the east, August, 0-0-30, K. John.
Magwe, and vicinity, August, 0-0-34. K. John.
Nyaungbinywa (Magwe), August, 0-0-43. K. John.
Myingyan, September, 1-1-2. K. John.
Tada-U (Sagaing), September, 0-0-7. K. John.
Kin-U (Shwebo), September, 0-0-1. Saw San Thwe.

External characteristics.—Length, 140-220 mm. Diameter, 4·9 mm. First dorsal pore on 10/11 (2), 11/12 (42).

Spermathecal pores with centers at or near *C* (some Mandalay), pores lateral to *C* (Tada-U), in lateral part of *CD* (Myingyan), center at or close to *D* (some Mandalay), one pore only at m*BC* (2 Nyaung binywa). Female pore on left side (79, two of which have an imper forate punctation at site of right pore), right pore present but usually smaller and the whitened area around it smaller than that on left side. Vestibular apertures in *AB*, longitudinally elliptical to slit-like, always open. Midventral region between apertures slightly tumescent and cross-hatched as on relaxed specimens of *excavatus*. A ventral region including both vestibular apertures may be slightly depressed in which case a slight longitudinal elevation is present just lateral to each of the apertures. The median wall of each vestibulum is thin, with two rather conspicuous, circular to shortly elliptical protuberances, as anterior and posterior corners. Penes (?) small, white, annular. anterior portion of each annulus slightly thickened and with a transversely ellipsoidal appearance.

Genital markings transverse, reaching laterally to or slightly beyond *B*, on 15/16 and 18/19 (121) except as follows. Anterior marking lacking but site white, slightly tumescent, cross-hatched with numerous furrows (3 Taungdwingyi). No genital markings (1 Taungdwingyi). An asymmetrical marking on 19/20, from near mV to *A* on left (2) or right (1) side (Taungdwingyi and Nyaungbinywa). A marking on 14/15 (3 Taungdwingyi and Nyaungbinywa), as large as that on 15/16 (1) or smaller (2) and then in one case from mV to *A* on left side. Marking on 18/19 small, from near mV to *A* on left side (1 Nyaungbinywa).

Internal anatomy.—Typhlosole begins in xxvii (1), xxviii (48) or xxix (6). Lateral to the typhlosole there is always present on each side, in the first one or two typhlosolar segments or occasionally in the segment next in front as well, a longitudinal row of protuberant, dark red, transversely placed patches, one to six in a row ; one (1), two (3), four (23), five (8), six (1). Ventral caeca and supra-intestinal glands located as shown in table.

Circulatory system as in *gigas* except as follows : Extra-oesophageals connected by a transverse vessel just behind 5/6. Supra-oesophageal usually a definite median vessel terminating with oesophageal bifurcations of hearts of xi and xiii. An extra connective between extra-oesophageals, in one specimen, is fairly large and just anterior to 5/6. Dorsal vessel terminates with hearts of vii (130).

Location of ventral caeca and of supra-intestinal glands

Segments	Number of specimens from						
	1	2	3	4	5	6	7
33-38	1	—	..	—	—	—	—
34 38	—	4		—	—	—	1
34-39	4	—		2	1	—	—
34-40	1	1	..	—	—	1	—
34-41	—	—	..	3	—	—	—
34-42	—	—		1	—	1	—
35-38	1	—		—	—	—	—
35-39	3	4		—	6	2	—
35-40	2	3	..	9	2	—	—
35-41	1	—		—	—	—	—
35-42	—	—	..	3	—	—	—
35-43	—	—	..	1	—	—	—
35-44	—	—		—	1	—	—
36-40	—	1	..	—	—	—	—
36-41	1	—	..	1	—	—	..
37-41		—	..	—	2	—	—

Location of ventral caeca and of supra-intestinal glands—contd.

Segments	Number of specimens from						
	1	2	3	4	5	6	7
86-91	—	—	—	—	—	—	1
86-92	—	—	1	—	—	—	—
87-92	—	—	2	—	—	—	—
87-93	1	1	1	—	—	—	—
87-94	—	—	1	—	—	—	—
88-92	—	—	1	—	—	—	—
88-93	—	—	1	—	—	—	—
88-94	3	2	—	—	—	—	—
89-94	1	1	—	4	—	—	—
89-95	5	—	—	—	—	—	—
90-95	2	5	—	—	—	—	—
90-96	3	1	—	2	—	—	—
91-96	1	4	—	1	1	—	—
91-97	—	—	—	11	8	1	—
92-97	—	—	—	5	—	—	—
92-98	—	—	—	9	5	—	—
92-100	—	—	—	—	—	1	—
93-98	—	—	—	—	—	1	—
93-99	—	—	—	3	1	—	—
94-100	—	—	—	1	—	1	—

1. Taungdwingyi. 2. Hills east of Taungdwingyi.
3. Mandalay. 4. Magwe and vicinity.
5. Nyaungbinywa. 6. Myingyan. 7. Kin-U.

Testis sac annular (135), passing over dorsal blood vessel. Hearts of xi within the sac but each in a tube of delicate tissue as are also hearts of xii. Bulbus ejaculatorius small, white, covered over or within posterior wall of vestibular bulb.

Spermathecal duct usually less than two mm long, constricted in parietes, not narrowed entally, with no externally recognizable muscular sheen. Lumen transversely slit-like in cross section ectally, rather crescentic entally due to presence on posterior wall of a rather wide and fairly high ridge on which there is a vertical groove. The ridge is especially obvious at opening into ampulla. Three high ridges are present on posterior wall of duct in Tada-U and Kin-U material. Diverticula are shortly ellipsoidal to digitiform, median and lateral (268 spermathecae) except as noted below. A length of more than two mm was attained by five diverticula of Tada-U and Kin-U worms.

Body wall bulged into coelomic cavity over genital markings but not thickened, longitudinal musculature apparently continued across the protuberances but thin, especially over posterior genital marking.

Penial setae (16 Mandalay) 1·85-2·55 mm long, 23-34μ thick at base 14-22 at midshaft, 18-32 at tip. Number, 10-12 (8 batteries). In Taundwingyi material (32) 2. 53-2.98 mm long, 32-45μ thick at base, 22-36 at tip. Number, 7-10 (16 batteries). In worms from Magwe, Nyaungbinwa and Myingyan (68) 2·5-3·06 mm long, 32-51μ thick at base, 20-32 at tip. Number, 7 (2 batteries), 8 (13), 9 (13), 10 (4), 12 (2). Shaft straight with slight curvature of terminal ectal portion (Mandalay) or sigmoid and occasionally (7 setae) with spiral twisting more (Taungdwingyi) or less (Magwe) marked. Tip widened, thinner at edges, tapering to a point, occasionally more or less hollowed as in bowl of a spoon and (except at Taungdwingyi) pink. Ornamentation of small thornlike to triangular teeth in more or less regular circles. A segment of the shaft, 0·5 to 0·7 mm from tip is dark (Mandalay). Reserve setae (Mandalay) are deep red. The tip of the shorter ones usually is distinctly spoon-shaped but the bowl becomes increasingly less distinct as size increases. Reserve setae may be bowed but show no spiral twisting.

Abnormality.—(No. 1) Left spermatheca with no median diverticulum, duct only about half the usual thickness (Magwe). (No. 2) Left spermatheca with an extra diverticulum of one seminal chamber on posterior face of duct about halfway between lateral and median diverticula (Taungdwingyi). (No. 3) Right spermatheca lacking (Taungdwingyi).

Parasites.—Nematodes are present in numbers in the coelomic cavity of xii of each Taungdwingyi specimen. One only was found (same place) in each of two Magwe specimens, two in a Nyaungbinywa worm. Nematodes were numerous in the testis sac of several Tada-U specimens.

Remarks.—Little variation has been found in this species with respect to various taxonomically important characteristics. A female pore was present on right side of seven of the 110 specimens examined in this connection, but in each case the pore, as well the whitened field around it, was smaller than that of the right side. The range in location of spermathecal pores, even including two somewhat aberrant worms, is just a half that of *constrictus*.

Genital markings have been lacking in only one of all worms collected, an anterior marking in two other specimens. An extra marking has been present, on 14/15 (six times), on 17/18 (once), on 19/20 (seven times). Two diverticula have been present in 348 (+?) spermathecae, the median diverticulum of a left spermatheca lacking in one worm an entire right spermatheca lacking in another specimen.

Number of segments with supra-intestinal glands, in an individual, was 5-9, but eight and nine segments were obtained only once each. Number of segments in a local population was 9-11, as indicated by samples of 4 specimens (Myingyan) to 32 (Magwe). The number for the species only 15, lxxxvi-c. Number of intestinal caeca was 4-10 and number of segments involved only twelve, xxxiii-xliv.

THE PHYLOGENY OF THE *foveatus* GROUP

The inornate mutation, except in *spinulosus*, has been recognized in this group of species only three times, in one individual of *foveatus* and in two of *planatus*. Variation in number of genital markings is slight in each species. Lateral intestinal caeca are lacking except in *foveatus* where rudimentary pockets are just beginning to appear in some of the populations. Supra-intestinal glands usually are in 5-7 metameres and the axial locations, throughout the entire group, involves only 21 segments.

In addition to this high degree of species stabilization, the group as a whole, is uniform with respect to the following characteristics: Location of first dorsal pore, on 11/12. Presence of brown pigment. Invagination of both fissures into a single vestibulum. Restriction of the genital markings, always unpaired and median, to *BB*, and absence of coelomic glands. Right female pore lacking. Lateral typhlosoles replaced by a row of flat red patches. Abortion of the dorsal blood vessel and associated commissures anterior to the hearts of vii. Absence of anterior testes as well as the male funnels of x and their ducts. Presence of a battery of reserve penial setae.

Another species, *bifovis*, is similarly characterized (1 inornate individual) except that two discrete vestibula are invaginated and for present convenience is appended to the *foveatus* group.

The common ancestral form that apparently should be assumed for such a group of species arose by establishment of three of the standard mutations postulated above, metandric, foreshortening and oviductless. Absence of records of male funnels in x agrees with the scarcity of cases in which vestiges of the dorsal trunk are retained to indicate long establishment for the first two. Incidence of persistence of an apparently functional right female pore, 4·8 per cent. in *foveatus*, 5·9 per cent. in *planatus*, 7·3 per cent. in *excavatus*, 6·3 per cent. in *bifovis*, 21·3 per cent. in *spinulosus*, indicates more recent establishment of the third. Possibly the three were established in the order already mentioned. Absence of any unpigmented individuals, in each of the species, is thought to indicate ancient acquisition of a chemical process possibly for elimination of certain metabolic wastes. Similarly absence of any variation as to pairing of genital markings or a situation in *BB* indicates that the restrictions on those structures were acquired early in the evolution of the group. This also may have involved the union at mV of originally paired and postsetal anlage suggested above for *strigosus* though a location on the intersegmental levels apparently crossed in present ontogenetic development is assumed for greater convenience in the subsequent part of the discussion. The vestibulum, in this line of evolution appears to be as ancient as anything just mentioned. Invagination of this pocket, like the development of a battery of reserve penial setae, is induced by the prostate anlage These growth centers presumably have been responsible for development of the fissures throughout the *Eutyphoeus* phylogeny. A mutation for considerable subsequent extension and prolongation of that induction effect in individual ontogeny might conceivably give rise to the vestibulum at one evolutionary step. Presence of penisetal batteries in *hastatus*, *constrictus* and other uninvaginate species proves that a separate mutation is necessary if these ranks of reserves are also to be achieved in a single step.

From the advanced proto-foveatus thus characterized, *foveatus* is derived by restriction of number of markings to two, on 14/15 and 15/16, their subsequent enlargement and union to form a single area often showing at the equator of xv more or less obvious evidence of a double origin. Additionally, a temporary annular tumescence around each fissure became extended into a permanent tubular penis, and the testis sac was reduced to a ventral chamber. The range of *foveatus*, as now delimited (p. 167), includes a southern sector of the Arakan Yomas and the recent alluvium of the deltas region. If an origin of *foveatus* almost in historical times is to be avoided, its site must be placed in the yomas, presumably on the eastern slopes or in the eastern ranges. Migration thence eastwards may have been speeded by flood-water transportation.

E. spinulosus apparently can be derived directly from *foveatus* by establishment of the mutation unidiverticulate along with a modification of penial setae and acquisition of a tendency to reduce the size of the anterior portion of the genital marking or even to eliminate the whole area. In this change the standard mutation inornate presumably is involved and if so the restricted anterior abortion may then be attributable to incomplete penetrance. Also apparently indicated is a trend toward reduction in number of supra-intestinal glands and ventral caeca. The species is known today only from the recent alluvium of Bassein district which is of later deposition even than that where *foveatus* is found. Accordingly, an origin of the species in the eastern slopes or hills of the Arakan Yomas and at the southern frontier of the *foveatus* range is predicted. This geographical origin again involves eastward migration and/or transportation to explain present distribution.

To the north of the *foveatus* range *planatus* has been derived from the proto-foveatus by reduction of the ancestral genital markings to one on 13/14 and by reduction in number of intestinal caeca to four to seven. Reduction of the testis sac to a suboesophageal chamber is under way. Even within the vertically short range of about a hundred miles half a dozen easily recognizable differences apparently could be used to distinguish two subspecies, one northern and one southern. Indeed, all but one of the dissected specimens can be referred by supra-intestinal glands alone to one or the other of two such taxa though only twenty segments are involved in the entire range. Relatively recent transport of both types across the Irrawaddy is indicated by the restricted distribution on the east bank. An origin in the eastern ranges of the Arakan Yomas and eastward migration again is anticipated.

Well above the *planatus* area as now known *cochlearis* was derived by elemination of a genital marking on 14/15 to leave one on 15/16

A tendency to more posterior location of supra-intestinal glands is indicated. The species is, of course, distinguished from previously discussed members of the group, as they are from each other, by characteristics of vestibula and penial setae less amenable at present to phylogenetic exploitation. The range extends from Pakokku north along the west bank of the Chindwin river. Some unconfirmed records indicate a possibility of fairly recent transport across the river.

E. excavatus has been derived by establishment of the unidiverticulate mutation and has retained the genital marking on 14/15 lost by *cochlearis.* Otherwise there seems to be little to differentiate the species for vestibula are identical and penial setae more difficult to distinguish than previously. The range is on the wrong side of the Chindwin-Irrawaddy axis and the distribution apparently is such as to require crossing at an earlier period than for the previous species, possibly before the Irrawaddy had broken through to the Chindwin, in order to permit migration north into Sagaing district. The unknown fauna of the region between Minbu and Pakokku on the west bank of the Irrawaddy may be expected to throw some light on this question of appearance of the unidiverticulate mutation with reference to the crossing.

E. bifovis has a genital marking on 15/16 as in each of the *foveatus* group except *planatus* but is distinguished from all of that group by presence of a postclitellar marking on 18/19, and by a marked lateral migration of spermathecal pores. The vestibulate induction may not have been sufficiently strong or continued long enough to invaginate a median portion of xvii thus leaving two discrete vestibula. A penial annulus may have become permanent around each fissure. The 200 mile vertical range in central Burma, without indication of segregation of variants, parallels the ranges of three *foveatus* group species to the west. Origin directly from *excavatus* is contraindicated by the bidiverticulate spermathecae, and there are distributional difficulties involved in local derivation together with *excavatus* from a common ancestor. These difficulties are temporarily avoided by placing origin in the north where the fauna is largely unknown and from whence migration to south may have taken place before junction of the Irrawaddy with the Chindwin.

THE *gigas* GROUP

Eutyphoeus gigas Stephenson 1917

Sandoway, September, 0-0-1. I. M. Ismailjee.
Taungup (Sandoway), September, 0-13-0. I. M. Ismailjee.
Myebon (Kyaukpyu), September, 0-2-0. I. M. Ismailjee.
Myohaung (Akyab), September, 0-1-10. I. M. Ismailjee.
Kyauktaw (Akyab), September, 68-0-2. I. M. Ismailjee.
Buthidaung-Maungdaw (Akyab), September, 0-24-5. I. M. Ismailjee.
Akyab, September, 9-0-0. I. M. Ismailjee.
Paletwa (Arakan Hills), September, 0-0-40. I. M. Ismailjee.

External characteristics.—Pigmentation may be continued ventrally into *BC* or even to *B* or *A* (Paletwa). First dorsal pore usually on 11/12.

Spermathecal pores usually in median portion of *BC*, occasionally centered at *B*. Female pore, whenever recognizable, on left side.

Two penisetal follicle pores on a distinct tubercle. Two setae occasionally protrude through one of the apertures. A fairly large and firm annulus, with appearance of being a permanent organ, always seated on body wall at periphery of penisetal pore tubercle. Ventral margin of the annulus softer and slightly but variously lobed and capable of some ventral extension. Annulus centrally or laterally located on male porophores. These may be large, longitudinally elliptical, tough discs of slight parietal thickening (1 Paletwa and Sandoway worms), smaller and then circular to transversely elliptical. The surface is smooth (Sandoway) or cross-furrowed and with an appearance of slight tumescence (preservation artefact ?). Porophores may be transversely depressed in front of the annulus so as to approximate, more or less closely, the anterior and posterior margins, or the entire porophore may be depressed in a regularly concave manner so as to bring annuli below general level of body surface, or a portion of the porophore just in front of or behind or to one side of the annulus may be deeply depressed. The entire peripheral portion of the porophore is occasionally depressed deeply in which case (5) the annulus is seated on a central protuberance and with a superficial appearance of a large tubular penis in a well-like vestibulum, with roof slightly protuberant into coelomic cavity.

		Localities						
		1	2	3	4	5	6	7
Unpaired and median	Presetal on viii	1	..	..	..	..	..	10
	Postsetal on viii	..	..	..	..	..		1
	Postsetal on ix	1	..	..	..	..	..	..
	On 11/12	..	1	..	..	..	..	..
	On 12/13	..	1	..	..	..	..	..
	Postsetal on xiii (or on 13/14)	..	..	..	1	1(*a*)	..	1
	Postsetal on xiv (or on 14/15)	..	..	..	1	2(*a*)	3	18
	Postsetal on xv (or on 15/16)	..	..	..	1	2(*a*)	1	24
	18/19	..	..	..	..	..	..	3(*d*)
	19/20	1	..	..	..	..	..	..
	20/21	1	..	..	..	..	..	..
Paired, in *AA*	Postsetal on xv	..	..	..	..	..	5	..
	,, ,, xvi	..	..	..	..		2	1
	,, ,, xviii	..	..	..	..	..	5	7(*c*)
	,, ,, xix	..	..	..	..	..	..	2
Paired, in *AB*	Postsetal on viii	..	..	..	..	..	5	..
	,, ,, ix	..	..	..	..	..	1	..
	,, ,, xvi (*b*)	..	..	..	..	..	..	36
	On 18/19	..	..	..	2	..	..	13
	,, 19/20	..	..	..	7	3	1	25
	,, 20/21	..	..	2	7	2	1	7
	,, 21/22	..	..	2	..	..	..	..
Paired, in *BC*	Postsetal on vii, just in front spermathecal	..	1	2	6	1	2	3
	Presetal on vii, just behind spermathecal pore.	..	2	..	..	..	..	
	Postsetal on viii	..	6	..	..	..	..	..
	,, ,, ix	..	2	..	..	..	..	..
	Postsetal on xv (or on 15/16)	1	..	..	..	..	2	..
	Postsetal on xvi (or on 16/17)	..	..	..	1	..	1	..

(*a*) Juveniles. Markings rudimentary, posterior margins at intersegmental furrows, anterior margins some distance behind equators.

(*b*) These markings may replace the greyish, transverse crescentic areas often present in front of the male porophores, or may be united with the crescents or even within the crescents.

(*c*) Markings on two of these worms are united mesially although the double origin is clearly indicated.
(*d*) Median marking is united with markings of *ab* in two of these worms.

Postclitellar markings of *ab* may extend deeply into *aa*, occasionally almost to the midventral line as well as into *bc* although usually not so far.

Genital markings transverse and shortly elliptical to spindle-shaped.

Localities, 1-7. Key sheet or localities was destroyed along with other records.

Internal anatomy.—The mid-dorsal, longitudinal muscle band is pigmented.

Typhlosole begins in caecal segment but with a slight protuberance into xxvii. Lateral typhlosoles represented by a dark red elliptical area which is present only in about half the specimens and which may be continued around anterior margin of caecal aperture. Lateral intestinal caeca distinctly marked off, long, rather digitiform, usually ventrally directed, rarely turned upwards, in xxviii (25). Ventral intestinal caeca in xxxii-lx (1), xxxii-lxi (1), xxxiii-lviii (1), xxxiii-lix(1). Supra-intestinal glands in four to six segments as shown in the table.

Location of supra-intestinal glands in E. gigas

Segments	Number of specimens from							
	1	2	3	4	5	6	7	8
82—85			1					
82—86							1	
82—87								2
83—86							1	
83—87			1				3	2
83—88								1
84—87			1					
84—88							5	4
84—89								4
84—90								1
85—89								7
85—90								5
86—89					1	3		
86—90				2	5	1		3
86—91				2	1			2
87—90						3		
87—91		1		2	2	2		5
87—91		1		2	1			2
88—92		3			2			
88—93*	1	2		1				
89—93	3	2			1			
89—94	3	1		2				
90—94	1	2						
90—95	1	1						

1. Sandoway 2. Taungup. 3. Myebon.
4. Myohaung. 5. Kyauktaw. 6. Akyab.
7. Buthidaung-Maungdaw. 8. Paletwa.

Dorsal blood vessel ends with commissures of vii (104), with a pair of (functionless ?) commissures just in front of gizzard (1 Myohaung), or turning ventrally in front of gizzard on left side as a (functionless ?) commissure of vi (1 Paletwa). Supra-oesophageal trunk usually represented by an X-shaped figure on gut in xii-xiii, posterior limbs of the "x" joining hearts of xiii, anterior limbs disappearing into gut wall. Junction of the four limbs occasionally elongated so as produce a short median vessel, the figure then more like that of parentheses in contact by their convex sides. A median vessel formed by junction of anterior bifurcations of hearts of xiii is long enough, in just one worm, to be joined by oesophageal bifurcations of hearts of xi. Extra-oesophageals

* As in type from Rangamati in Chittagong Hill Tracts of Bengal.

turn upwards just in front of 4/5 and anteriorly in v unite, separating again slightly behind 5/6, then dropping nearly to ventral parietes. The trunks again turn upwards just in front of 8/9 and are there connected by a short transverse vessel just before passing through 8/9. In x the trunks pass on to ventrolateral or lateral aspect of gut and anteriorly in xi into gut wall. A small branch may pass ventrally at anterior end of calciferous gland but this is often unrecognizable so that the whole trunk appears to be continued posteriorly on dorsal margin of median wall of calciferous gland, turning ventrally at hind end of gland. The ventral trunk bifurcates in region of subpharyngeal ganglia, branching as it passes dorsally along the circumpharyngeal nervous commissures. No subneural trunk (106). Lateroparietal trunks, which have been recognizable in *BC* as far back as lx, pass in xiii onto ventral face of gut and disappear from sight on posterior face of calciferous gland. A median vessel on the floor of the post-typhlosolar portion of the gut bifurcates anteriorly, the branches passing dorsally and then anteriorly at lateral margins of supra-intestinal glands. Hearts of xi-xiii latero-oesophageal, bifurcations of hearts of xiii continued as posterior limbs of the X-shaped figure mentioned above, oesophageal bifurcations of hearts of xii opening into anterior limbs of the figure. Oesophageal bifurcations of hearts of xi pass into a transverse vessel which may be recognizable on each side of gut almost to mL. Commissures of x-vii lateral, no oesophageal bifurcations having been recognizable in any specimen in x.

Nephridia of iii are aggregated into a rope-like cord which is zigzag looped on the parietes.

Testis sac ventral (106).

Spermathecal duct 1-2 mm long, lumen irregularly slit-like in cross-section, two high, narrow vertical ridges, each with a groove, on the posterior wall between diverticular apertures. Diverticula elongate, median and lateral (212 spermathecae). An elongate stalk is often recognizable with a cluster of the seminal chambers at ental end, or additional chambers may be located on what appears to be the stalk, or the whole diverticulum may be filled with sperm in a zigzag looped cord. The lateral diverticulum of the right spermatheca of a Taungup worm is bifid nearly to the duct.

Genital marking glands sessile on parietes, a few nearly transparent (longitudinal muscle ?) fibres sometimes recognizable across the gland.

Penial setae (12) 6·45-8·25 mm long, 70-90μ thick at base, 52-61 at midshaft, 24-38 at tip. Shaft usually straight but may be bowed or slightly sigmoid and then with two curves in opposite directions. Tip red, slightly flattened but not widened, tapering to a short spine. Ornamentation of small spine-like teeth in scattered rows beginning 0·2 mm from ectal margin. Number, 6-12 (6 batteries). The terminal spine is characteristic of functional setae of more than a hundred worms but is rarely perfect. Reserve setae red, bowed.

Abnormality.—(No. 1) Ventral setae of xvii on right side sigmoid of about the samé size and with same ornamentation as those of xvi, and xviii. Male genital terminalia lacking on right side, right vas deferens continued into xxvii (Kyauktaw).

Parasites.—Nematodes are present in coelomic cavities of several Paletwa worms and in smaller numbers in worms from other localities. Elongate but unbranched gregarines of about the same size as *A. singularis* are present in coelomic cavities of Paletwa worms as well as in some from other localities.

Juveniles.—Male porophores and genital markings are unrecognizable on Akyab juveniles. A small, transverse fissure is present in *AB* at equator of xvii, within which tips of two penial setae are usually visible, slightly behind and about at m*AB* the minute, transversely slit-like to crescentic male pore is recognizable.

Remarks.—The penial annulus in this species seems to be permanent. It must develop around the fissure present in young juveniles (later juvenile stages unavailable). The male porophore on which the annulus is seated in adults is more variable than in most species. Large porophores of especial toughness may serve as suckers to grip the region around a spermathecal pore of a copulatory partner while temporary extensions (?) of the annulus are inserted into the pore. A small porophore may be protrusible, with annulus at tip as an intromittent organ inserted more deeply into lumen of spermathecal duct. Live specimens that would have shown how the annulus is protected from friction during locomotion have not been seen.

A Lucknow record of this species (Bahl, 1927) rests on misidentification of *E. nicholsoni* (p. 203). *E. gigas* is known only from a southern portion of the western mountain wall between India and Burma.

Eutyphoeus quinquepertitus Gates 1930

Internal anatomy.—Typhlosole begins in xxviii (2). Lateral typhlosoles simple, low lamellae in xxviii. Lateral caeca in xxviii (2). Ventral caeca in xxxii -lv (1), xxxiii-lii (1). Supra-intestinal glands in lxxix-lxxxiii (1), lxxx-lxxxiv (1).

Spermathecal duct about two mm long, lumen irregularly slit-like in cross section due to presence of vertical ridges on anterior and posterior walls. Diverticula stalked.

Body wall not especially protuberant into coelomic cavity over large genital marking, glandular (?) tissue associated with the marking apparently in the parietes and covered by a thin, tough layer of longitudinal muscle.

Remarks.—Brown pigmentation of the types has become unrecognizable (formalin preservation). Worms are not white, however, but grey ventrally as well as dorsally.

The ' tubular penis .. with two marginal lips ' of one type, and the ' annular penis ' of another, may represent different but early stages (apical) of eversion of the vestibulum and in such a manner that prostatic and male pores are within the lumen of the protrusion into vestibular cavity.

Eutyphoeus rarus Gates 1925

Kungyangon (Hanthawaddy), September, 0-0-3. K. John.
Twante (Hanthawaddy), September, 0-0-11. K. John.
Wanetchaung (Insein), September, 0-0-3. K. John.
Taukkyan (Insein), September, 0-0-1. K. John.
Bassein, October, 0-0-23. K. John.
Prome, August, 0-0-5. K. John.
Labu (Prome), August, 0-0-7. K. John.

External characteristics.—First dorsal pore on 11/12 (12). Clitellum reddish or brownish, protuberant or not.

Spermathecal pores centered about at *B* (Prome, Labu), laterally but usually at or just median to m*BC* (others). Female pore on left side (50).

Posterior protuberance from penis may be enlarged and gorged with blood, the pointed flaps bent up against the gorged portion.

A genital marking present just in front of each spermathecal pore (1 Labu). Unpaired median markings increasing in size posteriorly, on xii-xvi or xiii-xvi (2 Labu).

Internal anatomy.—Typhlosole begins in xxviii (53) but projects slightly into posterior portion of xxvii. Lateral typhlosoles low, in xxviii (46), occasionally (7) unrecognizable, possibly as a result of maceration of intestinal wall. Lateral intestinal caeca ventrally directed, in xxviii (53).

Location of genital markings in E. rarus

		Twante	Kungyangon	Wanetchaung	Bassein
Unpaired, median.	On 18/19	7	..	8	..
Unpaired or paired but united in *AA*.	Postsetal on xiii	1	..	..	2
	" " xiv	6	..	1	21
	" " xv	6	1	2	24
	" " xvi	..	..	..	24
Paired but united.	Postsetal on xviii	..	..	..	6
Paired, in *AB*.	Postsetal on xvi	11	2	8	..
Paired in *A*-m*BC*.	on 21/22	2	3	..	..
	on 22/23	..	1	..	..

Location of supra-intestinal glands and ventral caeca in E. rarus.

Segments	Number of specimens from 1	2	3	4	5	6	7	8	9
73—76	..	..	1	..	..	..	..	..	..
73—77	..	..	1	..	1	..	..	..	
74—77	..	..	..	..	..	..	1		..
74—78	..	2	2	..	..	..	9		
74—79	..	2	1	..	..	..	..	.	..

Segments	Number of specimens from 1	2	3	4	5	6	7	8	9
75—78	..	..	1	2	..	..	1	..	..
75—79	..	1	1	1	..	..	8	1	2
75—80	1	1	1	..	..	..	..	..	..
76—79	..	3	..	..	..	..	..	..	..
76—80	..	..	1	1	..	..	4	3	..
76—81	3	..	2	..	..	..	..	..	..
77—81	..	..	4	..	..	..	..	5	..
77—82	2	..	..	..	..	..	..	..	..
78—81	..	1	1	..	..	..	..	..	..
78—82	..	..	1	2	1	..	..	..	1
78—83	1	..	..	..	..	..	..	..	..
79—82	..	..	1	..	..	..	..	..	..
79—83	..	..	1	..	..	..	..	2	..
79—84	..	..	1	..	..	..	..	..	..
80—83	..	..	1	..	..	..	..	..	..
80—84	..	..	..	2	1	..	..	..	..
80—85	..	..	..	..	1	2	..	..	..
80—86	..	..	..	..	..	1	..	..	..
81—86	..	..	..	..	..	1	..	..	..
32—43	1	..	..	..	..	..	..	..	..
32—44	1	..	..	..	..	..	..	..	..
32—45	2	..	..	..	..	..	..	..	..
32—51	..	..	..	..	..	1	..	..	..
33—43	1	..	..	..	..	..	..	..	..
33 46	..	1	..	..	..	1	..	..	..
33—48	1	..	..	..	..	1	..	..	..
33—51	..	..	..	..	..	1	..	..	..

1. Labu.
2. Rangoon.
3. Rangoon and Sandoway, var. *deminutus* Gates 1930.
4. Sandoway, var. *duplex* Gates 1930.
5. Sandoway, var. *simplex* Gates 1930.
6. Prome.
7. Bassein.
8. Twante.
9. Kungyangon.

Circulatory system as in *gigas*. The extra-oesophageals may be united shortly in a posterior portion of v (1), within 5/6 (1), posteriorly in v and in 5/6 (1), or from just behind 4/5 to just behind 5/6 (47), not united but connected by a transverse vessel just behind (2) or just in front (1) of 5/6. Dorsal blood vessel continued anteriorly along right side of gizzard to which it is adherent, passing ventrally just in front of gizzard to ventral trunk (1). Left heart of xiii lacking (1 Kungyangon).

Testis sacsuboesophageal (52). Bulbus ejaculatorius small, whitish, in parietes (Prome and Labu).

Spermathecal duct about one mm long, muscular. Lumen rather crescentic in cross section due to presence on posterior wall between diverticular apertures of two or three fairly high vertical ridges. Diverticula median and lateral (106 spermathecae).

Penial setae (102 from various localities) 2·99-4·7 mm long, 30-80μ thick at base, 22-47 at midshaft, 18-51 at tip. Shaft straight except for a slight curve at ectal end. Tip pink, tapering to a sharp spine which may be about 10μ long but is undamaged in only 4 of the 146 functional setae examined in this connection. The tip in some Bassein, Prome and Labu worms somewhat widened, the blade 5-10μ thicker than entally. Ornamentation of very small thorn-like teeth in circles 8-20μ apart, irregularly broken into rows of 2-8 teeth. Number, 5-11 (50 batteries). Reserve setae with straight or bowed shaft, red (except Prome and Twante), tip tapering to a terminal spine which is bifid in 5 setae.

Remarks.—Protrusion of the penes has been secured in anesthetics but eversion of the vestibula has never been observed though not, perhaps, impossible.

Incidence of inornate individuals in one Sandoway collection, 20·8 per cent, suggests that the taxon resulting from that mutation, f. *simplex*, may be true-breeding in isolation.

PHYLOGENY OF THE *gigas* GROUP

Species of this group are all characterized as follows: Presence of brown pigment. Location of first dorsal pore on 11/12. Right female pore lacking. Lateral intestinal caeca present. Ventral caeca numerous. Abortion of the dorsal blood vessel and associated segmental commissures anterior to hearts of vii. Absence of anterior testes as well as the funnels of x and their ducts. Reduction of the testis sac to a suboesophageal chamber.

Unpigmented individuals never have been found though deposition seems always to be sparse, especially posteriorly, in two species. Intestinal caeca always are well developed and in xxviii, an occasional individual varying only as to direction of the pocket. The typhlosole, of more variable origin in the *foveatus* group, here always begins in xxviii, the caecal segment. Incidence of presence of male funnels (one or two) in x was 2·5 per cent in 40 specimens of *gigas*, 2·3 per cent in 86 of *rarus*, and in each of these cases deferent ducts were not developed. Incidence of persistence of vestiges of the dorsal trunk anterior to the hearts of vii was 1·8 per cent in 106 specimens of *gigas*. A right female pore has not been found in any of these species, condition may have prevented its recognition in some specimens of *gigas*, even though the right funnel always seems to be normally developed. Associated with this high degree of stabilization is the usual variation in number and location of ventral caeca and supra-intestinal glands.

Although the morphology agrees with the distributions to support a common origin for the *gigas* and *foveatus* groups, presumably in the Arakan Yomas, the phylogenetic separation took place before the proto-foveatus had modified its lateral typhlosoles or acquired its restrictions on the genital markings, but after establishment of the mutations brown (for pigment), metandric, foreshortening, oviductless and battery. Lateral intestinal caeca were acquired and stabilized as to form and location (in xxviii) presumably before segregation of the extant species.

From the common ancestor of the group *gigas* has been derived by elimination of the lateral typhlosoles, development of (or retention?) of coelomic glands in association with the genital markings, development of a permanent penial annulus around each fissure. The primitive multiplicity and indefiniteness of axial and intrasegmental location of the genital markings has been retained. The *gigas* range extends from the Arakan Yomas into Chittagong at least to Rangamati. The species is thought to have migrated west into Bengal from the southern yomas.

E. rarus has been derived by development of a small penial annulus with protrusible posterior flaps, as in *macer*, and the withdrawal of each annulus into a small, well-like vestibulum possibly eversible as in some of the *levis* group. Lateral typhlosoles were retained as well as the primitiveness of genital markings (with coelomic glands) but the inornate mutation may be spreading in some Sandoway population. The *rarus* range extends from the Sandoway coast across the yomas and into the recent alluvium of the deltas region. Arrival in the latter part of the range, where it is still rare, must have been recent and a result of eastward migration and/or transportation. Westward migration from its source in the yomas has been stopped by the sea.

E. quinquepertitus has been derived by acquisition of large and presumably completely eversible vestibula with a muscular bulb in the roof but with loss, of the penial setae. Lateral typhlosoles were retained but the genital markings have been stabilized in a five-sited arrangement. A vestibulate mutation must be associated here with another mutation for early abortion of the setal follicles adjacent to the prostates for no traces of them have been recognized. Nor have fissures been recognized though beginning eversion of the vestibular apex seemingly produces an appearance of a fissure surrounded by an annulus. The species must be assumed for the present to have originated *in situ.*

INDIAN SPECIES

Eutyphoeus incommodus (Beddard) 1901

External characteristics.—Length, 40-120 mm. Diameter, 2½-6 mm· size, at Madhosingh, 25-80×3-6 mm., the majority at or close to the lower limit; at Robertsganj, 40-75 × 2½-4 mm., except one worm which is 140 × 6 mm. Segments, to 156. Pigmentation unrecognizable behind

Location of genital markings in E. incommodus

Locality	Markings on segment																Totals
	No marking	11—15	12—15	12—16	12—16, 18	13	13—14	13—15	13—16	13—16, 18	13—16, 13—19	13—16, 19	14	14—15	14—16	14—16,18	15—16	
Ghakla	..	..	..	..	..	..	1	28	27	..	..	..	..	..	..	..	..	56
Ahraura	..	..	..	..	..	..	1	21	8	..	..	..	..	..	..	..	..	30
Benares . .		..	1	1	..	..	..	..	43	2	..	..	..	1	1	..	..	52
Chunar . . .	..	..	..	1	..	..	1	4	1	..	..	..	..	..	..	..	..	7
Madho Singh	1	..	..	..	..	..	12	243	20	..	..	..	..	..	..	..	..	276
Zafarabad	..	..	..	..	..	..	..	25	54	..	..	..	..	..	..	..	..	80
Jaunpur	..	..	..	..	..	..	..	6	64	2	..	..	..	..	2	..	1	75
Janghai	..	..	..	3	..	..	..	6	140	2	..	..	..	2	3	..	..	156
Jhusi	..	..	..	1		..	..	18	101	2	..	..	..	..	..	..	..	122
Allahabad—																		
(1)	6	1	29	1	..	..	..	26	R	2	2		..	3	4	..	1	75+
(2)	..	..	1	..	..	..	..	13	40	..	..		..	..	..	..	..	54
(3)	2	..	..	..	..	3	1	82	11	..		..	..	1	..	..	..	100

Ghoorpur	.	..	..	2	2	1	..	..	35	94	3	..	..	..			..	..	140
Partabgarh	.	..	..	..	4	..	..	..	..	169	1	..	..	..	..		..	..	174
Sultanpur	.	..	..	.	1	..	..	..	3	94	2	1	1	..	..	2	..	..	104
Fyzabad		..	..	..	4	1	..	..	..	87	..	..	..	..	..	..	..	..	92
Fatepur	.	..	..	..	1	..	..	..	11	81	..	..	..	..	..	..	..	..	93
Rae Bareilly	.	..	..	..	8	..	..	12	8	207	3	1	..	..	..	..	..	1	229
Lucknow	.	2	..	..	..	..	..	..	2	89	..	..	..	2	..	1	..	..	96
Bara Banki		..	..	3	..	..	..	1	113	6	..	..	..	..	2	..		..	125
Fatehpur (4)		..	..	..	..	..	..	..	30	22	..	..	..	..	..	..	..	..	52
Rewa		..	..	..	..	..	..	1	10	..	..	..	..	..	..	..	..	..	11
Robertsganj	,	..	..	..	..	..	..	2	198	24	..	..	..	1	..	..	..	..	225
Larhaoti		..	..	..	..	..	..	..	4	192	..	..	..	..	1	2	..	..	199
Totals	.	11	1	36	27	2	4	20	889	1,574	19	4	1	3	11	17	1	3	2,623+

(1) Near Jumna River
(2) Bund Road, Aliengang.
(3) McPherson lake.
(4) Bara Banki District.
Remainder of specimens were not counted.
All Markings are lacking on left side (1 Janghai, 1 Rae Bareilly) or on right side (1 Zafarabad), of three specimens.
Occasional absence of one marking of a pair is not recorded.

the clitellum, usually very slight in the preclitellar dorsum but in three specimens (Allahabad, October) pigmentation is obvious anteriorly and in one of them about as dense as in *nicholsoni*. First dorsal pore on 10/11(1), 11/12 (61, but with a pore-like though apparently imperforate marking on 10/11 in several cases), 12/13 (9). The clitellum may be thinner or even totally lacking ventrally. In the latter case ventral boundaries are rather indefinite or very conspicuous and then sometimes sinuous.

Spermathecal pores always in median port of *BC*. Female pores both present. Genital markings postsetal, in region of *AB*, on some of xi-xvi as shown in the table below.

Internal anatomy.—Typhlosole begins in the region of xxii-xxiv. Ventral caeca and supra-intestinal glands as in table. Dorsal blood vessel uninterrupted (71), paired commissures or hearts always present in v-xiii, except that in one worm the left commissure of vii is represented only by a short dorsal stump with a rounded end. Commissures of iv were not found. Lateroparietal trunks are clearly visible, in juvenile specimens, back to the region of the supra-intestinal glands but in adults usually have been recognized only from *ca.* xix-xx anteriorly, as well as from the gland region posteriorly.

Location of ventral caeca and supra-intestinal glands

Segments	Number of specimens from			
	1	2	3	4
27—31	..	1	..	..
27—33	6	..	..	..
27—34	..	..	1	..
28—31	..	4	..	..
28—32	..	1	..	..
28—33	7	..	..	..
28—34	22	..	..	..
28—35	3	..	..	..
29—31	..	1	..	..
29—32	..	1	..	..
29—33	1	..	..	..
29—35	..	..	..	1
30—32	..	1	..	..

Segments	Number of specimens from					
	1	2	3	4	5	6
62—64	..	..	..	1	..	..
62—65	..	..	..	3	..	..
63—66	..	..	..	5	..	..
63—67	..	4	..	..	..	1
63—68	..	1	..	..	..	..
64—67	..	..	..	1	..	..
64—69	..	1	..	..	..	..
65—68	..	..	..	..	..	1
66—70	4	..	..	..	..	1
66—71	..	..	..	..	..	1
67—70	1	..	..	..	..	1
67—71	3	..	..	..	..	..
67—72	1	..	..	..	1	1
68—71	3	..	..	..	1	3
68—72	15	..	1	..	..	4
68 73	4	..	..	..	..	..
69—72	1	..	..	..	3*	2
69—73	7	..	..	..	..	5
69—74	2	..	..	..	..	..
70—73	4	..	..	..	5	..
70—74	7	..	..	..	..	5
71—74	1	..	..	..	1	..
71—75	..	..	..	..	..	1
72—75	..	..	..	..	..	2

1 Allahabad and Naini. 2. Rewa. 3. Nowgong.
4. Bara Banki. 5. Lakhaoti. 6. Previous records.

* In addition, one specimen with a single pair of rudimentary glands in lxviii.
Glands are in lxiii-lxvii (1 Saharanpur), lxx-lxxiii (1 Patna).

All of the Bara Banki specimens listed above are small and have genital markings on xiii-xv only.

Seminal vesicles of ix always well developed. Posterior vesicles usually reach back to 13/14, occasionally pushing 13/14 in to contact with 14/15, but may extend into xiv (11), xv (7), or even xvi (3).

Life history.—One postsexual aclitellate worm (March, Patna) has been found. Clitellar segments are marked by a slight brownish discoloration quite distinct from normal brown pigmentation and genital markings are quite unrecognizable. Spermathecal ampullae and seminal vesicles are shrunken and brownish. Prostates are also of the same brown color. Each penisetal battery has only one or two setae.

Abnormality.—(No. 1) An extra spermatheca on the right side with pore on 6/7 (No. 2) A half segment intercalated between xvi-xvii on the left side bears the male porophore. Left genital marking of xiv lacking, right marking of xvi doubled anteroposteriorly. (No. 3) An extra male porophore on the left side of xviii is associated with a prostate and a battery of penial setae (but no bulbus). (No. 4) Spermathecal pore on 6/7, female pore on xiii, male porophore on xvi, on the left side. Genital markings on left sides of xiv-xv, right sides of xiv-xvi. Septum 7/8 present on left side only. Intestinal origin in xiv, last heart in xii on left side. Testes and male funnels of left side in ix, x, xi, seminal vesicles in viii, and xii. Left ovary in xii. Left male terminalia in xvi. The gizzard is symmetrical. (No. 5) Genital markings on xiii-xv. Male porophores on xvi and xvii. Prostates and penial setae also present in xvi but male deferent ducts continued into xvii as usual. (No. 6) Left male porophore and terminalia lacking. Left male ducts become filamentous and translucent in xvi. (No. 7 and 8) Female pore on xiii, male pore on xvi on right side. Seminal vesicle in viii, testes and male funnels in ix and x, rudimentary seminal vesicle in xi, ovary in xii, heart of xiii lacking, male terminalia in xvi, on the right side.

Remarks.—The identification of some Lucknow specimens (Bahl, 1927, p. 485) was questioned in the revision of the Indian species (Gates, 1938, p. 118). The worms now have been examined. The identification was correct but the supposed penes are merely unusually protuberant margins of the fissures on the male porophores.

E. incommodus now appears to be the only holandric species that has acquired pigment.

The slight variation in location of supra-intestinal glands is especially noteworthy in view of the distribution. The range extends from Calcutta at least through the Gangetic plain. Extensions along river valleys into the Deccan, and across the Aravalli divide into the Indus valley may be due to migration or to transportation by man (as at Rawalpindi).

Eutyphoeus quadripapillatus Michaelsen 1907

Chhitauni (Gorakhpur district, U. P.), October, 1-23-40. Cedric Shaw.

External characteristics.—Length, 88-100 mm. Diameter, 3-4 mm. Segments, 152-165. Unpigmented. First dorsal pore on 10/11 (4), 11/12 (48), 12/13 (4). Clitellum, of a faint yellowish or yellow brown, extends into xiii and xvii, occasionally (18) reaching 17/18, lacking in *BB* on xvii and thinner in *BB* on xiii-xvi.

Spermathecal pores in *AB*. Female pores both present (51, unrecognizable on the others). Male porophores may be perfectly flat discs or immediate margins of the fissures may be slightly protuberant, or the whole disc may be raised in a rather conical fashion.

Genital markings postsetal, in *AB*, or with centers at or lateral to *B* but reaching mesially to or nearly to *A*, on xiii-xiv (58), xiii-xv (1), xiii (3), lacking on 1 juvenile and 1 clitellate specimens.

Internal anatomy.—Ventral intestinal caeca and supra-intestinal glands as shown in the table. Dorsal blood vessel always (50 specimens) uninterrupted, with commissures and hearts in v-xiii, commissures occasionally (2) recognizable in iv (2). Lateroparietal trunks in one specimen are distended with blood and visible all the way back to the posterior end of the body.

Location of ventral caeca and supra-intestinal glands

Segments	Number of specimens	Segments	Number of specimens
27—30	1	63—66	2
27—31	7	64—67	19
27—32	23	65—67	1
27—33	4	65—68	22
27—35	1	66—68	2
28—31	2	66—69	3
28—32	7	67—70	1
28—33	4		
29—32	1		

Seminal vesicles of xii usually reach back at least into xxvi, once to lxxiii. Posterior end portions (2 specimens) are softened as if disintegrating. Although the vesicles in one worm reach only into xvi and show no indications of disintegration at their rounded posterior ends, there are, in a number of subsequent segments, septally constricted masses of tissue that seem quite different from the easily fragmented aggregations of coelomic corpuscles sometimes filling coelomic cavities between gut and parietes. Vesicles of one worm are under the gut behind xiv and unrecognizable until the intestine is rolled over to one side. Vesicles are confined to xii (no fragments recognized posteriorly) in one worm with spermatozoal iridescence in the spermathecae.

Remarks.—The ventral follicles of xvii are retained throughout life. Ability to produce normally shaped setal shafts is lost in some juvenile stage, the follicles of sexual animals containing numerous small spheroids and ovoids or larger bodies of more irregularly odd shapes (Gates, 1947). Appearance of follicle contents usually is such as to suggest discontinuous deposition of setal material. An undischarged sigmoid seta was once found in an adult (Gates, 1938, P. 108) and larger bodies may sometimes look as if they had been irregularly eroded chemically. No evidence of fibrillation, as at ectal ends of penial shafts in macerated worms of other species, has been observed. Whether continued and disorderly secretion, or solution of undischarged shafts, is involved, the condition prevailing in this species seems to represent a stage in elimination of penisetal follicles, a process which has been completed in other species. As formation of penial instead of sigmoid setae is induced by growing prostate glands (p. 108), the disordered functioning of the follicles in *quadripapillatus* results from modification in the prostatic induction capacity. This may be brought about by the mutation "apenisetal" already suggested on another page. Penetrance at an earlier stage, and more effectively, would then permit abortion of the follicles before maturity is attained, as in *quinquepertitus*.

Eutyphoeus gammiei (Beddard) 1888

Lokra (Balipara Frontier Tract, Assam), 8. xi. 1939, 0-1-0. Dr. S. L. Hora (Indian Museum.)

External characteristics.—First dorsal pore on 10/11. Spermathecal pores in median half of *BC*. The vestibulum is almost as deep in *AA* as laterally so that the worm can be characterized as definitely univestibulate. The genital marking, in *BB*, on 20/21, shows no indications of double origin.

Internal anatomy.—First recognizable ventral caecum in xl. Supra-intestinal glands in cxxxiv-cxl. Penial setae, including reserves, usually with chevron markings. An exceptional seta, with simple tip and ornamentation of closely crowded irregular circles of fine spines, has a single crack in the region where the splits of the chevron markings usually are located.

Remarks.—Although the genital marking is quite obvious and distinctly demarcated, no parietal modification is recognizable aside from the epidermal thickening. Any caeca anterior to xl might well have been unrecognizable because of maceration of gut wall forward nearly to xv (as in many preserved specimens of this as well as other genera).

Some thirty or so specimens, from a range larger than that of any Burmese species though less extensive than those of *incommodus* and *waltoni*, are all that have been available for study. They show that supra-intestinal glands are in 4-6 consecutive segments of xcviii-cxl. This variation in location is about twice that of some of the Burmese species and about four times that of *incommodus* and *waltoni*.

Eutyphoeus orientalis (Beddard) 1883

Chhitauni (Gorakhpur district, U. P.), October, 0-1-1. Cedric Shaw.

External characteristics.—Pigmentation dense. Genital markings on ix (Chhitauni), xv (Chhitauni and 4 Dehra Dun), xvi (Chhitauni and 5 Dehra Dun), 18/19 (Chhitauni and 5 Dehra Dun), 19/20 (4 Dehra Dun), 20/21 (1 Dehra Dun).

Internal anatomy.—Supra-intestinal glands are in lxxxvi-xc (2 Dehra Dun), lxxxvii-xci (2 Dehra Dun), lxxxviii-xcii (1 Dehra Dun), xc-xcvi

Penisetal tips are usually softened but on one functional and one reserve seta are spoon-shaped. Ornamentation is readily recognizable under ordinary high power.

Remarks.—This species is distinguishable at present from *waltoni* only by the penes which are annular rather than elongate, presence of genital markings on xvi, and a more posterior location of the supra-intestinal glands—in lxxxvi-xcvi instead of lxxviii-lxxxvi. *E. orientalis* has been found hitherto only in a north-eastern part of the *waltoni* range and at Dehra Dun to which it may have been transported accidentally by man. Although the geographical range now appears to be so much smaller than that of *waltoni*, variation in location of supra-intestinal glands is of the same order in both species.

Eutyphoeus waltoni Michaelsen 1907

External characteristics.—Length, to 180 mm. Diameter, to 8 mm. All worms larger than 140×8 mm. (strongly contracted at preservation) were obtained from compost heaps. Pigmentation dense. Genital markings are located as shown in the table.

Location of genital markings

Segment	Number of specimens from								
	1	2	3	4	5	6	7	8	
8	1	..	..	..	..	..	2	..	
9*	496	23	51	35	43	45	38	19	
10	6	..	5	1	1	1	1	1	
13	1	..	..	..	..	2	2	1	
14	185	10	25	30	29	39	35	9	
15*	496	25	50	36	46	48	37	15	
18/19*	497	25	50	34	43	49	39	19	
19/20	99	3	19	4	..	20	17	5	
20/21	14	..	2	..	..	2	1	1	
21/22	3	..	..	..	..	1	..	..	
	500	25	51	36	46	49	40	19	Number of specimens studied.

1 Allahabad and Naini.
2 Gorakhpur and Chhitauni.
3 Chunar.
4 Rae Bareily.
5 Rewa.
6 Lucknow.
7 Fatehpur.
8 Benares.

Postclitellar genital markings are in sequence, if a marking is present on 21/22 markings are also present on 18/19-20/21.

*Two of these three pairs of markings are present in every worm of the Allahabad series.

Markings are entirely lacking on one worm of the Fatehpur series.

Markings occasionally are present on xi-xii and 14/15-15/16 : on ix-xiii, 14/15-15/16 18/19 (1 Udaipur), ix-xv (1 Sultanpur).

A perfectly developed genital marking, with distinctly demarcated rim and central portion, is present on xvi ,or 16/17 ,of one worm from Rae Bareily.

Internal anatomy.—Locations of supra-intestinal glands of a few specimens are shown in the table.

Location of supra-intestinal glands

Segments	Number of specimens from				
	1	2	3	4	
76—80	1	..	..		
77—79		1	..		
77—80	1	..			
77—81	1	..		..	
78—81	2	1	..	1	
78—82	1	..	..	..	
79—82	2	3	2	2	
79—83	4	1	..	..	(Bahl and Lal, 1933.)
80—83	1	2	1	3	
80—84	..	1	..	4	(Also, Thapar, 1934.)
81—84	2	3	..	1	
81—85	1		..	3	
82—86	..	..	..	1	

1 Allahabad. 2 Chittauni. 3 Fyzabad.
4 Previous records except for those of Bahl and Thapar.

Abnormality.—(No. 1) Left male terminalia lacking. Left male duct dwindles to a thread in xvii without entering the parietes. (No. 2) Spermathecal pores on 7/8, 8/9, L9/10. No genital markings on ix-x. Four spermathecae normal, the left posterior represented only by a muscular duct which tapers entally to a pointed end. (No. 3) Paired female pores. Genital markings on ix, 17/18, 18/19. Vestibula in xvi. A short but unusually stout penis (?) with distal aperture ends blindly, without a vestibulum, in parietes, on left side of 15/16. (No. 4) Left spermatheca lacking. (No. 5) A small penis present on xvi on left side, in a rudimentary vestibulum. Ventral setae of left side of xvi also penial. Left male duct continued normally into xvii.

Eutyphoeus nicholsoni (Beddard) 1901

Eutyphoeus gigas, Bahl, 1927, Quart. J. Mic. Sci. 71, pl. 485.

External characteristics.—Size, to 270×10 mm all larger than 170×8 mm (preserved contracted as usual) obtained from compost heaps (manure and leaves) and when relaxed 300-450 mm long. Pigmentation dense. Female pores present on both sides, only five specimens.

Genital markings, except as noted below, are between equators of xv and xvi. Markings are transversely elliptical and obviously separated at mV in most Lucknow specimens and all from Fatehpur, Bara Banki, Benares, Moghul Serai, Chunar and Ahraura. In some worms from the latter localities markings may even be widely separated and restricted to *AC*. Markings are united at mV in all Sohagi specimens. In Chakia and Robertsganj series respectively, markings are obviously separate (58 and 42), almost in contact (5 and 6), united but with deep incisions of anterior and posterior margins at mV (2 and 4). Deviations from the normal pattern (of one or two markings on 15/16) were found occasionally. Right marking (4 specimens), left marking (1), both markings (1) lacking. An extra marking on left side (12), or right side (6), or right and left sides (6) of 14/15. An extra marking on left side (3), right side (4), or right and left sides (3) of 18/19. An extra marking on left side of 18/19 but left marking of 15/16 lacking (1). A marking on 18/19 is present in three of twenty Fyzabad worms.

Internal anatomy.—Supra-intestinal glands as in table. The dorsal blood vessel ends with or just in front of commissures of vii (76) or apparently, with a right (2) or left (1) or right and left (1) commissures of vi. These supposed commissures could not be traced in any of those four specimens to the ventral trunk. Pharyngeal nephridia, in relaxed specimens, quite obviously are aggregated into a zig-zag-looped cord on the parietes on each side.

Location of supra-intestinal glands

Segments	Number of specimens from					
	1	2	3	4	5	6
80—83	1					
80—84	6					
80—85	3	4				
81—84	2					
81—85	19	7				
81—86	3					
82—86	12	6		1		1
83—86	2		2			
83—87	4	3	3			2
84—87			1			1
84—88		2			1	4
84—89					1	1
85—88						1
85—89			1			1

1 Allahabad. 2 Nowgong. 3 Lucknow.
4 Rewa. 5 Robertsgang. 6 Previous records, and includes Thapar's Lucknow record (83-87) and Beddard's Calcutta record (84-88).

Seminal chambers 5-11, rather digitiform but usually shortly looped, slightly zigzagged or distally branched, usually aggregated into a single fan-shaped cluster which has 2-5 separate openings into the spermathecal duct. One or two of the chambers occasionally are completely separated from the cluster.

Abnormality.—(No. 1) Genital markings, vestibula and penes lacking. Clitellum continued to 17/18 ventrally as well as dorsally Ventral setae and apertures of their follicles unrecognizable on xvii. Left male duct splits into two widely separated portions in xiv which unite in xvi and then in xvii dwindle to a filament that does not enter the parietes. Right male duct thickened in xv-xvii and in xviii, without entering the parietes, becomes attached to follicles of ventral setae. Rudimentary prostates (?) without ducts and penisetal follicles are present in xvii but do not enter the parietes ! Spermatozoal iridescence in seminal chambers of the spermathecae shows that copulation had taken place. (No. 2) Genital marking, vestibulum, setae *a-d* of xvii-xix and male terminalia of left side lacking. Left male duct dwindles to a translucent cord in region of 15/16 and shortly disappears.

Remarks.—The identification of some Lucknow specimens (Bahl, 1927, p. 485) was questioned in the revision of the Indian species (Gates, 1938, p. 118). The worms in question now have been examined and quite obviously are referrable to *nicholsoni.*

The variation in location of supra-intestinal glands (Table) is slight and seems especially small in a range about as large as that of *incommodus* (after excluding extensions presumably due to accidental transportation). Midventral union of originally paired genital markings appears to be well under way and a uniformity of exial location comparable to that of *E. foveatus* has been achieved.

Phylogeny of Indian species

Holandric species are unknown from the almost unexplored region between the Burmese hills of the Arakan Yomas and the Gangetic Valley at longitude of Calcutta. It is necessary then, at present, to assume that the proto-eutyphoeus range extended across the Indo-Burmese mountain wall well towards or even into the Gangetic plain. There the proto-eutyphoeus became *incommodus* by acquisition of brown pigment, restriction of genital markings (paired) to intraclitellar and postsetal locations (on xiii-xvi) in region of *AB*, restriction of ventral caeca to xxvii-xxxv and of supra-intestinal glands to 4-6 of segments lxii-lxxv, and development of numerous diverticula on the spermathecae. The latter condition may well have been brought about by eliminating the stalks of a pair of polyloculate diverticula so that each seminal chamber now has its own opening directly into the spermathecal duct. This change could have been accomplished at a single step by a mutation which may be called " stalkless_2 ".

E. quadripapillatus apparently can be derived almost directly from *incommodus* by elimination of the genital markings in xv-xvi, inhibition of formation of penial setae, restriction of ventral caeca to xxvii-xxxii and of supra-intestinal glands to lxii-lxx. However, since segregation of the two species the spermathecal pores have migrated somewhat laterally in *incommodus* though retained in *quadripapillatus* in *AB*, the primitive position.

E. annandalei Michaelsen 1907, from the Kumaon region just west of Nepal, is known only from the very briefly characterized holotype, The species seems to be distinguishable from *incommodus* by the primitive bidiverticulate spermathecae, absence of genital markings on xv-xvi, and location of the spermathecal pores. As the species cannot be derived directly from *incommodus* it must have evolved from the proto- eutyphoeus before establishment of $stalkless_2$. Along with acquisition of further restrictions on the genital markings, the spermathecal pores have been moved even further laterally than in *incommodus*.

A trans-Arakan equivalent of the metandric *levis* group in eastern Burma is present in the Himalayas through Nepal into Kumaon. The comparison is suggested by the absence of pigment, the uninterrupted dorsal blood vessel, the genital marking glands and especially by the lateral intestinal caeca. The latter are in xxiv, the segment in which they are now developing in *annulatus*, or possibly in *nainianus* Michaelsen 1907, in xxiii. Genital markings show some of the *levis* group restrictions, being in part postsetal in *AB*, on x in *lippus* Gates 1934, on xiv-xv in *nepalensis* Michaelsen 1907, on xvi in *nainianus*, though the intraclitellar locations are also shared by species of the *incommodus* group. Each of the Himalayan species, as in the *levis* group, can be derived from the proto-eutyphoeus by establishment of the metandric mutation. Additionally, $stalkless_2$ has been involved in the phylogeny of *nainianus* and *nepalensis*.

E. pharpingianus Michaelsen 1907 is of uncertain status but if it does belong in *nepalensis* group persistence of male funnels in x would seem to indicate, as in the case of *levis*, that the least specialized species insofar as lateral caeca are concerned is of most recent origin.

An Indian equivalent of the *constrictus* group in central Burma between the Chindwin-Irrawaddy and Irrawaddy-Sittang axes, must be sought among species known only from their types, sometimes unique or even juvenile. A *constrictus* stage with uninterrupted dorsal trunk is shown by *assamensis* Stephenson 1926, *festivus* Gates 1938 (*comillahnus* and *scutarius* Michaelsen 1907?), a *peguanus* stage of abortion possibly by *turaensis* Stephenson, 1920 (*comillahnus* and *scutarius*?), a *plenus* stage of foreshortening by *aborianus* Stephenson 1914 and *callosus* Gates 1938. The last two have lost the right female pore and have posteriorly united spermathecal diverticula ($stalkless_1$) as in the Burmese *ferinus*, but in *festivus* spermathecal diverticula may be as yet only posteriorly directed. Uncertainty as to important taxonomic characters of each species contra-indicates further discussion except to note that the range of these forms extends from Chittangong (*comillahnus* and *scutarius*) north through Cachar (*assamensis*) to the Khasi (*callosus*, *festivus*) and Garo Hills (*turaensis*) as well as to the Abor country (*aborianus*) of the far eastern Himalayas.

E. gammiei (Beddard), 1888, has four specializations of the *foveatus—gigas* groups; metandry, foreshortening, penisetal batteries, single female pore, and may prove to have the fifth, pigment. Invagination of the fissure-bearing regions and absence of lateral intestinal caeca suggest comparison with the *foveatus* group. Indeed, the vestibulum, in a considerable part at least of the range, is almost exactly the same as in *cochlearis* and *excavatus*. The genital marking system is less restricted than in the *foveatus* group for little evidence of stabilization either as to number or axial location has been recognized and median union of paired markings is still under way. The protofoveatus ancestor, in its westward migration, did however acquire one specialization lacking in the *foveatus* group and rare in other Burmese groups, as spermathecal diverticula are either approximated posteriorly or actually united (stalkless$_1$). Other peculiarities are an increase in number of ventral caeca (xxv-c) and posterior shifting of the supra-intestinal glands, here in 5-6 of segments xcviii-cxxx. The *gammiei* range extends from Chittagong through Cachar into the Garo Hills and across the Brahmaputra plains into the Himalayas and there from Darjiling to the Abor country. The southern part of this range is at the *cochlearis* latitude. Much more material, in much better condition than in the past, is needed to show whether *gammiei* is a single species. *E. kempi* Stephenson 1914, from the Abor country, apparently is distinguished from *gammiei*, with which it had been united, by the elongate penes (*foveatus* type) and the stalkless$_1$ condition.

The rest of the Indian species, with nine specializations, metandry, maximal foreshortening, penisetal batteries, single female pore, pigment, coelomic glands associated with genital markings, a ventral testis sac, vestibula and definite penes, do lack lateral intestinal caeca. Penes, with the exception of *E. orientalis*, are elongate (as in *foveatus*) and at the terminal stage of evolutionary development of this organ. *E. waltoni*, like *orientalis*, has retained the primitive pairing of genital markings and still shows considerable variation in their number and axial location, though spermathecal pores have migrated well laterally. *E. nicholsoni* has reduced the markings to a single pair, on 15/16, but median union has not yet been completed throughout the species. One additional specialization in each species is shown by the spermathecae which are in one stage or another of the stalkless$_1$ development. Coincidence of the ranges with that of *incommodus*, which helped to convince Stephenson (1923, p. 428) that the Gangetic plain "could be looked on as the proper range of the genus" does at first seem to require origin of the *orientalis* group *in situ*. Indeed about all that is required to derive *waltoni* from *orientalis* is to elongate the annular penes of the latter. Nevertheless, in all the *Eutyphoeus* domain there is nowhere else such intraspecific uniformity throughout such large ranges (see for instance data on supra-intestinal glands locations). Nowhere else is there so great difference between holandric and metandric species. Further light on this, as well perhaps as other peculiar problems of the Gangetic valley, is anticipated from the area of unknown fauna east of Calcutta.

DISCUSSION

RELATIONSHIPS AND PHYLOGENY OF THE GENUS *Eutyphoeus*

The genus *Scolioscolides* Gates 1937, is remarkably like *Eutyphoeus* morphologically. Indeed, about all that is required to derive the former from the latter is transfer of capacity for developing prostates from xvii into xviii and in the proto-eutyphoeus stage. Such a transfer can be brought about, according to the evidence provided by aberrant individuals in species of several genera by a single step. The prostates, from a more posterior location in *Scolioscolides,* exert their attractive influence on the male deferent ducts before the latter have passed through xviii and so effectively that they grow posteriorly straight toward and then into those organs. Further growth of the prostates then carries the level of junction considerably away from the body wall so that the male duct in the adult joins the ental end of the duct portion of the prostate.

S. bergtheili (Michaelsen) 1907, the single species found as yet, is known only from the type locality in the Darjiling district of the Himalayas. In this species the prostates not only have lost the capacity to induce production of penial setae but seem to have acquired the ability to inhibit setal production in the adjacent ventral follicles which presumably atrophy early in ontogenetic development leaving no evidence of their previous existence. Additionally in this species, the typhlosole has been reduced to a low ridge, ventral caeca have been restricted to xxiv-xxviii, the supra-intestinal glands to two consecutive segments (in region of lix-lxi), and originally paired genital markings (possibly now restricted to presetal locations on xi-xiii and xx-xxi) have been united at mV Lateral intestinal caeca have been developed, as in the *nepalensis* group of Himalayan *Eutyphoeus* species, but further anteriorly, in segment xxi. Intrageneric evolutionary developments excepting reduction of the typhlosole appear then to be of the same general nature as in *Eutyphoeus,* so far as can be estimated from our present knowledge of but one species. One of those developments may be attributable to the mutation apenisetal already postulated in the phylogeny of several *Eutyphoeus* species.

Bahlia Gates 1945, is more like *Eutyphoeus* morphologically than any other genus except *Scolioscolides* and has essentially the same male terminalia, at the same axial location, as in the proto-eutyphoeus, in addition to lateral typhlosoles. Derivation from the proto-eutyphoeus is however impossible. Since segregation of these two genera ventral intestinal caeca have been acquired, a pair of spermathecae opening on 8/9 has been eliminated, septa 5/6-7/8 have been aborted, and an extra diverticulum has been acquired on each spermatheca, in the *Eutyphoeus* line. Meanwhile spermathecae of viii were lost in the *Bahlia* line. Reduction in number of spermathecae may have taken place, in both lines, at about the same time (or subsequently?) a posterior pair of prostates was eliminated. With disappearance of the latter organs, the male ducts which previously had opened on xviii could be attracted towards the prostates of xvii. This attraction however becomes effective ontogenetically only after the ducts have nearly passed through xvii in their posterior growth so that they are now compelled to turn and grow down into the parietes behind the prostate gland.

The point on the evolutionary tree at which bifurcation of *Bahlia* and *Eutyphoeus* is to be placed, now seems to depend on structures barely mentioned in older taxonomic characterizations and usually ignored in phylogenetic theorizing. These calciferous glands are in x and xi in *Bahlia* but only in xi in *Eutyphoeus.* In preference to postulating addition of a pair of such highly developed structurs in *Bahlia,* and rather than push segregation into a still more remote past before the organs had been closed off from the oesophageal lumen, it is assumed that the common ancestor was quadriglandular at least, and that one pair, in x, was eliminated in the *Eutyphoeus* branch. *Bahlia*, in this as well as other respects, is more like the common ancestral form than *Eutyphoeus* is.

B. albida Gates 1945, the single species, is known only from a very few individuals obtained in the Allahabad sector of the Gangetic plain and the immediately adjacent portion of the Deccan. The species must have lost the anterior testes long ago (possibly a generic characteristic?) as male funnels of x are lacking. Ventral setae of the spermathecal segment are enlarged and modified so that the shape of tip and ornamentation is much the same as in the copulatory setae developed in certain speceis of *Calebiella* Gates 1945, *Lennogaster* Gates, 1939, *Octochaetoides* Michaelsen 1922, and *Pellogaster* Gates, 1939. In spite of the common evolutionary potentiality demonstrated by those specialized setae, all of these genera, like *Hoplochaetella* Michaelsen 1900, and most other Indian octochaetines, must be placed in collateral lines.

Ramiella Stephenson 1922, can be associated more closely to the *Bahlia-Eutyphoeus* line but only through a form so primitive as to be able to give rise to all species of that genus. Such a proto-ramiella had a gizzard in v, an intestinal origin in xiv or even anteriorly, no calciferous glands or typhlosoles, the last pair of hearts in xii, paired male, female, prostatic and spermathecal pores (on 7/8-8/9) in region of *AB*, male pores on xviii, two pairs of prostates opening to the exterior on xvii and xix, and four pairs of seminal vesicles in ix-xii. Prostates had not acquired ability to induce modification of setal form and all ventral follicles of xvii-xix may have retained sigmoid setae throughout life. To give rise to the *Bahlia-Eutyphoeus* line three changes were necessary, transfer of the gizzard behind 5/6 into vi, elongation of the oesophagus to push intestinal origin back into xv, development of calciferous glands. The latter process can be visualized from conditions still prevailing today in certain species of *Pellogaster* and *Ramiella* as follows. A median fold grew out from the floor of the gut in the region of x-xii or xiii and after becoming more or less lamelliform was divided at its free margin into two parts as the intestinal typhlosole of certain species of *Octochaetoides* is today. Each secondary lamella, falling over laterally, in effect closed off ventrolateral portions of the oesophageal lumen from the ingesta. Thus protected against erosion by passing soil particles, transverse ridges containing the calciferous cells could become much thinner and their number much greater. Union of median margins of such thin lamellae with the enlarged adjacent half of the ventral typhlosole and of the latter to the gut wall at regions of septal insertions would then provide the required intramural, half-bean shaped calciferous glands opening into the central lumen through a dorsal slit. Only two pairs of glands are now needed in the common ancestor though three or even four in x-xii or xiii, may have been present (and retained in some as yet undiscovered types?). Rather than postulate independent acquisition of a long series of structures—intestinal typhlosole, lateral intestinal typhlosoles, supra-intestinal glands at the posterior end of the median typhlosole, hearts in xiii—segregation of the two lines is placed after the development of those organs.

The proto-ramiella range may well have extended over most of India south of the Himalayas, possibly also well into Burma, but the various evolutionary changes just outlined presumably took place in the Gangetic valley or the adjacent Deccan. There at any rate the few subsequent modifications were made to give *Bahlia* while in some part of the region now occupied by the Indo-Burma mountain wall the longer series of changes resulted in the proto-eutyphoeus.

PHYLOGENCY OF THE ORIENTAL OCTOCHAETINAE

The proto-ramiella also is primitive enough to provide an ancestral stage for the remainder of the Indian octochaetines with the single exception of *Howascolex*. Near universality of intestinal origin in xv or posteriorly in the group requires early extension of the oesophagus through xiv. Subsequently two major lines seem to be required by the gizzards. In the *Ramiella* branch of the one-gizzard line that organ has since been transferred into segment vi in all but one species, the oesophagus has been eztended additionally through xv in at least one species, and some have acquired an oesophageal or intestinal typhlosole or both. Minor evolutionary developments shown by extant species of *Ramiella* are : dislocation of spermathecal pores laterally or posteriorly, ontogenetic elimination of the ventral setae in the spermathecal segments, development of the rolled-tube type of penial setae.

The gizzard remained in v in another branch of the same line but the oesophagus was extended still further posteriorly. In the *Octochaetoides* descent, where all prostates (4) and spermathecae (4) were retained, oesophageal elongation put the intestinal origin back into xvii.

Subsequent development of calciferous glands was at two different levels. The two calciferous pockets are evaginated asymmetrically in one group and are constricted off so completely as to leave a short, slender stalk opening into gut at region of insertion of septum 15/16. In the excretory system the last remaining nephridial funnels have been lost, a development which now appears to be unique in the Octochaetinae. One species has become metandric and so recently that the male funnels are still present in x. Several species have acquired hearts in xiii. Two or three pairs of seminal vesicles have been eliminated, in ix-x, x-xi, or ix-xi. Species are found throughout much of peninsular India but little is known of their individual distribution or variation. Those with calciferous glands (of unknown structure) associated with 14/15 almost certainly should be generically separated and such information as is now available suggests a possibility that one other group of species may have to be split off.

In the far south of India, in forms that had also retained the gizzard in v, prostates long age were reduced to two, in xviii, where they acquired ability to attract posteriorly growing male deferent ducts into an early ontogenetic junction. Seminal vesicles in ix-x were also eliminated, but all four spermathecae, as well as all testes, have been retained. *Travoscolides* Gates 1940 alone has retained the four-paired arrangement (lumbricin) of the setae and a short oesophagus (intestinal origin either in xv or xvi). Reniform calciferous glands, four pairs in xi-xiii, are so constricted off as to open through stalks from ventral poles into the oesophagus close to mV An early stage in the development of this type of gland, in which calciferous pockets are still only slight bulges from floor of gut, apparently is shown by species of *Pellogaster* in the two-gizzard line. A typhlosole has been developed, and hearts have been added in xiii. In the excretory system, the nephridial anlage from xiv posteriorly apparently have been split, in an embryonic stage, longitudinally and each of the 20-24 stomate derivatives, instead of boring through the parietes to an external nephropore, now grows on towards the intestine into which they all open through two postseptal canals *via* a single intratyphlosolar excretory duct. Nephridia of ii-iv have disappeared, those of v-xiii have become tufted with loss of funnels and acquired openings into the pharynx or oesophagus.

Number of setae has been increased in the rest of this group. In *Spenceriella* (Indian section only), the gizzard has been transferred to vi, the oesophagus has been extended into xvi but no typhlosole or calciferous glands have been developed. The setae are twelve per segment in two of the forms, the two extra on each side lateral to *D* and all in regular longitudinal ranks. In another form the number has been increased to 14 to 17 in the posterior segments where only *a* and *b* setae are in regular ranks. Regularity of ranks is said to be completely lacking in another species where the number is now 50 or so per segment. The other two genera have extended the oesophagus into xix, but, like *Spenceriella*, have not yet acquired hearts in xiii. In *Priodochaeta* Gates 1940, with 30-40 setae per segment, the typhlosole is still rudimentary but three pairs of out-pocketed calciferous glands, in xiv-xvi, have been acquired. Each gland is still constricted off only dorsally and ventrally so as to open widely at hilus by a vertical slit about as high as the oesophageal lumen. In *Priodoscolex* Gates 1940, which now has 75-80 setae per segment and a more definitely lamelliform typhlosole, large reniform calciferous glands are evaginated in xiv-xvii. These glands are constricted off so that the stalks of two glands of a side in a segment unite to open into the gut at mL by a single minute aperture (secondary division of a single gland?). In the circulatory system there is a subneural trunk, a vessel that is lacking in all other Indian Octochaetinae. Nephridial anlage in the last few segments apparently have been split longitudinally so as to provide 20-24 funnelled tubes each of which may still have its own epidermal nephropore. The gizzard, as in *Priodochaeta* has been considerably enlarged and is now three mm long but there has been no transgression of limits of segment v. Body length in these two genera is from 230 to 330 mm but is much shorter in other genera with male pores on xviii. The ranges appear to be limited in this line. *Spenceriella* is known only from the Palni Hills, *Priodochaeta* from the Nilgiris, *Priodoscolex* from Mysore, and *Travoscolides* from Cochin and Travancore.

In the rest of the one-gizzard line that organ has been transferred into vi, intestinal origin into xv or posteriorly and a typhlosole has been developed. In the evolution of *Calebiella* four pairs of reniform calciferous glands have been evaginated in x-xiii but are still incompletely constricted off so as to open directly through the hilus into the gut at or near mL. The typhlosole has been enlarged and become deeply bifid ventrally and at its hind end supraintestinal glands of a simple sort may have been developed. Seminal vesicles of x-xi have been eliminated in the only species. A pair of hearts has been added, in xiii.

In the evolution of *Hoplochaetella* the oesophagus has been extended into xvi and calciferous glands have been constricted off more completely so as to open through short slender stalks from the hilus into the gut ventrolaterally. Setae have been multiplied and are 50-80 per segment. Seminal vesicles of xi have been eliminated but those of x are still retained in some species. Hearts have been added, in xiii, in most species. Although the male deferent ducts still grow back into xviii, one on each side then turns forward to pass into the posterior face of the anterior prostatic duct while the other continues back and into the anterior face of the posterior prostatic duct. Even in the few species that have recently become biprostatic (with no reduction in number of spermathecae), the male ducts still pass into xviii though all then turn anteriorly to join the prostates of xvii. A muscular thickening of the male deferent duct (bulbus ejaculatorius) is developed, in some species, just prior to union with the prostatic ducts. The median nephridium on each side in an intestinal portion of the body, in at least one species, has been secondarily enlarged and its duct, instead of penetrating through the parietes, grows laterally to join with those of other segments in a longitudinal excretory canal eventually opening to the exterior in the anal region. Additionally, this nephridium in some posterior segments has become multistomate (Gates, 1940), a condition which may be attributed to longitudinal splitting of the preseptal portion of the original nephridial anlage. A continuation of this process into the postseptal portion of the embryonic organ presumably would result in a condition similar to that now prevailing in *Priodoscolex*. *Hoplochaetella* arose in the western portion of the Indian peninsula and *Calebiella* in the north, perhaps in the Gangetic valley.

The remainder of the Indian octochaetines (again excepting *Howascolex*) can be arranged in a single line initiated by addition of a gizzard in vi. Associated therewith have been the usual oesophageal extension, bringing intestinal origin into xv, and development (except in one small branch) of an intestinal typhlosole but no addition of hearts in xiii. *Pellogaster* has lost the seminal vesicles of ix-x and has a typhlosole that ends abruptly without special glandular tissues. Definite calciferous glands have not yet been developed. A bifid oesophageal typhlosole in x-xiii of one species provides an early stage from which the intramural type (*Bahlia-Eutyphoeus*) as well as one evaginated type (*Lennogaster-Eudichogaster*) of gland may have been developed. Extension laterally of the broad, dorso-ventrally flattened typhlosole of another species could cover slight ventrolateral depressions containing rudimentary lamellae, with further evagination followed by constriction providing a series of four pairs of glands opening through oesophageal floor as in *Travoscolides.* The oesophagus may have been extended, in some forms, into xvi. Ventral setae of spermathecal segments are dehisced early in some species but become copulatory in others. The *Pellogaster* range apparently includes the north-eastern part of peninsular India and possibly some part of the Gangetic valley.

In another branch of the two-gizzard line, calciferous glands were evaginated in segments x-xii (one pair lost from xiii?) to open without stalks by dorsal poles into longitudinal grooves in the gut wall still shtc off by median partitions. In the genus *Lennogaster,* lateral typhlosoles have appeared, and the posterior end of the median typhlosole has been enlarged, perhaps by differentiation of glandular tissue. Seminal vesicles of ix-x have been eliminated in some species, all four pairs in others. The anterior testes may have been lost in one species and posterior testes must have been aborted at two different times. Posterior prostates and spermathecae have been suppressed in one group of specise and male ducts are now attracted into parietes of xvii though opening independently there as in *Bahlia-Eutyphoeus. Lennogaster* apparently arose in the northern part of peninsular India but its range now appears to extend into Burma (2 species).

In another branch of the two-gizzard line, evaginated calciferous glands were reduced to two pairs, in xi-xii, and glandular tissue at the hind end of the typhlosole was segregated into discrete supra-intestinal glands but not in the same manner as in *Bahlia-Eutyphoeus.* Seminal vesicles of xi, or x-xi, have been eliminated. *Eudichogaster* presumably arose in the northwestern part of peninsular India to which it now seems to be confined.

In a *Barogaster* branch, calciferous glands also were reduced to two pairs, in xi-xii, but glands are so constricted off as to leave short stalks from dorsal poles opening directly into the oesophageal lumen, a longitudinal groove and median partition having disappeared (as also in *Rillogaster* Gates 1939). Glandular tissue has been differentiated at posterior end of typhlosole in a sort of grid-like thickening of the intestinal roof but without demarcation into discrete glands. One pair of prostates must have been eliminated and the other has been transferred into xviii where the male ducts are attracted into anterior faces of prostatic ducts at the parietal level. *Barogaster* apparently is restricted to the northern half of peninsular India.

A long isolated branch apparently never developed a typhlosole or associated glandular tissue but has shifted the gizzards back into vi-vii. Reniform calciferous glands are evaginated in xi-xiii and constricted off to leave a fairly long stalk passing from hilus to oesophagus just in front of the septa. Seminal vesicles of x-xi, posterior spermathecae and anterior prostates have been eliminated and male deferent ducts are now attracted into xix where they presumably join the prostatic ducts. The single species of *Rillogaster* is known only from one locality in western peninsular India.

Oviducts, it should also be mentioned, have been united ectally to open by a single median pore in four genera, *Hoplochaetella, Eudichogaster, Barogaster* and *Rillogaster*. The uniporal condition also has been found in one individual of *Pellogaster isabellae* Gates 1945.

Howascolex, the remaining Indian octochaetine, merits little more than passing mention. This genus has been a convenient depository of a geographical and morphological motley of little known species. The excretory system supposedly has been studied in one species but its name is known only from a museum label and the trivial portion of the nomen nudum, if correctly descriptive, means that the species cannot go in the egnus even in its present heterogeneity. Two evolutionary developments appear to be now under way in Indian species, multiplication of setae in the intestinal region and multiplication of nephridia in an anterior portion.

To trace the descent of the octochaetines still further back there now needed a form from which the proto-ramiella can be obtained with a minimum of modification and in accordance with limitations of known geographical distributions. A protoplutellus (Megascolecinae), obtained in the same way as other protoprimitive forms postulated above, is distinguished from the protoramiella by the desired holonephry but had already become biprostatic with pores on xviii. The required quadriprostatic stage may be obtainable in the Acanthodrilinae but that group is without indigenous representation in the oriental region. Slowly accumulating evidence however makes it increasingly possible that the remaining group of Stephenson's Megascolecidae, the Ocnerodrilinae, does have endemics in that region. A primitive form would necessarily have a short oesophagus, an intestinal origin in xii, only two pairs of hearts in x-xi, four pairs of seminal vesicles in ix-xii, but no calciferous glands, typhlosoles, supra-intestinal glands or caeca, nor a subneural trunk in the vascular system. It may have had a gizzard in v or none but was holonephric, *i.e.*, having a single pair of stomate nephridia with parietal nephrophores in each segment. Species similar in many of the most important respects to such a form are present in India and Burma and are unknown elsewhere. Of the changes necessary to derive the protoramiella from such an ocnerodriline, elongation of the oesophagus into xiv, and addition of a pair of hearts in xii, are of the same sort as had to be postulated in the various octochaetine lines. The other change requires only transverse fragmentation of the postseptal portion of the embryonic anlage of the holonephric tubules after which each fragment acquired its own parietal nephropore. The median fragment, retaining the original connection with the preseptal rudiment would develop into a stomate nephridium, the others, without such connection remaining astomate. This change now can be seen, in the backward look, to have been of major importance though at the time it would have seemed justification at most for generic separation. Such evidence as is available from *Howascolex* suggests that the fragmentation may have been confined at first to an anterior portion of the body and was later extended througheut the whole axis. Multiple organs presumable arising from fragmentation of a single embryonic rudiment occasionally are noted in individual earthworms that presumably are to be regarded as mutants. Establishment of a mutation for transverse fragmentation of the post-septal portion of nephridial anlage appears then to be a possible explanation of the origin of the meronephric type of excretory system characteristic of most Indian octochaetines. Subsequent developments in the various lines have been limited to modifications that now appear to be minor, such as elimination of funnels of median nephridia, first anteriorly and then posteriorly, secondary enlargement of median tubules and development of longitudinal excretory ducts, development in a limited number of anterior segments of the habit of opening into a pharyngeal portion of the gut rather than through the parietes, suppression of nephridia in one or more anterior segments, increase or decrease in extent of fragmentation of nephridial anlage. Although of a somewhat similar nature, the longitudinal splitting of the preseptal rudiment, foreshadowed in *Hoplochaetella,* has ended in development of intestinal enteronephry, in the genus *Travoscolides,* but which has reached a greater degree of specialization in the Megascolecinae.

SUMMARY

Gross anatomy of digestive, circulatory and excretory systems are remarkably uniform throughout all of the genus *Eutyphoeus,* in environments ranging from semidesert to rain forest and from tropical sea level to Himalayan heights. Intrageneric differences in these three systems are restricted to length of median intestinal typhlosole, number and axial location of ventral intestinal caeca as well as of two-paired sets of supra-intestinal glands, location of lateral intestinal typhlosoles and lateral caeca, number of nephridial ranks in posterior segments, number of such metameres in which median nephridia still retain funnels, extent of abortion of dorsal blood vessel and associated segmental commissures within the first seven segments. The relative uniformity in these organs is in striking contrast to the marked variability in the reproductive system. Here, differences in anatomy involve all structures except ovaries. Among the more important are the following : Two pairs of testes or one pair and then in x (proandry) or xi (metandry). Presence (with or without part or all of its deferent duct) or absence of male funnels after disappearance of corresponding gonads. Functional or functionless right oviduct. Testis sac lacking, annular, U-shaped or ventral and then without or with secondary dorsal extensions. Spermathecae uni-, bi-, or multi-diverticulate. Spermathecal diverticula uniloculate or multiloculate. Male terminalia avestibulate, univestibulate or bivestibulate, with or without intromittent organs which may be porophores capable of temporary elevation with pores at apices, eversible invaginations, protrusible annular or tubular penes, without or with penial setae and in the latter case with or without batteries of size-graded reserves. Genital markings lacking or present and then paired or unpaired, segmental and pre- or post-setal or intersegmental, without or with coelomic glands which may or may not be capsulated.

Characteristics available for taxonomic use necessarily are mainly of the reproductive system with digestive and circulatory systems together

providing several others of more or less limited value. Lateral typhlosoles hitherto unrecognized, like the thickenings of the intestinal wall into which they are modified or by which they are replaced, apparently are always developed in species that have them. Presence and absence provide one pair of characteristics but these structures, so insignificant that any function is questionable, now appear to be more valuable for indication of intrageneric relationships. Lateral caeca, as well as typhlosoles, are always associated with the anterior end of the median typhlosole in a limited number of segments (xxii-xxviii) and supra-intestinal glands are always at the posterior end. Ventral caeca are always in typhlosolar segments and usually much nearer the anterior than the posterior end, neither of which is reached even in the longest series known. Funnels on median nephridia may prove to be confined to post-typhlosolar segments. In addition to the few characteristics provided by the typhlosolar portion of the gut there are only presence or absence of dark pigment and presence or absence of dorsal displacement of *d* setae, also of limited use. In the reproductive system, presence or absence of a vestibulum as well as number and certain conformations, presence or absence of penial setae, presence or absence of a battery of size-graded reserves, provide taxonomically useful characteristics, some of which may be recognizable only at maturity

Individual variation hampers use of all other characteristics regardless of system. Lateral intestinal caeca appear to be universally present, of characteristic conformation and definite axial location or always lacking in certain species but in others often are scarcely distinguishable from fortuitous bulges and at best are variable as to size, shape, direction, degree of constriction from gut, even location. Ventral intestinal caeca, like the supra-intestinal glands, apparently in all species, vary both as to number and axial location. Number of gland sets in this genus always is small, 2-9, but the region in which they are found may comprise ten or fewer segments in some species to forty or more in others. Genital markings generically confined to ventrum of some fourteen anterior segments, are present in most species but may be lacking in occasional individuals, small local populations or throughout a considerable portion of a species range. Critical ectal portions of penial setae, frequently damaged in use, distorted by strong mortal constriction or fibrillated during maceration, may be similar in closely related species but markedly different in an occasional individual, short series or local population. Penes may be absent in some individuals in a local population or represented by annular protuberances possibly only of a temporary nature. Although many more anatomical characteristics can be used for definition of species than was formerly recognized, they are inadequate individually as well as collectively in one situation or another. No "museum" criterion is available for determination of taxonomic status when material is limited to a single individual or a short series. Populations of rather similar anatomy, when geographically separated from each other by considerable distances, have been considered to be different species. Adjacent or overlapping populations that appear to be rather closely related to each other morphologically have been treated as species when they cannot be derived directly from each other but only from a common ancestral from no longer extant (cf. *levis* group), except in case of *manipurensis* where the two subspecies now recognized may prove to be worthy of a higher status. Residues usually have been separated into species according to stages reached in evolutionary developments, as in the *constrictus* group; loss of anterior testes in *hastatus* ⟶ *constrictus*, in which loss of dorsal blood vessel and associated branches anterior to commissures of vi ⟶ *peguanus*, in which loss of dorsal blood vessel anterior to commissures of vii ⟶ *plenus*.

Within some of the species so delimited infra-specific taxa may be recognizable. One hundred percent of the material of *E. planatus* that has been available from an unusually small range could have been referred to two geographical subspecies by external as well as by various internal characteristics, and indeed, in almost the same percentage by locations of supra-intestinal glands alone. One hundred percent of the specimens of *peguanus* from the deltas region has been referable almost at a glance, by slight but easily recognizable external characteristics to subsp. *peguanus* and the same percentage of trans-Sittang worms has been referable to subsp. *similis*. Variation in internal organs such as supra-intestinal glands and intestinal caeca appears to be about the same in the two subspecific ranges. Within each of those ranges there can be further distinguished, again by external characteristics (axial location of genital markings), several formae each of which may prove to breed true (with reference to those characteristics) when isolated. *E. constrictus* apparently has no genital markings in the little known northern half of its unusually long range but the same "inornate" condition is found, though only in low frequencies, throughout the southern half. There, external characteristics (as well sometimes as certain aspects of internal organization) may be very similar to those of *hastatus* in the same locality. Solution of various taxonomic problems with reference to populations of the *hastatus-constrictus* complex, in the jungles of the Pegu Yomas, was postponed indefinitely by the late world war and determination of status of several India "species" still awaits acquisition of further material in better condition and longer series.

Discontinuities in geographical distribution of species of *Eutyphoeus* are few, rather small and restricted to the proper generic range with two exceptions. The latter, presence of Gangetic species in Pakistan and Bombay, obviously are attributable to transportation and presumably by man. Internal discontinuities, in absence of characteristic differences in variation, also are attributable to recent transportation by man, with estimates sometimes possible as to original sources. Ranges of three fairly stabilized Gangetic species probably have been extended recently by migration and/or transportation but only into adjacent areas along river valleys leading into the Deccan or across the Aravalli divide into the Indus Valley (Gates, in press). Outside of the generic range and contiguous areas worms of this genus apparently have been unable to avail themselves of the opportunities for new colonization that must have been increasingly provided by man during the last four centuries. The range of the genus now has been quite accurately determined as to southern, eastern and western boundaries. There remains to be learned just how far north the genus has been able to penetrate into the Himalayas, as extension in those mountains east of Burma or west of Nepal is not anticipated. Species ranges, in Burma, appear to be of two distinct sorts. One, involving considerable north-south extent, characterizes three Burmese species, *hastatus*, *constrictus*, *bifovis*, and possibly one Indian species (*gammiei*). The other, is of a much shorter extent, with ranges of related species succeeding each other in a north-south direction (cf. *levis* and *foveatus* groups). Stabilization of genital markings and other external characteristics, as well as of supra-intestinal glands (typhlosolar termination) and intestinal caeca, in various combinations, possibly under way in local populations of *hastatus* and *constrictus* in the Pegu Yomas, may represent an earlier stage in the evolution of smaller range species.

The variation that has caused so much trouble to systematists in *Eutyphoeus* involves precisely those characteristics by which species must be distinguished and shows that evolution still is going on throughout the genus. Just as in the more remote past *hastatus* evolved into *constrictus*, so today small local populations of the former, in south-central Burma, appear to be passing (or to have passed very recently) into a *constrictus* stage. Passage from the *constrictus* to the *peguanus* stage, in at least one locality of the Pegu Yomas, must have been almost at once, if not directly from *hastatus*, as elsewhere, in the vicinity of Pyinamana, *constrictus* may have gone straight into a *plenus* stage. Several local populations of *foveatus* also appear to be evolving into a *spinulosus* stage. Rapid evolution at times is indicated by persistence of *hastatus* male funnels of x, now useless and usually lacking in metandric species, through the *constrictus-peguanus* and *constrictus-plenus* stages.

Direction of evolution sometimes is clearly indicated by certain organs: male funnels in segments from which the testes have disappeared, a right oviduct without external aperture, anterior portions of the dorsal blood vessel with associated segmental commissures that are of much less than normal size or even functionless, malfunctioning or even functionless penisetal follicles Some other trends can be deduced from comparative anatomy: Lateral dislocation of spermathecal pores. Increase in number of seminal chambers in spermathecal diverticula. Modification in activities of penisetal follicles to produce batteries of size-graded reserve setae apparently long before sexual maturity. Perfection of mechanisms for direct transfer of sperm into spermathecae of a copulatory partner, this having been anticipated, as it were, by the generically characteristic thick duct with lumen and aperture large enough to receive an intromittent organ. Trends with respect to structures such as genital markings, supra-intestinal glands, ventral intestinal caeca, penial setae, are much more difficult to recognize. Each of two opposites occasionally may be indicated. Some degree of stabilization as to number as well as location of markings, glands and caeca, however, has been achieved at various times and places.

Evolutionary changes have taken place repeatedly and independently in *Eutyphoeus* according to the evidence provided by distribution. Tubular penes have been developed, presumably by elongation of smaller but definite annular ones around fissures, in the Arakan Yomas of Burma, in the Eastern Himalayas and the Gangetic valley. The dorsal blood vessel has been foreshortened in several sections of Burma, as well as in the plains of the Ganges, and the interspecific variation in incidence of persistent vestiges indicates that this change has taken place at different times. Metandry has been achieved in different parts of Burma, in the Himalayas and in the Gangetic area. Attainment of this meroandric reduction at different times is evidenced by presence or absence of seminal vesicles of ix, of anterior gonoducal funnels with or without their ducts and the various stages of regression in funnels as well as ducts. Intestinal caeca have been evaginated, though usually not in the same segments, in different parts of the eastern border of the generic range in Burma, in a northern as well as a southern section of the Indo-Burmese mountain wall and in the Himalayas. Median spermathecal diverticula have been lost twice in eastern Burma, once each in central Burma and in Manipur. Considerable similarity in gross anatomy need not then be evidence of close relationship, and contrariwise, closely related species may be distinguished from each other by structural differences about as great as are to be found in this genus.

Also involved in much of the present discussion are assumptions that issued from a study of aberrant or monstrous individuals and of juveniles in which development of various reproductive structures can be followed, as it were, merely by seriation of growth stages. (1) Development of gonoducal funnels is induced by the gonads, as presumably, development of seminal vesicles or ovisacs (when present) is induced by testes or ovaries. Persistence of male funnels of x in metandric species such as *peguanus* is explained as due to abortion of gonads only after funnel induction and in some cases only after the funnel ducts have acquired autogenous growth. Disappearance of the ducts and finally even of the funnels in older metandric species then must be attributed to increasingly earlier abortion of the testes. (2) Development of most of the male terminalia is induced by the prostates. If the prostates are lacking the terminalia do not develop and male deferent ducts, whether shorter or longer than usual, do not acquire external apertures. When prostates are shifted to another segment the rest of the terminalia also develop there. Included in the developments thus induced are; acquisition by male deferent ducts of superficial apertures, anterior migration of male pores from an original postequatorial position forward into fissures as the latter develop, protrusion of margin of each fissure as an annular penis, elongation of an annular to a tubular penis, invagination of the fissure areas into one or two chambers, or development around each fissure of some sort of a porophore, migration of apertures of setal follicles into closer proximity to prostatic and male duct pores, modification of activity of the adjacent follicles to produce penial setae, sometimes with size-graded reserves. Evolution, insofar as the terminalia are concerned, has involved increase in number of developments induced by the prostate, intensification or other modification of those inductions, all of which take place rather late in ontogenetic growth. When prostates are lacking all of those developments are of course omitted and follicle apertures of ventral setae remain in the usual locations. Follicles, as formerly in the long distant past, produce ordinary sigmoid rather than penial setae, Loss of a late ontogenetic induction in this case then results in a return to an ancestral condition that was not anticipated previously (Gates, 1939, p. 183).

A hypothetical ancestral form has been obtained by subtraction of all species specializations in this genus. With that proto-eutyphoeus, species of *Eutyphoeus*, insofar as present knowledge of anatomy permits, have been filiated phylogenetically and arranged in groups according to phyletic relationships for the first time. The mountain wall between India and Burma now appears to have been the center of *Eutyphoeus* evolution, and perhaps a more appropriate one than the Gangetic plain (Stephenson, 1914, p. 323) for animals eventually to climb 15,000 feet into the Himalayas. From that wall an ancestral proto-eutyphoeus passed across Burma into a region comprising the western edge of the Shan Plateau as well as the southern hills down through Amherst district to the Ye River, where it became segregated into species of the meroandric *levis* group (proandric and metandric). In the opposite direction it penetrated into the Indian lowlands where, without loss of holandry it became differentiated into *incommodus*, *annandalei* and *quadripapillatus*. To the north and in the mountains, after giving rise to the genus *Scolioscolides*, it became segregated into species of the Himalayan equivalent of the *levis* group. Subsequently migration to the east from the mountain wall brought into Burma a form that became *hastatus* and which gave rise in the central yomas to species of the *constrictus* group. The oldest of these has hardly escaped from the Pegu Yomas, but another, *peguanus*, was able to cross the Sittang into the *levis* group territory but only down to the mouth of the Salween and more recently has spread throughout the deltas region. The same ancestor of *hastatus*, or a form with similar evolutionary capacity, passing westwards gave rise to a trans-Arakan equivalent of the *constrictus* group (*scutarius*, *comillahnus*, and others, all of uncertain status). Finally, from that same wall, a proto-foveatus, passing east into the Chindwin-Irrawaddy axis, was segregated into species of the *foveatus* group, due south in the Arakan Yomas into species of the *gigas* group, and to the west into the *gammiei* complex, possibly still further on, in the Indian lowlands, part or all of the *orientalis* group.

Hypothetical ancestral forms obtained for other oriental octochaetine genera in the same way as the protoeutyphoeus have been filiated first with the derived species (mostly without mention in the present contribution) and then with each other. This oriental phylogeny includes various genera erected since the last discussion of the subject by Stephenson (1930) and makes use of recently acquired information regarding calciferous glands (Gates, 1937-1940) and excretory systems (Bahl, 1919-1946). The evolution of the nephridial system in the oriental octochaetinae, as now outlined for the first time, is based, except for one assumption as to longitudinal splitting of nephridial anlage, on ideas advanced by Bahl which are however set in a more appropriate systematic framework because other organization also has been taken into consideration. Further studies like those of Bahl and his students are required, both for phylogenetic and taxonomic purposes, in meronephric genera and especially in the Megascolecinae. The best documented evolutionary sequence in calciferous glands involves ; appearance of a ventral oesophageal typhlosole, its heightening and bifurcation, appearance of transverse calciferous lamellae, union of median ends of those lamellae with the lateral faces of the typholosolar bifurcations to form the intramural sort of gland characterizing *Eutyphoeus*, *Scolioscolides* and *Bahlia*. Each lamella forming area, in another line, is evaginated laterally into a stalked sac and the typhlosole has been reduced to two small valves one over each stalk aperture still within a slight groove. Retraction of stalked extramural glands into an intramural situation, required at least twice in the classical phylogeny, still seems unlikely (Gates, 1938, p. 45). Other octochaetine methods of gland evolution are suggested by stalk-gut relationships ; evagination from the ventral side close to mV, from the dorsal side, or from regions of septal insertion, sometimes with complications due to lobing of primary evaginations and acquisition by secondary lobes of their own stalks, etc. Such variety in development and gross anatomy, to say nothing of microscopic structure, together with differences in number and axial origin, require more consideration in phylogeny as well as taxonomy than the customary reference to absence or presence and then sometimes to number and segmental location. Even such casual characterization has been omitted in classical definitions of megascolecine genera.

Some of the evolutionary changes that have taken place in *Eutyphoeus* (such as acquisition of pigment, lateral migration of spermathecal pores, modifications in spermathecal diverticula, mercandric reductions, elimination of penial setae, etc.) also have been made within other octochaetine genera. Some changes, invagination of copulatory chambers, development of penes and intestinal caeca, fore-shortening of the dorsal blood vessel, absent elsewhere in the Octochaetinae, have taken place within genera of one or more other subfamilies or families. Only regression of the right oviduct, certainly a rather odd development in animals so fundamentally symmetrical as are earthworms, has not been found elsewhere and now seems to be unique.

Evolutionary changes such as migration of female pores mesially, ectal union of oviducts to open by a single pore at mV, dislocation of spermathecal pores mesially or away from the intersegmental furrows, and then anteriorly or posteriorly, loss of a pair of spermathecae or prostates, etc., not only have taken place independently within different octochaetine genera but also time and again within genera of other families. Variation in number and segmental location of gizzards, length of oesophagus, number as well as location of hearts and calciferous glands, number of setae, and as to presence or absence of typhlosoles, etc., is lacking, as in *Eutyphoeus*, in many genera of the Octochaetinae and other (sub) families. The single gizzard in *Perionyx* however may be in v, vi or vii, according to species. The number of gizzards as well as their location, in the Moniligastridae, may vary considerably from one individual to another in a local population of a species. Intestinal origin in *Perionyx* may be in any of segments xv to xx according to species but with frequent individual exceptions. Morphologically quite similar species of *Plutellus* may differ from each other mainly as to presence or absence of a typhlosole. Number of pairs of setae in *Spenceriella*, as well as other genera, varies from one species to another if not from one individual to another in the same species. The single morphological characteristic, union of male and prostatic ducts in xviii, that was supposed to distinguish the phylogenetic (sub) family Megascolecinae (Stephenson) or Megascolecidae (Michaelsen) now has been found in two other (sub) families. Individual variation in calciferous glands has not been found yet and most of the cases of interspecific differences are in phylogenetically defined genera (*Howascolex* and the Megascolecinae) obviously in need of revision. Meronephry is universal in the Octochaetinae, only generic in the Microchaetinae and Megascolecinae, but excretory systems have been studied too little to permit any conclusion with reference to intrageneric or individual variation. Lack of hierarchy in characteristics that must be used in earthworm taxonomy, frequent independent development of the same conditions in so many evolutionary lines, and paucity of unique major changes, has been responsible in part for the difficulties in classification of earthworms and its present unsatisfactory state.

In the Octochaetinae three genera clearly are more closely related to each other than usual in that family. One of them, *Scolioscolides*, can be derived directly from *Eutyphoeus*, certainly from a primitive form similar to the proto-eutyphoeus. This derivation requires little more than a single change, translocation of capacity for developing prostates from the *Eutyphoeus* segment to that next behind, which has taken place in intrageneric evolution (*Diplocardia*, *Pheretima*) and occasionally is found in mutant individuals of *Pheretima* sp. Other modifications involved in that derivation may arise from changes in induction resulting in part at least from the difference in axial location. The other genus, *Bahlia*, can be derived only from some extinct common ancestral form. Other oriental octochaetine genera, like *Bahlia*, usually can be filiated only indirectly. Direct filiations, with the ancestral genus surviving alongside daughter and grand-daughter genera, as in the classical earthworm phylogeny, must be very rare if at all possible.

The protoramiella which also can be ancestral to other Indian octochaetines except the little known and taxonomically confused *Howascolex*, differs significantly from the corresponding protoprimitive form in the nearest family (geographically as well as morphologically) only by one characteristic,—presence of two or more pairs of nephridia per segment instead of one. The initial evolutionary change then needed to derive the protoramiella and through that all other oriental octochaetines is merely transverse fragmentation, in an early embryonic stage, of the usual single pair of nephridial anlage. This fragmentation initially may have been a mere halving, to give, as in the microchaetine genus *Tritogenia*, four tubules per segment.

Hybridization between species has not been recognized in the genus *Eutyphoeus* and may well have had little or no importance in its evolution. This is in agreement with Pickford (1937, p. 46) who found "that species hybridization has played but a small part" in the evolution of the South African Acanthodrilinae. Vestigial anterior portions of the circulatory system could have been interpreted in certain Burmese localities as a result of a cross between *constrictus* (*dorsal vessel intact*) x *peguanus* (vessel foreshortened). But the same vestigial conditions have been found in circumstances where that or any similar cross is impossible.

Some of the genetic changes that must have been the bases of evolution in this family bring about shifts in "developmental fields" and other gradual modifications. Some correspond to the classical "mutations" of the De Vriesian period. Such "mutations", postulated to explain certain evolutionary changes in *Eutyphoeus* and other octochaetines, have been named, for convenience of discussion, at opportune places in the present contribution. The evidence for these hypothetical mutations is provided by aberrant or monstrous individuals of various genera as well as *Eutyphoeus* since identical evolutionary changes can be expected to originate in the same way in different lines. These mutations may produce their major recognizable effect at any stage of the life history; a meronephric mutation early in embryonic development, foreshortening perhaps somewhat later after the circulatory system has been well developed in the embryo, elimination of spermathecal diverticula late in ontogeny when worms have about attained adult size. Delayed penetrance of the metandric mutation, until after induction of spermiducal funnel development, is assumed, to explain persistence of these useless structures. Eventual disappearance of both ducts and funnels can then be attributed to earlier penetrance. Incomplete or delayed penetrance also has been invoked to explain persistence of the anterior section of the dorsal blood vessel in occasional individuals of species where foreshortening is usual. Genetic determiners for certain evolutionary changes may however be ineffective or become inoperative in later stages of embryonic development. Thus there are meronephric nephridia and two dorsal blood vessels in an anterior portion of the body in certain species of *Howascolex* and *Diplocardia* (Acanthodrilinae) respectively, the primitive condition (holonephridia and single dorsal vessel) retained posteriorly.

Mutation "athecal" has had no role in the evolution of *Eutyphoeus* or any other oriental octochaetine though involved in the ancestry of *Bimastos* (Lumbricidae) and *Criodrilus* (Criodrilinae), as well as of various other lumbricid and megascolecine species. Presumably the "prerequisites" for perpetuation and spread of the mutation, such as spermatophores that can adhere to the exterior of a copulatory partner (Criodrilinae) or uniparental and presumably parthenogenetic reproduction (sp. of the megascolecine *Pheretima*), have been lacking in the octochaetines. Mutation "aprostatic" may have had no evolutionary significance in the Octochaetinae because of inability of male deferent ducts, in absence of prostate glands, to acquire openings to the exterior.

Scolioscolides can be derived directly from *Eutyphoeus* or rather from the proto-eutyphoeus by a single change, shift of prostatic development from one segment to that next behind. Aberrant individuals in species of *Pheretima* indicate that such a change can be brought about at one step by mutation. A new genus of earthworms then apparently can arise by establishment of a mutation (along with associated changes of induction) and be characterized by a condition previously thought to distinguish an entire (sub) family (Megascolecinae or Megascolecidae).

Furthermore, the single change required to derive the basic octochaetine protoramiella from the protothatonia, transverse fragmentation of the single pair of nephridial anlage, presumably can result from mutation. Mutant individuals of that sort have not yet been recognized in holonephric species but aberrant individuals in which other embryonic anlage were fragmented have been found. A systematist already familiar with the protothatonia might well have disregarded a single individual of a protoramiella as an unimportant aberration, or for several individuals might have made a different species. Prior to writing this, the genus *Perionyx* was redefined so as to keep within it one species which differed from all others almost only in having had each of the embryonic nephridial anlage split longitudinally into five or six portions, each of which develops into an apparently normal nephridium. At most this unusual species will have to be transferred to a new genus. If however the species had happened to be one with considerable evolutionary potentiality it could in time have given rise to a group of genera possibly even requiring recognition as a subfamily or family. In the same way the Octochaetinae is today distinguished from the two most closely related subfamilies only by the meronephry.

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CATALOGUE OF MAMMALS IN THE ZOOLOGICAL SURVEY OF INDIA*

IV PRIMATES : PROSIMII, TARSIOIDEA AND PLATYRRHINE[1]

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(Plate II)

Except the Oriental Lorisoidea, the groups of Primates under report are very poorly represented in this collection. There are in all 171 specimens representing forty-eight forms. For want of skulls and localities, the identification in some cases is provisional. Several geographical and individual variations have been recorded in the present study. Wherever subspecies cannot be determined, the distributions are not given.

I am indebted to Drs. S. L. Hora and B. Biswas of this department for many useful suggestions.

REMARKS ON THE CLASSIFICATION

Although no attempt is here made to deny the affinities of Tupaoids with the Primates, yet it has been thought convenient to exclude them from the Primates for the present (*contra* Simpson, 1945). It matters a little whether border-line forms between any two groups are referred to one group or the other; but it does matter much to cause a radical change in the old procedure (*see* also Evans, 1942; Ellerman and Morrison-Scott, 1951, pp. 8 and 189; and Hill, 1953, pp. 5 and 24).

Hill (1953) in his monumental monograph has divided Primates into two grades, Strepsirhine and Haplorhine. Strepsirhine has been further divided into suborders Lorisoidea and Lemuroidea, and Haplorhini into suborders Tarsioidea and Pithecoidea. Preferring a compromise between this system and the one advocated by Simpson (1945) in his great work on the classification of mammals, I would divide the Primates into three suborders, Prosimii, Tarsioidea [2] and Anthropoidea[3] which arrangement was also recommended by Gadow (1898). While giving Tarsioids an infraordinal rank under the suborder Prosimi, Simpson (*op. cit.*, p. 182) says "The Paleocene and the earlier Eocene members of the two groups are very much alike, indeed often indistinguishable on more than a generic level unless known by excellent material. Synthetic and intermediate types occur" In all probability, as Simpson (*op. cit.* p. 185), himself suggests, Anthropoidea also arose from Prosimian ancestors if not later than Tarsioidea at least

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* The earlier parts (No. II and III) of this series were headed: "Catalogue of Mammals in the Indian Museum (Zool. Surv.)"

[1] For reports Nos. I, II and III see Khajuria (1953, 1955 and 1956). Report No. I also contains some general remarks on the collection and the explanation of the abbreviations used in the measurements of the skulls.

[2] An earlier name for this group is Tarsii (Gadow, 1898) but is not in general usage.

[3] No doubt the name Pithecoidea Pocock as used by Hill (*op. cit.*) for this group is more expressive than the earlier and commonly used name Anthropoidea but the rejection of the nomenclatorial terms on the basis of their literary meaning will lead to a great confusion.

about the same time and, therefore, there should be contemporaneous synthetic types between Prosimii and Anthropoidea also. The fact that those types have not been discovered so far cannot jeopardize their existence. Regarding the arrangement followed by Hill (*op. cit.*) it appears to me that the differences between Tarsioids and Anthropoids are more than those between Lorisoids and Lemuroids. These differences, on the whole, appear to be almost of the same value as those between Prosimii and Anthropoidea. This consideration coupled with the belief that both Tarsioidea and Anthropoidea arose from the Prosimian ancestors in the Palaeocene or the early Eocene leaves me with no alternative but to accede to all these three groups equal taxonomic ranks.[1]

The classification of Prosimii is strictly in accordance with Simpson (*op. cit.*), except that following Hill (*op. cit.*) Galagos are raised to a family rank.

The classification of Cebidae below generic level is in more unsatisfactory state than that of the other Primates. Good revisions except a few like that of genus *Ateles* by Kellogg and Goldman (1944) are not available; and in many cases the results of various workers are contradictory. In the case of Callithricidae Hershkovitz (1949) has cleared off much of the difficulty, although he has left the genus *Callithrix* as it was. I have followed him in the division of Callithricidae into three genera, *Leontocebus*, *Marikina* and *Callithrix* with three subgenera under *Marikina*. Thomas's (1922) genera, *Mico* and *Hapale*, are considered as synonyms of *Callithrix*, but *Cebuella* has been given a subgeneric rank on account of some dental peculiarities and diminutive size. Pocock (1925) and Simpson (1945) have been mostly followed in the classification of the generic and super-generic groups of Platyrrhine.

THE CATALOGUE

Sub-order PROSIMII

Infra-order LEMURIFORMES

Super-family LEMUROIDEA

Family LEMURIDAE

Sub-family *LEMURINAE*

Lemur[2] **catta** Linnaeus

1758. *Lemur catta*, Linnaeus, *Syst. Nat.* I, p. 30 (Madagascar).

Material—

10560	♀	Skin and skull	Zool. Gardens, Calcutta (13-1-1914).
10729	♂	Skull (exhibited)	Zool. Gardens, Calcutta (30-9-1929).
12270 (I.M. 74a)	♂	Skin and skull (damaged).	Madagascar. E. F. Kelaart (1852).
12271 young (I.M. 74b).	♂	Skin and skeleton	W. Rutledge (4-2-1876).
12272		Skin (exhibited)	....

[1] When this work was in press, Hill's (1955) wonderful work on Tarsioidea was received. A perusal of his learned views (pp. 1—2) has increased my belief in the correctness of the classification here recommended.

[2] Hill (*op. cit.*) has divided the genus *Lemur* into three subgenera, *Lemur*, *Varecia* and *Prosimia*. Since the species included under the sub-genus *Prosimia* are distinguishable on the basis of important cranial characters, it seems reasonable to replace subgenus *Prosimia* by three sub-genera typified by (1) *Lemur macaco*, (2) *L. mongoz* and (3) *L. rubiventis* and *L. fulvus*. However, as I have not examined sufficient material no names for these sub-genera are proposed here.

Measurements—

Skin No. 10560.—*hb*, 450 ; *t*, 575 ; *hf*, 100.

Skulls. [1]

Z. S. I. Reg. Nos.	*l*	*cb*	*ow*	*mw*	*ml*
10560 . . .	82·5	74·7	47·1	16·9	*
10729 . . .	84·3	76·8	47·1	18·2	55·5
12270 . . .	82·5	75·1	48·4	18·7	54·2

Remarks.—The pinnae of the specimens are well clothed with long white hairs on both sides ; and the hairs on the hands are much darker at their bases (*cf.*, Hill, 1953, p. 389). The description of the pelage well agrees with that given by Elliot (1913). Elliot (*op. cit.*) and Hill (*op. cit.*) gave the length of the skull as 75 mm. which is noticeably shorter than those of the adult skulls in this collection.

Distribution.—Madagascar : from Fort Dauphin towards the south and along the western border to the Morondava River.

Lemur variegatus variegatus Kerr

1792. *Lemur macaco variegatus*, Kerr, *Anim. King.* p. 86 (Madagascar).

Material—

10566	Skin . .	No history.
12276, 12277, 12278, 12279	Skins and skulls .	Do.

Remarks.—The specimens agree well with the description of this sub-species as given by Hill (1953) ; but as stated by him, there are many variations. In all the skins there is a variable amount of pale orange yellow in the white parts of the pelage especially on the dorsal surface. In No. 12276, it is much more pronounced. Nos. 10566 and 12276 are much darker in the black parts of their pelage than other specimens. An important variation occurs in the extension of the white of the dorsal side. In No. 12276 it is connected with the white of the sides of the head and the neck by a broad white mid-dorsal band, while in Nos. 10566, 12278, and 12279 it does not extend beyond the shoulders. No. 12277 shows an intermediate condition between these two extremes.

Distribution.—Coastal area of Madagascar north of the Bay of Antongil.

[1] Young skulls and those inserted within the skins are not measured.

Lemur macaco Linnaeus

1766. *Lemur macaco,* Linnaeus, *Syst. Nat.* I, p. 34 (Madagascar).

Material—

6789	♂	Skin	W. Rutledge.
10557	♀	Do.	Zool. Gardens, Calcutta (26-10-1917).
10558	♂	Do.	Zool. Gardens, Calcutta (21-9-1914).
12273	♂	Do.	Purchased (29-11-1879).
12274 (I.M. 76b).	♂	Skin and skull without lower jaw.	Rajendar Mullick (1864).
12275 (I.M. 76c).	♂	Skin	Purchased (27-11-1879).
12285	♂	Skin (damaged) and skull.	Zool. Gardens, Calcutta (1-9-1914).

Measurements—
Skins—

Z. S. I. Reg. Nos.	*hb*	*t*	*hf*	*e*
10557	475	..	100	37·5
10558	469	515	107·5	25

Skull No. 12285.—*l*, 94·5 ; *cb*, 86·5 ; *ow*, 53·5 ; *mw*, 18·5 ; *ml* 64·2.

Remarks.—The ventral surface is slightly paler than the dorsal surface in the males also. In the female the forelimbs are much paler than the neck and the hind limbs. The tail is well-suffused with orange especially towards the tip. The toes are blackish only towards their distal ends. There are no red suffusions on the occiput. The base of the tail is yellowish with an orange tinge (*cf*. Hill, 1953, p. 402). In the skull No. 12285 there are large bony tumours on the anterior ends of the premaxillae, the maxillae and the nasals (Pl. II, figs. 1 and 2). This has been diagnosed by Prof. S. K. Bose of Nil Ratan Sircar Medical College, Calcutta, as a case of exostosis which according to him sometimes occurs in mammals. The left tumour is much larger and is perforated by holes communicating with the sockets of the canine and of the first premolar.

Distribution.—Madagascar : confined to the forested parts of north-west coastal area and to the neighbouring coastal islands, including Nosy bé. Range extends southwards as far as Bay of Bombetoka (Hill, 1953).

Lemur fulvus rufus Audebert

1800. *Lemur rufus,* Audebert, *Hist. Nat. Singes makis,* p. 12, pl. 2 (Madagascar).

Material—

10559	♂	Skin	Zoological Gardens, Calcutta (11-11-1914)

Measurements of the skin.—*hb*, 400 ; *t*, 489 ; *hb*, 100 ; *e*, 31·2.

Remarks.—The following variations are worthy of note. The scrotum is brownish black which colour also spreads towards the root of the tail. The underside is very pale ochraceous buff but with the white predominating. There is a pygal patch of brownish hue. On the dorsal surface the shorter hairs are tipped with white and the longer ones with black. The rufous hue on other parts of the body is on the whole less pronounced (*cf.* Hill, 1953, p. 416).

Distribution.—Along the west coast of Madagascar from the Bay of St. Augustin to the Bay of Narinda, also on whole of the central plateau.

Lemur fulvus albifrons E. Geoffroy

1796. *Lemur albifrons*, E. Geoffroy, *Mag. Encyclop.* I, p. 20 (Madagascar).

Material—

12283 (I.M. 77a).	♂	Skin and damaged skull .	Maharaja of Burdwan (1858).

Remarks.—The description of the specimen closely agrees with that given by Hill (1953, p. 414), but the white also spreads on the throat and the chest. The colour becomes gradually paler towards the rump.

Distribution.—North-eastern Madagascar about as far south as Bay of Antongil.

Lemur fulvus fulvus E. Geoffroy

1812. *Lemur fulvus*, E. Geoffroy, *Annu. Mus. Hist. nat.* XIX, p. 161 (Type locality unknown but probably Tamatave region, East Madagascar).

Material—

10054	♂ .	Skin and skull . .	Zool. Gardens, Calcutta (25-9-1915).
12280 (I.M. 80*b*).	♀ .	Skin and incomplete skull	Maharaja of Burdwan (1858).
12281 (I.M. 80*a*).	♀ . .	Skin (damaged)	Rajindar Mullick (1851).
12292	♂	Skin and skull	....
12293	. .	Do. .	...

Measurements—

Skin No. 10054.—*hb*, 462·5 ; *t*, 535·5 ; *hf*, 77·5 ; *e*, 37·8.
Skull No. 10054.—*l*, 90·7 ; *cb*, 88·5 ; *ow*, 51·7 ; *mw*, 19·0.

Remarks.—No. 10054 is noticeably darker than the other specimens and the spots above the eyes are reddish brown. In No. 12295 the hairs towards the mid-dorsal line are a tint of orange. In No. 12280 the skin of the muzzles has been peeled off, but its colour was described by Blyth[1] (1858) as blackish. The specimen was identified by Anderson (1881) as *L. mongoz* Linn. which was evidently a mistake. No. 12281 has been provisionally identified as the head portion is missing; but according to Anderson (*op. cit.*) the specimen resembled No. 12280 in its characters.

[1] Blyth (*loc. cit.*) described this specimen as *L. flaviventer* Lesson. Anderson *loc. cit.*) refers it as the type of *L. flaviventer* Blyth.

Distribution.—Eastern coastal tracts of Madagascar in the Tamatave idstrict (Hill).

Lemur fulvus collaris E. Geoffroy

1812. *Lemur collaris*, E. Geoffroy, *Annu. Mus. Hist. nat.* XIX, p. 161 (Madagascar).

Material—

12290 (I.M. 78a).	♂	Skin and skull	W. Rutledge (27-8-1880).
12291	♂	Skin	Zool. Gardens, Calcutta (15-11-1881).

Measurements of the skull No. 12290.—*l*, 88·5; *cb*, 79·4; *ow*, 47·0; *mw*, 17·2; *ml*, 58·1.

Remarks.—In No. 12290 the general effect of the colour is brownish. The individual hairs are greyish brown with a very pale orange band. The tips of the hairs are also pale orange (*cf.* Hill, 1953, p. 416), but the onger and coarser hairs are mostly black. The other specimen (No. 12291) is more brightly coloured but the outside of the arms are quite dark. In No. 12290 the spots above the eyes are reddish brown. The colour towards the dorsal median line is darker but there is no well-defined stripe. The top of the head in No. 12290 is much darker than in No. 12291. The pygal patch in No. 12290 is reddish brown but in the other specimen it is not so clearly defined. The under parts in both the specimens are yellowish buff.

Distribution.—Eastern coastal tract of Madagascar south of the area occupied by the nominate race (Hill).

Lemur fulvus E. Geoffroy (subsp. ?)

Material—

10956	♂	Skin (exhibited)	Zool. Gardens, Calcutta (28-3-1932).
12288 (I.M. 80c).	♀	Skin	W. Rutledge (11-10-1880).
12289 young (I.M. 80e).	♂	Skin and skull	Do. (17-8-1880).

Remarks.—These specimens were identified by Anderson (1881, p. 93) as *L. mongoz* Linn. but they lack the white muzzle which is characteristic of that species. The colour of the muzzle in No. 12288 is blackish with a tinge of red. The cheeks are not differentiated from the general colour of the head where the individual hairs are greyish with white tips. There is a predominance of orange rufous over the whole of the dorsal surface behind the neck and over the tail. The under parts including the throat and inner side of the limbs are dirty white or yellowish. The hands and the feet are brownish with reddish tinge.

No. 12289 differs from the preceding specimen in having the muzzle and the top of the head entirely black and also in the presence of less red in the pelage except on the hands and the feet. No. 10956 is bright orange all over. The individual hairs are provided with grey bases and orange tips, but they are interspersed with some longer black-tipped hairs as usual. The hairs on the ventral surface have paler bases. The pinnae and the areas below the ears are provided with noticeably long hairs which are Hay's Russet (Ridgway, 1912, pl. XIV) in colour. This coloration also spreads over the forehead but the top and the back of the head are black. The areas just above the eyes are orange, but are less bright than the adjoining areas. The muzzle as usual is black and is joined by a narrow streak of the same colour with the black crown. The hands and the feet are much darker than the arms and the legs. The tail towards its distal end is especially long-haired and gradually darkens towards the tip. The specimen appears to represent an important variation of some race of *L. fulvus*, possibly *L. f collaris.*

Lemur [?] **fulvus** E. Geoffroy

Material—

12284 . .	Skull . . .	Zool. Gardens, Calcutta (21-9-1914).
12286 . .	Do. . .	....

Measurements of the skulls—

Z. S. I. Reg. Nos.	*l*	*cb*	*ow*	*mw*	*ml*
12284. . .	91·5	85·1	54·4	18·5	..
12286.	91·8	85·6	53·5	19·0	..

Remarks.—The specimens have been identified according to the key provided by Hill (1953, p. 388), but as the skins are not available the identification is provisional.

Lemur mongoz mongoz Linnaeus

1766. *Lemur mongoz*, Linnaeus, *Syst. nat.* 12 ed., I, p. 44 (Probably Anjouan Island).

Material—

12282 (I.M. 80*d*).	♂ . .	Skin and skull	, Purchased (4-12-1880).

Measurements of the skull.—*l*, 75·2 ; *cb*, 67·0 ; *ow*, 44·4 ; *mw*, 16·7 ; *ml*, 48·7

Remarks.—The following differences from Hill's description have been noted. The red of the cheeks spreads as light orange over whole of the head, the neck, and the shoulders. The individual hairs of these areas are dark grey at the base with an orange subterminal band. On the rest of the back and the limbs the subterminal band is whitish though the orange tint is still slightly visible here and there. A patch near the root of the tail is brownish. The under parts are yellowish without any greyish band across the chest.

Distribution.—Anjouan and Mohéli in Comoro Islands but not in Mayotte. Mainland of Madagascar along the south bank of the Betsiboka River upto its headwaters at least as far as on the plateau as Ambatondrazaka, Sihanaka country (Hill).

Lemur mongoz Linnaeus (subsp. ?)

Material—

12360 (I.M. 79*a*).	♂	Skull	Zool. Gardens, Calcutta (28-10-1879).

Measurements of the skull.—*l*, 88·2; *cb*, 78·2; *ow*, 19·4; *ml*, 57·8.

Remarks.—The specimen seems to resemble *L. m. coronatus* Gray in its size and in the development of palatine air sinuses. The cranial bones are thick and heavy showing pathological condition.

Lemur [?] **rubriventer** [1] I. Geoffroy

1850. *Lemur rubriventer*, I. Geoffroy, *Compt. Rend.* XXXI, p. 876 (Madagascar)

Material—

12287	♂	Skull	Zool. Gardens, Calcutta.

Measurements of the skull No. 12287.—*l*, 86·6; *cb*, 79·0; *ow*, 49·5; *mw*, 18·2; *ml*, 60·0.

Remarks.—The specimen has been identified according to the key provided by Hill (1953, p. 388). As the skin is not available the identification is provisional.

Distribution.—Greater part of Madagascar.

Family INDRIIDAE

Propithecus diadema diadema Bennett

1832. *Propithecus diadema*; Bennet, *Proc. zool. Soc. Lond.* p. 20 (Madagascar).

Material—

10564 (I.M. 81*b*).	♀	Damaged skin and skull	Purchased (21-1-1879).
12269 (I.M. 81*a*).	Ad.	Skin and skull	British Museum, Exchange (6-1-1879).

Remarks.—The specimens closely agree with the description given by Hill (1953, p. 569) except that the back of the head does not match with the shoulders, extensor surface of the arms, and the sides of the body, and is much darker than these parts. Also, the tail in No. 12269 (in No. 10564, it is missing) is uniformly creamy and is not paler in the middle. No. 10564 is much darker than No. 12269.

Distribution.—Madagascar, eastern coastal belt from the Bay of Antongil southwards to Masora River extending inland in suitable country as far as the capital or little beyond (Hill).

[1] It is not clear why this lemur has been distinguished by Shwarz (1931*b*) and Hill (1953) from *L. fulvus* and *L. mongoz* by the ear being hairy both on the inner and on the outer sides. I find that at least in those forms of *L. fulvus* and *L. mongoz* which are present in this collection the pinnae are hairy on both sides.

Super-family DAUBENTONOIDEA [1]

Family DAUBENTONIIDAE

Daubentonia madagascariensis (Gmelin)

1788. *Sciurus madagascariensis*, Gmelin, *Syst. at.* 13 ed., I, p. 152 (North-Western Madagascar).

Material—

7612	♂	Skin and skull (exhibited)	Madagascar. Purchased from E. Gerard.

Remarks.—Some differences from the description of the pelage given by Elliot (1913, p. 1) and Hill (1953, p. 697) have been noted. The general colour may be described as dark reddish brown with the white showing here and there. Many long hairs on the neck, the shoulders and the back are white-tipped. Mostly, the individual hair has two kinds of bands, a dark reddish brown and a paler. These bands vary much in their extent and intensity of colour. Some hairs are either reddish brown or yellowish white.

Distribution.—North-west of Madagascar and in the eastern Madagascar from the Bay of Antongil to Mahanoro.

Infraorder LORISIFORMES

Family LORISIDAE

Loris tardigradus lydekkerianus Cabrera

1908. *Loris lydekkerianus*, Cabrera, *Bol. Soc. Exp. Hist. nat. Madrid*, p. 139 (Madras, India).

Material—

10786♂, 10787♂ . .	Skins and skulls . .	Chettiri Range, Salem District, Madras, 4 to 9-6-1929. N. A. Baptista.
12233 S. ad. ♂, 12234♀, 12235♂.	Skins and skulls .	Malur, Kolar Dist., East Mysore, 2,200′, 12-10-1912. G. C. Shortridge.
12236 .	Skin and skull .	Nundidroog, N. W. Kolar District, East Mysore, 3,000′, 20-10-1912. G. C. Shortridge.

Measurements—

Skulls.—2♂ from Chettiri Range : *l*, 51·4-52·4 ; *cb*, 47·4-48·5 ; *ow*, 30·5-31·5 ; *mw* 8·8-10·0 ; *ml*, 29·1-30·2.

1♂ from Kolar District : *l*, 51·2 ; *cb*, 45·6 ; *ow*, 31·5 ; *mw*, 10·1 ; *ml*, 28·8.

1♀ from Kolar District : *l*, 50·4 ; *cb*, 45·6 0 ; *ow*, 27·7 ; *mw*, 9·4 ; *ml*, 27·2.

1 unsexed ad. from Kolar District : *l*, 49·1 ; *cb* (broken) ; *ow*, 28·4 ; *mw*, 9·8 ; *ml*, 26·7.

Skins.—2♂ from Chettiri Range : *hb*, 222-240 ; *hf*, 46-50 ; *e*, 30.

1♂ from Kolar District : *hb*, 250 ; *hf*, 53 ; *e*, 30.

1♀ from Kolar District : *hb*, 202 ; *hf*, 48 ; *e*, 28.

[1] The dental formula for this group as given by Forbes (1894, p. 15) and Hill (1953) p. 677) is I, 1/1 ; C, 0/0 ; P, 1/0 ; M, 3/3 ; but Schwarz (1931*b*, p. 400) gives the formula as I, 3/0 ; C, 1/1 ; P, 4/0 ; M .1.2.3/1.2.3 which is evidently an error.

Remarks.—The two skins from Chettiri range are markedly different in colour from the other skins, being clearly tinged with pale buff in the dorsal pelage. Out of the three specimens from the same locality in the collection of the British Museum, one was described by Pocock (1939, p. 178) as having the same colour as the skins just mentioned. Thus three out of the five specimens collected from Chettiri range resemble the Malabar race *L.t. malabaricus*. Apparently the species is unstable in this area. There is no indication of the darker median line on the foreback as described by Pocock (*op. cit.*).

Distribution.—The Eastern Ghats extending westward to Mangalore and Mysore.

Loris tardigradus (Linnaeus) (subsp. ?)

1758. *Lemur tardigradus*, Linnaeus, *Syst. nat.* ed. 10, p. 29 ('Ceylon ').

Material—

6770		Skin and skull	Ceylon. Colombo Museum.
10569	♂	Do.	Zool. Gardens, Calcutta (21-2-1919).
10570	♂	Skin	Zool. Gardens, Calcutta (12-2-1919).
10734	♂	Skin and skull	Madras ? Purchased (29-11-1929).
12237		Incomplete skeleton	W. Elliot (1843 ?).
12238	♂	In spirit	Zool. Gardens, Calcutta (18-6-1914).
12239	♂	Do.	Zool. Gardens, Calcutta (19-11-1914).
12240	♂	In spirit	Zool. Gardens, Calcutta (28-5-1914).
12241	♀		
12242	S. ad.	Skin	Medical College, Calcutta (1844).
12243 (I.M. 84*e*)	S. ad.	Imperfect skin and skeleton	Shan States, J. Anderson (1870).
12260, 12261, 12262, 12263	(♀).	Parts of skins and skulls	Zool. Gardens Calcutta (Nov., 1915).
12296		Skull (damaged)	
12365 (I.M. 84*g*).	♂	Incomplete skeleton	W. Rutledge (21-7-1876).

Measurements—

Skins—

Z. S. I. Reg. Nos.	*hb*	*hf*	*e*
10569	240	50	25
10570	237	50	1

Skulls—

Z. S. I. Reg. Nos.	*l*	*cb*	*ow*	*mw*	*m.*
10569.	48·8	46·2	32·0	9·0	28·0
12260.	50·2	46·9	31·8	9·1	28·5
12261.	46·7	41·6	27·9	8·9	24·8
12262.	48·8	44·5	32·4	9·3	27·1
12263.	50·9	47·1	32·5	9·5	28·5

Remarks.—No. 12243 was identified by Anderson (1881, p. 98) as *L. gracilis* Geoffroy St. Hillaire which is a synonym of *L. tardigradus* (Linnaeus). The latter, and in fact the whole of the genus *Loris*, is considered at present to be confined to South India and Ceylon only. While giving Shan States as the locality of this specimen Anderson (*loc. cit.*) stated that the specimen along with another was purchased in Rangoon from a Shan who said that he had obtained them in Shan States. Although the possibility of a wrong information about the locality is not ruled out, yet the chances of a Shan or any one else obtaining specimens from South India or Ceylon and selling them in Rangoon were also very remote in 1870. The specimen cannot be identified very accurately because only a part of the skin is available. It was described by Anderson (*loc. cit.*) as shorter-limbed and with smaller orbits and narrower and more pointed muzzle than the animals from Ceylon and India (Pl. II, figs. 3 and 4). If the locality is taken as correct, there are two possibilities : (1) an undescribed form of *Loris* may be occurring in the Eastern Shan States—an interesting case in support of Hora's Satpura Hypothesis (Hora, 1944) ; (2) The specimen may be a *Nycticebus pygmaeus* Bonhote which is a very interesting border-line form between *Loris* and *Nycticebus*, resembling the former in important cranial and dental characters and even in the absence of the spinal stripe in some specimens. In fact the only important character in which the present specimen differs from *N. pygmaeus* is the presence of sub-equal upper incisors (Pl. II , fig. 3). Although nothing is on record regarding the character of the upper incisors in *N pygmaeus*, yet in the figure published by Bonhote (1907) the inner upper incisor is shown to be appreciably larger than the outer one.

The range of *N. pygmaeus* is now considered to include Laos, Cochin China and Tonkin, and thus very much approach the locality of the present specimen. The tail appears to be absent in the present specimen but this is also true in some specimens of *Nycticebus* (*vide* Hill, 1953).

Nycticebus coucong coucong (Boddaert)

1785. *Tardigradus coucong*, Boddaert, *Elench. Anim.* p. 67 (Java according to Thomas and Malacca according to Chasen).

Material—

5239	♀	. Skin and skull .	Padan, Mergui, 13-2 1881. J. Anderson.
12247, (I.M. 83*m*) ♂ ; 12248, (I.M. 83*n*) Adol.		Skins . . .	Malacca. F. W. Lindstedt (1846).

12258 (I.M. 83s).	♂ .	Skin and skull .	Penang. Zool. Gardens, Calcutta (26-5-1877).

Measurements of the skull No. 12258.—*l*, 59·7 ; *cb*, 57·9 ; *ow*, 38·2 ; *mw*, 13·5 ; *ml*, 2.

Remarks.—In all the specimens the facial mask is not so distinct as in a specimen of *javanicus* in this collection. No. 12248 is much paler than the other specimens and appears to approach *N. c. bengalensis*, but this is probably due to the imminence of moult. In Nos. 5239 and 12258 the spinal stripe is much broader and darker on the shoulders.

Distribution.—Java ?, Sumatra, Malaya and Mergui Archipelago.

Nycticebus coucong bengalensis (Lacépède)

1800. *Loris bengalensis*, Lacépède, *Tabl. Mam. Oies.* 2nd ed., p. 68 (Bengal).

Material—

7730	.	Foetus in spirit	Chittagong, East Pakistan. B. B. Osmaton.
12244 (I.M. 83a).	♀ .	Skin . .	Tippera, East Pakistan. F. Skipwith (1846).
12245 (I.M. 83c).	Ad. .	Skin and skull	Tippera, East Pakistan. A. Grote (28-7-1864).
12246 (I.M. 83b).	Young	Do. .	Tippera, East Pakistan. F. Skipwith (1846).
12256 (I.M. 83h).	♂ .	In spirit .	Dhubri, Goalpara District, Assam. P. R. Chowdary (17-8-1867).
12257 (I.M. 83i).	♂ .	Do. .	Bhamo, Upper Burma. J. Anderson [2nd Exped. W. China (1875)].
12356 (I.M. 83j).	♂	Skeleton .	Dhubri, Goalpara Dist., Assam. P. R. Chowdary (5-7-1868).

Measurements of the skull No. 12356.—*l*, 66·9 ; *cb*, 64·2 ; *ow*, 41·1 ; *mw*, 15·5.

Remarks.—The colour of the specimens has appreciably faded away on account of long exposure during exhibition in the Museum Galleries or due to the action of the preservative, but still close approximation to the characteristic colour pattern is visible. The young one No. 12246 is in full coat with somewhat indistinct spinal stripe. It is also provided with a single pair of upper incisors.

Distribution.—From Assam in the west to Annam in the East.

Nycticebus coucong javanicus E. Geoffroy

1812. *Nycticebus javanicus*, E. Geoffroy, *Annu. Mus. Hist. nat.* XIX, p. 164 (Java).

Material—

12249 . (I.M. 83gg)		Skin	Java. Batavian Society (1845).
12359 (I.M. 83k)	Ad.	Skull without lower jaw	Do.

Measurements of the skull No. 12359.—*l*, 64·5 ; *cb*, 61·8 ; *ow*, 40·8 ; *mw*, 13·7.

Remarks.—Anderson (1881, p. 97) did not assign any locality to this specimen but Blyth (1863, p. 18) stated that it came from Java. Although Pocock (1939, p. 171) opined that *N. c. javanicus* may be the same as the nominate race, yet the subsequent workers like Chasen (1940) and Hill (1953) are undecided upon this issue. The present specimen closely agrees with the characters assigned to *N.c. javanicus* by Stone and Rehn (1902) and Lyon (1907).

Distribution.—Java.

Nycticebus coucong (subsp. ?)

Material—

7673		Skin and skull	A. S. R. Anderson.
7712	♂	Do.	W. Rutledge.
12250 (I. M. 83*q*).	Young ♂	Do.	Do. (12-3-1870).
12251 (I.M. 83*t*).	Adol. ♀	Skin	Do. (13-1-1873).
12252 (I.M. 83*o*).	Adol.	Do.	Mr. Bell (1857).
12253	♂	In spirit	Zool. Gardens, Calcutta (10-7-1915).
12254	♂	Viscera in spirit	? Burma. W. Rutledge or O. Blight.
12255	♂	In spirit	Zool. Gardens, Calcutta (7-11-1914).
12259		Skeleton	W. Rutledge (18-6-1879).
12264	♀	Skin (incomplete) and skull.	Zool. Gardens, Calcutta (4-10-1915).
12265		Skull without lower jaw.	
12294	♂	In spirit	No history.
12295	♀	In spirit	No history.
12297 (I.M. 83*ff*)	Ad.	Skeleton	Do.
12349 (I.M. 83*x*)	♂	Do.	W. Rutledge (8-9-1876).
12350 (I.M. 83*w*)	Adol.♀	Do.	Do. (22-3-1876).
12351 (I.M. 83*y*)	Ad.	Do.	J. Anderson (1-12-1872).
12352 (I.M. 83*aa*)	♂	Do.	Do. (7-7-1853).
12353 (I.M. 83*v*)	♂	Do.	W. Rutledge (22-11-1875).
12354 (I.M. 83*u*).	♂	Do.	Do. (13-2-1875).
12355 (I.M. 83*bb*)		Do.	Do. (1-2-1875).
12357 (I.M. 83*z*)		Do.	J. Anderson (1-12-1872).

Measurements of skulls—

Z. S. I. Reg. Nos.	*l*	*cb*	*ow*	*mw*	*ml*
12259 .	56·9	54·8	36·6	12·1	35·0
12264 .	54·4	52·8	36·5	12·3	36·0
12265	65·8	53·8	36·8	12·1	..
12297 .	63·8	61·5	40·9	13·8	41·0
12349	57·4	54·5	34·4	12·5	36·7
12350	56·2	53·8	36·2	12·5	37·2
12351 .	57·2	54·5	36·0	12·0	35·7
12352	62·2	60·4	37·0	12·8	41·8
12353	62·2	59·6	39·1	13·2	40·5
12354	61·5	58·3	37·6	12·2	39·2
12355 .	61·5	57·5	39·5	13·6	41·4
12357	58·0	55·7	38·5	12·0	..

Remarks.—No. 7712 is dirty whitish all over with a well-marked spinal stripe which is nearly black on the foreback, but the head mask is indistinct. In No. 7673 the head mask is quite distinct, almost approaching *N.c. javanicus*. The colour, however, resembles that of *N. c. coucong*. No. 12251 is probably a *N. c. coucong*. Nos. 12250 and 12252 are dismounted specimens from the Museum Galleries and as such have suffered much from foxing. In the spirit preserved specimens also the colour has been much faded away.

In the skulls measured the temporal ridges may be upto 12·8 mm. apart in the middle. The measurements as given above are much smaller than those of *N. c. bengalensis* Lacépède and *N. c. tenasserimensis* Elliot as given by Pocock (1939, p. 173). In No. 12353 there is a supernumerary upper molar on the right side.

Family GALAGIDAE

Galago crassicaudatus E. Geoffroy

1812. *Galago crassicaudatus*, E. Geoffroy, *Annu. Mus. Hist. nat.* XIX, p. 166 (No locality but fixed by Thomas as Quelimane, Mozambique),

Material—

12267 (I.M. 86*a*).	♂	Skin	Earl Northbrook (14-1-1875).

Remarks.—The specimen was identified by Anderson (1881, p. 98) as *G. garnetti* Ogilby which is now considered as a race of *G. crassicaudatus*. According to Schwarz (1931, p. 44) there is a dark tip to the tail in *G. garnetti*, and the general colour is brownish ; but Hill (1953) states that the head and the neck are also darker. None of these characters are present in the present specimen. Since the colour is buffy the specimen appears to approximate to the nominate race.

Distribution.—Confined to savannah tracts in the whole of tropical Africa south of Sahara as far south on the east as Natal and as far inland as Zoutpansberg in Transvaal.

Galago senegalensis E. Geoffroy

1796. *Galago senegalensis*, E. Geoffroy, *Mag. Encyclop.* I, pp. 38-41 (Senegal, French West Africa).

Material—

12266	Skin (exhibited).	No history

Remarks.—The colour of the specimen as far as it can at present be examined is dark grey with longer or shorter paler tips to the hairs except on the tail where the hairs are wholly whitish. There is no interocular whitish stripe and the eyes are not bordered by black as described by Hill (1953, p. 227) in the case of the nominate race.

Distribution.—In savannah country throughout Sudan and East Africa, from Senegal and Gambia to Limpopo, westwards into Angola (Hill).

Galago alleni Waterhouse

1838 (1837). *Galago alleni*, Waterhouse, *Proc. zool. Soc. Lond.* p. 87 (Island of Fernando Po)

Material—

12268	♂ .	In spirit .	. Zool. Gardens, Calcutta (8-10-1882).

Remarks.—Although the measurements of the specimen are not recorded in the fresh state, yet they appear to be much larger than those given by Hill (1953, p. 230). The distal ends of the nails especially on the toes are strongly concave. The penis resembles in form with the figure given by Hill (*op. cit.*) but the number of the spines on each basal plate varies from one to three.

Nothing can be said about the coloration as the specimens has been in spirit for quite a long time.

Distribution.—From the lower Niger, the Ubangi, the Congo, the Gulf of Guinea and the Island of Fernando Po (West Africa).

Suborder TARSIOIDEA

Family TARSIIDAE

Tarsius tarsier borneanus Elliot

1910. *Tarsius borneanus*, Elliot, *Bull. Amer. Mus. nat. Hist.* XXVIII, p. 153 (Sandak River, Dutch West Borneo).

Material—

7603	In spirit .	Borneo. Purchased (E. Gerard).

Remarks.—Chasen (1940) described this race as very richly coloured and showing rufous and golden buff on upper parts. As these colours are not now visible on account of the action of the preservative, the identification should be taken as provisional.

Distribution.—Borneo.

Suborder ANTHROPOIDEA

Infraorder PLATYRRHINE[1]

Family CEBIDAE

Subfamily *AOTINAE*

Aotus trivirgatus nigriceps Dollman

1909. *Aotus nigriceps*, Dollman, *Ann. Mag. nat. Hist.* (8) LV, p, 200 (Chanchamayo, Peru).

Material—

7617		Skin (exhibited)	Peru. Purchased (E. Gerard, 18-3-1898).

Remarks.—The hairs on the dorsal surface are banded with buff and blackish but the bases are brownish. The ventral side of the root of the tail is liver brown. There are white spots over the eye but they do not extend backward and then curve inward to meet at the occiput as described by Elliot (1913, p. 8). Also, the colour is not the darkest on the mid-dorsal line with hairs tipped with reddish brown as described by him.

Distribution.—Peruvian Andes.

Aotus trivirgatus Humboldt (subsp. ?)

1812 (1811). *Simia trivirgata*, Humboldt, *Rec. Observ. Zool.* I, p. 28 (Cassiquare).

Material—

12299 (I.M. 63*a*)	♀	In spirit	W. Rutledge (16-9-1880).

Remarks.—The specimen was identified by Anderson (1881, p. 85) as *Nyctipithecus* (=*Aotus*) *felinus* Spix and by Elliot (1913, p. 5) as *Aotus infulnatus* (Kuhl). Both these names are considered by Hershkovitz (1949, p. 401) as synonyms of the present species which, according to him, is the sole representative of the genus *Aotus*.

The colour is much faded away on account of the action of the preservative. The hairs are annulated with whitish and brownish bands. The underparts and the eyespots are yellowish. The three head stripes just reach the top of the head. The tail has got an orange wash especially on the ventral side of its root.

Subfamily *PITHECINAE*[2]

Pithecia[3] pithecia (Linnaeus)

1766. *Simia pithecia*, Linnaeus, *Syst. Nat.* I, p. 40 (Guiana).

Material—

10550 (I.M. 64*a*)	♀	Skin and skull	Eriquito River, British Guinea. Exchange (21-1-1879).

Remarks.—The hairs are banded brownish black and whitish. The hairs on the side of the muzzle, the lips, and the chin are yellowish.

Distribution.—Interior of Demerara, French Guiana and the region of the Rio Negro and the Rio Branco, Brazil (Elliot).

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[1] At the time when infraordinal rank for this group was proposed by me (Khajuria, 1953), I was unaware of similar views of Romer (1949) independently arrived at.

[2] The specimens are identified according to Elliot (1913).

[3] Placed on *the official list of the generic names in Zoology* (Opinion 122); but see Miranda Ribeirio (1941, p. 800).

Chiropotes satanus (Hoffmannsegg)

1807. *Simia satanas*, Hoffmannsegg, *Mag. Ges. Nat. Freunde, Berlin*, X, p. 93 (Cameta, on the right bank of the Rio Tocantins near its mouth, Brazil).

Material—

12298 (I.M.65a)	. . ♂	.	In spirit . .	W. Rutledge (13-8-1879.)

Remarks.—As the specimen is preserved in spirit the true nature of its colour pattern cannot be judged. It is being retained in this form under the authority of Anderson (1881, p. 86).

Distribution.—British Guiana, forests near Para, Lower Amazon banks of the Rio Orinoco, the Rio Tocantins, the Rio Negro, Brazil (Elliot).

Subfamily *ALOUATTINAE*[1]

Alouatta villosus (Gray)

1845. *Mycetes villosus*, Gray, *Ann., Mag. nat. Hist.* XVI, p. 220 (Guatemala).

Material—

10549 (I.M. 55a)	. . ♀	Skin and skull . . .	Panama. By Exchange (21-1-1879).

Remarks.—The specimen was identified by Anderson (1881, p. 83) as *Mycetes palliatus* Gray; but on the basis of the description given by Elliot (1913), it is diffcult to agree with Anderson. Locality of the specimen, however, does fall within the range of *A. palliatus*. The specimen agrees well with the description of *A. villosus* as given by Elliot (*op. cit.*, p. 268). The entire colour is jet black with a slight brownish tinge on the underside. Some silvery hairs are found along the lateral parts of the body especially along the left side. Some similar hairs are also found along the back but are totally hidden by the black hairs. Bases of the black hairs are slightly paler.

Distribution.—Eastern and north-eastern Guatemala, Honduras and upto ? Panama (Elliot).

Alouatta ursina Humboldt

1815. *Simia (Stentor) ursina*, Humboldt, *Rec. Obs. Zool.* I, p. 355, pl. 30 (Venezuela).

Material—

10547 (I.M.53a)	♂	Skin and skull	Brazil. Exchange (21-1 1879).

Remarks.—There is no dorsal line darker than the flanks as described by Elliot (*op. cit.*, p. 274). The dorsal surface including the head is yellowish. The individual hairs are banded yellow and brownish but the yellow predominates.

Distribution.—Venezuela, districts of Brazil from Espirito Sant to Bahia, Peru (Elliot).

[1] The forms included under this group are identified according to Elliot (1913). No better revisionary work based on the skin characters appears to be available.

Alouatta seniculus (Linnaeus)

1766. *Simia seniculus*, Linnaeus, *Syst. Nat.* I, p. 37 (Cartagena, Columbia).

Material—

10548 (I. M. 54*a*)	♀	Skin and skull	Exchange (21-1-1879).

Remarks.—The back is golden yellow and is much contrasted against the head, the neck, the shoulders, the arms, the legs, and the tail which are chestnut brown. The under surface is sparsely haired. The tip of the tail is paler.

Distribution.—Columbia and forests between Rio Negro and Solimoes, Rio Madeira, and Brazil (Elliot).

Subfamily *CEBINAE*

Cebus[1] **capucinus** (Linnaeus)

1758 (nec. 1766). *Simia capucina*, Linnaeus, *Syst. Nat.* ed. 10, p. 29 [Type locality unknown but fixed by Goldman (1914, p. 99) as 'Northern Columbia'].

Material—

10544	Young ♂	Skin	Zool. Gardens, Calcutta (27-11-1911).
10536 (I.M 62*a*)	♂	Skin and skull	Exchange (21-1-1879).
11965 (I.M.62*b*)	Adol. ♀	Do.	Purchased (16-12-1878).
11979 (I.M. 62*d*)	Young ♂	Do.	Do. (27-11-1879).
12320 (I.M. 62*c*)	Young ♂	Skin and incomplete skeleton.	Do. (23-12-1879).
12321	Young ♂	In spirit	W. Rutledge (27-1-1879).
12322	Young ♂	Do.	Do. (19-5-1881).
12358 (I.M. 61*a*)	♂	Skeleton (incomplete)	Zool. Gardens, Calcutta (15-10-1880).

Measurements of the skull No. 12358.—*l*, 90·5 ; *cb*, 69·0 ; *zw*, 61·5 ; *ow*, 43·0 ; *mw*, 25·5 ; c^1m^3 26·8 ; *ml*, 58·6.

Remarks.—The specimens are identified according to Hershkovitz (1949). The races of this species are little understood and those mentioned by Hershkovitz are not diagnosed by him. The colour of the darker parts varies from black to brownish black with a tinge of red. The paler parts vary from buff to chamois (Ridgway, 1912, pl. XXX). In No. 10544 the hairs of the anterior border of the black crown cap appear to be erect. In No. 11965 the hairs of the pale band on the forehead are divided into two horn-like groups of hairs. The hairs of the dark crown cap radiate from a whorl. The spirit preserved specimens have been provisionally identified as their colour has mostly been bleached by the preservative.

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[1]Placed on the *Official list of generic names in Zoology* (Opinion 91), but see Miranda Ribeirio (1941, p. 829).

Nos. 10546, 11965, 11979, and 12320 were identified by Anderson (1881, p. 85) as *C. hypoleucus* Humboldt. This was evidently due to the great confusion which existed regarding the identity of *C. hypoleucus* and *C. capucinus* in those days.

Distribution.—From Honduras south into Western Columbia and Western Equador (Hershkovitz).

Cebus albifrons Humboldt

1812 (1811). *Simia albifrons*, Humboldt, *Rec. Obs. Zool.* I, pp. 324-356 (No locality).

Material—

10545 (I.M. 60*a*)	♂	Skin	Exchange (21-1-1879).
12323	♂?	Skin and skull	Zool. Gardens, Calcutta (3-6-1913).

Measurements of the skull No. 12323.—*l*, 93·5 ; *cb*, 67·5 ; *zw*, 55·3 ; *ow*, 43·1 ; *mw*, 26·8 ; c^1m^3, 28·0 ; *ml*, 55·2.

Remarks.—For want of localities the correct subspecific identification is not possible. No. 10545 was identified by Anderson as *C. flavus* (Schreber) which is now considered as unidentifiable. In this specimen the colour is snuff brown (Ridgway, 1912, pl. XXIX) all over the upper surface and on the external surface of the legs becoming darker on the tail and still darker on the crown. On the outer surface of the arms it is much paler. The upper surfaces of the hands and the feet are somewhat darker than the adjoining parts. On the other parts of the body the colour is buff or brownish buff. The dark crown cap is pointed in front and projects into the pale forehead area. No. 12323 is much paler all over the body than No. 10545, with the tail not darker than the back.

Distribution.—Undefined.

Cebus apella (Linnaeus)

1754. *Simia apella*, Linnaeus, *Mus. Reg. Ad. Fred.* p. 3, pl. 1 (Surinam or Dutch Guiana).

Material—

12324	♂	Skin and skull	Zool. Gardens Calcutta (2-5-1910).
12325	♂	Do. (exhibited)	....

Measurements—

Skin No. 12324 : *hb*, 412·5 ; *t*, 475 ; *hf*, 125 ; *e*, 37·5.

Skull No. 12324 ; *l*, 99·3 ; *cb*, 77·0 ; *zw*, 60·4 ; *ow*, 43·2 ; *mw*, 30·5 ; c^1m^3, 29·2 ; *ml*, 63·5.

Remarks.—Tate (1939) and Hershkovitz (1949) have suggested that probably only one species of the tufted cebus is recognizable and that the oldest name for this species is *C. apella* (Linnaeus). The number and diagnostic characters of the subspecies under this species have, however, yet to be ascertained.

In No. 12324 the back is walnut brown (Ridgway, 1912, pl. XXVIII) becoming darker on the shoulders, the arms, the thighs and the base of the tail, but the bases of the hairs are whitish. Towards the distal half, the tail is covered with black and white hairs. A notable feature of the specimen is the presence of the patches of white hairs on the left side of the back, the arms, the legs, and on the tail. The ventral side is sparsely haired with white hairs on the belly, the chest, and the throat (behind the black beard). On the chest the white and the reddish brown hairs are mixed up. On the inner surface of the legs and the arms, there is a mixing up of the white and the black hairs. The ventral side of the root of the tail is reddish. The tuft on the crown is in the form of a longitudinal crest formed by inwardly directed hairs from the forepart of the crown. There is a whorl on the right side of this crest. Behind this tuft there is also a transverse crest of hairs.

No. 12325 mainly differs from the preceding specimen in being slightly paler and in the absence of white hair patches. The white hairs around the face are also much fewer. On the back the hairs lack the whitish bases on No. 12324. The tufts on the crown in this specimen appears to be absent.

Both the specimens are provided with broad black crown caps with extension on the side of the face meeting on the chin.

Distribution.—Undefined.

Saimiri sciurea (Linnaeus)

1758. *Simia sciurea*, Linnaeous, *Syst. Nat.* I, p. 19 ("India"=South America)

Material—

3691	♂	Skin and skull	British Guiana. Exchange (1878).
7641	Adol. ♂	Do.	Zool. Garden, Calcutta (26-12-1897).
8037		Skin	D. Ezra (31-1-1906).
10960	♀	Skin (exhibited)	Zool. Gardens, Calcutta (19-2-1934).
12316 (I. M. 66c)	♂	Skin, incomplete skeleton and viscera in spirit.	O.L. Fraser (30-10-1878).
12317 (I. M. 66e)	♂	In spirit	W. Rutledge (30-9-1879).
12318 (I.M. 66f)	♂	Do.	Do. (20-5-1879).
12319	♂	Imperfect skin	Do. (19-3-1886).

Remarks.—The specimens agree well with the description given by Lönnberg (1940*a*). In none of the specimens there is a black spot between the eye and the ear. In No. 7641 the crown cap is separated off from the back by a pale band. The colour on the back and the forelegs is also much redder. The specimens can thus be referred to *S.sciurea codajazensis* Lönnberg (1940*a*), but for want of locality no commitment is advisable.

The colour of the spirit-preserved specimens is much faded away. The lips in these specimens are blackened and tips of the tail are reddish-brown. The identification in their cases is tentative.

Distribution.—Northern South America in Venezuela (Schlegel), Guianas (English, Dutch and French), on the Amazon and several of its tributaries ; Santa Fe'de Bogota [I. Geoffroy, quoted by Elliot, 1913)].

Saimiri (?) **madeirae** Thomas

1908. *Saimiri madeirae*, Thomas, *Ann. Mag. nat. Hist.* (8) II, p. 90 (Humayta, Middle Rio Madeira, Amazonas).

Material—

7494	♂ .	Skin and skull	. W. Rutledge (21-12-1896).

Remarks.—Elliot (1913, p. 310) distinguished this species from others by its blue grey head. However, Lönnberg (1940*a*, p. 2) considers the restriction of the ochraceous colour of the hands generally to the wrist as the chief distinguishing character of this species. According to him there is a yellowish tint basally to the hairs of the crown, and the bluish grey may be restricted to the hind limbs only. The present specimen agrees well, with the Lönnberg's description. The grey of the arm is contrasted with the colour of the back. There is a black bar in front of the ear. The bluish tinge is only very faintly visible. In some hairs from the dorsal side, there are two black rings instead of only one as described by Lönnberg (*op. cit.*). As the locality is unknown the identification is provisional.

A study of Lönnberg's account shows that this species and *S. sciurea* (and probably many others) are merely geographical races of one and the same species.

Distribution.—Rio Madeira, the Rio Tapajoz and adjoining areas, Amazonas.

Ateles[1] **paniscus** (Linnaeus)

1758. (*Simia*) *paniscus*, Linnaeus, *Syst. Nat.* ed. 10, I, p. 26 [Brazil but restricted to French Guiana by Kellogg and Goldman (1944)].

Material—

3685 (I.M. 57*a*)	. . ♂ .	Skin (Damaged)	By Exchange (21-1-1879).
10733	♂ .	Skull	. . Zool. Gardens, Calcutta (29-11-1929).

Measurements of the skull.—*l*, 112·0 ; *cb*, 91·3 ; *zw*, 67·2 ; *ow*, 52·2 ; *mw*, 28·9 ; c^1-m^3, 30·9 ; *ml*, 75·2.

Remarks.—It is difficult to decide as to which of the two races recognized by Kellogg and Goldman (1944) of this species the specimen under report may belong. The length of the hair shows it to be *A. p. chamak* (Humboldt) ; but, since the face appears to be flesh-coloured, the specimen can also be referred to the nominate race. The skull is provisionally determined as the skin is not available.

Distribution.—Western Matto Grasso, Eastern Bolivia, and from north-eastern Peru to Carribbean coast of Guianas.

[1] Placed on the *Official list of generic names in Zoology* (Opinion 91) ; but see Miranda Ribeirio (1941, p. 828).

Ateles belzebuth belzebuth E. Geoffroy

1806. *Ateles belzebuth*, E. Geoffroy, *Ann. Mus. Hist. nat. Paris*, VII, p. 272, pl. 16 [Unknown but restricted by Kellogg and Goldman (1944) to Esmeralda, West of the mouth of the Rio Guapo, on the Rio Orinoco and south of Duida, Venezuela].

Material—

3680 (I.M. 59*a*)	♂	Skin	By Exchange (21-1-1879).

Remarks.—The specimen was identified by Anderson (1881, p. 84) as *A. chuva* Schlegel which is now considered as a synonym of the form under report. The specimen agrees well with the description given by Kellogg and Goldman (1944).

Distribution.—Lowlands from near the junction of the Rio Orinoco and the Rio Caura in central Venezuela south to the valley of the Rio Negro, westward to Colombia east of Cordillera Oriental (Mambita), Equador, east of the crest of the Andes and North-eastern Peru (Sarayacu) —Kellogg and Goldman.

Ateles geoffroyi (?) **geoffroyi** (Kuhl)

1820. *Atele(s) geoffroyi*, Kuhl, *Beitr. Zool. Anat.* p. 26 [Type locality unknown but restricted by Kellogg and Goldman (1944) to San Juan del Norte (Greytown), Nicaragua].

Material—

3688 . (I.M. 58*a*)	♀ .	Skin (damaged)	Central America. By Exchange (21-1-1879).

Remarks.—The colour is conspicuous by the absence of the black except on the forehead, the back of the head, the khees, the outer sides of the forearms, the hands and on the feet. The general colour on the back, the arms, the chest, and the belly is a tint of ochraceous buff but slightly redder on the belly. Black hairs are present on the arms especially on the outer side of the forearm. The hairs on the throat and the cheeks and paler. The hairs on the forehead are entirely black. There is a marked darker patch on the back of the head but the bases of the hairs are of the same colour as that of the back.

Distribution.—Coastal region bordering San Juan del Norte or Martina Bay, south eastern Nicaragua. probably ranging across through the low-land to the Pacific coast (Kellogg and Goldman).

Ateles geoffroyi (?) **vellerosus** Gray

1865. *Ateles vellerosus*, Gray, *Proc. zool. Soc. Lond.* p. 73 [Brazil ? but restricted by Kellogg and Goldman (1944) to Mirador, about 15 miles north-east of Huatusco, Veracruz, Mexico, altitude 2,000 ft.].

Meterial—

3689 . (I.M, 58*b*)	. Ad. .	. Skin and skull . . .	By exchange (21-1-1879).

Remarks.—For want of locality the subspecific identification is provisional. The specimen agrees well with the description of *vellerosus* given by Kellogg and Goldman (1944). There is, however, no darkening along the median line of the back. The forwardly directed hairs of the crown prominently project over the forehead and are mixed with some silvery hairs.

Distribution.—Unbroken forests of Veracruz and eastern San Luis Potosi and southeast-ward through Tobasco across the Isthmus of Tehuatepec in eastern Oaxaca, to Honduras and El Salvador, except highlands of Guatemala (Kellogg and Goldman).

Ateles [?] geoffroyi grisescens Gray

1868. *Ateles grisescens*, Gray, *Proc. zool. Soc. Lond.* p. 732 [Type locality unknown but restricted by Kellogg and Goldman (1944) to the Rio Tuyra, southeastern Panama].

Material—

3684 (I.M. 56a)	♀	Skin and skull	Brazil ? By Exchange (21-1-1879).
12300 (I.M. 58c)	Adol. ♂	Skin and viscera in spirit	W. Rutledge (18-8-1878).

Remarks.—The identification of the specimens is tentative. No. 3684 was identified by Anderson (1881) as *Ateles ater* F. Cuv. which is now considered as synonym of *A. paniscus* (Linnaeus). The specimen differs from *A. paniscus* in having white side whiskers and a small partially concealed forehead patch. Also, in addition to black hairs there are many hairs which are either yellowish or silvery with black tips or with black and yellowish annulations. The locality given is Brazil which does not appear to fall within the range of the present form. No. 12300 was referred by Anderson (*op. cit.*) to *Ateles geoffroyi* Kuhl. It differs from No. 3684 in being brownish instead of black and in greater abundance of yellowish or old gold hue (Ridgway, 1912, pl. XVI) in the pelage. In most of the features the specimens agree well with the description of the present form as given by Kellogg and Goldman (1944).

Distribution.—Presumably the valley of the Rio Tuyra and probably south-east-ward through the Serrania del Sapo of extreme southeastern Panama and the Cordillera de Baudo of north-western Colombia (Kellogg and Goldman).

Family CALLITHRICIDAE

Leontocebus rosalia (Linnaeus)

1766. *Simia rosalia*, Linnaeus, *Syst. Nat.* ed. 12, I, p. 41 ("Brazil").

Material—

3695 (I.M. 70a)	Ad.	Skin and skull	By Exchange (21-1-1897).
7662	♂	Do.	Zool. Gardens, Calcutta 29). 11-1898).
10881		Skin (exhibited)	Do.
11966	♂	Skull	W. Rutledge (22-12-1889).
12305	♂	Skin (exhibited)	Do. (3-11-1880).
12361 (I.M. 70b)	♂	Incomplete skeleton	Do. (3-11-1880).
12362	♂	Do.	Exchange (28-5-1880).

Measurements of skulls—

Z.S.I. Reg. No.	*l*	*cb*	*zw*	*ow*	*mw*	c^1-m^2	*ml*
11966	55·0	44·8	34·0	26·7	16·5	15·4	..
12361	54·0	44·8	33·4	27·2	16·7	15·0	36·0
12362	55·9	44·4	..	..	16·1	15·5	35·2

Remarks.—No. 10881 is much paler (pale buff) on the upper surface but perhaps this may be due to long exposure. In No. 12305 the front side of the legs and some areas towards the root of the tail are pale buff and much contrasted with other parts of the body.

Distribution.—Coastal southeastern Brazil (Rio De Janeiro and Sao Paulo).

Subgenus **Tamarin**

Marikina tamarin (Link)

1795. *Cebus tomarin*, Link, in J. E. Gray's *List Mam. Coll. Brit. Mus.* XIV (1843)[1] (Pará).

Material—

12303 (I.M.73*a*)	♂	Skin and incomplete skeleton	W. Rutledge (May, 1879).
1967	♀	Skin and skeleton	Do. (30-8-1882).
12304 (I.M. 73*b*)	♀	In spirit	Do. (14-5-1879).

Measurements of the skull No. 11967.— *l*, 47·3 ; *cb*, 39·8 ; *zw*, ? ; *ow*, 23·2 ; *mw*, c^1-m^2, ? ; *ml*, 31·9.

Remarks.—Hershkovitz (1949) recognized two sub-species but without giving their diagnostic characters. As the localities of the above specimens are unknown, it is not possible to identify them subspecifically.

Distribution.—Lower Amazon, Pará, and near the mouth of the River Tocantins (Hoffmannsegg).

Subgenus **Oedipomidas**

Marikina oedipus Linnaeus

1758. *Simia oedipus*, Linnaeus, *Syst. Nat.* ed. 10, I, p. 28 (America, but restricted by Hershkovitz (1949) to Rio Sinú, department of Bolivar, Colombia).

Material—

3694 (I.M.71*a*)	♂	Skin and skull	By Exchange (21-1-1879).
8040		Skin	D. Ezra (31-1-1906).
12301 (I.M. 71*e*)	♂	Skin	W. Rutledge (28-10-1880).
12302 (I.M. 71*c*)	♂	In spirit	Do. (13-9-1880).
12363	♂	Skeleton	Do. (3-11-1880).
12364	♀	Do.	Do. (13-9-1880).

Measurements of skulls—

Z.S.I. Reg. Nos.	*l*	*cb*	*zw*	*ow*	*mw*	c^1m^2	*ml*
12363	7·8	38·6	30·7	26·0	13·8	12·8	30·3
12364	48·4	38·9	30·9	25·2	13·8	12·5	..

[1]Gray's original work is not available to me. Sherborn gives the reference as follows.—Jacchus (Link), J. E. Gray's *List Mam. coll. B.M.*, 1843, 14,.—*Cebus* 1795. See Hershkovitz (1939) who revived *tamarin* Link to replace *ursula* Geoffroy and *ursula* Hoffmannsegg but without giving the original reference.

Remarks.—In all the specimens the rump and the outer surface of the thighs is mars orange or burnt sienna (Ridgway, 1912, pl. II). No. 8040 is peculiar in the absence of buffy grizzling on the back and in being paler. No. 3694 is redder, the burnt sienna also appearing on the shoulders.

Distribution.—Northern Colombia, from Golfo de Darién Antioquia, east to Rio San Jorge, department of Bolívar, thence north between the coast and the west bank of Rio Magdalena as far as Cartagena and at least the southern portion of the department of Atlantico, may also occur in the area between Rio San Jorge and Cauca (Hershkovitz).

Subgenus **Marikina**

Marikina leucopus Günther.

1876. *Hapale leucopus*, Günther, *Proc. zool. Soc. Lond.* p. 743, pl. 72 (Near Medellin, Antioguia, Columbia).

Material—

3692 (I.M. 72*a*)	♂	Skin and skull	Antioquia, Colombia. Exchange (21-1-1879).
7693	Adol.	Do.	Exchange (21-1-1874).

Remarks.—The specimens agree well with the description given by Hershkovitz (1949). The hands, the feet, and the outer sides of the arms and legs are whitish.

Distribution.—In Columbia from the confluence of Rio Magdalena and Cauca, department of Bolívar, north into the department of Antioquia ; altitudinal range from near sea level to approximately 1,000 meters above. The species does not occur naturally east of Rio Magdalena and west of Rio Cauca (Hershkovitz).

Subgenus **Callithrix**

Callithrix jacchus (Linnaeus)

1758. *Simia jacchus*, Linnaeus, *Syst. Nat.* I, p. 27 (America).

Material—

7675	♀	Skin and skull	Zool. Gardens, Calcutta (10-7-1899).
7676		Do.	? Tiretta Bayeer (10-7-1899).
7747	♂	Do.	Zool. Gardens, Calcutta (14-3-1902).
7773		Do.	W. Rutledge (14-3-1902).
7894, 7900, 7902		Do.	Zool. Gardens, Calcutta (23-12-1903).
8048		Skin	Isle of Marajo, Brazil. W. Rutledge (31-1-1906).
10914	♀	Do. (exhibited)	Zool. Gardens, Calcutta (17-3-1931).
11980 (I.M. 67*j*)	♀	Skin and skull (damaged)	W. Rutledge (9-9-1872).

Material—contd.

12310 (I.M. 67*f*)		♂	Skin and incomplete skeleton	W. Rutledge (5-10-1876).
12311		♀	Skin and skull	Do. (21-6-1898).
12313 (I.M. 67*g*) 12314 (I.M. 67*h*).		Juv.	In spirit	E. Blyth (1851).
12315			Skin (incomplete)	Zool. Gardens, Calcutta (28-10-1916).

Measurements of the skull No. 12310.—*l*, 46·8 ; *cb*, 38·7 ; *zw*, 30·9 ; *ow*, 23·6 ; *mw*, 12·6 ; c^1-m^2, 11·5 ; *ml*, 31·5.

Remarks.—No. 7900 is the darkest of the lot. The top of the head, the neck, and the shoulders are dark brown and this colour extends on the sides of the trunk where it is almost black. No. 8048 is the palest specimen. On the crown and on the neck of this specimen the hairs have almost white bases with brownish tips. The hairs on the rest of the body are provided with nearly white tips. The rest of the specimens are intermediate between these two extremes.

In the juvenile the patch of hairs on the forehead is first to appear.

Distribution.—Island of Marágó, Brazil.

Callithrix penicillata (E. Geoffroy)

1812. *Jacchus penicillatus*, E. Geoffroy, *Ann. Mag. nat. Hist.* XIX, p. 119 (Brazil).

Material—

12308 (I.M. 68*a*)	Adol.	♂	Skin and viscera in spirit.	H. Swaries (15-1-1869).
12309	?	♀	Skin	W. Rutledge (11-11-1884).

Remarks.—No. 12309 is darker on the head and the neck but slightly paler on the other parts than the other specimens. The hairs except on the head and the neck are banded with blackish brown or brown and orange or buff. The intensity of the colour and the extent of the bands are variable on different parts. The belly and the inside of the thighs are brownish.

Distribution.—Provinces of Goyaz, Minas Geraes, and Espirito Santo between 14 and 17 degrees S. lat. Rio Parama in South America (Natterer.)

Subgenus **Cebuella**

Callithrix pygmaeus (Spix)

1823. *Jacchus pygmaeus*, Spix, *Sim. Vespert. Bras.* pl. xxiv, fig. 2 (Tabatinga on the Rio Solimõēns, Brazil).

Material

10977		Skin (exhibited)	Colombia. Purchased from Shibayama Natural Science Laboratory, Japan (5-8-1937).
12307 (I.M. 62*a*)	Ad.	Incomplete skin	By Exchange (21-1-1879).

Remarks.—In No. 12307 the hairs on the back are annulated with blackish brown and pale orange yellow. The intensity and the extent of the two kinds of annulations are variable on different parts. On the forehead and the sides of the face, the basal band is pale orange, and on the rest of the upper side, it is blackish brown. The belly and the inner side of the limbs are buffy but the hairs on the chest and the throat have an orange wash with black tips. No. 10977 is much paler. The tips of the hairs of the head, the neck and the throat are light brown. There is a long conspicuous white subterminal band in the hairs all over the rest of the upper surface giving general whitish colour to the pelage. The cheeks are whitish.

Lönnberg (1940*b*) described *niveiventris* as a race of *C. pygmaeus*. For the want of locality, it is difficult to decide to which of the two races the specimen under notice should be referred to.

Distribution.—Forests along the Solimões and Ucayali rivers, Brazil, north into Mexico (Bates).

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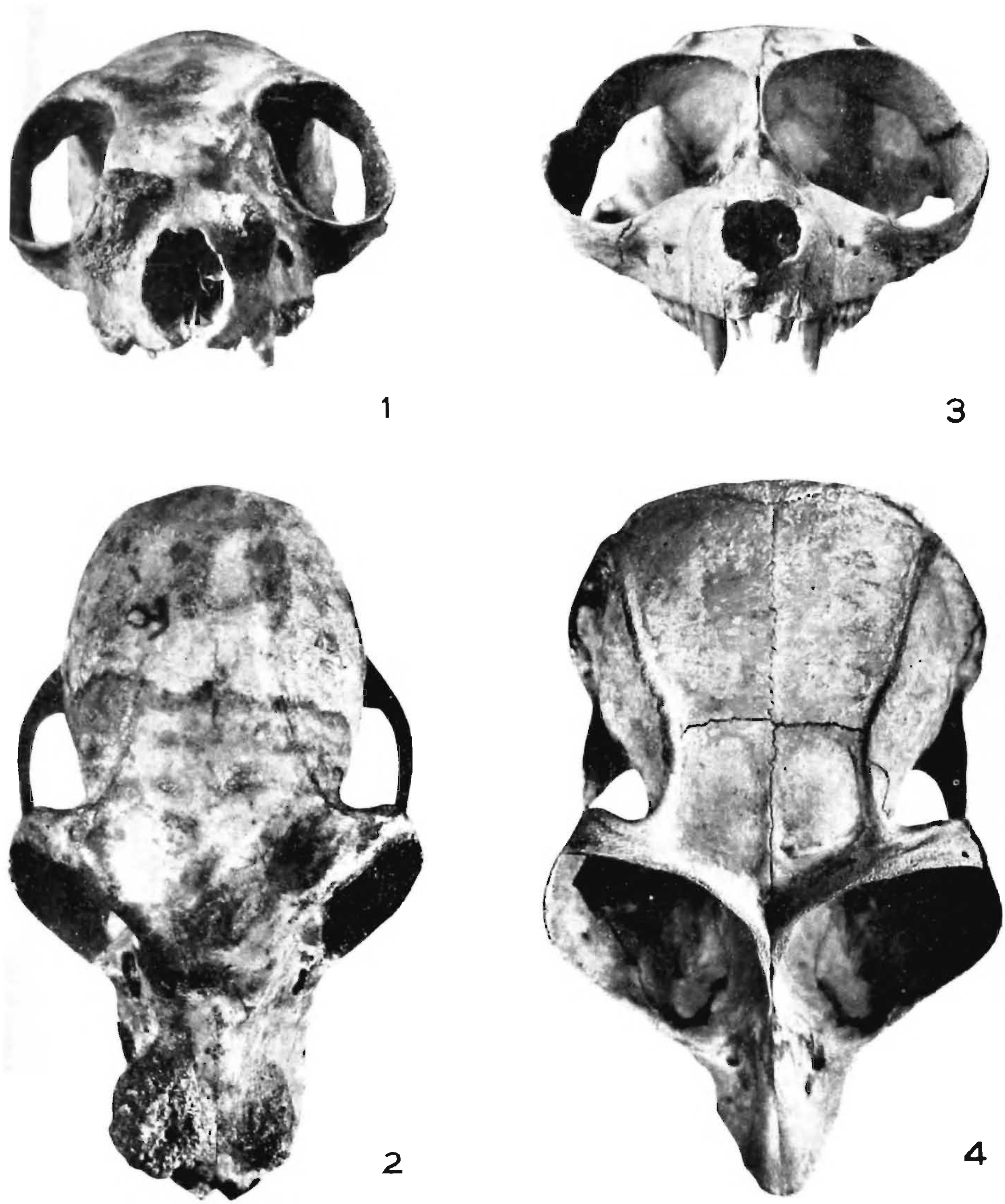
EXPLANATION OF PLATE II

FIGS. 1 & 2.—Dorsal and front views of the skull of *Lemur macaco* Linnaeus showing exostosis, *ca.* x 1.

FIGS. 3 & 4.—Dorsal and front views of skull of *Loris tardigradus* Linnaeus [?] from eastern Shan States, *ca.* x 2.



Skulls of *Lemur* and *Loris*.

ON TWO NEW SPECIES AND A NEW VARIETY OF CRABS (DECAPODA : BRACHYURA) FROM BOMBAY STATE

By B. F. CHHAPGAR, *M.Sc., Taraporevala Marine Biological Research Station, Bombay.*

INTRODUCTION

During the course of study of a collection of crabs from Bombay State, the author came across some forms which, on cursory inspection, could not be identified with hitherto described specimens. A detailed examination, assisted by comparison with allied forms, however, revealed that the forms were new to science. The findings were confirmed by Dr. K. K. Tiwari of the Zoological Survey of India, and Dr. M. W. F. Tweedie of the Raffles Museum, Singapore.

It may here be remarked that the nearest allied forms to the new crabs have not been recorded from the west coast of India. The type species *Leptodius euglyptus* Alcock, of the new variety *Leptodius euglyptus quadrispinosus*, occurs in Galle and Mergui. *Pinnotheres quadratus* Rathbun, which is most nearly allied to *Pinnotheres vicajii*, the new species described here, has as its type locality the Gulf of Siam, where it was first collected by Rathbun[1] in 1910. Tesch[2] (1918) also described it from Labuan in his Siboga Expedition Reports. The species of *Pseudograpsus* so far known to science have been recorded from Japan through the East Indian Seas to New Caledonia and Fiji, Flores, Celebes, Halmaheira, Amboina, the Moluccas, etc. The nearest locality of a species of *Pseudograpsus* is Nicobars, the home of *Pseudograpsus setosus*. The presence of the new species from Bombay thus extends the range of this genus further westwards.

A description of the forms is given below.

SYSTEMATIC ACCOUNT

Tribe BRACHYGNATHA

Subtribe *BRACHYRHYNCHA*

Family XANTHIDAE

Subfamily *XANTHINAE*

Genus **Leptodius** Milne-Edwards

Leptodius euglyptus Alcock

1898. *Leptodius euglyptus*, Alcock, *J. Asiat. Soc. Bengal*, LXVII, pp. 121, 122.

quadrispinosus, var. nov.

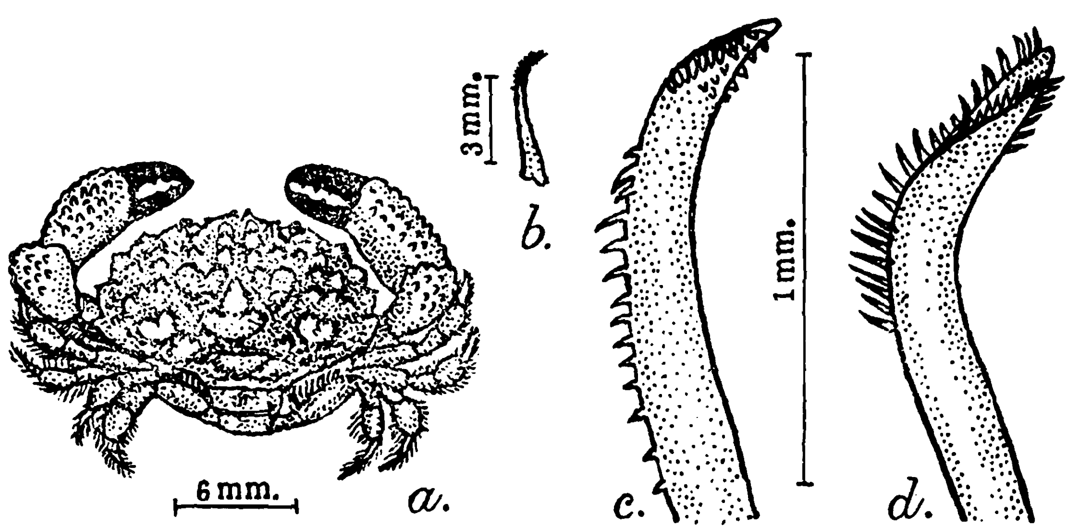
[1] Rathbun, M. J., *K. danske vidensk. Selsk.* (7) V, no. 4, p. 333, text-fig. 15 (1910).
[2] Tesch, J. J., *Siboga Exped.* XXXIXc$_1$, p. 261, pl. 17, fig. 2 (1918).

Material examined.—Numerous adult specimens, of both sexes, were collected among rocks at Port Okha, on the Saurashtra coast.

Description.—Carapace two third as long as broad, rather strongly convex in its anterior two-thirds, flat posteriorly; its regions well delimited, convex, and as completely areolated as any *Actaea*, the areolae being strongly convex and somewhat pitted transversely (text-fig. 1).

Front projecting beyond the orbit, from which it is separated by a notch, cut into two lobes of which the outer angles are prominent; its breadth not quite a third of the carapace.

Antero-lateral borders cut into four conical teeth, not including the outer angle of the orbit, or a small denticle below it; postero-lateral borders strongly convergent, as long as the chords of the antero-lateral borders.



TEXT-FIG. 1.—*Leptodius euglyptus quadrispinosus*, var. nov.
a. Dorsal view of Crab : ×2 ; *b.* 2nd left abdominal appendages of male : ×3 ; *c.* Tip of same, enlarged : ×40 ; *d.* Tip of 2nd left abdominal appendage of male *Leptodius euglyptus* Alcock : ×40.

Chelipeds unequal; the upper and outer surfaces of the wrist strongly wrinkled and pitted; the upper surface of the hand nodular, upper half or more of the outer surface of the hand longitudinally ridged and transversely wrinkled; fingers short, stout, hollowed (but not broadened) at the tip.

Legs with the carpopodite and propodite longitudinally ridged and grooved above, the carpus more distinctly so, the dactylus furred.

Side walls of carapace, edges of the upper surface of the arm, and edges of legs, but especially the upper edge of the meropodites, hairy.

Colour, during life, of carapace pink, a white longitudianal band from the front across the gastric region, fingers of chelipeds and front lower corner of the hands blackish brown.

Type-specimen.—Male, (No. C3359/), Zoologicl Survey of India (Ind. Mus.), Calcutta.

Type-locality.—Port Okha on the Saurashtra coast, 11th & 12th February, 1953. (Coll. B. F. Chhapgar.)

The measurements of the holotype (male) are given below :

length of carapace	10·0 mm.
breadth of carapace . .	14·5 mm.

Remarks.—This variety resembles *Leptodius euglyptus* Alcock in the sharp *Actaea*-like sculpture of the carapace, but differs from it in having only four teeth on the antero-lateral borders, as well as in the relationship of the lengths of the antero-lateral and postero-lateral borders. In this case, the postero-lateral borders are as long as the chord of the antero-lateral borders, whereas in *Leptodius euglyptus* Alcock they are shorter than the chord of the antero-lateral borders.

The posterior male abdominal appendages are elegantly bent, serrulate near the tip, proximal to which are about 12 to 15 larger spinules. These spinules do not extend up to the tip. (In *Leptodius euglyptus* Alcock the spinules are longer and sharper and extend right up to the tip ; the serrulations are also sharper and form only a single row.)

Family PINNOTHERIDAE

Subfamily *PINNOTHERINAE*

Genus **Pinnotheres** Latreille

Pinnotheres vicajii,[1] sp. nov.

Material examined.—Four females (two of them berried), and two males represent the present collection. Both sexes were obtained from the bivalve *Paphia malabarica* at Bombay, each crab living separately in a shell.

Description.—Female (text-fig. 2) : Body soft, carapace subquadrate anterior angles pronounced but with rounded corners, smooth, without any indication of grooves, slightly convex, no pigment spots. Length and breadth of carapace subequal. Lateral margins entire, curved, diverging behind the anterior angles ; posterior border straight.

Front straight, broad, about a third the breadth of the carapace at the anterior angles. Eyes small, pigmented, visible in a dorsal view, orbits circular, eyestalks short. Antennae minute and placed within the orbital hiatus.

Merus-ischium of external maxillipeds a broad plate, with the inner (posterior) margin slightly concave and the antero-internal angle pronounced : propodus elongate, broad and spatulate, it reaches farther than the inner angle of the merus. Dactylus minute, styliform, inserted at inner margin of propodus, just over-reaching the inner angle of the merus, and reaching to the end of the propodus.

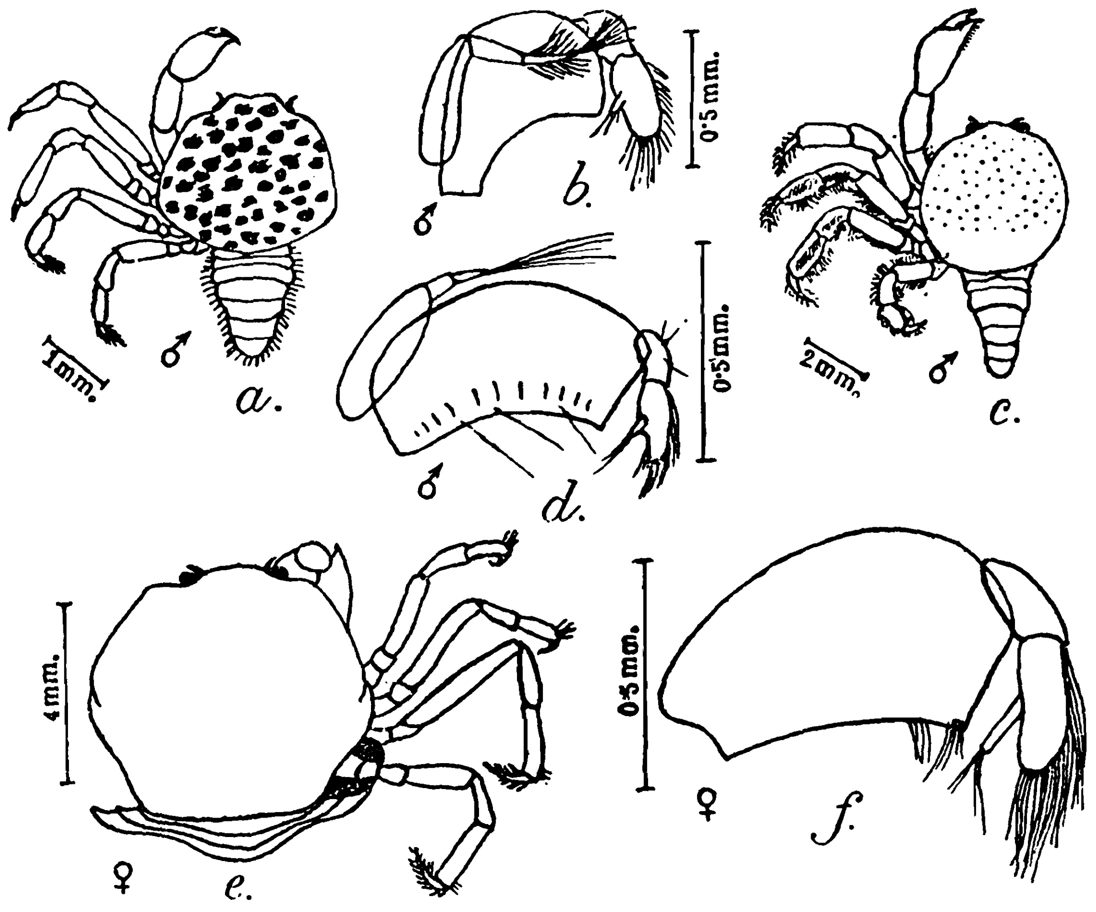
Chelipeds smooth, equal, stout ; wrist longer than broad, palm twice as long as high, and twice as long as the fingers, a triangular tooth on the movable finger, three teeth on the proximal half of the thumb—the

[1] The author has great pleasure in naming this species after Mr. Vicaji D. B. Taraporevala, with whose munificence the completion of the Taraporevala Aquarium and Marine Biological Research Station was possible.

middle one smaller than the other two, which are subequal; tips of finger and thumb crossed, pointed. A fringe of hair on the inner part of the lower border of the thumb.

Third pair of walking legs the longest, last pair longer than the first; propodites with a few silky hairs distally; dactyli of the first two pairs subequal in length, strongly hooked, those of the third and fourth pairs about twice as long as the first two, subequal, hairy and slender, regularly curved. Abdomen of seven joints.

Male: Carapace smooth, well calcified, circular, without any trace of anterior angles, widest at the base of the first pair of walking legs: covered with minute, scattered pigment spots on the anterior half of the carapace up to a line joining the bases of the second pair of walking legs. Lateral margins entire, posterior border convex.



TEXT-FIG. 2.—*Pinnotheres vicajii*, sp. nov.

a. Dorsal view of male *Pinnotheres quadratus* Rathbun, with abdomen extended; *b.* External maxilliped of same; *c.* Dorsal view of male *Pinnotheres vicajii*, sp. nov., with abdomen extended; *d.* External maxilliped of same; *e.* Dorsal view of female *Pinnotheres vicajii*, sp. nov.; *f.* External maxilliped of same.

Front about a fourth the greatest breadth of the carapace, straight. Eyes, orbits and antennae similar to those of the female.

Merus-ischium and propodus of external maxillipeds similar to those of the female, except that the propodus is abruptly narrowed in the distal half. Dactylus not even reaching the antero-internal angle of the merus, as it does in the female. A brush of hairs at the tip of the last joint of the exognath of the external maxillipeds, but no hairs along the sides of this joint.

Chelipeds smooth, equal, stout; a fringe of hair on the inner (anterior) border of the arm: palm inflated distally, $1\frac{1}{2}$ times as long as high, twice as long as the fingers; a fringe of hair on the inner side of the lower border of the hand extending to the tip of the thumb: a large, triangular tooth on the movable finger fits between two smaller ones on the thumb.

Third pair of walking legs the longest, the last pair shortest: inner borders of carpus and propodus of the second and third pair of legs, as also all borders of the last pair fringed with silky hairs. A fringe of hair runs diagonally from the inner border of the proximal end of the carpus to the outer border of the distal end of the propodus of the second and third pairs of legs. Dactyli of first three pairs of legs subequal, those of the last pair slightly shorter; all hairy.

Abdomen seven-jointed, narrow, no fringe of hair on its borders. The breadth at the base of the terminal segment surpasses the length.

Colour, during life, yellow; in the male the carapace is covered with minute black pigment spots.

The measurements of the type-specimens in millimetres are given in the following table:—

	Type female.		Type male.	
Length of carapace	5·6		4·0	
Breadth of carapace	6·4		4·0	
Breadth of front	1·3		1·1	
Breadth of anterior border of carapace	4·1		—	
	left.	right.	left.	right.
1st walking leg				
merus	0·75	0·75	0·84	0·84
carpus	0·45	0·47	0·34	0·36
propodus	0·66	0·67	0·47	0·49
dactylus	0·28	0·28	0·20	0·23
2nd walking leg				
merus	1·13	1·14	1·00	1·07
carpus	0·50	0·56	0·45	0·45
propodus	0·75	0·79	0·50	0·52
dactylus	0·28	0·29	0·20	0·24
3rd walking leg				
merus	1·69	1·13	1·70	1·73
carpus	0·84	0·66	0·44	0·47
propodus	1·28	0·90	0·60	0·75
dactylus	0·46	0·38	0·26	0·28
	(regenerated)			
4th walking leg				
merus	0·84	1·03	0·71	0·70
carpus	0·41	0·52	0·37	0·33
propodus	0·73	0·75	0·49	0·47
dactylus	0·47	0·51	0·23	0·22

Type-specimen.—Male, No. C3361/1, Zoological Survey of India (Ind. Mus.), Calcutta.

Type-locality.—Bombay, 17th April, 1953. (Coll. B. F. Chhapgar.)

Remarks.—This species is allied to *Pinnotheres quadratus* Rathbun in the pigmentation of the male carapace and the small size of the dactylus of the external maxillipeds, but differs from it in several important characters as shown below :—

P. quadratus Rathbun	*P. vicajii*, sp. nov.
Carapace of male subquadrate.	Carapace of male circular.
Anterior angles of male carapace pronounced, though rounded.	No trace of anterior angles in male.
Carapace of male divergent from before backward, with the lateral borders straight, widest near the bases of the third pair of walking legs.	Carapace of male circular, lateral borders curved, widest near the bases of the first pair of walking legs.
Posterior border of carapace in the female concave.	Posterior border of carapace in the female straight.
A triangular depression on the cardiac region in the female.	No triangular depression on the cardiac region in the female.
The whole surface of the carapace of male covered with coarse, irregularly-shaped pigment spots.	Only the anterior half of the carapace of male covered with minute, rounded, scattered pigment spots.
Last joint of exognath of external maxillipeds of male with hair along the sides as well as at the tip.	Last joint of exognath of external maxillipeds of male with hair only at the tip.
Dactylus of external maxillipeds of male spatulate, of the same width throughout its length.	Dactylus of external maxillipeds of male narrowed in the distal half.
Palm of male chelipeds bulbous throughout.	Palm of male chelipeds inflated only distally.
Dactyli of only the last two pairs of walking legs of male hairy.	Dactyli of all the walking legs of male hairy.
Abdomen of male broad, with hair on its border.	Abdomen of male narrow, without hair on its borders.
Very minute crabs (Tesch[1] mentions a berried female measuring 2·85 mm. long and 3·2 mm. broad, and a male 2·4 mm. long and 2·75 mm. broad. Rathbun[2] mentions a female 5.2 mm. long and 5.3 mm. broad).	Larger crabs—berried female 5·6 mm. long and 6·4 mm. broad. Male 4·0 mm. long and 4·0 mm. broad.

[1] Tesch, J. J., *Siboga Exped.* XXXIXc[1], p. 261, pl. 17, fig. 2 (1918).
[2] Rathbun, M. J., *K. danske vidensk. Selsk.* (7) V, no. 4, p. 333, text-fig. 15 (1910).

Family GRAPSIDAE

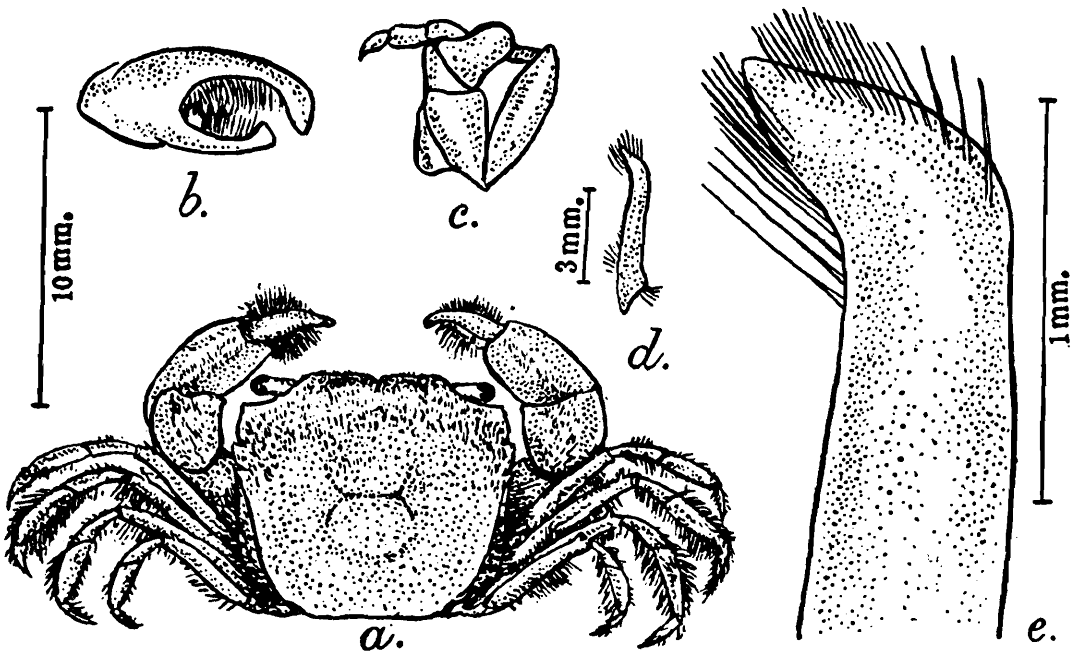
Subfamily *VARUNINAE*

Genus **Pseudograpsus** Milne-Edwards

Pseudograpsus intermedius, sp. nov.

Material examined.—Ten males and four females (two of them berried) from Bombay represent the present collection. They were caught in mud under stones.

Description.—Carapace squarish, flat, depressed, very little broader than long, frosted (text-fig. 3). Anterior half of carapace up to the cervical groove covered with minute, scattered, fine, brownish hairs which are more profuse on the front, orbits, epigastric lobes and lateral, borders. Regions of carapace not well indicated except in the middle of the carapace where the grooves are disposed in the shape of the letter H. Cervical groove distinct but not very deep, semicircular. Two distinct epigastric lobes behind the front. Borders of carapace thin and sharply defined : the antero-lateral borders lined with profuse hair



TEXT-FIG. 3.—*Pseudograpsus intermedius*, sp. nov.

a. Doral view of male ; *b.* External view of chela of male ; *c.* External maxilliped ; *d.* 2nd left abdominal appendage of male ; *e.* Tip of same, enlarged.

and cut into three distinct, flat teeth (including the external orbital angle) which decrease in size from before backward and are not serrate. Postero-lateral boundaries of the carapace forming a distinct facet, sharp, keeled and continued to the bases of the last pair of legs.

Front (at its anterior angles) a little more than a third the breadth of the carapace at the external orbital angles : very slightly obliquely deflexed, straight, with a slight concavity towards the middle, prominent, sublaminar.

Buccal cavern square. External maxillipeds gaping, but not very widely : their exognath narrower than the ischium : their merus shorter, but anteriorly much broader, than the ischium : merus auriculate (expanded) at the outer angle, so that the palp articulates near the middle of the merus.

Chelipeds subequal, but variable in size: considerably longer, and vastly more massive, than the legs in adult males. Shorter in the female, and though stouter than the legs, not vastly so. Inner border of arm and wrist clothed with long, silky hairs. Inner angle of wrist produced sharply to form a broad spine. Fingers gaping, longer than the upper border of the palm : the space between the fingers covered with a thick matt of long, entangled, silky hairs, under which, at the base of the fingers, is hidden a white, fleshy lobe.

The borders of the joints of all the legs, particularly the posterior border of the merus and both borders of the carpus and propodus, thickly fringed with long, dusky hairs. The two middle pairs of legs the longest, the last pair the shortest. Propodites of legs cylindrical, dactyli styliform.

Abdomen in both sexes of seven segments. In the male the abdomen becomes gradually narrow till the penultimate segment. Last segment abruptly narrowed and tongue-shaped. Posterior male appendages stout and straight, but bent suddenly at the tip, which bears brushes of hairs.

Colour, during life, chestnut.

The measurements of the holotype (male) and an average female, are given below :—

	Male.	Female.
Length of carapace	10·0 mm.	6·75 mm.
Breadth of carapace	11·0 mm.	7·25 mm.
Breadth of front	4·0 mm.	2·6 mm.

Type-specimen.—Male, No. C3363/1, Zoological Survey of India (Ind. Mus.), Calcutta.

Type-locality.—Bombay, 17th March, 1953. (Coll. B. F. Chhapgar.)

Remarks.—Tesch[1], in his discussion of the *Grapsidae* divides the species of *Pseudograpsus* into two different groups, viz.—

(1) large species (up to 4 cm.), chestnut coloured. Cervical groove very deep, semicircular. Three last joints of the legs with a fur of black hairs ;

(2) small species (up to 1·5 cm.), white. Cervical groove indistinct, nearly straight. Legs naked.

It will be seen that the new species offers a combination of the characters of the above two groups. Although it is a small species (measuring only up to 1·0 cm.), the specimens are chestnut coloured. Again, the cervical groove, though semicircular, is not very deep. The legs, too, are covered with dusky hair.

[1] Tesch, J.J., *Siboga Exped.* XXXIXc, pp. 97, 98 (1918).

ACKNOWLEDGMENTS

The author takes this opportunity to express his graiteful thanks to late Dr. S. L. Hora, Director, Zoological Survey of India, for affording the necessary facilities at the laboratory of the Zoological Survey of India, and to Dr. K. K. Tiwari of the Zoological Survey of India, and Dr. M. W F. Tweedie of the Raffles Museum, Singapore, for confirmation of identification of new forms. His grateful thanks are also due to Dr. C. V Kulkarni, Director of Fisheries, Bombay, for his constant guidance and encouragement throughout the course of his studies.

SHIPWORMS OF INDIA. II

SEVEN MORE SHIPWORMS FROM SOUTH INDIA

By N. BALAKRISHNAN NAIR, *Zoology Research Laboratory, Madras*

INTRODUCTION

In a previous paper[1] the author had described ten shipworms from Madras, five belonging to the genus *Bankia* Gray, and five to the genus *Teredo* Linnaeus. Of these, seven were new to science. But the examination of more material collected from both the east and west coasts of South India has yielded seven more forms, one assignable to genus *Bankia* and the rest to the genus *Teredo*. Four of these, *Bankia* (*Nausitora*) *gabrieli*, *Teredo* (*Teredo*) *indica*, *Teredo* (*Teredora*) *minoris* and *Teredo* (*Teredothyra*) *linearis*, are new to science. *Teredo* (*Teredo*) *parksi* and *Teredo* (*Teredo*) *furcillatus* described in this paper were first recorded from the Pearl Harbour and Samoa by Bartsch (1921) and Miller (1924) respectively, and subsequently from other areas in the Pacific (Sivickis 1928, Edmondson 1942) and Indian oceans (Moll 1936). This clearly shows the extensive range of distribution not only of these forms, but of other forms as well. Although the occurrence of *Teredo* (*Teredo*) *navalis* in the European waters has been reported by several authors and also in Cochin (Erlanson, 1936) and Vizag (Ganapati and Nagabushanam, 1954) the Indian form does not appear to have been properly studied. As will be obvious from the description given in this account it differs from the European form in several minor details which are probably of ecotypal nature.

Since very little is known about the Teredine fauna of the Indian coast, an attempt has been made here to give detailed descriptions of the forms occurring in the area. It is hoped that a thorough search of the underwater wooden structures, the native wooden crafts plying in the brackish waters and the lush vegetation fringing the coastal regions which are subjected to submergence under sea water during spring tides, would not only yield more material but also indicate the extent to which the forms described are distributed.

The material for the present study has been recovered from the drift logs or planks washed ashore in large numbers on Madras beach especially during the north-east monsoon times, from temporary marine structures made of timber, from hulls of boats and with the help of wooden test blocks fixed in the sea.

SYSTEMATIC ACCOUNT

Genus *Bankia* Gray

Subgenus *Nausitora* Wright

***Bankia* (*Nausitora*) *gabrieli*, sp. nov.**

[1] *Rec. Indian Mus.* LII, pp. 387-414 (1956).

Genus *Teredo* Linnaeus
Teredo (*Teredo*) *parksi* Bartsch var. *madrasensis*, nov.
Teredo (*Teredo*) *furcillatus* Miller
Teredo (*Teredo*) *indica*, sp. nov.
Teredo (*Teredo*) *navalis* Linnaeus
Subgenus *Teredothyra* Bartsch
Teredo (*Teredothyra*) *linearis*, sp. nov.
Subgenus *Teredora* Bartsch
Teredo (*Teredora*) *minoris*, sp. nov.

Genus **Bankia** Gray, 1840

1840. *Bankia*, Gray, *Gen. Synops. Brit. Mus.* 42nd ed., p. 150, *nomen nudum*.
1842. *Bankia*, Gray, *Gen. Synops. Brit. Mus.* 44th ed., p. 76 (diagnosed but no species named).
1847. *Bankia*, Gray, *Proc. zool. Soc. Lond.* p. 188. (as synonym of *Xylotrya* Leach, 1817).

Subgenus **Nausitora** Wright, 1865

Type: *Bankia* (*Nausitora*) *dunlopei* Wright
1865. *Nausitora*, Wright, *Trans. Linn. Soc.* XXIV, p. 51, pl. 46.
1922. *Nausitora*, Wright, *Bull. U. S. nat. Mus.* CXXII, p. 12.

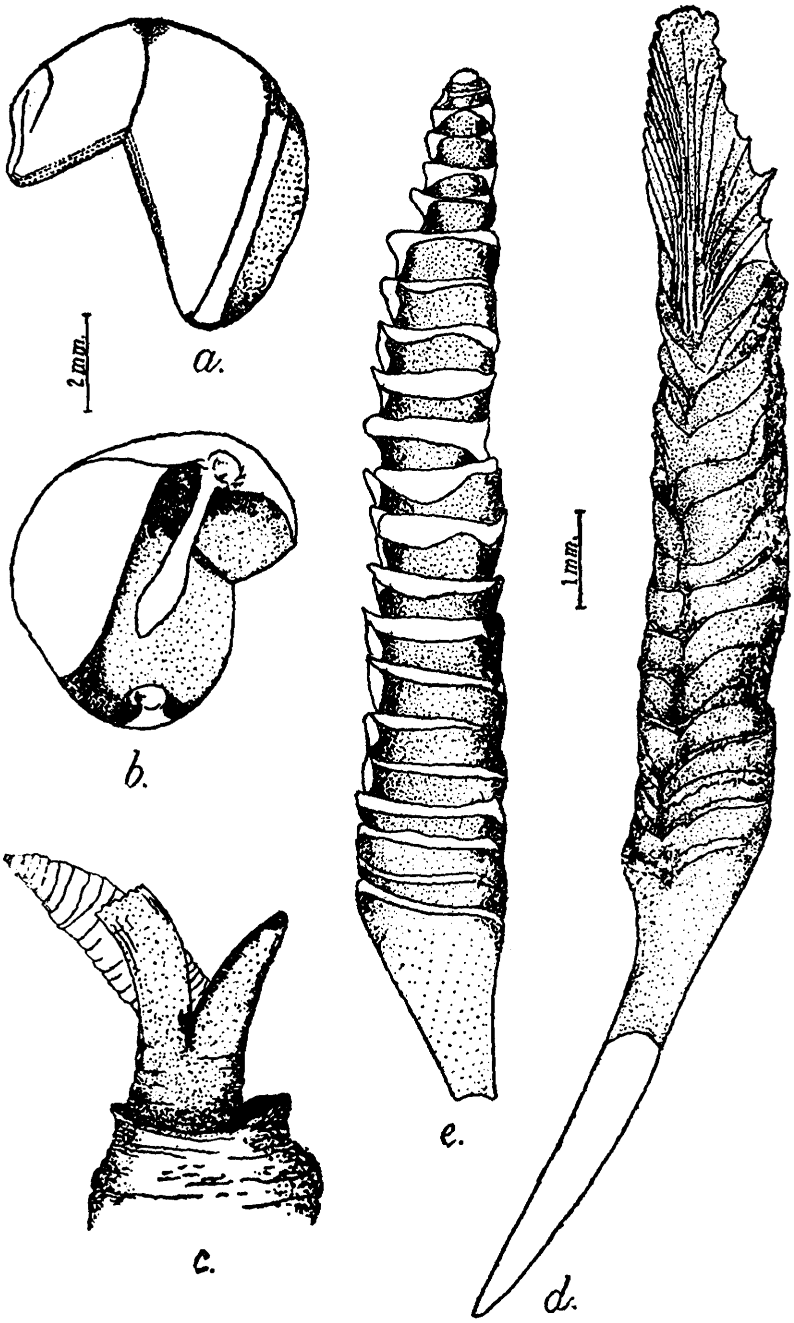
Bankia (Nausitora) gabrieli, sp. nov.

Locality.—Seven shipworms were collected by Rev. Fr. Gabriel from the hull of a discarded country canoe made of teak-wood at Ernakulam, West coast.

Measurements.—The largest specimen measured 15 cms. long (alcohol preserved). But the author has seen one specimen of the same species in the collection of Rev. Fr. Gabriel measuring more than 12" One specimen 13·5 cms. long has been selected as the type of the species.

Shell length—5·7 mm. Shell height—5·9 mm. Pallet length—13·7 mms., Pallet stalk—3·4 mms.

Characters.—The shell is sub-globular and its height is more than the length. The ventral half of the anterior lobe and anterior part of the median lobe are slate coloured. The anterior lobe is large and is almost as wide as the anterior part of the median lobe. The umbonal side of this lobe has undergone considerable erosion and the dental ridges borne by it have been worn away leaving an almost smooth area. However, towards the ventral side about 35 dental ridges could be counted. They slightly bend downwards after their origin from the moderately deep sinus and then extend backwards across the lobe to meet the anterior end of the dental ridges of the anterior median portion, almost at a right angle. These dental ridges are of regular width and their edges are finely serrated. These ridges are separated by spaces as wide as themselves. The denticles on the median part are tubercular and stronger than those of the anterior lobe. The median lobe of the shell is large and its anterior part bearing the dental ridges is the broadest part of the shell forming nearly 44 per cent of entire length and 76 per cent of the median part. The umbonal side of this region also has undergone extensive erosion and the dental ridges are clearly visible only on its anterior 2/3, there being only 30 denticulated ridges. The middle portion of the median part forms a depressed groove which is crossed by rough wrinkles, and the non-denticulated curved extensions of the dental ridges of the anterior area. There is a ridge running parallel to its length along the middle of this groove from the umbonal region to the extreme ventral tip where the knob is placed. The posterior median is narrow, convex and comparatively smooth. The shell of this species appears quite



TEXT-FIG. I.—*Bankia* (*Nausitora*) *gabrieli*, sp. nov.

a.-b. Outer and inner views of the shell ; *c.* Posterior extremity of the animal showing the collar, siphods, and pallet (one side only) ; *d.* Outer view of the entire pallet *e.* Inner view of the blade of the pallet.

remarkable, as the article is so greatly reduced by erosion that very little of it could be seen. The posterior margin of the median lobe is also eroded and its outline is irregular.

Viewed from within, the hinge area shows an eroded condition. The umbone bears a strong knob from which a blade extends for a little more than half the distance into the cavity of the shell, the distal end of which is slightly flattened leaving the proximal part to appear like a cylindrical stalk for it. A shelf is indicated beneath the posterior median area.

Pallets : Feather-shaped, with a cylindrical stalk which is much shorter than the blade. The blade is inequilateral and composed of compactly packed cones. Towards the basal part of the blade the cones are more compact and almost fused. The outer surface of the blade is decidedly convex, whereas the inner surface is flat. The blade is covered by a periostracum of a brownish hue. On the inner portion of the blade is a series of cross ridges marking the condensed cone-in-cone elements and periostracum.

Siphons : In the preserved specimens the siphons are short and conjoint until near the extremities. The inhalant is slightly thicker than the exhalant and is trumpet-shaped, fringed at the margin.

Collar : Well developed, but not rolled out as in the other Madras form, *Bankia* (*Nausitora*) *madrasensis* Nair.

Labial palps : Very small, being greatly reduced, seen as slight ridges.

Burrow : The calcareous tubing is very thick and non-adherent to the wall of the burrow.

Remarks.—In the possession of a pallet consisting of a series of cone-in-cone elements which are not entirely free at their distal ends but fused in the exterior surface, this Madras species is assignable to the subgenus *Nausitora* Wright. In the marked absence of an auricle it resembles *Bankia triangularis* Sivickis, *Nausitora messeli* Iredale, *et al*, but differs from the former in having very few denticulated ridges on the anterior and anterior median lobes when compared with that form in which it is reported as having about 300 ridges sculpturing that area. The anterior median area of the new species appears much more broader forming 44 per cent of the entire shell length and 76 per cent of the length of the median lobe, whereas in *triangularis*, it is described as about 1·5 times the rest of the median area and auricle combined. Further, *Bankia triangularis* is described as having a pallet of "medium size" with very closely packed cones, the composite nature of which is best seen from the outer surface. In the specimens before me the cone-in-cone elements forming the blade are clearly distinguishable both from the inner and outer surfaces. They resemble *Nausitora messeli* with respect to the shell characters, but differ markedly in the comparative structure of their pallets. In *Nausitora messeli* the specimen with a shell 15 mm. long and 15 mm. high possesses a pallet 21 mm. long, of which only 1·6 mm. belong to its stalk (blade width 1·2 mm.). In the present form when the shell is 5·7 mm. long and 5·9 mm. high the pallet is 13·7 mm. and its stalk measures 3·4 mm. *Bankia* (*Nausitora*) *braziliensis* Bartsch agrees with the new form in having partially eroded umbones and also in having a rather broad anterior median portion and a narrow auricle, but differs in the possession of a posterior median portion which is as wide as the anterior and middle portion of the median part. Besides these, the pallet of that species has a comparatively longer stalk and the distal half of the blade is covered with a thick calcareous deposit. Further, the relative proportions of the shell and pallets are also different.

Bankia quadrangularis Sivickis, *Bankia globosa* Sivickis, *Bankia (Nausitora madrasensis* Nair, also approach the new shipworm in the possession of a shell having a narrow auricle, while *Bankia quadrangularis* differs markedly from that in having 90 ridges for the anterior part and in having an anterior median portion which is almost equal to the middle median and posterior median put together and also in the possession of stout pallets with U-shaped cones and peg-like peduncle appearing as long as the blade. *Bankia globosa* differs in having a broad posterior median portion which equals in breadth to the anterior median unlike the form in question. In *Bankia (Nausitora) madrasensis* the pallet structure appears so different that the similarity observed in its shell structure has had to be considered quite insufficient as to suggest a resemblance.

After carefully comparing the important features of the specimens in question with those of other existing species it is found that they certainly come under the subgenus *Nausitora* and represent a peculiar form hitherto unknown to science which I venture to designate as *Bankia (Nausitora) gabrieli* after Rev. Fr. Gabriel of Sacred Heart College, Thevara. The description of this new species is given as follows :—

Shell height slightly more than shell length, with a very wide anterior median area forming 76 per cent of the length of the median lobe and wider than the anterior lobe and about 3 times the width of the rest of the median lobe, with an auricle which is very greatly reduced or completely absent and with a pallet which has a blade greatly longer than the stalk, the former composed of closely packed cone-in-cone elements covered over by a brownish periostracum.

Genus **Teredo** Linnaeus, 1758

Subgenus **Teredo** Linnæus

1758. *Teredo,* Linnaeus. *Syst. Nat.* 10th ed., p. 651.
1922. *Teredo,* Bartsch, *Bull. U. S. Nat. Mus.* No. CXXII, p. 17.

Teredo (Teredo) parksi Bartsch var. **madrasensis**, nov.

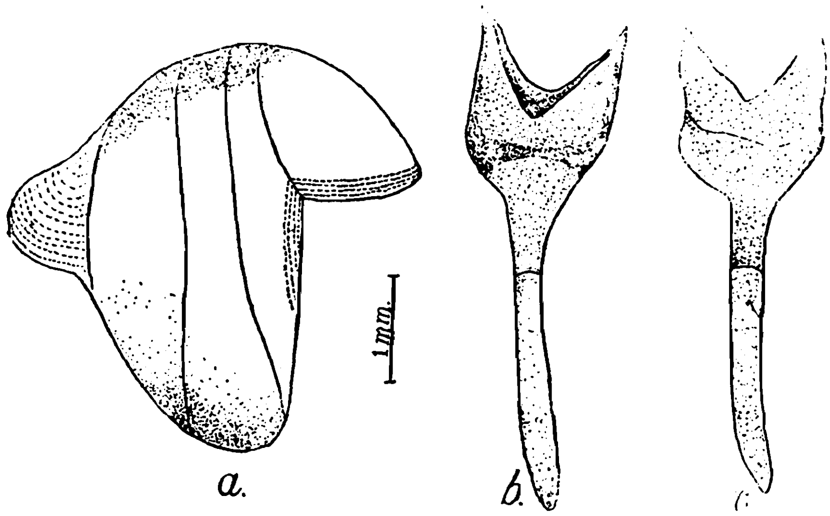
1921. *Teredo (Teredo) parksi,* Bartsch, *Proc. Biol. Soc. Wash.* XXXIV, pp. 28-29.
1942. *Teredo (Teredo) parksi,* Edmondson, *Occ. Pap. Bishop Mus.* XVII (10), p. 106.

Locality.—Two specimens were collected from a test plank of *Myristica* sp. fixed in the boat basin of the Madras harbour which was in water from August 7th to November 15th, 1954. The test plank was also bored by *Martesia* and fouled thickly by barnacles, lamellibranchs, hydroids, and polyzoans. *Sphæroma* were also present in the empty tunnels of the borers. Besides the two entire specimens, shells and pallets were also obtained from empty burrows from the same plank.

Measurements.—Length of the specimen (burrow) 6·3 cms. Shell length—3·7 mm. Pallet—3·7 mm. Shell height—3·6 mm. Pallet stalk—2·1 mm. Breadth of the blade—1·3 mm.

Characters.—Shell white, globular, longer than high with sinus and callus and its anterior lobe bearing not less than 45 dental ridges which meet those of the anterior median almost at right angles. The anterior median is moderately broad and marked by closely packed dental ridges bearing stronger denticles than those on the anterior lobe. The junction between the ventral border of the anterior lobe and anterior median portion forms a right angle. The middle median is a fairly broad and depressed area crossed by strong incremental lines. The posterior median is convex and thick and is also crossed by similar incremental lines of growth. The auricle is small, wider than high and marked by concentric lines. Internally the shell is smooth with strong dorsal and ventral knobs. From the inner underside of the dorsal knob a flat blade is pendent which hangs into the cavity of the shell for about half its length.

Pallet.—Paddle-shaped, with a long slender stalk which is slightly curved and about twice the length of the expanded part of the blade. Blade is excavated at the distal end more deeply on the convex outer face than on the flattened inner face.



TEXT-FIG. 2.—*Teredo* (*Teredo*) *parksi madrasensis*, var. nov.
a. Outer view of the shell; *b.-c.* Outer and inner views of the Pallet.

Collar.—Slightly developed.

Siphons.—Inhalant wider and longer.

Burrow.—With thin lining.

Remarks.—This species was described by Bartsch (1921) from piling in Pearl Harbour. It has subsequently been reported by Miller (1924) as occurring in the test blocks in Samoa, and Sivickis (1928), declared it to be common in the Philippine islands. Edmondson (1942) recovered it from several stations about Hawaii and Moll (1936) listed it from Penang island. A distinctive feature noticeable in the present form is the absence of a black or brown colour for the periostracum which results in giving the blade a white appearance. In this feature the pallets are contrasted with those of *Teredo parksi* reported by Bartsch from Pearl Harbour and Miller and Edmondson from the Pacific islands. A full description of the Penang form is not available. In view of the differences exhibited by the Madras specimens both in shell and palletal features, I propose for them the new varietal name *madrasensis* and give the description as follows:—

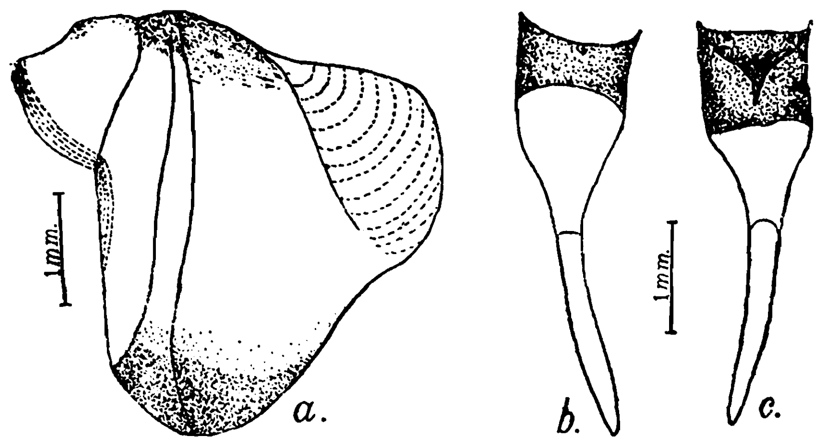
The shell with a broad anterior lobe and a small auricle, pallets with along slightly curved stalk which is about twice the length of the expanded part of the blade, the distal end of the latter excavated more deeply on

The covex outer face than on the flattend inner face. The periostracum covering the distal part of the blade is colourless.

Teredo (Teredo) furcillatus Miller, 1924

1924. *Teredo furcillatus*, Miller, *Univ. Calif. Publ. Zool.* XXVI, p. 149, pl. 10, figs. 16-20.

1942. *Teredo* (*Teredo*) *furcillatus*, Edmondson, *Occ. Pap, Bishop Mus.* XVII (10), p. 113.



TEXT-FIG. 3.—*Teredo* (*Teredo*) *furcillatus*.
a. Outer view of the shell; b.-c. Inner and outer faces of the pallet.

Locality.—Three specimens were collected from a plank of *Mangifera* sp. used in a jetty construction in the Kayankulam backwaters on the west coast during the month of October, 1953. On close examination these were found to be *Teredo* (*Teredo*) *furcillatus* described by Miller (1924) from Tutuila and Honolulu harbour. Certain differences as observed in the Indian and Honolulu forms are pointed out below.

Measurements.—Shell height—3·8 mm. Shell length—4 mm. Pallet length—3·7 mm. Pallet stalk—1·9 mm. Breadth of blade—1 mm.

Characters.—Shell subglobular with its length more than the height The anterior lobe with sinus and reflected callus is crossed by about 20 denticulated ridges which are separated by spaces twice as wide as themselves. These dental ridges meet those of the anterior median part in slightly more than a right angle. The anterior median part is moderately broad and is crossed by about the same number of ridges as on the anterior lobe with the denticles stronger and more compactly placed being separated only by mere lines. The middle median area is a depressed groove crossed by the non-denticulated extensions of the dental ridges of the anterior lobe. The posterior median part is convex and is the widest part forming about 68 per cent of the length of the median area and is crossed by the further extensions of the dental ridges. The posterior part forms a very prominent auricle slightly broader than even the anterior lobe and its surface is marked by strong lines of growth.

Pallets.—Paddle-shaped with the stalk longer than the blade. The distal tip of the latter is deeply excavated on the outer margin, while the inner margin is only slighly cupped. The distal half of the blade is covered by an yellowish brown periostracum.

Siphons.—In alcohol preserved specimens the inhalant and exhalant siphons are of equal length. The inhalant is coloured brown.

Collar.—Moderately developed.

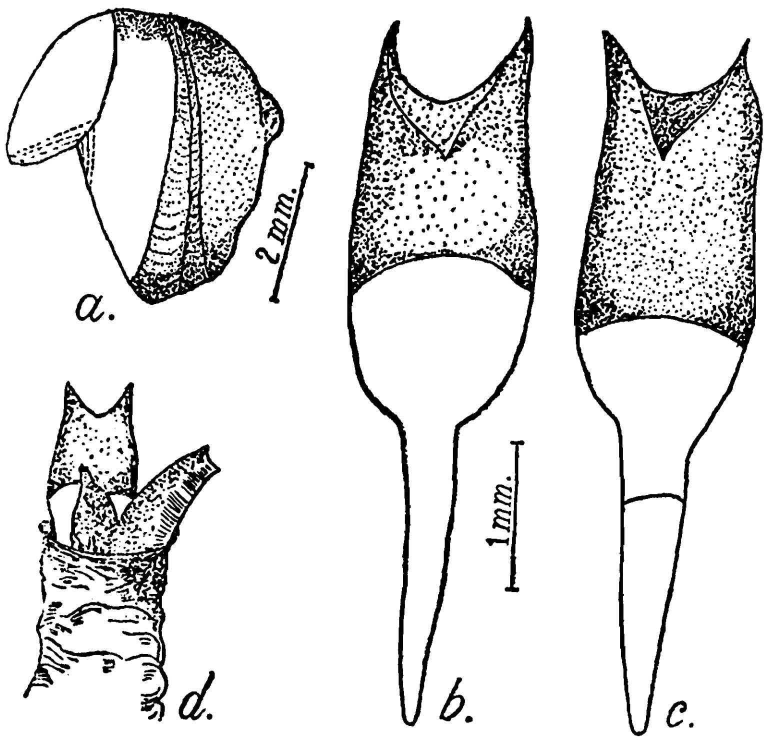
Burrow.—Information not available.

It has been reported as occurring in the Cochin harbour by Erlanson (1936).

Remarks.—For a new shipworm collected from Tutuila, Samoa, Miller (1924) used the specific name *furcillatus*. His description 'shell with the anterior lobe shorter and narrower than *Teredo parksi* and the auricle decidedly longer and broader' holds good for the Madras forms as well.

Teredo (Teredo) indica, sp. nov.

Locality.—Three live specimens were recovered from a test plank of *Myristica* sp. fixed in the boat basin of the Madras harbour which was in water from April 10th to July 19th, 1954. The wood was riddled by *Martesia*. The empty tunnels of this species with shells and pallets were also found besides the three live ones.



TEXT-FIG. 4.—*Teredo* (*Teredo*) *indica*, sp. nov.
a. Outer view of the shell; *b.-c.* Inner and outer views of the pallet; *d.* Posterior extremity of the animal showing collar, siphons and pallet (one side only).

Colour.—The caecum of this new shipworm was very conspicuously coloured pink which was clearly visible through the translucent mantle in the fresh specimens. This colouration is rather remarkable in view of the fact that the wood into which the animal was boring and with which the caecum was filled up was colourless. The siphons had a brownish hue.

Measurements.—The animal is slender and the burrow of the largest of the three measures 5 cms. It is selected as the type.

Shell length—4 mm., Shell height—4·1 mm., Pallet length—4·3 mm., Palllet stalk—1·6 mm., Breadth of the blade—1·2 mm.

Characters.—Shell globular, thin and white. The anterior part has a moderately deep sinus, the extreme anterior margin of which is covered with a fairly thick callus reflected over the exterior. The rest of the anterior lobe is sculptured by slender rib-like denticulated ridges. They are more closely approximated at the anterior callus than at their junction with the median part where the spaces that separate them are about as wide as the ridges. Not less than 53 of these ridges are present in the type, some of the early ones, however, are worn out at the umbone. In cross section the dental ridges are roughly triangular and bear numerous minute closely spaced denticles on their outer dorsal margin. The anterior median part joins the anterior part at its ventral margin in almost a right angle. The junction of the anterior lobe with the median part appears as a slightly impressed line extending from the umbones to the ventral margin. The anterior median part is broad forming about 31 per cent of the total length of the shell and about 47 per cent of the median part and is marked by closely packed dental ridges bearing denticles which are stronger and stouter than those of the anterior lobe and whose long axis is transverse to that of the ridges. The ridges are separated by deeply impressed lines only. They meet those of the anterior area almost at right angles. The middle median portion is a light yellowish, depressed groove crossed by the enfeebled non-denticulated extensions of the dental ridges of the anterior area. The posterior median is convex and its surface is marked by rather irregular incremental lines. This part forms a small auricle marked by weak lines of growth.

Interior white. The umbones form a small dorsal knob from the inner underside of which is pendant the apophysis which is thin and broad extending for more than half the distance of the inside of the shell towards the ventral knob. The junction of the anterior and median part forms a thread-like ridge. The posterior portion extends over the median as a prominent shelf.

Pallets.—Paddle-shaped, with stout cylindrical stalk tapering to a point. The distal $\frac{2}{3}$ of the blade is covered by a dark brown periostracum and the extreme distal portion of this region is hollowed out and the lateral tips are drawn out as two horns, the left one of which is slightly longer.

Siphons.—The inhalant is wider and twice as long as the exhalant and with the rim fringed.

Collar.—Slightly developed.

Burrow.—Lined by thick calcareous material which is not firmly adherent to the walls of the burrow.

This is an incubatory species. The specimens on removal from the wood when placed in a bowl of fresh sea water extruded a stream of larval veligers. These were cultured in the laboratory successfully and the details of development are reserved for a separate paper. The veligers had translucent shells and showed great activity. Immediately after their release from the mantle cavity of the mother they descende rapidly to the bottom of the bowl. Within one or two minutes they protruded their velum and began creeping about the bottom first in a straight line for a short distance after which they began moving in circles and swam up towards the surface.

Remarks.—In the possession of a shell whose height is slightly more than its length, with anterior lobe bearing not less than 53 denticulated ridges, a broad anterior median area which forms about 47 per cent of the median part and bearing an equal number of denticulated ridges as the anterior lobe, having an auricle, which is very small and narrow, an apophysis which is broad and thin, and in the possession of a paddle-shaped pallet having a small straight cylindrical stalk which tapers to a point, with a blade whose breadth is less than the length of the stalk, the distal $\frac{2}{3}$ of which is covered by a dark brown periostracum and the extreme distal portion hollowed out and the lateral tips drawn out, the present form is clearly distinguishable from all the other 31 forms whose descriptions or figures are avilable for purposes of comparative study and hence treated as a new species *Teredo* (*Teredo*) *indica* which is described as follows :

Shell height more than shell length with anterior lobe having 53 dental ridges and an equal number of dental ridges for the anterior median lobe when the shell is 4 mm. long and 4·1 mm. high. The anterior median lobe forms about 47 per cent of the median part, while the posterior region of the latter forms a very narrow and small auricle. Pallets with short cylindrical stalks measure 1·6 mm., when its overall length is 4·3 mm., with a blade the broadest part of which measures 1·2 mm. and the distal $\frac{2}{3}$ of which is covered by a dark brown periostracum.

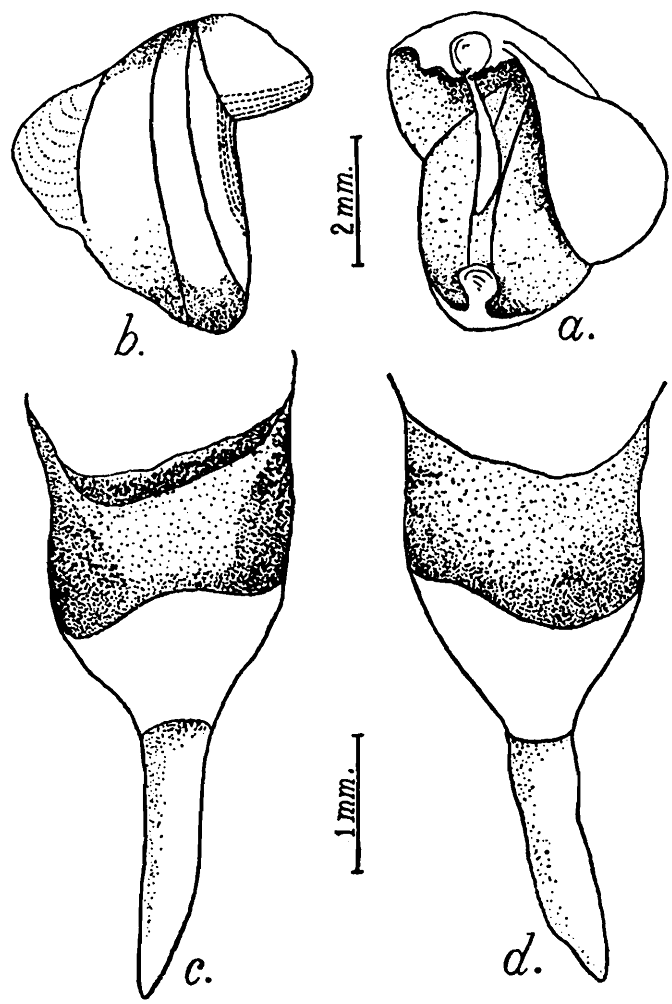
Teredo (Teredo) navalis Linnaeus

1758. *Teredo navalis*, Linnaeus, *Syst. Nat.* 10th ed., p. 651.

Locality.—Four specimens were collected from a test plank submerged for sixty-six days, 2 miles from the Madras beach beyond San Thome. 3 more were collected from Alleppey on the West coast by Sreemati Gomati Balakrishnan during June, 1954, from a discarded canoe. Of the specimens collected from the test plank, the largest had a burrow measuring 9·5 cms. in length. It is presumed that this form is about 66 days old.

Measurements.—Shell height—4·8 mm., Shell length—4·7 mm., Pallet length—4 mm., Pallet stalk—2 mm., breadth of blade 1·6 mm.

Characters.—Shell sub-globular, slate coloured except the dorsal side of the posterior median and auricle. The anterior margin of the anterior lobe with a moderately deep sinus is covered with a smooth translucent callus which is reflected over the exterior portion where the dental ridges are covered by it. The dental ridges radiate from this anterior smooth portion fan-shaped backwards over the anterior lobe in an even gentle curve. They are separated at the posterior extremity by spaces about twice as wide as themselves. There are about 30 of these ridges, but a few at the umbone are eroded. They are finely denticulated at their free border. The anterior median part joins the anterior part at its ventral margin in almost a right angle. The junction of the anterior part with the median part appears as a slightly impressed line extending from the umbone to the ventral margin. The dental ridges of the anterior lobe meet those of the anterior median in almost a right angle. The anterior part of the median area is marked by 18 dental ridges bearing fine denticles. The middle median portion is a shallow concave area crossed by the non-denticulated curved extensions of the dental ridges of the anterior median portion and coarse wrinkles which make the surface of this area quite rough. The posterior median area is convex and its surface is crossed by the further extensions of the non-denticulated dental ridges which end at the junction of the posterior median with the auricle. The auricle which is given off by the posterior



TEXT-FIG. 5.—*Teredo* (*Teredo*) *navalis.*
a.-b. Inner and outer views of the shell ; *c-d.* Outer and inner faces of the pallet.

median is a conspicuous one and its surface is marked by concentric lines of growth paralleling the ventral margin. The interior is white. The anterior part joins the middle part in a raised tumidity. The inner surface is smooth except the auricle which shows concentric lines. The auricle extends over the posterior median as a moderately strong shelf. The umbones are curved inwards and form a prominent knob from the underside of which extends for more than half the distance into the cavity of the shell the apophysis, which is flat and thick and is orientated at right angles to the inner surface of the median part. The extreme ventral tip of the median part bears a strong knob.

Pallets : are spatulate, with a straight cylindrical stalk which is almost of the same length as the blade. The distal part of the blade forms a dark-brown periostracum which is hollowed out at the free margin and terminates in two lateral horns. The basal calcareous portion of the blade is slightly convex outside and flat in the inner face.

Siphon.—The inhalant siphon is fringed at the tip, but wider and stouter than the exhalant which extends for only half the length of the inhalant siphon.

Burrow.—Lined with thick calcareous material. The opening is a simple slit without any septa or partitions.

Remarks.—In the possession of a shell with a moderate sized auricle, with an anterior lobe possessing 30 denticulated ridges and anterior median with 17 denticulated ridges, it almost agrees with the description of *Teredo navalis* quoted by Bartsch (1922). The pallet of the present form has an overall length of 4 mm. of which 2 mm. belong to its stalk which is straight terminating in a point, whereas in the former the stalk is decidedly shorter, slightly twisted and somewhat dilated at its tip. Further, in the Madras form the blade expands beyond the stalk much more than in the European form forming a concave outline (though not so suddenly as in the American species). Its inhalant siphon is also markedly longer than the exhalant siphon. In the absence of a more detailed information about the type of *Teredo* (*Teredo*) *navalis* the specimens before me are tentatively referred to *navalis*.

Subgenus **Teredothyra** Bartsch

Type : *Teredo* (*Teredothyra*) *dominiecensis* Bartsch

1921. *Teredothyra*, Bartsch, *Proc. biol. Soc. Wash.* XXXIV, p. 26.

1922. *Teredothyra*, Bartsch, *Bull. U. S. nat. Mus.* No. CXXII, p. 22.

1927. *Teredothyra*, Bartsch, *Bull. U. S. nat. Mus.* No. C, p. 540.

In this subgenus the pallets are doubly cupped at the terminal portion.

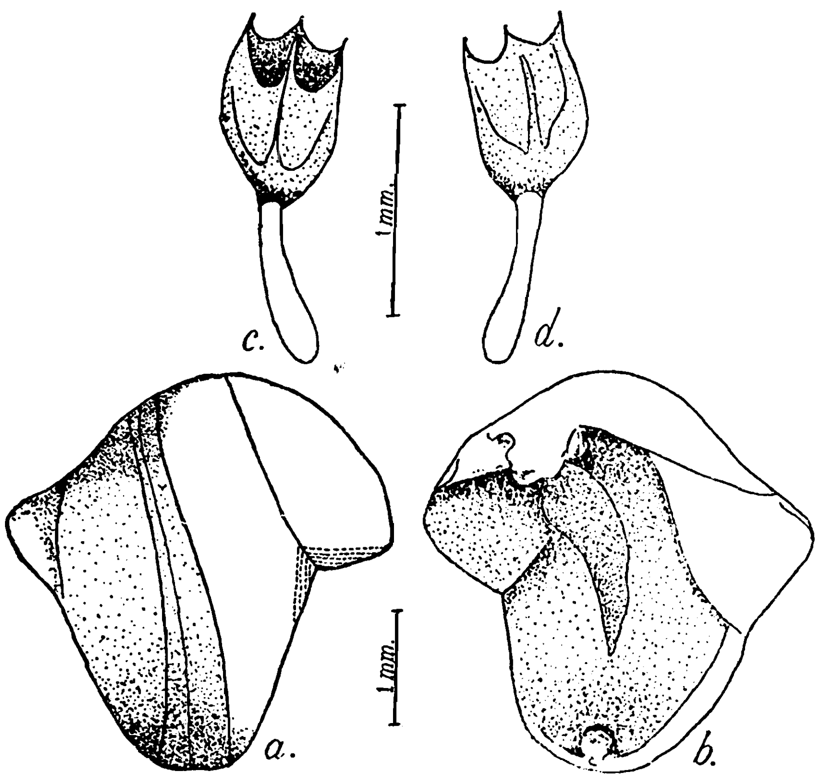
Teredo (Teredothyra) linearis, sp. nov.

Locality.—Three specimens were collected from a floating piece of Maruthu wood (*Terminalia arjuna*) in the Royapuram shore on the 19th January, 1954. All of them were small, but the burrow of the largest measured only 3·5 cms. long, the shell and the visceral mass were thin and the branchial region very thin and drawn out at the tip of which the small pallets could be seen.

Measurements.—Shell length—3·4 mm., Shell height—3·5 mm. Pallet length—1·7 mm., Pallet stalk—0·8 mm., Breadth of blade—0·5 mm.

Characters.—Shell sub-globular and white. The anterior lobe is provided with deep sinus and reflected callus. This area is crossed by not less than 100 denticulated ridges which are separated by spaces as wide as the ridges at their junction with those of the anterior median. A few dental ridges are eroded at the umbonal region The anterior median area is broad, broader than the posterior median and almost of the same width as the anterior lobe and its surface is crossed by an equal number of denticulated ridges which are closely packed, being separated only by mere impressed lines. They meet those of the anterior lobe at slightly more than a right angle. The middle median is a shallow depressed area having a central groove running throughout its length from the umbone to the ventral knob and is crossed by non-denticulated ridges which extend into the convex posterior median area, the latter giving off an auricle at its dorso-median aspect. The auricle is narrow, bearing on its surface thin incremental lines.

Interior is white and smooth, the umbonal knob is slightly smaller than the ventral knob from the inner underside of which is pendent a broad blade which extends for slightly more than half the distance into the cavity of the shell. The junction of the anterior lobe with the median is marked by a tumid ridge. The auricle does not strongly project into the cavity of the shell as a conspicuous shelf.



TEXT-FIG. 6.—*Teredo (Teredothyra) linearis*, sp. nov.
a.-b. Outer and inner views of the shell ; *c.-d.* Outer and inner faces of the pallet.

Pallets : are small with short cylindrical slightly twisted stalk, the latter occupying only 47 per cent of the entire length of the pallet. The expanded blade is hollow throughout its length, the cavity being divided into two chambers by a median septum.

Burrow has a thin calcareous lining which is adherent to the wood.

Remarks.—This form belongs to the subgenus *Teredothyra* Bartsch which is characterised by its pallets being doubly cupped terminally. If the important characters are carefully studied and compared with those of the other nine forms belonging to this subgenus, one would be surely inclined to consider this boring mollusc as quite new to science. But of all these species, its resemblance to *Teredo (Teredothyra) dominiecnsis* Bartsch appears more close especially in the form of the pallets. It can easily be distinguished from other species of the group by the possession of a shell whose height is always slightly more than its length, an anterior lobe which is higher than broad bearing about 100 denticulated ridges which meet those of the anterior part of the median lobe at slightly more than a right angle, with a distinct moderately broad convex and smooth posterior median part which is about 38 per cent of the length of the middle lobe of the shell having a narrow auricle at its posterior dorsal part which does not strongly project into the cavity of the shell as a conspicuous shelf and having an apophysis which is broad and long. So, I take the liberty to propose for this the new specific name *linearis* and give the description as follows :—

Animal slender with a thin viscera and enlongated branchial region shell, the height of which is more than its length, with a moderately broad anterior median part and on almost equally broad posterior median part with narrow auricle placed postero-dorsally which does not strongly project into the cavity of the shell to form a shelf and with pallets which are doubly cupped at the terminal portion with overall length of 1·7 mm. (when the shell is 3·4 mm, long and 3·5 mm. high), about 47 per cent of which belongs to its stalk, the blade of which is hollow throughout its length, the cavity being divided into two chambers by a medium septum.

Subgenus **Teredora** Bartsch,1921

Type *Teredo malleolus* Turton

1921, *Teredora*, Bartsch, *Proc. biol. Soc. Wash*, XXXIV, p. 26.

1922, *Teredora*, Bartsch, *Bull. U. S. nat. Mus.* CXXXII, p. 32.

1942, *Teredora*, Edmondson, *Occ. Pap. Bishop Mus.* XVII (10), p. 127.

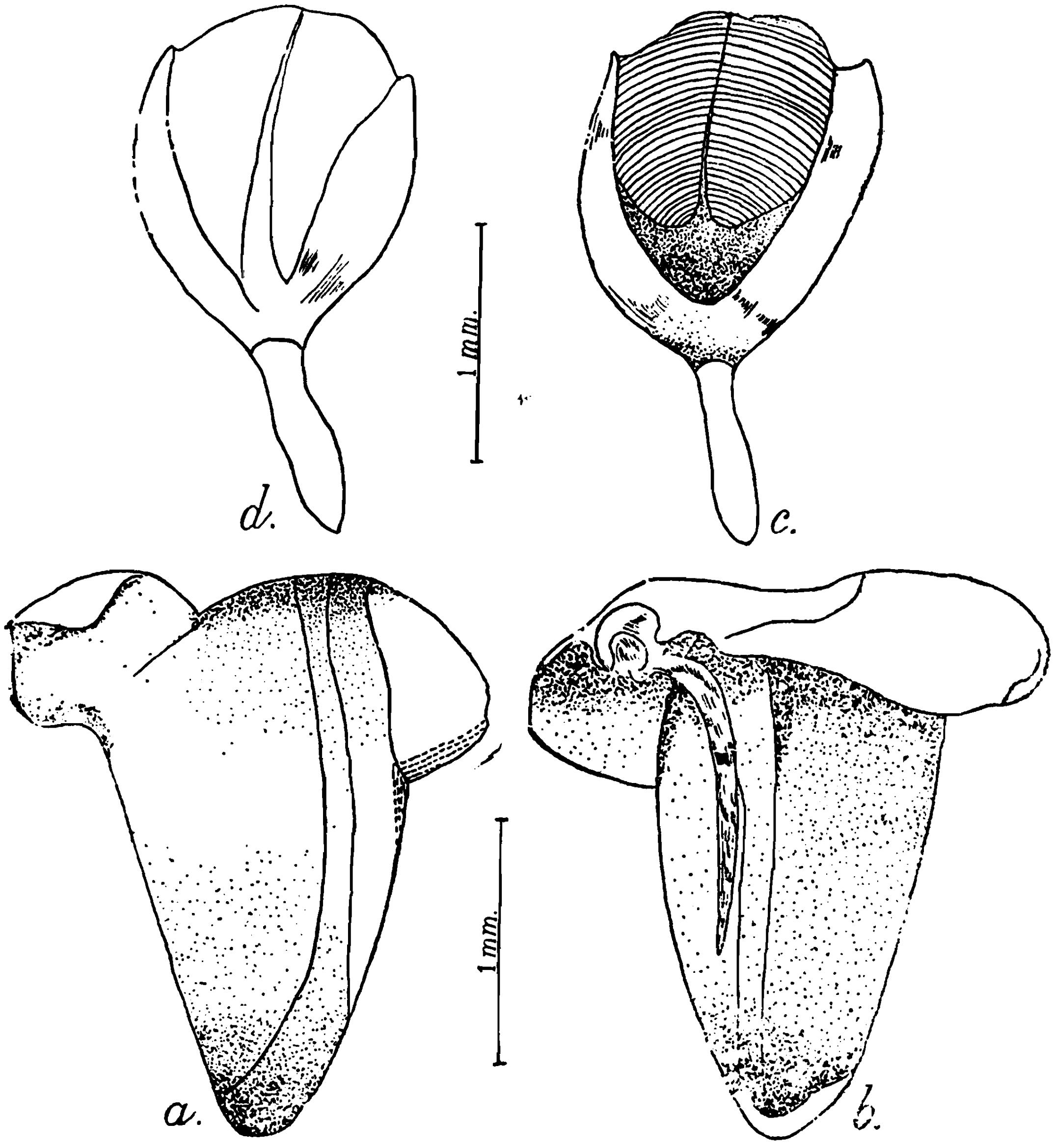
Teredo (Teredora) minori, sp. nov.

Locality.—Five specimens were recovered from a floating log on 12th January, 1954 from the Madras coast.

Measurements.—The burrow of the largest and sexually mature forms measured 3·2 cms. Shell length—2·0 mm. Shell height—24 mm. Pallet length—2·2 mm. Pallet stalk—0·8 mm. Breadth of blade—1·2 mm.

Characters.—The median part of the shell is considerably elongated and the anterior lobe and the anterior part of the median lobe are coloured light green. The anterior lobe has a shallow sinus and a reflected callus. From the former the dental ridges numbering notless than thirty emerge and pass backwards in an even curve. Some of these ridges are eroded at the umbonal region and separated by spaces about twice as their width. The anterior part of the median lobe is a narrow region and bears on its surface closely crawded dental ridges (of an equal number as on the anterior lobe) bearing stouter denticles at their free margins, the adjoining ridges being separated by mere impressed lines only. The middle-median portion forms a shallow area through the centre of which extends a very rough groove from the umbone to the ventral margin which is crossed by the enfeebled sub-obsolete extensions of the nental ridges. The posterior median portion is very broad, about twice as wide as the anterior and median part taken together. This area is smooth and convex and forms a moderately large exceedingly oblique auricle which is placed on the dorsal margin and is reflected at its distal end. This auricle resembles a pallet attached to the posterior median part in such a manner that it appears to project as much on inside as on outwards. At the junction of the auricle with the posterior median part there is an inflexion.

The interior of the shell is white. The umbones project into the interior as a strong boss from the ventral side of which is pendant a long cylindrical blade for more than half the distance into the cavity towards the ventral tip. A knob is present at the extreme ventral tip of the median portion. The anterior median portion forms a tumid line at its junction with the anterior lobe. The inner surface of the auricle bears lines of growth.



TEXT-FIG. 7.—*Teredo* (*Teredora*) *minoris*, sp. nov.

a.-b. Outer and inner views of the shell ; *c.-d.* Outer and inner faces of the pallet.

Pallet.—Small, paddle-shaped with a cylindrical stalk. To the latter is attached a solid blade the median portion of which is depressed and nail like. The nail portion is marked by feeble concentric lines with a tumid ridge starting from its base and running through its centre and tapering to a point at the distal tip of the blade. The inside of the blade is smooth and shows a prominent ridge running through its centre, to the distal tip of the blade.

Burrow.—with a thick calcareous tubing which is adherent to the wood.

Collar.—Slightly developed.

Remarks.—This shipworm may rightly claim its position into the subgenus *Teredora* Bartsch in the possession of a spoon-shaped pallet not cupped at the terminal border and without periostracum and the blade having a nail-like depression marked by concentric lines of growth, a shell with auricle placed upon the posterior median portion in such a way that half of it projects as a shelf inwardly. It resembles *Teredo (Teredora) thomsoni* Tryon in having an obsoletely ribbed pallet blade and a shell with an auricle which is obliquely placed, but differs from it in the possession of a green coloured shell whose height is proportionately much more than its length, whose auricle is of moderate size, the distal tip of which is reflected outwards and whose apophysis is not broad and expanded basally, but cylindrical and tapering to a point. Other differences are shown by the pallet, such as, the absence of the 'pocket' which is present at the basal margin on the outer side of the Thompson shipworm, and the presence of a tumid ridge running through the centre of the nail-like portion from the base to the tip of the outer face of the pallet. Further the relative proportions of the shell and pallet are also different. Hence the author intends to describe it as a new species based on the important characters mentioned.

ACKNOWLEDGMENTS

The author takes this opportunity to express his grateful thanks to Dr. C. P. Gnanamuthu, Director, University Zoology Laboratory, for his help and guidance in the preparation of this paper and to Dr. G. Krishnan, Reader, University Zoology Laboratory, for encouragement. The author is also thankful to Dr. Harald A. Rehder, Curator, Division of Molluscs, United States National Museum, Washington, for sending copies of all the papers published by the United States National Museum on marine boring molluscs.

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BIONOMICS AND SOME ANATOMICAL PECULIARITIES OF THE LIMBLESS LIZARD *BARKUDIA INSULARIS* ANNANDALE

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CONTENTS

INTRODUCTION

Degeneration of the limbs is of widespread occurrence in some families of lizards such as the Scincidae, the Dibamidae and the Anguidae. Of these, the two families Scincidae and the Anguidae are represented in India while the distribution of Dibamidae extends from the southern Indo-China and the Philippines to the New Guinea Archipelago. The reduction of the limbs is accompanied by an elongation of the body with a corresponding increase in the number of body vertebrae. In India, three genera of limbless lizards have been reported, namely, *Nessia* Gray and *Barkudia* Annandale belonging to the family Scincidae and a third genus, *Ophisaurus* Daudin of the family Anguidae. Six species of *Nessia* have been recorded, differing from one another in the varying degree of reduction of the limbs, the most degenerate being *Nessia layardi* (Kelaart) in which the limbs are completely absent, the hind ones being represented by a pair of minute horny tubercles hidden by scales in a depression of the body on either side of the vent. In *Ophisaurus gracilis* (Gray) and *O. harti* Boulenger there are no external vestiges of the limbs.

The genus and the only species *Barkudia insularis* was described by Annandale[1] based on a single specimen which he dug out from loose earth from the root of a banyan tree on Barkuda Island in the Chilka lake. A second specimen was seen by Dr. F. H. Gravely in the same locality, in 1919, rapidly burrowing into the earth. The only specimen collected by Dr. Annandale has since been reported lost from the Indian Museum during the floods at Banaras[2]. One of us recorded

[1] Annandale, N., *Rec. Indian Mus.* XIII, pp. 17-21 (1917).
[2] Personal communication to the senior author from the Director, Zoological Survey of India.

the occurrence[1] of a limbless lizard belonging to the genus *Barkudia* Annandale in the Andhra University campus. The first specimen was collected in July, 1949 and since then several specimens have been collected and an intensive study made of the bionomics and anatomy of this form. On a comparison of the local form with the description given by Annandale for the type species *B. insularis*, some minor differences are noticed but these do not appear to be of sufficient taxonomic value to warrant describing the present form as a new species of the genus. Unfortunately, the specimen collected by Annandale has since been lost and, as such, any comparison has to be made only with the description. We are, therefore, referring the local form as *Barkudia insularis* Annandale. A specimen of the lizard has been deposited in the Zoological Survey of India, Calcutta.

The present paper is an attempt to give the bionomics of the lizard based on our observations for the past five years. A detailed account of the anatomy will be published elsewhere shortly.

We are indebted to Dr. S. L. Hora, Director, Zoological Survey of India, for kindly confirming the identification of the lizard and for valuable suggestions in preparing this paper.

HABITAT, LOCOMOTION AND OCCURRENCE

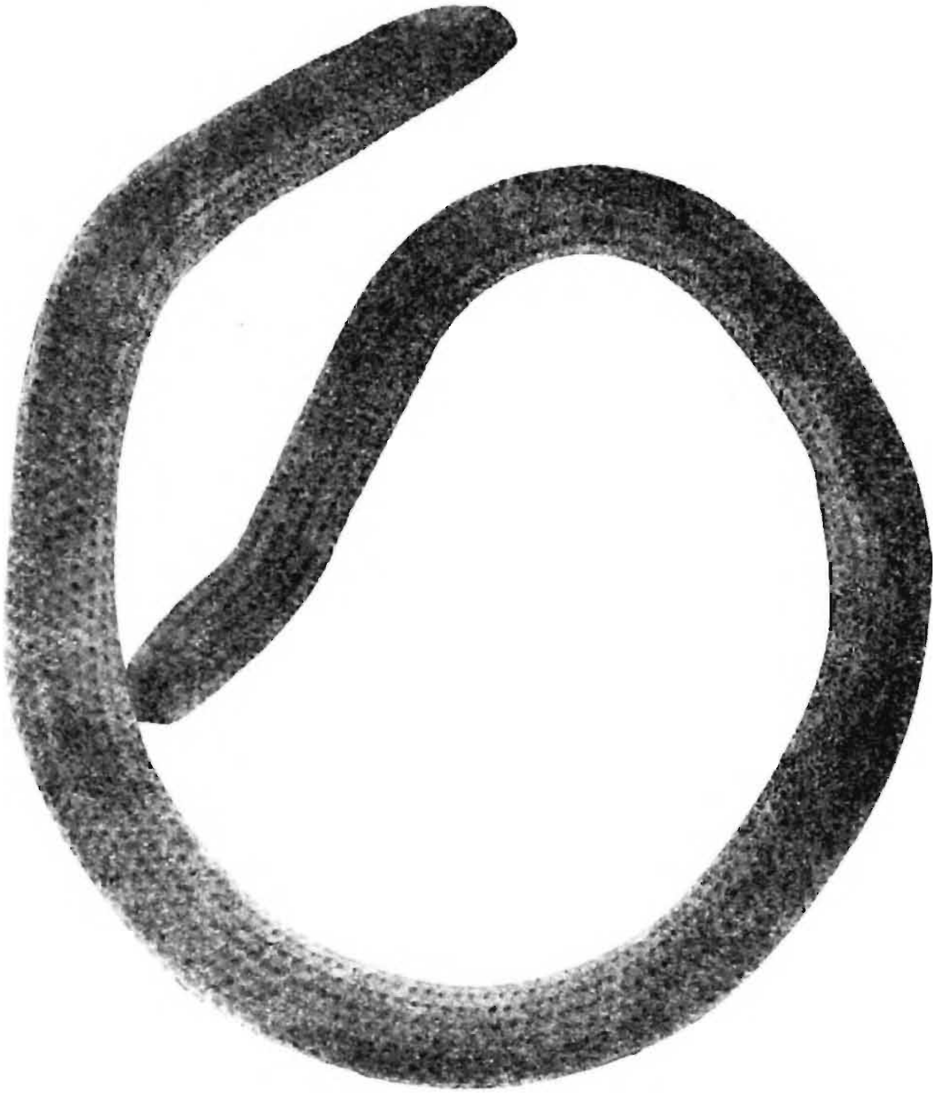
Waltair, where the University Campus is located, is a small hillock having an elevation of 157′ above M. S. L. The soil is made up of loose red sand and the vegetation is mostly composed of low shrubs and cashewnut groves. *Barkudia* lives buried in the shady sub-soil amidst the cashewnut plantations, overlaid by a thick layer of decaying leaves. In the same habitat could be seen a variety of other animals like centipedes, millipedes, beetles and their larvae, termites, spiders, scorpions and the blind snake *Typhlops* sp.

The lizard has been dug out at various depths below the surface. They may be found a few inches below ground to a depth of a foot or more. We have never seen them above ground, at any time, in their natural habitat. They live in distinct burrows or tunnels which do not collapse in the damp soil. When the lizards were kept in damp soil inside rectangular boxes with sides made of glass, the animals readily constructed the tunnels and their movements could be observed from outside. The tunnels have a zig-zag tortuous course in response to its snake-like locomotion and the animal moves both forwards and backwards in the tunnel with the same agility. They do not seem to live permanently in any one tunnel and the tunnels are frequently made afresh with the result that the soil is always kept in a loose and well aerated condition. When the animal is dug out and released on the soil it burrows with extreme rapidity and in a few moments it disappears below ground. The animal first lifts up its head and immediately the wedge-shaped snout is struck into the soil and the body performs active undulatory movements pushing aside the loose dry surface sand on either side. Once the head and part of the body enters the soil the rest of the body

[1] Ganapati, P. N. and Krishnan Nayar, K., *Current Science*, XXI, pp. 105-106 (1952).

is quickly drawn in and the animal disappears from sight, in a trice. When left on polished floor it is restless and its movements are very clumsy. It progresses by undulatory movements very much like that of a snake.

These lizards have been collected all through the year though they are seen in smaller numbers in the colder months of November, December, and January. They are also rare in the rainy months from June to October. They are fairly common in the summer months when the adult as well as juvenile forms are present.



TEXT-FIG. 1.—*Barkudia insularis* Annandale; entire.

External features.—The adult lizard (text-fig. 1) is long, slender and cylindrical with a short blunt tail. The head is dorso-ventrally flattened and narrowed anteriorly into an efficient burrowing wedge-shaped snout formed by the transversely elongated, rostral shield which projects beyond the lower jaw. The head is slightly broader than the tarnk but there is no distinct neck. In a specimen measuring 22 cms. the following were the dimensions of the various regions :—

Snout-Vent Length	15·0 cms.
Tail-length .	7·0 cms.
Snout-Orbit length . .	0·5 cm.
Head length . .	1·0 cm.
Mouth-orbital length . .	0·7 cm.
Inter-orbital length . .	0·5 cm.

The colour pattern has been found to vary to some extent from individual to individual. The common pattern is a glossy brown with a black spot in the middle of each scale. These spots form longitudinal rows which vary in number from 8 to 14 but ten of these rows are more conspicuous than the others. The ventral side is creamy white in colour. Towards the tail region the coloration gets more and more deep ending in a distinct uniformly dark pigmented cap over the tip of the tail. Some individuals instead of being glossy brown may be steel blue or orange brown in colour. The tip of the tail instead of being uniformly black may have a more diffuse pigmentation which increases in density gradually towards the tip. A number of individuals showing the two characteristic types of coloration of the tail were examined with a view to find out whether the difference has anything to do with the sex of the individual and it was found that both types occur in either sex. It is possible that the coloration may have something to do with the periodic shedding of the skin (Miller)[1], or it may be that there are two distinct varieties of the same species occurring locally.

The minute external narial openings are present on the dorso-lateral edges of the snout just above the rostral shield at the antero-lateral edge of distinct nasal shields.

The ear openings are also minute and are located on the dorso-lateral sides at the posterior end of the head at about the level of articulation of the lower jaw and behind the parietal shields.

The eyes are also small but quite functional. They are present on the dorso-lateral sides of the head, in between the external narial openings and the ear apertures. A well developed movable lower lid is present.

The tail is cylindrical and rounded at the tip. The relative length of the tail with the rest of the body is highly variable. In some cases the tail is nearly half as long as the body while in others it is less than a fourth the body length. As in many other lizards the tail is highly fragile and the animal is also capable of regenerating its broken tail.

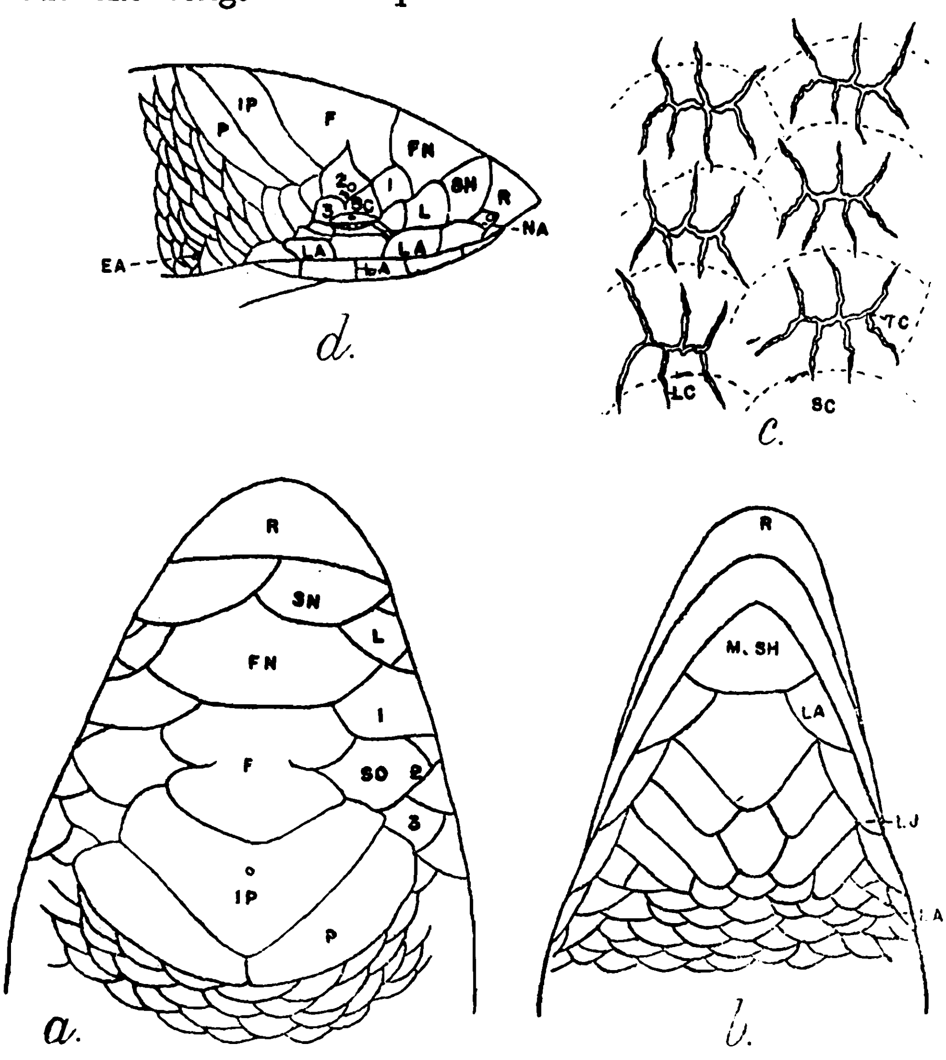
The head is covered by the shields and the body by the scales (text-fig. 2 *a, b, d*). The genus is characterised by three large azygous shields in the dorso-median side of the head and a number of smaller shields. Anteriorly is the rostral emarginate laterally to receive the nasals. The supra-nasals are large, in contact with one another behind the rostral and with the first labial. The first large azygous shield, fronto-nasal, is broader than long and larger than the frontal which follows. The middle azygous shield, frontal is longer than the fronto-nasal, strongly emarginate laterally to receive the first supraocular. The third shield, interparietal is much larger than the frontal. The parietals are narrow and obliquely placed, in contact with the fronto-nasal also. The third is small. There is a single loreal, a large single preocular, a single superciliary, a single subocular and two postoculars. The lower eyelid is composed of two or three scales while the upper eyelid is vestigeal. There are four supralabials; the third largest, below the eye, and a single azygous postmental (text-fig. 2, *c*).

[1] Miller, C.R., *Ecol. monogr.* Durham N. C. XIV (3), pp. 71-289 (1944).

There are 140 scales between the postmental and the preanal scales. There are 20 to 22 scales round the middle of the trunk. The preanal scales are not enlarged.

The head is very small and consequently the gape of the mouth is small. The teeth are pleurodont, arranged in a row both along the upper and the lower jaw. They are small, conical and slightly curved. In addition to the teeth on the jaws there are also teeth on the palate. The pterygoid at its anterior end, where it meets the palatine, bears on each side a row of two or three conical teeth (text-fig. 3*b*) arranged in an oblique row along the flange of the bone. There are no teeth on the palatine or vomer. The new teeth arise at the base of the old ones as in Anguidae and not in the sockets of the old ones as in the Scincidae.

The tongue is long and slender and bifid at both ends. The animal shoots out the tongue at frequent intervals.



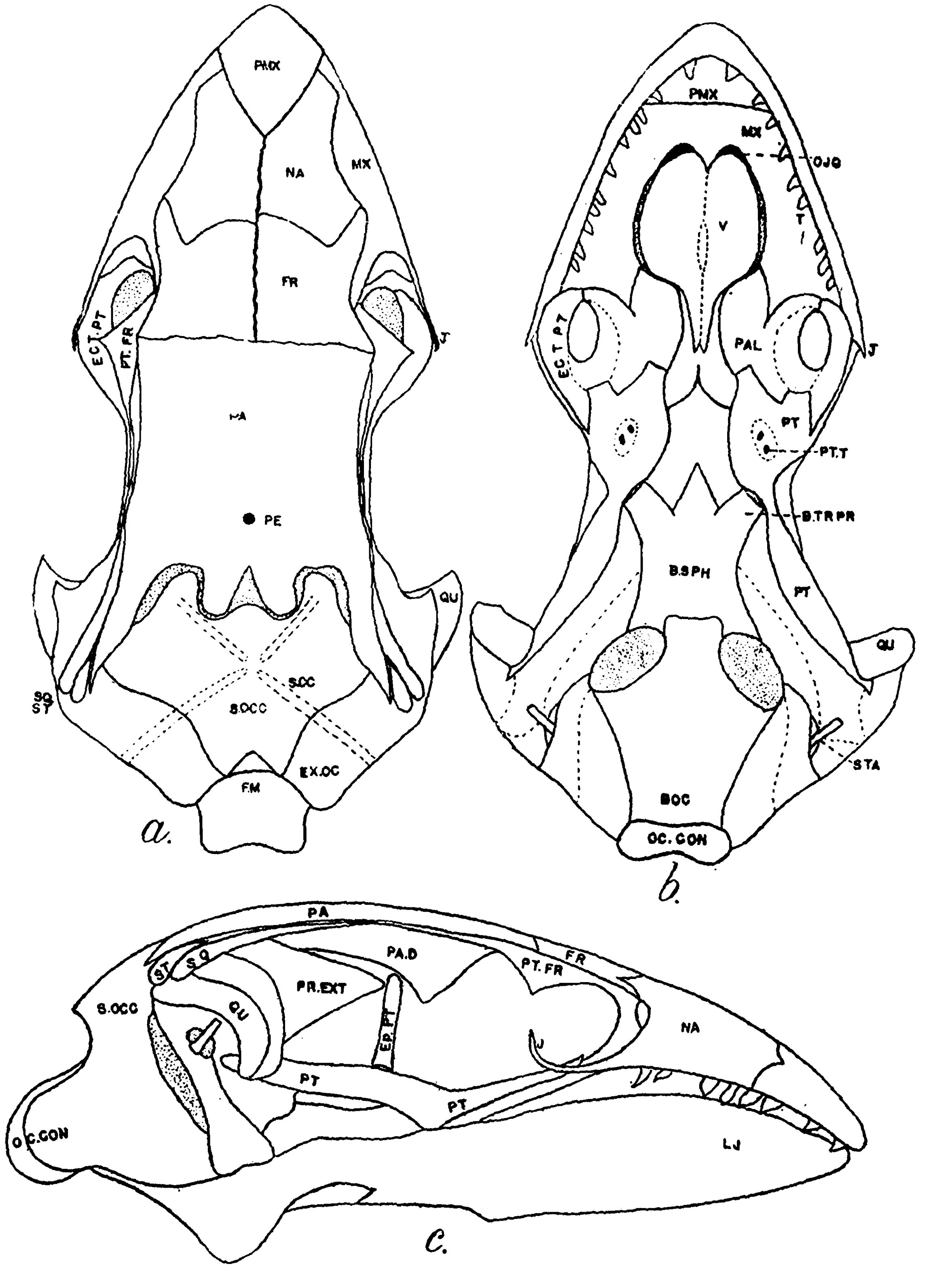
TEXT-FIG. 2.—*Barkudia insularis* Annandale.

a. Dorsal view of head showing the arrangement of shields; *b*. Lateral view of head; *c*. Ventral view of head; *d*. Microscopic structure of scales.

EA., ear aperture; F., frontal shield; FN., fronto-nasal shield; IP., interparietal shield; L, loreal shield; LA., upper and lower labial shields; LC., longitudinal canal; LJ., lower jaw; M. SH., mental shield; NA., nasal shield; P., parietal shield; R, rostral; SC., scale; S.C., supraciliary; SO., supra-oculars 1, 2, and 3; SN., supranasal shield; TC., transverse canal.

FOOD AND FEEDING HABITS

Barkudia is mostly insectivorous in its diet. Examination of the gut contents of a large number of specimens has shown termites, adults and larvae of beetles, insect's wings and appendages, centipedes, and occasionally remains of spiders and scorpions. As already mentioned in an earlier part of the paper these animals, which constitute the prey of the lizard, are found in large numbers in the natural habitat of the lizard.



TEXT-FIG. 3.—*Barkudia insularis* Annandale.

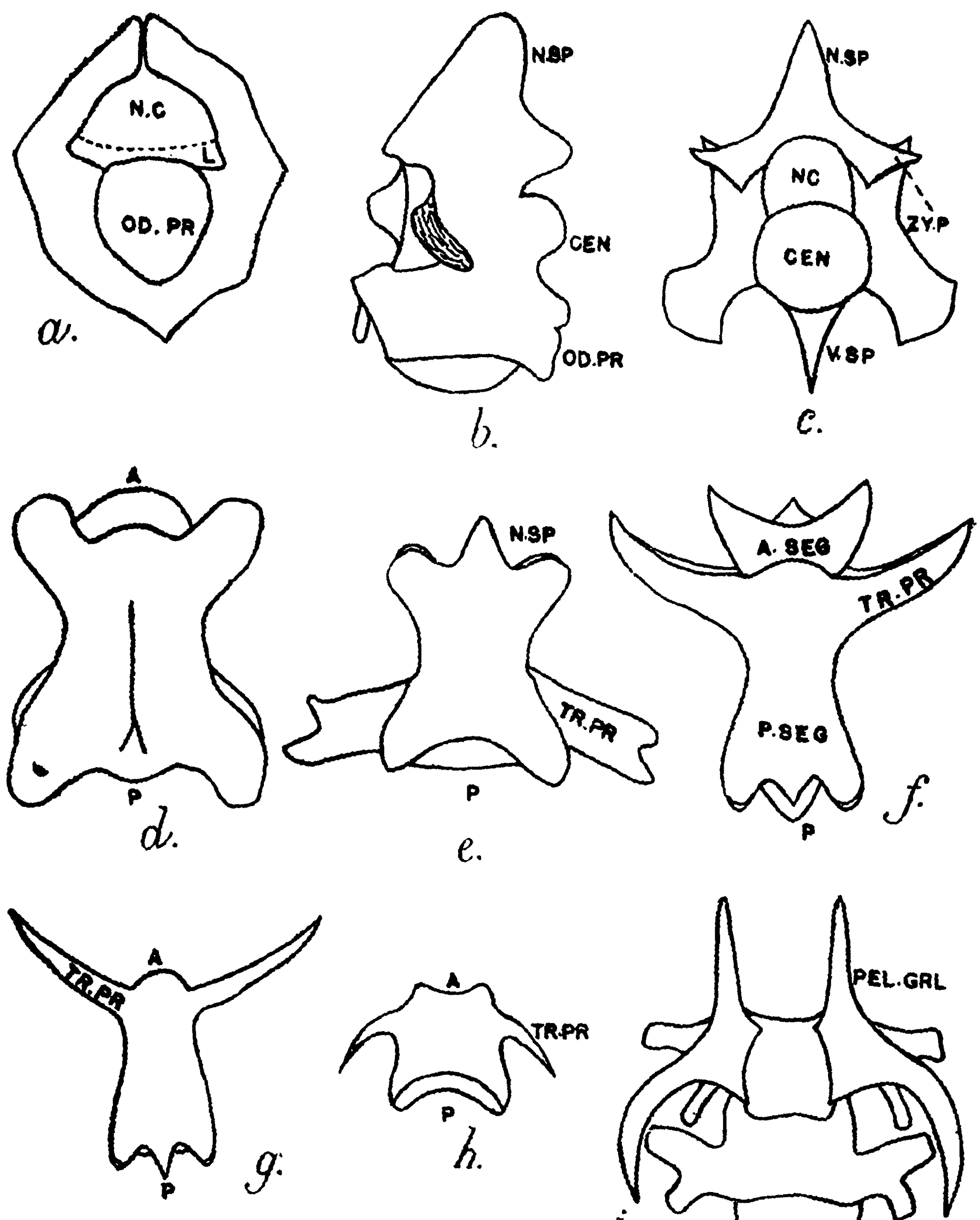
a. Dorsal view of skull; *b*. Ventral view of skull; *c*. Lateral view of skull.

BOC., basioccipital; B. TR. PR., basitrabecular process; BSPH., basisphenoid; ECT. PT., ectopterygoid; EP. PT., epipterygoid; EX. OC. exoccipital; FR., frontal bone; F.M., foramen magnum; J., jugal; LJ., lower jaw; MX., maxilla; NA., nasal bone; OC. CON., occipital condyle; OJO., opening of the organ of Jacobson; PA., parietal bone; PE., pineal eye; PAL., palatine; PMX., premaxilla; PR. EXT., prootic extension; PT., pterygoid; PT. T., pterygoid teeth; PT., FR. post-frontal; QU., quadrate; S. CC., semicircular canals; S .OCC., supraoccipital; SQ., squamosal; ST., supratemporal; V., vomer.

We have observed the feeding habits of the lizard under laboratory conditions. A colony of termites was introduced into the terrarium where the lizards were kept. The termites soon started going in all directions and some of them burrowed into the earth. A few moments later, presumably owing to the disturbance caused, one of the *Barkudia* was seen to pop out its head, from the burrow, and to remain in that position for a while and when it noticed the presence of the termites it pushed out its head and a part of the body, waited for a few moments and with a sudden jerk it snapped the prey and immediately withdrew into the burrow. This operation was repeated several times before the lizard finally withdrew into its burrow. Apparently a small quantity of soil is also gulped in along with the prey as the stomach contents examined invariably showed an admixture of sand.

ANATOMICAL PECULIARITIES

Most of the specialisations and degeneration associated with the elongation of the body, disappearance of the limbs and assumption of a burrowing mode of life are to be found in the skeletal system. The skull is conical, tapering to a fine point anteriorly (text-fig. 3 *a*, *b*, *c*). The orbito-temporal region is specially elongated with a marked lengthening of the parietal above and the pterygoids below. The contour of the whole skull including the snout is remarkably smooth without any angles and projections, which are likely to impede a burrowing subterranean life. The frontals and the parietals have downward extensions which form the side walls of the cranium along with the well developed prootic extension. The frontal downgrowths separate the orbits in the median line. The elongation of the cranium up to the base of the nasal capsules, the absence of the lower temporal arcades and both the fossae, the extreme reduction of the temporal bones, the possession of strong membrane bones surrounding the olfactory capsules and the formation of an efficient burrowing tip by the premaxillae, maxillae, nasals and vomer are the other specialised features associated with the subterranean life of the lizard. While *Barkudia* shares the above degenerate features with other burrowing lizards, there are indications to show that in other respects degeneration has not completely set in. A superior temporal arcade formed by the meeting of the forward process of a tiny squamosal and a backward process of the post-frontal could be made out even though a fossa is not present. A very much reduced second temporal element, namely, the supratemporal is present. A well-developed but slender epipterygoid is present. The basitrabecular processes are also well developed. The line of flexion seems to be still metakinetic at the parieto-supraoccipital angle as evident by the presence of a wide gap between the two where the tendons from the body are attached. In other burrowing lizards this line has shifted either completely or to some extent to the fronto-parietal suture and the flexion is mesokinetic which is a specialised feature not seen in *Barkudia*. The hyoid apparatus is complex in *Barkudia* as in typical lizards, unlike the condition in *Anniella* where it is a simple rod which is bifurcate posteriorly with a simple branchihyal attached to the end of the branches, The number of vertebrae is very large and the maximum number observed by us is 113 made up of 69 pre-caudals and 44 post-caudals. The vertebrae are procoelous (text-fig. 4, *a—f*). All the pre-caudals except the first three and the last three bear ribs and the caudal vertebrae have long transverse processes. All the caudal vertebrae possess complete chevrons at the posterior end of their centra. The transverse splitting of the vertebra commences from the third caudal. The split is in the anterior region (text-fig. 4, *f—h*) cutting off a small anterior segment



TEXT-FIG. 4.—*Barkudia insularis* Annandale.

a. Atlas; *b.* Axis, lateral view; *c.* A Cervical vertebra showing well-developed neural spine, ventral spine and transverse process; *d.* A typical vertebra; *e.* A sacral vertebra showing the forked transverse processes; *f.* A typical caudal vertebra showing the plit in the anterior region; *g.* the posterior segment of the caudal vertebra; *h.* the anterior segment of the caudal vertebra; *i.* Sacral region showing the two halves of pelvic girdle.

A., ligament running across the atlas in its middle; N.C., neural canal; N.SP., neural pine; OD. PR., odontoid process; P., posterior end; P. SEG., posterior segment; PEL. GRL., pelvic girdle; TR. PR., Transverse process; V. SP., ventral spine; ZY.F., Zygapophyses.

and a large posterior segment. The number of body as well as tail vertebrae varies.

The pectoral girdle is completely absent and not even vestiges of it are left. The corresponding blood vessels supplying the limbs and girdle are also absent. The sternum is also totally absent.

Though not even vestiges of the hind limbs are present the pelvic girdle is represented by a pair of tri-radiate bones, one on either side, attached by ligaments to the vertebra immediately next to the last rib bearing vertebra (text-fig. 4, *i*). These two bones do not meet in the mid-ventral line.

In the internal anatomy of the soft parts also there are some characteristic changes. All the internal organs show a marked elongation, as in the snakes, corresponding to the elongation of the body. The alimentary canal is more or less a straight long tube without many coils as in the normal lizards. The liver has only a single well developed long lobe with a very small secondary lobe. The main lobe extends for a little distance behind the heart to the posterior end of the stomach.

There are two lungs, both functional, but asymmetrical in conformity with the elongated snake-like body. The right lung is very much elongated while the left is smaller and about half the length of the right one. The trachea is also very long.

In the circulatory system there are a few special features. The heart is shifted far backwards but it has the normal saurian structure. Consequent on the absence of the anterior limbs and girdles no trace of the blood vessels supplying these organs are seen. It is remarkable that there are many more than the normal number of arteries supplying the alimentary canal. There are as many as five or six branches of the dorsal aorta supplying the oesophagus, two gastrics, an anterior mesenteric and a posterior coeliaco-mesenteric. The two iliacs run backwards and end in the vestiges of the pelvic girdle.

In the nervous sytem the brain has a normal lacertilian structure but there are a few peculiarities connected with the sense organs. The external narial openings are very minute which prevent sand particles and other foreign bodies entering the nasal organs when the animal burrows. The Jacobson's organs are well developed and according to Pratt[1] this is associated with the ground living existence. It is more or less spherical lying beneath and lateral to the junction of the anterior and the olfactory chambers of the nasal organ. Posteriorly it opens by a slit-like aperture into the buccal cavity. The walls of the organ are much crenated. The choanal tube connecting the nasal sac with the pharynx is drawn out into a ductus naso-pharyngeus as in other burrowing lizards.

The eyes though very minute in size have a normal structure and are not in any way degenerate. There is no trace of the upper eyelid while the lower lid is well developed and movable. In some of the sections of the eye we have observed a vascular tissue extending from the

[1] Pratt, C. W. M., *Proc. zool. Soc. Lond. CXVIII*, pp. 171-201 (1948).

retina through the vitreous chamber to the base of the lens which corresponds to the pecten in lizards. The presence of a pecten has not been reported in any of the other burrowing lizards.

A tympanic membrane hidden by muscles is present below the external ear apertures. The middle ear has a normal structure with the columella auris and the internal ear has the semicircular canals and the calcareous otolith.

BREEDING HABITS

In the male the external genitalia consists of a pair of tubular hemipenis which, when withdrawn, are directed backwards and lie parallel to the vertebral column on the postero-lateral sides of the cloacal chamber.

We have not yet succeeded in getting the eggs of the lizard despite intensive search for them for the past five years. In one of the terraria where a female was kept in captivity an oblong egg measuring nearly 15mm. in length was collected. The egg was pure white covered by a leathery shell membrane. On opening the egg was found to be in a damaged condition. The lizard was dissected and a second egg similar to the one described above removed from the left oviduct. This also did not contain the embryo and apparently was unfertilised. Though large numbers of the lizard have been dissected we have not so far any evidence to show the existence of viviparity in the present form as has been reported in some of the Scincidae. The smallest specimens examined by us were about 12cms. in length and were very active like the adults. We are inclined to believe that *Barkudia*, like many other Scincidae, is oviparous. The search for the eggs from the natural habitat of the lizard is being continued.

DISCUSSION

It is interesting to compare the limbless burrowing *Barkudia* with similar lizards reported from other parts of the world. Excellent accounts are available of the African burrowing skink *Acontias meleagris* (Brock)[1], of the American limbless lizard *Anniella* (Coe and Kunkel[2]; Bellairs[3]; Miller[4], and the Amphisbaenids of Africa and South America (Zangerl[5]; Bellairs[6]). Besides the above, brief scattered reports of other burrowing lizards are also available.

From Brock's account of the skull of *Acontias meleagris* many of the features described for the form seem similar to those of *Barkudia*. The prootic bone has a prootic extension which forms part of the side wall in the orbito-temporal region. A large epipterygoid widely separated from the quadrate is present. The features in which it differs

[1] Brock, G. T., *J. Linn. Soc.* (*Zool.*) XLI, pp. 71-88 (1941).

[2] Coe, W. R. and Kunkel, B. W., *Trans. Conn. Acad.*, XII, pp. 349-403 (1906).

[3] Bellairs, A., *Proc. Zool. Soc. Lond.* CXIX, pp. 73-83 (1950).

[4] Miller, C.R., *Ecol. monogr.* Durham N.C., XIV (3), pp. 71-289 (1944).

[5] Zangerl, R., *Amer. Midland. Nat.*, Notredame, XXXI (3), pp. 417-454 (1944) *Amer. Midland. Nat.*, Notredame, XXXIII (3), pp. 764-780 (1945).

[6] Bellairs A., *J. Linn. Soc.* (*Zool.*), XLI, pp. 482-512 (1949); *Proc. Zool. Soc. Lond.*, CXIX, pp.73-83 (1950).

from *Barkudia* are the absence of a superior temporal arcade, the palatal bones being large and scroll-like, open as a groove all along the ventral median line and the tube containing an elongation of the nasal passage with the internal nares situated at the posterior end of the palatines. The skull is mesokinetic instead of the metakinetic condition of *Barkudia*.

In *Acontias niger* (Peters)[1] and *A. plumbens* (Bellairs) the squamosal and post-orbital form a complete superior temporal arch as in *Anguis* and *Ophisaurus*. The same condition is seen in *Barkudia* except that the elements concerned in the formation are post-frontal and squamosal.

From Bellairs' account of *Nessia* a burrowing skink from Ceylon, the anatomy of the skull seems to be similar to that of *Barkudia, Anniella* and *Acontias*. Here too the temporal region of the skull is elongated, the fronto-parietal downgrowths are present, the temporal arches have been lost, squamosal and jugal are reduced, and the post-orbital absent.

Brock gives the characters of *Typhlosaurus auranticus* (Anelytropsidae) based on Peters' figures and says that all the features are very similar to *Acontias meleagris* except that instead of the one vestigeal temporal bone in *T auranticus*, both *Acontias* and *Barkudia* have two.

Feylinidae and Anelytropsidae also conform to the features characterising burrowing forms in that they are stated to lack temporal arcades (Boulenger[2] ; Cope[3] ; Camp[4]). The epipterygoid and basitrabecular precesses are well-developed (Bellairs), as in *Barkudia, Anniella* and *Acontias*. In *Feylinia* the parieto-occipital angle does not seem to be much reduced as is the case in *Barkudia*.

The various accounts on *Anniella* (Bellairs, Coe and Kunkel[5]; Miller, confirm the similarity of features of this form and *Barkudia*. A few in which it differs are that the posterior margin of the parietal is unusual in possessing a triangular median process which projects backward over the processus ascendens. Bellairs states "It seems likely that in *Anniella* the transference from the primitive metakinetic condition to the mesokinetic state has largely taken place" There is no superior temporal arcade in *Anniella*.

Anguis fragilis (Anguidae) according to Bellairs serves to illustrate an early stage in burrowing adaptation. Here there are frontal downgrowths, a feature not restricted to burrowing forms alone. Parietal downgrowths, the presence of which is associated with burrowing existence, are absent in *Anguis*. Moreover the skull shows metakinetic line of flexion as in *Barkudia*.

A comparison of *Barkudia* to Amphisbaenidae reveals a few interesting points. The general morphology of the skull is similar, and in *Amphisbaena voilacea*, Brock states that "it is even more slender and

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[1] Peters, W.C.H., *Naturwissenschajtloche Reive nach Mossambique. Zoolog'e* Amphibien. G. Reimer, Berl n (1882).

[2] Boulenger, G. A., *Catalogue of the lizards in the British Museum* (Natural History) (1887).

[3] Cope, E. D., *Ann. Rept. U. S. Nation. Mus.* (1889), pp. 151-1294 (1900).

[4] Camp, C. L., *Bull. Amer. Mus. Nat. Hist.* XLVIII, pp. 289-482 (1923).

[5] Coe, U. R. and Kunkel, B. W., *Amer. Nat.* XXXVIII, pp. 487-490 (1904), *Anat. Anz.*, XXVI, pp. 219-222 (1905).

lacking in angles and projections calculated to impede a subterranean existence. The downgrowths of parietals and frontals have formed a solid cranial box extending to the skull floor and entirely obliterating the inter-orbital septum. There is no trace of an epipterygoid nor of any temporal arcade bones. The lower jaw is foreshortened and the quadrate relatively lengthened which has the effect of lessening the gape of the jaws in a manner one might expect to be favourable to a burrowng mode of life" Versluys[1] pointed out that Amphisbaenidae possessed mesokinetic skulls. He also reports that a basitrabecular process is lacking in *Amphisbaena*. According to Bellairs Amphisbaenidae 'presents a combination of highly adaptive features with certain others, less obviously adaptive'. From Zangerl's account, it is clear that vestigeal sternem and shoulder girdle elements are present in all genera of Amphisbaenidae. The pelvis and hind limbs are highly vestigeal. In his words 'the numerically varying position of the cloacal region in different Amphisbaenidae and the variable qualitative and quantitative development of the ribs transverse and ventral processes at the end of the cloacal series suggest a phylogenetic displacement of this region towards the tail' The eyes are reduced in varying degrees.

Brock referring to Peters' account of the burrowing snakes *Typhlops* and *Glauconia* finds a close similarity between the skull of *Glauconia* and *Amphisbaena*. She, moreover, states that 'the typical ophidian skull has a very unique appearance, but its peculiarities are all modifications to provide the wide gape of the specialised snake. When we discount these modifications we find that the remaining ophidian characters are those described for *Glauconia*, features which are all associated with a subterranean existence'.

She further adds that "In this comparative study of *Acontias* with other burrowing lizards and snakes, I have detected no features in skull structures which differentiate the Ophidia from the Lacertilea. The burrowing lizards and burrowing snakes form an intermediate series which completely bridge the gap between the typical lizards and the specialized snakes"

SUMMARY

The paper deals with the bionomics and some aspects of the anatomy of a limbless lizard, *Barkudia insularis* Annandale occurring in the University Campus, Waltair.

The lizard is an efficient burrower and lives in underground tunnels. It is mainly insectivorous in diet. Its food and feeding habits are briefly described. The eyes are normal and functional, unlike the degenerate condition found in some of the Amphisbaenidae. Minute external ear openings are present. The internal organisation shows the usual asymmetrical condition in some of the organ systems, such as the lungs, liver, etc. which is associated with the elongation of the body and the assumption of a snake-like condition. In the blood vascular system there is no trace of the vessels supplying the anterior limbs and the pectoral girdle, in conformity with the total absence of the pectoral

[1] Versluys, *Zool. Jahrb.* Suppl. XV (2), pp. 545-716(1912).

girdle and the anterior limbs. The iliacs are represented supplying the vestiges of the pelvic girdle.

In the skull the important specialised features are the elongation of the cranium up to the base of the nasal capsules, the absence of the lower temporal arcades and their fossae, the presence of the downgrowths of frontals and parietals which along with the prootic extension form a side wall to the cranium, the presence of strong membrane bones surrounding the olfactory capsules and the formation of an efficient burrowing tip by the premaxillae, maxillae, nasals and vomer.

The pectoral girdle and the anterior limbs are totally absent while the pelvic girdle is represented by vestiges.

The anatomical peculiarities of *Barkudia insularis* are compared with those of other burrowing lizards recorded from other parts of the world and a general discussion made about the evolutionary trend of these limbless lizards in the light of our present knowledge of the subject.

NICHOLLSIDAE, A NEW FAMILY OF PHREATOICOIDEA (CRUSTACEA : ISOPODA)

By KRISHNA KANT TIWARI, *M.Sc., Ph.D., Zoological Survey of India, Calcutta.*

The suborder Phreatoicoidea of isopod crustaceans is mostly represented in Australia, Tasmania, and New Zealand, and occurs outside this area in South Africa (3 species belonging to the genus *Mesamphisopus* Nicholls[1]) and India (monotypic genus *Nichollsia* Chopra and Tiwari[2]). Chopra and Tiwari placed *Nichollsia* in a new subfamily Nichollsinae under the family Amphisopidae with which it agrees in having lacinia mobilis on both the mandibles. The authors had, however, taken account of the many acute differences that the Indian genus shows when compared with other members of this suborder.

About two years back, Prof. G. E. Nicholls made the following remarks in a personal communication to me:

> " I entirely agree with you—after reading the paper[3] that you were justified in separating it[4] from the Hypsometopinae. Indeed on account of the structure of the uropods (in adult) of which I was ignorant, I think it might even warrant a separate family—*there is nothing like it in living or fossil forms!* It clearly represents a very early departure from the main line." (Italics mine.)

A re-examination of the material of *Nichollsia kashiense*, preserved in the Zoological Survey of India, Calcutta, in the light of the remarks made by Prof. Nicholls has convinced me that there are many marked differences between this species and its relatives in South Africa and Australian region, and these should serve justify establishment of a new family to accommodate the Indian form.

Order ISOPODA

Suborder *PHREATOICOIDEA*

Family NICHOLISIDAE, nov.

The characters of this family are as follows:

Body long, subcylindrical, vermiform ; head relatively short, cervical groove incomplete.

Peraeon segments longer than deep, with well marked mesial sternal ridges, first segment free from head ; pleon segments with pleura feebly expanded downwards ; tail-piece long, smooth, without a suture between the sixth pleon segment and telson ; posterodorsal edge of telson emarginate with corresponding lateral margins crenulate.

[1] Nicholls, G. E., *Pap. & Proc. Roy. Soc. Tasmania* 1942 (issued Aug. 1943) ; and *ibid*, 1943 (issued Dec. 1944).

[2] Chopra, B. N., and Tiwari, K. K., *Rec. Indian Mus.* XLVII, pp. 277-290 pl. xvii-xx (1950).

[3] It refers to the paper by Chopra and Tiwari (1950), cited above.

[4] The genus *Nichollsia* Chopra & Tiwari.

Both mandibles with lacinia mobilis; maxillula with numerous setose spines on the proximal endite; coxae of peraeopods not fused with pleura of related segments, nor their bases expanded; pleopods without coupling hooks or epipodites, almost free from setae or spines, endopodite mesially cleft, exopodite bilobed with the second lobe lateral in position; uropods long, smooth, distomesial edge of the peduncle armed with three blunt tubercles; outer ramus of the uropod longer than the inner, lamella with a tuft of stiff setae at the apex; the inner ramus short, stout, shaped like the blade of a sickle.

Penial stylet free from endopod, curved, with a complex musculature.

Type genus.—*Nichollsia* Chopra & Tiwari, 1950.

Remarks.—Family Nichollsidae contains characters peculiar to itself and also those occurring in other phreatoicoid families.

With Amphisopidae this family agrees in the general structure of mouth parts. They are clearly amphisopine. The presence of lacinia mobilis on both the mandibles is a distinctive feature of Amphisopidae which it shares with the Indian family. Again the condition of cervical groove, multi-jointed filament of antennule, presence of several plumose setae on the proximal endite of maxillula and the structure of maxilla link Nichollsidae with Amphisopidae.

The general facies of *Nichollsia* is, however, more phreatoicine, than amphisopine. As in Phreatoicidae, the first peraeon segment in Nichollsidae is free from the head, the coxae of peraeopods are not fused with pleura of related segments and the bases of peraeopoda are not flattened.

The simillarity of Nichollsidae with Amphisopidae and Phreatoicidae seem to end here. It has many unique features of its own, new to the suborder. The most important characters, however, relate to the pleontelson.

As pointed out by Prof. Nicholls the telson and uropods of *Nichollsia* are very peculiar and "have nothing like it in living or fossil forms". Without any exception the tail-piece and uropods in all phreatoicoid isopods are armed with several spines and there is a distinct suture marking the boundary between the sixth pleon segment and telson. In Nichollsidae this suture is absent and by way of armature there are only three spines on each side on the antero-inferior pleural margin of tail-piece. The uropods, with the outer rami much longer than the inner, show a condition very much like that in syncarida and reverse of that met with in all members of Phreatoicoidea. The emarginate postero-dorsal edge and the crenulate postero-lateral margin of telson of *Nichollsia* is, similarly, wothout parallel in the suborder.

The sexual dimorphism in the outer ramus of uropods is an interesting feature of *Nichollsia*. In the females the outer ramus, although longer than the inner, is never very long. In the males, although the young ones resemble females, as growth proceeds the size of the outer ramus increases at a faster rate and in the large specimens it may be one and a quarter times as long as the tail-piece.

The pleopods of Nichollsidae agree with those in other families in the structure of the exopodite of the first pair. But the endopodites of all, and exopodites of remaining four pairs, are typically nichollsine. The mesially cleft endopodite of pleopod is not met with in Amphisopidae and Phreatoicidae and probably it represents a condition unique in whole of the order Isopoda. The exopods of second to fifth pleopods, though bilobed as in other Phreatoicoids, have the lobes laterally placed unlike others where the general conditions is that these lobes are terminal. The tendency towards lateral displacement of these lobes is present in the subterranean amphisopid genera *Hyperoedesipus* and *Phreatoicoides*. There are no coupling hooks on the sympodites of pleopods in Nichollsidae, and there is a general absence of setae or hairs from the entire pleopods. As in *Hyperoedesipus* and *Phreatoicoides* there are no epipodites on pleopods. All other members of Phreatoicoidea have epipodites on the posterior three or four pleopods.

Judged from the behaviour of live animals of this family in the laboratory, the pleopods seem to be exclusively respiratory in function and do not appear to have any active role in propulsion. In fact, the members of this family are no good swimmers at all, and when compelled to do so the movements very much resemble those of a caterpillar disturbed in his rambles.

The distinctive characters of Nichollsidae are no doubt, due to its isolation from the parent stem at a very early period in the geological history. Hardly any of these characters can be classed as primitive except perhaps the sternal ridges on the peraeon segments. The subterranean habitat of this family has led to specialisation of many features. On the other hand the ancient characters of Nichollsidae are those that it shares with Amphisopidae and Phreatoicidae. These are not many and are easily outnumbered by its distinctive features. It is, therefore, quite reasonable to separate the Indian genus from Amphisopidae, where it was placed by its authors, and to keep it in a new family.

The addition of Nichollsidae raises the number of families in the suborder Phreatoicoidea to three, which can be distinguished from each other as follows :

I. Lacinia mobilis on both mandibles.

A. Endopodite of pleopods mesially cleft; outer ramus of uropod longer than the inner.

NICHOLLSIDAE.

(Monotypic : India.)

B. Endopodite of pleopods entire; outer ramus of uropod shorter than the inner.

AMPHISOPIDAE.

(South Africa ; Australia ; Tasmania.)

II. Lacinia mobilis only on the left mandible.

PHREATOICIDAE.

(Bassian region of Australia ; New Zealand.)

NEW SPECIES AND SUBSPECIES OF INDIAN FRESHWATER PRAWNS

By KRISHNA KANT TIWARI, *M.Sc., Ph.D., Zoological Survey of India, Calcutta*

While studying the unnamed collections of the freshwater prawns of the genus *Palaemon* preserved in the Zoological Survey of India (Indian Museum), I have come across several new species and subspecies. Most of these have already been described by me[1] on earlier occasions and the present note contains brief descriptions of four more forms which seem to be new to science.

Family PALAEMONIDAE

Subfamily *PALAEMONINAE*

Palaemon assamensis, sp. nov.

Diagnosis.—Rostrum generally longer than the antennular peduncle, occasionally extending as far as the apex of the antennal scale, 0·5—0·8 as long as carapace, broadly triangular in profile, upper edge horizontal, apex acute; rostral formula 7-11/2-5 with usually three teeth on the carapace behind the orbital border.

Carapace with scattered, minute prickles.

Third maxillipeds not extending beyond the middle of the antennal scale.

First pair of peraeopods with chela slightly longer than half the carpus.

Second pair of peraeopods subequal, subcylindrical, not as thick as in *P. hendersoni*, $\frac{3}{4}$ to $\frac{4}{5}$ as long as body in adult males but never less than half the total length of body at any stage in both the sexes; merus always somewhat longer than carpus; carpus gradually thickened distally, generally more than thrice but never more than five times as long as its distal thickness; palm slightly broader than carpus, a little compressed, longer than carpus in males measuring more than 45 mm. and subequal to or shorter than the latter in young males and females; chela more than twice as long as carpus in adult males but may be less in females and young males; fingers slightly longer than palm, fluted, with velvety pubescence arranged along the grooves, females and young males with fluting and pubescence weaker, cutting edge non-gaping, with teething as in *P. hendersoni* but weaker.

[1] Tiwari, K. K., *Rec. Indian Mus.* XLV, pp. 329—331 and 333—345 (1949; *Ann. Mag. nat. Hist.* (12) V, pp. 27—32 (1952).

Largest male 70 mm. in total length, largest female 61·7 mm., egg-bearing females from 45 to 50 mm. generally.

Type-specimen.—Holotype, Male, No. C 3339/1, Zoological Survey of India, Calcutta.

Type locality.—Someswari River, near Siju, Garo Hills, Assam; Coll: D4s. S. W. Kemp and B. N. Chopra, March 1922.

Remarks.—This species belongs to the *hendersoni* group because of its longitudinally grooved fingers of the second pair of peraeopods. It has a very wide range of distribution in the Eastern Himalayan region, the Chota Nagpur Tract and the Satpuras in India and in Burma. It generally occurs in streams in hilly localities and does not seem to be present in plains. This species contains two distinct subspecies one of which appears to be restricted to the Satpura and Vindhya hills in Madhya Pradesh, while the other is widely distributed in the hilly parts of Eastern Nepal, West Bengal, Assam and in the Arakan and Pegu Yomas of Burma.

Palaemon assamensis assamensis, subsp. nominate

Rostrum 60 per cent to 80 per cent of carapace length, with dental formula 7-11/1-5 (usually 8-10/2-4); carpus of the second cheliped 3·5-4·0 times as long as its distal thickness, and subequal to, or longer than, palm in females and young males.

Distribution.—I have examined about five hunded males and females of this subspecies from Chota Nagpur Tract, Kharagpur Hills, Eastern Nepal, Bengal Duars and Terai, and Eastern Assam in India and from Arakan Yomas, Pegu Yomas, Mytkina District and neighbourhood of the Inlé Lake in Burma.

Palaemon assamensis peninsularis, subsp. nov.

Rostrum 50 per cent to 60 per cent of carapace length, rostral formula 6-10/2-5 (usually 7-9/2-3); second pair of chelipeds of a slightly stouter build than in *assamensis*; carpus 3·0—3·5 as long as its distal thickness; palm not shorter than carpus in any stage; largest male 60 mm., egg-bearing females 45-50 mm.

Type-specimen.—Holotype, Male, No. C-3341/1, Zoological Survey of India, Calcutta.

Type locality.—The Nerbudda River at Khetgaon (22·50 N., 81·20 E) Mandla District, Madhya Pradesh [Nerbudda Survey, Stn. 42].

Distribution.—I have examined several males and females of this subspecies from various localities in the Vindhya Pradesh west of the Rihand river and in the Satpura range along the left bank of the Narmada river upto Pachmarhi in the Mahadeo Hills.

Palaemon canarae, sp. nov.

Diagnosis.—Rostrum resembling that of *Palaemon lamarrei* in shape, extending beyond the apex of antennal scale by $\frac{1}{5}$ to $\frac{1}{3}$ of its length, rostral formula 6-10/4-6 (usually 79/4-6) with one or two teeth on the carapace behind the orbital edge, arrangement of the upper teeth as in *P. lamarrei.*

Carapace smooth, shorter than the rostrum, the ratio of the length of the rostrum to carapace being $1\frac{1}{6}$ to $1\frac{1}{4}$.

First pair of peraeopods slender, about a third as long as the total length of the body ; carpus $\frac{1}{3}$ of the entire leg, and twice as long as the chela.

Second pair of peraeopods slender like the first pair, but longer being about half as long as the body ; carpus less than 33 per cent of entire leg, 10-11 times as long as its distal diameter ; chela about $\frac{2}{3}$ of the carpus : fingers $\frac{3}{4}$-$\frac{4}{5}$ as long as palm.

Appendix masculina in the second pleopod of the male short, not reaching the apex of the endopod, hairy.

Outer margin of the endopod of uropod without an accessory spine near the subapical tooth.

Females probably longer than the males, largest female 46 mm., egg-bearing females 36-46 mm., largest male—a damaged individual—being in the neighbourhood of 40 mm.

Type-specimen.—Holotype, Female (egg-bearing), No. C-3124/1, Zoological Survey of India.

Type locality.—Sitanadi River near Ghats, South Kanara (Madras).

Distribution.—South Kanara District of the Madras State.

Material examined.—Sitanadi River near Ghats, 8♀ (4 berried), 4♂, Coll. H. C. Wilson, 25-1-1916 ; Yenni Holi, near Karkal, 7♀ (2 berried), 1♂, Coll. H. C. Wilson 27-1-1916 ; Temple Tank Karkal, 8♀ (1 berried), 1♂, Coll. H. C. Wilson, 22-1-1916.

Remarks.—Palaemon canarae is very similar to *Palaemon lamarrei* in general appearance and the shape of its rostrum. The two can, however, be easily distinguished by the dentition of the lower edge of rostrum, and by the structure of appendix masculina in males. *P. lamarrei* is so far not known to occur in South Kanara.

Palaemon banjarae, sp. nov.

Diagnosis.—Rostrum subequal to carapace, extending as far as the apex of the antennal scale, lanceolate in profile, upper edge convex, apex pointed ; rostral formula 12-15/4-6 with two teeth on the carapace behind the orbital edge, teeth on the upper edge equal, equidistant.

Third maxilliped extending beyond the antennal peduncle by half its terminal joint.

First pair of peraeopods slender, about a third as long as the body, and one and a half times the carapace ; carpus twice as long as the chela.

Second pair of peraeopods longer than the first pair, slender, equal on two sides and in both the sexes, from half to two-thirds as long as the body ; carpus longer than merus, slightly thickened distally ; chela subequal to carpus in males, trifle longer than the latter in females ;

fingers about three-fifths as long as palm, their basal portion slightly hairy in female, cutting edges with two teeth on the mobile, and one on the immobile finger, near their bases.

Appendix masculina in males short, hairy.

Endopod of the uropod with a small, movable, accessory spine at the base of the large subapical tooth.

Females larger in size (38·7 mm.—43·5 mm.) than males (28·5 mm.—39·1 mm.). No egg-bearing females in the collection.

Type-specimen.—Holotype, Female without eggs, No. C-3343/1, Zoological Survey of India, Calcutta.

Type locality.—Banjar River off Aonrai Forest Village, Baihar Tehsil (Dist. Balaghat, M.P.).

Material examined.—7♂, 6♀ Coll.: K.K. Tiwari. 6-2-1954 from the above locality.

Remarks.—*P. banjarae* bears some resemblance to *P. kistnensis* which occurs plentifully in the type locality. The convex rostrum of *P. banjarae* is sufficient to distinguish it from the other.

A NEW RACE OF THE STRIATED SCOPS OWL, *OTUS BRUCEI* (HOME), FROM WEST ASIA

By AJIT KUMAR MUKHERJEE, *M.Sc., Zoological Survey of India, Calcutta*

In the course of my studies on the Scops owl (*Otus*), I found that the populations of *Otus brucei* (Hume)[1] from the Middle East differ sufficiently from those of Western India to justify subspecific recognition. I propose to name it as—

Otus brucei exiguus, subsp. nov.

Type.—B.N.H.S.[2] No. 11947 ; adult male ; Bagdad, Iraq ; July 1921 ; Cox Cheesman collection.

Diagnosis.—Compared with *Otus b. brucei* of Bombay State, it is smaller and darker with broader central streaks on upper and lower plumage.

Measurements—

		Wing	Tail	Bill from skull
The Type of *O.b. exiguus*	♂	148	74	19
Other specimens of Iraq, Iran, Baluchistan . . .	2♂	152,156	71,73·5	19,20
	1♀	154	76	20
O.b. brucei (Gilgit and Bombay State)	2♂	158,164	77,80	19,20
	3♀	163,165,165	77·5,81,82	20,20,21·5

Range.—Iraq, Iran, and Baluchistan.

There is a single specimen from Pamir in the Indian Museum collection which I am unable to separate from *O.b. exiguus*. However, more specimens are needed to be examined before we come to any conclusion as to correct placing of the Pamir populations.

[1] I do not agree with Meinertzhagen [(*Bull. Brit. orn. Cl.* LXIX (1), p. 165 (1949)], in considering *O. brucei* (Hume), as a race of *O. scops* (Linn.).

[2] Stands for Bombay Natural History Society.

Remarks.—The more important distinguishing characters of the two races of *Otus brucei* may be summarized as follows :—

	O.b. brucei	*O.b. exiguus*
Colour of the ruff	Pale buff. Feathers narrowly edged with dark brown.	Grey. Feathers brodly tipped.
Colour of the back	Pale earthy brown with nearly obsolete dusky cross vermiculation. Central narrow shaft stripe on each feather less prominent.	Dark isabelline with darker cross vermiculation. Central shaft stripe of each feather more prominent.
Colour of breast and abdomen	Fulvous white with a narrow, central, dark brown shaft stripe on each feather.	Grey with a broad, central, clove brown shaft stripe on each feather.
Colour of scapulars	Buff.	White.

I am grateful to the authorities of the Bombay Natural History Society for the loan of some material for my study and for allowing me to describe a specimen from their collection.

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