INDIAN EARTHWORMS.

XII. The Genus *Hoplochaetella*.

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Introduction.

The genus was established by Beddard in 1890, with the name *Hoplochaeta*, for *Perichaeta stuarti* Bourne 1886 which had been characterized very inadequately and, in part, erroneously. Beddard later (1895) became doubtful of his own genus and withdrew it. Michaelsen (1900) retained the genus but with a slight change in spelling (to *Hoplochaetella*, *Hoplochaeta* having been preoccupied) and later (1909) included in it, along with the single Indian species, certain forms from New Zealand. The latter were removed to a distinct genus (*Hoplochaetina*) in 1921. The status of the genotype and of the genus itself remained dubious until 1925. After study of a single specimen in poor condition from the type locality of the genotype, Michaelsen recognized some of the more important generic characteristics and the necessity of suppressing Stephenson's *Erythraeodrilus*. Michaelsen's account of his worm is however inadequate for present purposes so that a satisfactory characterization of the genotype is still impossible.

Eleven species have been erected, each of which has been known hitherto either from a single specimen (*bifoveata* and *inornata*), or from one or several very short series. Types of one species are non-existent, those

of several other species, even when first studied twenty to thirty years ago were in " bad " condition. Six species are known only from the type localities. With the exception of the types of three species, *khandalaensis*, *powelli* and *stuarti*, all of the type material has been re-examined.[1] Only five lots of new material (hitherto unstudied) have been secured in recent years and four of these are short series with all of the specimens in poor to very poor condition. Fortunately, through the kindness of Mr. S. H. Prater, a fairly long series of well preserved specimens of *khandalaensis* has been secured. As a result of the paucity of material and poor condition of so many important specimens the status of at least two species remains doubtful, diagnoses of other species are tentative or incomplete, while four or possibly five species must remain unnamed until well preserved material is procured.

In 1923 Stephenson reduced two species, *affinis* and *bifoveata*, to varieties because he had come to think that " variable genital markings were previously accorded undue weight " Possibly because of some such opinion Stephenson used genital markings only once in his key (1923) and then unsuccessfully as a result of an unfortunate choice of pairs of characteristics that vary according to the condition of the animal (actually surface convex or depressed, with or without a recognizable circumferential groove). In absence of long series a decision as to the value to be allotted to genital marking characteristics in any particular species rests on analogy with conditions in other species. A decision made in this way is however liable to be reversed, especially in connection with the structures now under consideration.

In one species, *khandalaensis*, a series of 108 specimens has been studied. In that series each worm, without exception, has one segmentally located genital marking which is invariably median and symmetrically placed with reference to the midventral line. On 103 specimens the single marking is post-setal on xix. Four of the 108 specimens have an additional, more anterior marking of the usual type. One worm lacks the marking on xix but has a characteristic marking in the anterior location. Variation with respect to symmetry and pairing is *nil*, as to number and location slight. Two other species have sausage-shaped genital marking glands similar to those of *khandalaensis*. In one of these, *powelli*, in ten specimens from two localities there is always a pair of symmetrical genital markings on 19/20 though additional markings may occasionally (two specimens) be present; paired behind 19/20, unpaired and asymmetrical or symmetrical anterior to 19/20. In this species the diagnostic characteristic seems to be presence of a pair of genital markings on 19/20 while the variation in symmetry of an occasional extra anterior marking does not appear to be of importance. In the third species, *mullani*, in a series of seven specimens, each worm has one genital marking which is always asymmetrically placed but which is found in one of two different locations. Here there is variation as to location but none as to symmetry and number.

Of the species with sessile genital marking glands, *affinis* can be distinguished from *suctoria*, and *kempi* from *bifoveata* in much the same

[1] Types of *powelli* are in the British Museum and cannot be borrowed. There are no types of *stuarti*.

way as the three species with sausage-shaped genital marking glands are distinguished from each other; *affinis* and *suctoria* by the paired or unpaired genital markings, *bifoveata* and *kempi* by the symmetry or asymmetry in placement of the markings. In these circumstances *affinis* and *bifoveata* are both retained provisionally. Some slight support for the decision as to *affinis* is furnished by spermathecal characteristics.

With regard to *anomala* and the forms that must be considered in connection with it the situation is more difficult. Of the five clitellate types of *anomala* (as now restricted by exclusion of one type) two have no genital markings while each of two specimens has but one of the pair of markings present on xviii of the fifth worm which may represent the normal condition in this species. Of the two very short series to be considered in connection with *anomala*, four of the five clitellate specimens from Jog Falls have no genital markings, but the fifth has an unpaired median and symmetrical genital marking on 24/25, one of two specimens from Panchgani has no markings while the other has one or a pair (condition indeterminable) on 20/21. The argument from analogy with species having sausage-shaped genital marking glands is weakened here by the absence of genital markings on a large proportion of the specimens, but may be regarded as supported by the presence of other characteristics that appear to provide evidence for specific distinction of both series from *anomala*. The excluded type of *anomala*, distinguished from the types by genital marking characteristics, is similarly distinguished by additional characteristics that appear to be of taxonomic value.

In contrast to the variation just discussed, all species are rather uniform with respect to some characteristics often variable intrageneric ally. Thus the prostomium appears to be always epilobous in the quadriprostatic species, the condition in biprostatic species is uncertain. An anterior location of the first dorsal pore also seems to be characteristic. With but few exceptions, which may be only unimportant individual variations, the pore is on 4/5. Two of the apparent exceptions (location on 5/6 in *inornata*, on 6/7 in *kempi*) may be due to failure to recognize more anterior pores because of the poor condition of the material. All reproductive apertures are always minute. Excretory, circulatory and digestive systems are, so far as is known, uniform except for some slight intrageneric variation with regard to the hearts of xiii, the presence of fairly sharply demarcated intestinal caeca in one species, and possibly also some variation in segmental location of the gizzard.

Certain species, including *khandalaensis*, have been thought to be characterized by a brown colouration, a supposition which is very questionable in view of the fact that preservation in each case was alcoholic. Specimens of *khandalaensis*, preserved in formalin and examined very shortly after preservation, are always characterized by presence in the dorsum of a red pigment. It is quite possible that all quadriprostatic species at least are similarly characterized. In this connection it may be noted that all species of *Tonoscolex* are always unpigmented, a species of *Eutyphoeus* may be unpigmented or have a brown pigment with no intraspecific variation, while in *Pheretima* there is considerable intrageneric variation as to pigmentation.

Unpaired, lymph glands, have been found in all but three species, which are known only from softened specimens. In well preserved material the glands are present in a complete series from xv posteriorly. In some specimens, not so well preserved, the gland in xv has been seen, but from xvi posteriorly for some distance the glands are unrecognizable. Presumably this is due to disintegration in the middle region but confirmation is necessary. Similar lymph glands are known at present to occur only in *Pheretima.*

In eight quadriprostatic species septa 9/10-11/12 are closely crowded and united peripherally so as to reduce the coelomic cavities of x and xi to testis sacs of a rather peculiar type somewhat reminiscent of the condition of segment xi in certain species of *Eutyphoeus.* This type of testis sac may conveniently be referred to as septal. Stephenson does not refer to these septal sacs as testis sacs, and in using the general term in connection with *anomala* and *kinneari* he presumably intended to refer to a distinctly different type of structure. The characterization is however so vague that it is impossible to do more than suggest that the sacs of *kinneari* may be annular, U-shaped, or paired and vertical, while the sacs of *anomala* may be cylindrical. Characterization of the condition in *stuarti* is impossible. All three species, *anomala*, *kinneari* and *stuarti*, are known only from macerated specimens. Possibly presence of testis sacs of one sort or another is as characteristic of *Hoplochaetella* as of *Pheretima.*

In an emended diagnosis (Stephenson 1917, p. 358) *Hoplochaetella* is said to be apenisetal. There are, however, probably in each species, median to the ectal portion of each prostatic duct, chaetae that may for the present be referred to as penial. The number of follicles is unknown but at least one follicle is located on the median face of each prostatic duct, the usual location for at least one penisetal follicle, and another (or others ?), in certain species, may be imbedded in glandular material. Whether or not these follicles open directly to the exterior is unknown. In spite of careful search external apertures have not been found though this was perhaps to be expected from the condition of most of the material studied. In the absence of discrete apertures, follicles must either open indirectly to the exterior through the male pores (combined openings of male deferent and prostatic ducts) or be closed off ectally from the exterior. In the latter eventuality the setae are presumably without function. Some slight support for this is perhaps provided by the deep location in the parietes and the size relative to that of the worms. Shafts are small, varying in size from 0·2-0·4 mm. in length and with a maximum thickness of *ca.* 0·010-0·012 mm. Modifications from ordinary type are present though slight,—the sigmoid shape has been lost and the shaft has become practically straight but sculpturing of the tip and ornamentation are slight or lacking. In the circumstances it is uncertain whether we have here an early stage of modification into a more effective type of penial setae or a reduction preliminary to ultimate disappearance of setae once more efficient. A study of late embryonic and young juvenile stages might yield interesting information in this connection.

In each species certain ventral setae of some of segments vii-ix are modified as the copulatory setae. Presence or absence of ornamentation on these setae at present appears to be specifically characteristic and of value in diagnosis but whether other characteristics are capable of similar use is not yet obvious.

The posterior termination of the male deferent ducts is of especial interest. Stephenson observed that in *anomala* the vasa deferentia of a side pass into a region behind the anterior prostatic duct (possibly xviii) where one turns anteriorly while the other is continued into xix, indicating that the species has two pairs of male pores, a most unusual condition. This peculiarity was supposed to be characteristic of *anomala* only and is presumably the reason for the specific name, since in all other species of the genus " vasa deferentia unite and open in common with the anterior prostate on the seventeenth segment " (Stephenson 1920, p. 226). It is obvious, however, from inspection of dissected types and figures that Stephenson did not actually trace the male deferent ducts in any species to an external aperture or even to a junction with a prostatic duct. (Note statements which are usually to the effect that the deferent ducts " end " behind the anterior prostatic duct, *i.e.*, become invisible in his dissections and also *vide* fig. 26. pl. x, 1920). Tracing the course of the vasa deferentia in most species of this genus is unusually difficult, in part as a result of the presence of masses of glandular material within which the ducts may be imbedded. Repeated attempts to trace the course of the male deferent ducts have been unsuccessful and in none of the worms was a single duct dissected out unbroken from one end to the other. However, no evidence has been found to indicate that the deferent ducts of a side unite posteriorly in any quadriprostatic species. On the contrary paired ducts (or structures that look like ducts) have always been found posteriorly in each species. One duct of a side, presumably that from the anterior male funnel, joins the anterior prostatic duct of xvii, while the other deferent duct continues posteriorly to join the prostatic duct of xix. Although the necessity for confirmation of this condition in several species is admitted, it is almost certain that all quadriprostatic species of *Hoplochaetella* have four male pores.

The origin of the biprostatic species (presumably by disappearance of a posterior pair of prostates) is accordingly not as simple as it appeared to be when it was thought that both the deferent ducts of most quadriprostatic species united with the anterior prostatic ducts. The biprostatic condition may have arisen in an acanthodrilin ancestral form prior to the union of posterior deferent and prostatic ducts, in which case *Hoplochaetella* is diphyletic, or the posterior deferent ducts have lost an ancestral junction with the prostatic ducts of xix and secondarily acquired a new junction with the anterior prostatic ducts. If the latter should be correct one might almost expect to find, on analogy with the passage of the anterior ducts into xviii before turning forwards, that the other ducts pass further posteriorly, perhaps even into xix before turning anteriorly. Unfortunately all biprostatic specimens are in such poor condition that a more favorable opportunity for study of the deferent ducts must be awaited.

The junction of a vas deferens with the anterior prostatic duct on the posterior face of the latter in this genus, as well as the passage of the vasa deferentia into the parietes just behind the prostatic duct of xvii in *Eutyphoeus*, certainly appear to be good evidence for a phylogenetic derivation of both genera from ancestral forms with male pores on xviii (acanthodrilin condition) and for Stephenson's attraction theory (1920, p. 226). Unfortunately nothing seems to be known of the ontogenetic development of the male deferent ducts in earthworms (so far as can be determined from the literature available locally), but an investigation of this problem in species of *Hoplochaetella* might yield interesting results. Presumably the vas deferens grows posteriorly from a male-funnel rudiment rather than anteriorly from a male pore rudiment or otherwise. (Note that in those aberrant specimens of species of *Pheretima* in which prostates, prostatic ducts and male genital terminalia fail to develop, the vasa deferentia may be continued posteriorly for varying distances behind the male pore segments as if " searching " for the missing organs.) In these circumstances why is the prostatic duct " attraction " for the male deferent duct not exerted when the latter first comes into the neighbourhood of the former rather than at a later period after the " unattracted " duct has been able to grow posteriorly into a region behind the prostatic duct ?

In a number of species, glands of unknown function[1], referred to hereinafter as parietal glands, are protuberant more or less conspicuously into the coelomic cavities from the parietes in the prostatic region. These bodies must open either into the prostatic ducts within the parietes or directly to the exterior on the male porophores. No variation as to number or shape of these structures was found in the dissected specimens of *khandalaensis*. Hence it is assumed that the diverse confirmations found in other species are also characteristic.

The nature and relationships of the various structures in the region of the male pores, collectively referred to as the male genital terminalia, should be investigated from sections.

Hoplochaetella has been derived by Michaelsen (*vide* Stephenson 1915 and 1917) from the New Zealand genus, *Perieodrilus*[2], and by Stephenson (1917, 1923 and 1930) from the Madagascar-South Indian genus, *Howascolex*.[3] Without referring again to the problems raised by the phyletic derivation of one genus from another when both are

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[1] Stephenson refers to these structures as accessory glands, a term that he also applies to stalked glands associated with follicles of the copulatory setae.

[2] *Hoplochaetella* and *Octochaetus*, the only two genera common to India and New Zealand, formed the basis for the supposed land communication between the two areas independent of Australia. Indian species of *Octochaetus* are now recognized as generically distinct from the New Zealand forms (Gates 1933 and Michaelsen 1933) and the *Hoplochaetella-Perieodrilus* relationship needs no further consideration (*vide* Stephenson 1917, p. 358).

[3] Three species of *Howascolex* are thought to be endemic in South India. All of these are small worms, 1-2 mm. thick, though fairly long (60-110 mm.) for slender earthworms. In view of the small size of the South Indian species, endemicity in that region may be questioned. Occurrence of all three in South India may be the result of accidental or artificial importation. The only species known from Madagascar is fairly large, 120 mm. long and 6 mm. thick.

known only from extant and inadequately characterized species, certain points in connection with the supposed *Howascolex-Hoplochaetella* relationship should be noted.

In *Hoplochaetella*, the derived genus, calciferous glands are in x-xiii, while in *Howascolex*, the ancestral genus, the glands are in xvi with an occasional slight development in xv or xvii. Derivation of either of these conditions from the other appears to be improbable and further evolution in *Howascolex* would presumably be along the line of more definitely partitioning off from the gut, structures perhaps in the nature of stalked glands or sacs, as for instance in *Dichogaster*. In Indian species of *Howascolex* excretory organs are mega-nephridia only in the posteriormost portion of the body, micro-nephridia only anteriorly, while in *Hoplochaetella* micro-and mega-nephridia coexist from xx at least, if not xii-xiv, posteriorly. The micro-nephridial condition in the family Megascolecidae is thought to be the result of phylogenetic fragmentation of originally paired mega-nephridia, a process recapitulated in the ontogeny of certain forms. In accordance with this belief, mega-nephridial fission would be completed in anterior and middle portions of the body in Indian species of *Howascolex* while in the posteriormost segments the fission has not begun. In *Hoplochaetella* on the contrary fission presumably has only just begun in a region extending from segment xx to the hind end, for in that region there are paired mega-nephridia large enough to reach nearly to the mid-dorsal line. It should be noted, however, that micro-nephridia are fairly numerous even in the mega-nephridial segments of *Hoplochaetella*. If embryonic fission of mega-nephridia does take place in *Hoplochaetella*, it must be of such a nature that the original rudiment can still develop into a large mega-nephridium, a condition which can be derivative of that characteristic of the corresponding middle region in Indian species of *Howascolex* only by an evolutionary reversal so complete as to be extremely unlikely. In the Madagascar species of *Howascolex* mega-nephridia are presumably present throughout the body while micro-nephridia are present only in the region of xxxiv-lx and are few in number, two to fourteen per segment. From such a condition it is of course easier to derive the *Hoplochaetella* condition, yet it should be noted that a continuation of the process already begun in the Madagascar section of *Howascolex* should lead to the condition characteristic of the Indian section of *Howascolex* but not to that characteristic of *Hoplochaetella*. However it is doubtful if the excretory system of any species of *Howascolex* is sufficiently known to warrant further discussion of this matter, especially in view of the fact that slight maceration in specimens that are not very well preserved may prevent recognition of important characteristics of excretory systems if not of whole sets of organs. Development of the excretory organs in both *Howascolex* and *Hoplochaetella* is unknown.

The fact that the excretory systems are so different in the Indian and Madagascar sections of *Howascolex* is sufficient ground for suspecting that the genus (as recognized by Michaelsen and Stephenson) is not monophyletic, and such suspicion is further justified by differences

in the digestive and reproductive systems, the vascular system being practically unknown.

In spite of an awareness " that greater significance should perhaps be attached to the position and degree of development of the calciferous glands ", Pickford has recently (1937, p. 605) transferred to *Howascolex* South American species of *Wegeneriella* and *Acanthodrilus*. The genus as now emended by Pickford has calciferous glands in xvi with or without some slight development in xv or xvii, in xiv-xv, and in viii-xi. It is most unlikely that in the evolution of any " monophyletic " genus the calciferous glands have ' jumped ' around in any such manner. Furthermore *Howascolex*, in Pickford's sense, is now diagnosed as having true mega-nephridia accompanied by micro-nephridia. This is not definitive. Mega-nephridia and micro-nephridia are of so many different types that genera can no longer be defined merely by unrestricted use of the terms mega-nephridial and micro-nephridial. Leaving out of consideration a statement regarding the gizzard, Pickford's emended definition is so inclusive as to be capable of serving as a subfamily definition for all Indian genera of the former Octochaetinae except *Octochaetoides*. Without excepting the statement as to the gizzard, the emended diagnosis is broad enough to include several groups, probably of generic rank, of worms from such widely separated areas as India, Madagascar, Africa, and South America. To this group there would have to be added Stephenson's *Ramiella* which differs only in the complete absence of calciferous glands.

Hoplochaetella is one of the Indian genera formerly included in the obsolete Megascolecid subfamily Octochaetinae. All of the Indian genera, with the single exception of *Octochaetoides*, have exonephric, parietal micro-nephridia together with paired mega-nephridia (provided with the usual preseptal funnels) in a posterior portion of the body of variable length. So far as is known, none of these genera has enteronephric nephridia, either micro- or mega-, behind the clitellar region. All have tubular prostates.

When the Diplocardiinae was broken up and distributed among other Megascolecid subfamilies one genus, *Dichogaster*, was transferred to the Octochaetinae. The excretory systems of two Burmese species of *Dichogaster* have now been examined and in each of these species there are paired mega-nephridia provided with the usual preseptal funnels in the posteriormost segments. So far then as the combination of nephridial characteristics just mentioned above is concerned, *Dichogaster* can be included in a group along with *Howascolex*, *Hoplochaetella*, *Ramiella*, *Eutyphoeus*, *Scolioscolides*, *Barogaster*, *Eudichogaster*, *Lennogaster*, *Pellogaster*, *Rillogaster*, *Priodochaeta* and possibly also *Priodoscolex*. To avoid confusion attendant on use of the obsolescent term Octochaetinae this group of genera may be referred to as the *Hoplochaetella* group.

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SYSTEMATICS.

Genus **Hoplochaetella** Michaelsen.

1890. *Hoplochaeta*, (*non Oplocheta*, corr. *Hoplochaeta*, Rondani 1856, Dipt.) Beddard, *Proc. Zool. Soc. London*, 1890, p. 57. (Genotype-*Perichaeta stuarti* Bourne 1886).
1900. *Hoplochaetella*, Michaelsen, *Das Tierreich* X, p. 321.
1909. *Hoplochaetella* (*part*), Michaelsen, *Mem. Ind. Mus.* I, pp. 202-203. (Excluding New Zealand species.)
1910. *Hoplochaetella* (*part*), Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), p. 25. (Excluding New Zealand species.)
1915. *Erythraeodrilus*, Stephenson, *Mem. Ind. Mus.* VI, p. 100. (Genotype *E. kinneari* Stephenson 1915.)
1917. *Hoplochaetella*+*Erythraeodrilus*, Stephenson, *Rec. Ind. Mus.* XIII, pp. 354, 359, 388 and 402.
1920. *Hoplochaetella*+*Erythraeodrilus*, Stephenson, *Mem. Ind. Mus.* VII, pp. 223 and 227.
1921. *Hoplochaetella*+*Erythraeodrilus*, Michaelsen, *Mitt. Mus. Hamburg* XXXIII, p. 38.
1923. *Hoplochaetella*+*Erythraeodrilus*, Stephenson, *Oligochaeta*, in *F. B. I.* pp. 467 and 457.
1925. *Hoplochaetella*, Michaelsen, *Zool. Jahrb. Syst.* LI, pp. 314-315.
1926. *Hoplochaetella*, Stephenson, *Rec. Ind. Mus.* XXVIII, pp. 250 and 265.
1930. *Hoplochaetella*, Stephenson, *The Oligochaeta*, p. 848.

Diagnosis.—Quadrithecal, each spermathecal pore at or near the centre of a transversely placed area of slight epidermal tumescence. Male pores (combined openings of male deferent ducts, prostatic ducts and penisetal follicles ?) on small, paired porophores. Female pore median and presetal on xiv. Reproductive apertures all minute. Setae perichaetine; ventralmost setae of prostatic segments modified or lost, setae in vicinity of spermathecal pores modified (copulatory setae). On development of clitellar glandularity intersegmental furrows disappear and dorsal pores are occluded but setae are retained; clitellum annular, on xiii-xvi. First dorsal pore on (or on a furrow near to ?) 4/5. Pigmentation red. Septa all present from 4/5 posteriorly (except in *anomala* ?). Gizzard in (or belonging to ?) one segment. Calciferous glands four pairs in x-xiii, antero-posteriorly flattened, reniform with concave faces mesially, opening through short stalks directly into oesophageal lumen ventro-laterally. Intestine begins in xvi. Typhlosole simple, beginning in xxii-xxv. Hearts of x-xiii latero-oesophageal. Extra-oesophageal trunks below the gut throughout[1], with branches to calciferous glands, joined in xiii by a vessel formed by a union in xiv of a posterior latero-parietal vessel and an anterior commissure from the dorsal trunk. Supra-oesophageal trunk present in ix-xiii[2]. Excretory organs: closed (?), exonephric (?) parietal micro-nephridia from ii or iii posteriorly, closely crowded into paired vertical bands in ii-iii (or iii-iv ?), especially numerous and nearly covering the parietes in xiv-xvi; closed (?), enteronephric (?) micro-nephridia in paired clusters on the anterior faces of 4/5-5/6; open, exonephric (?) mega-nephridia with preseptal funnels, one pair per segment from xii-xiv posteriorly, rather small in xii-xiv to xix. Holandric, testis sacs present; seminal vesicles in ix and xii. Prostates tubular; ducts slender entally, with

[1] Not on or adherent to the gut.
[2] A negative characteristic is the absence of a subneural trunk.

spindle-shaped muscular widening ectally, narrowed again within the parietes. Spermathecal ducts slender ectally, widened and muscular entally, diverticula joining duct entally. One copulatory setal follicle opening to the exterior in conjunction with each of a number of shortly stalked, tubular glands contained within membranous sacs protuberant into the coelomic cavity.

Distribution.—Yercaud, Salem district (Madras Presidency), Nundydroog, and Jog Falls (Mysore State), in South India, and in Western India from Goa, North Kanara and Belgaum north to Bombay, Andheri and Matheran. At present all species appear to be restricted to the lowlands[1].

Key to species of Hoplochaetella.

1 *a.*	Quadriprostatic	2
b.	Biprostatic	11
2 *a.*	All spermathecal pores on viii, (rarely posterior pores on 8/9)	3
b.	All spermathecal pores not on viii though segmental	9
3 *a.*	Three pairs of parietal glands median to prostatic ducts, middle pair in xviii ..	4
b.	Parietal glands lacking or not in three pairs and none in xviii	6
4 *a.*	No genital markings, ca. 85 setae on xii ..	*inornata.*
b.	Genital markings present, 50-66 setae on xii ..	5
5 *a.*	Genital markings paired	*powelli.*
b.	Genital markings unpaired and median ..	*khandalaensis.*
6 *a.*	Spermathecal diverticula paired or in two groups of 2-3	7
b.	Spermathecal diverticula in circles	8
7 *a.*	Genital markings unpaired and symmetrical ..	*bifoveata.*
b.	Genital markings unpaired but asymmetrical ..	*kempi.*
8 *a.*	Genital markings unpaired and median, circle of diverticula with one hiatus	*affinis.*
b.	Genital markings in part paired, circle of diverticula uninterrupted	*suctoria.*
9 *a.*	Spermathecal pores on vii and viii	*stuarti.*
b.	Spermathecal pores on viii and ix	10
10 *a.*	Genital markings with central aperture, glands sausage-shaped, last hearts in xiii	*mullani.*
b.	Genital markings when present without central aperture, glands sessile, last hearts in xii ..	*anomala.*
11 *a.*	All spermathecal pores on viii	*kinneari.*
b.	Anterior spermathecal pores on vii	*H. spp.*

A. QUADRIPROSTATIC SPECIES.

Prostomium epilobous. Ventralmost setae of xix modified or lost. Male pores two pairs on xvii or 17/18 and xix or 18/19, one male deferent duct on each side turning anteriorly in xviii to pass into the posterior face of an anterior prostatic duct, the other duct passing into the anterior face of the posterior prostatic duct.

[1] Elevation of Yercaud may be between 3,000 and 6,000 feet. No information is available as to level at which worms were secured. Absence of mention of elevation in most other cases may be taken perhaps as indicative of elevations not much above the sea level.

Hoplochaetella affinis Stephenson.

1917. *Hoplochaetella affinis* (part) Stephenson, *Rec. Ind. Mus.* XIII, p. 399. (Type locality—Mormugao Bay, Portuguese India. Types in Indian Museum. Excluding specimens from Vareeg Islet.)

1923. *Erythraeodrilus suctorius var. affinis* (part), Stephenson, *Oligochaeta*, in *F. B. I.*, p. 466. (Excluding specimens from Vareeg Islet.)

Material examined.—From the Indian Museum; 5 aclitellate specimens labelled, "*Hoplochaetella affinis* Stephenson. Types. Mormugao Bay, Portuguese India (Donna Paula Bay and vicinity). Aug. 1916. Dr. S. W. Kemp. W 128/1.", and one aclitellate, dissected specimen labelled, "*Hoplochaetella affinis* Stephenson. Small Bay on S. W. side of Mormugao Bay, Portuguese India. Sept. 1916. Dr. S. W. Kemp. W 127/1".

External characteristics.—The first dorsal pore is on 4/5 (2). Spermathecal pores are minute and superficial, each pore at the centre of a transversely placed area of slight epidermal thickening (?) and shortly elliptical outline, the posterior pores on 8/9 (2 specimens) or slightly in front of 8/9, the anterior pores in front of the setal circle and slightly nearer to the circle than to 7/8, all pores about *cd*. Anteriorly dislocated setae of viii may be on a transverse line with the anterior spermathecal pores or may be about equidistant from a transverse spermathecal pore line and 7/8. Dislocated setae of ix may be in a fairly straight transverse line and also nearer to the anterior intersegmental furrow than to the setal circle from which they have been displaced. Dislocations of setae are shown below. Except for those in the spermathecal porophores each displaced setal follicle opens to the exterior at the centre of a small area of epidermal thickening (?) circular in outline.

Dislocated Setae.

Specimen	vii	viii	ix	REMARKS
1	*a* of left side posteriorly.	*a* of both sides posteriorly, *b* of left side anteriorly.	*a-d* of both sides anteriorly.	Posterior genital marking asymmetrical. Posterior spermathecal pores in front of 8/9. Type.
2	*a* of right side posteriorly.[1]	*a-b* of both sides anteriorly and in addition one seta on left spermathecal porophore and three on right.	*a-d* of both sides anteriorly.	Posterior spermathecal pores almost exactly on 8/9.
3	..	....	*a-c* of left side and *a-b* of right side anteriorly.	Abnormal.
4	*a* of both sides posteriorly.	*a-b* of left side and *a* of right side anteriorly, and in addition one seta on left spermathecal porophore and two on right.	*a-d* of left side and *a-c* of right side anteriorly and nearer to 8/9 than setal circle.	Posterior spermathecal pores in front of 8/9.
5	*a* of both sides posteriorly.	*a* of both sides anteriorly.	*a-d* of both sides anteriorly.	Posterior spermathecal pores practically on 8/9 (left pore doubled ?).
6	..	*a* of both sides anteriorly and in addition three setae, *b-d*, on each anterior spermathecal porophore.	*a-d* of both sides anteriorly, right *d* only slightly.	Posterior spermathecal pores in front of 8/9. W 127/1.

[1] This seta was removed. It lacks an ectal portion, but has the ental portion curved rather like the handle of a walking stick. Associated with this seta is a rudimentary gland.

Male pores are minute and superficial, each pore in region of *ce* (determined from xx) and towards the median margin of a transversely placed, greyish, translucent area of approximately elliptical outline and a width of about two intersetal intervals. Intersegmental furrows are lacking ventrally, but porophores are, so far as can be determined from these specimens, just anterior to site of 17/18 and just posterior to site of 18/19.

Genital markings are unpaired, median, transversely extended but not reaching on either side to the male pore lines, post-setal on xvii and xix on four specimens, each marking with a distinctly demarcated, translucent central portion, and an opaque, band-like, marginal rim. On one of these worms the posterior marking is slightly asymmetrical with relation to the male pore lines and on the left side reaches anterior to the setal circle of xix and in contact with the male porophore. A fifth specimen, with metameric abnormality in region of viii-ix has also two unpaired median markings, but the anterior marking appears to be mainly pre-setal, reaching in front to site of 16/17. On this specimen and on the worm with an asymmetrical posterior marking, a ventral region bearing the genital markings and the male porophores is rather deeply depressed. The anterior margin of a posterior marking or the posterior margin of an anterior marking may be concave, the marking being of a slightly crescentic shape.

Internal anatomy.—The gizzard is in vi (4). The intestine begins in xvi (4), a valve posteriorly in xv and anteriorly in xvi. The typhlosole begins in xxiii, and in an anterior portion is triangular in cross section.

Hearts of x-xiii are latero-oesophageal. The large commissures from the dorsal trunk in an anterior portion of xiv pass down to the level of the ventral face of the gut where each unites with a vessel of similar size, possibly from the parietes, and then passes through 13/14 to join the extra-oesophageal just as the latter turns laterally to pass to the posterior calciferous glands. Extra-oesophageals have been traced anteriorly only to 5/6. No subneural. Lateroparietal vessels were not found. Lymph glands are present, as in *khandalaensis*, and begin in xv (4). The anteriormost gland of one specimen contains two brown discs.

Excretory system has, as in *khandalaensis* the usual clusters on the parietes in ii and iii and on the anterior faces of septa 4/5 and 5/6.

Segments x and xi closed off as in *khandalaensis*. No seminal vesicles in x. Male deferent ducts not traced throughout, but duct-like cords in xviii pass to anterior faces of posterior prostatic ducts and posterior faces of anterior prostatic ducts. Parietal glands, at least of the *khandalaensis* type, are lacking. There may, however, be glandular material within the parietes around ectalmost portions of prostatic ducts with slight protuberances (?) into the coelomic cavities, or the matted tissues associated with the portions of the prostatic ducts just above parietal level may be wholly nephridial.

In the type, spermathecal diverticula are ventrally directed, digitiform and characterized by a brilliant spermatozoal iridescence, with the diverticula (9, 10, 11, and 12) in an incomplete circle, the hiatus on the posterior face of the duct and less than one quarter of the circle. One

spermatheca is about 4 mm. long, the slender and the thick portions of the duct each about 1 mm. long.

Glands of copulatory setae are in four coelomic sacs and are short, 1-2 mm. long. Copulatory setal follicles are on the anterior faces of the gland ducts, within the parietes, the ental ends of the follicles just recognizable above the parietes. Copulatory setae are ornamented.

Genital marking glands are large, almost in contact antero-posteriorly, and sessile on the parietes.

Remarks.—One specimen which had been dissected by Stephenson, must be regarded as the type. Two further specimens have now been dissected, the abnormal worm and another. The type, with the spermatozoal iridescence of spermathecal diverticula, is presumably a post-sexual aclitellate. Spermatozoal iridescence is lacking in the spermathecal diverticula of the other two specimens.

A sixth specimen, from a different locality in Mormugao Bay, has a label in Stephenson's handwriting, " var. *pallida* " On this worm the anterior genital marking which slightly transcends the male pore lines is on the probable site of 16/17, the margins about equidistant from setal circles of xvi and xvii. The posterior marking which is slightly shortened transversely appears to be about equidistant from setal circles of xix and xx and hence across 19/20. The typhlosole is at first triangular in section as in other species. None of the spermathecal diverticula is iridescent. One spermatheca, which was removed, has nine rather thickly digitiform and flattened diverticula in an incomplete circle with a posterior hiatus as in the types. On other spermathecae the hiatus in the diverticular circle is lacking or much smaller and inconspicuous.

Although reduced to the status of a variety of *suctoria* by Stephenson in 1923, *affinis* seems for the present to be distinguished by the absence of paired markings.

Diagnosis.—Male pores just anterior and posterior to sites of 17/18 and 18/19, each pore towards median margin of a transversely placed, translucent area of shortly elliptical outline. Spermathecal pores in *cd*, anterior pores in front of setal circle, posterior pores on or slightly in front of 8/9. Genital markings transversely placed, unpaired and median, two, post-setal on xvii and xix, not reaching laterally to male pore lines. Setae: 72/v, 80/ix, 74/xii, 65/xix, viii/0-4, xvii/0, xviii/1-3, xix/0; *a* dislocated posteriorly on vii, *a* or *a-b* of viii and some or all of *a-d* of ix dislocated anteriorly, each follicle opening externally through a circular porophore, some or all of *b-d* of viii usually on the anterior spermathecal porophores. Pigmentation red ? Length 140 mm. Diameter 7 mm.

Gizzard in vi. Last hearts in xiii. Unpaired lymph glands from xv posteriorly. Testis sacs formed by peripheral fusion of septa 9/10-11/12. Parietal glands (if present ?) not protuberant into coelomic cavities. Genital marking glands sessile on the parietes. Spermathecal diverticula short and digitiform and ventrally directed, in one circle (of 9-12) with fairly wide posterior hiatus. Copulatory setae ornamented[1]; short glands, in four coelomic sacs; an additional pair of sacs in vii.

Distribution.—Mormugao Bay, Portuguese India.

[1] Although penial setae are probably present no setae are visible externally on xvii and xix in the ventral region between the longitudinal male pore lines.

Hoplochaetella anomala Stephenson.

1920. *Hoplochaetella anomala* Stephenson, *Mem. Ind. Mus.* VII, p. 223. (Type locality—Belgaum, Bombay Presidency. Types in the Indian Museum.)
1923. *Erythraeodrilus anomalus*, Stephenson, *Oligochaeta*, in *F. B. I.*, p. 458.

Material examined.—From the Indian Museum: 2 aclitellate and 5 clitellate (2 dissected) specimens labelled, " *Hoplochaetella anomala* Stephenson. Types. Belgaum, Bombay Presidency. 5.6.1910. N. B. Kinnear. W 290/1 "; and 4 clitellate, macerated specimens labelled, " Near the S. bank of the Sharavati River. Jog Falls, Mysore State. H. S. Rao. Nov. 1928 ". From the Bombay Natural History Society: 2 clitellate, macerated specimens labelled, " Panchgani, Satara district. Sept. 1939. C. McCann ".

Notes on the types. External characteristics.—There are four chaetae in the setal circle of viii between the spermathecal pore lines and two to four on ix between the same lines, *i.e.*, ordinary setae in normal positions in setal circles and not on tumescences. On ix some of the setae lateral to *b* may be dislocated only very slightly. Setae are lacking ventrally on xvii and xix between the male pore lines but are present normally on xviii (*ca.* six to eight).

Male porophores are depressed. The minute male pores are clearly visible. There may be one or two further openings on each porophore close to the male pore but the epidermis is damaged and the pore-like appearances may be artefacts.

Two specimens have each an unpaired, post-setal genital marking on the left side of xviii, in line with and of about the same size as the male porophores. (Stephenson had one specimen with paired markings on xviii.) Markings in the region of 24/25 would be unrecognizable, if present, because of gelatinization in the post-prostatic region.

Internal anatomy.—Lymph glands if once present are now quite unrecognizable posteriorly as well as anteriorly.

Each specimen (3) has two, vertically place parietal glands associated with each prostatic duct, one just median and one just lateral to the prostatic duct; the lateral gland is more conspicuously protuberant into the coelomic cavity. These glands must open to the exterior through the prostatic duct or by apertures on the male porophore, possibly the latter. Each gland is hollow and filled with a flocculent coagulum. The male deferent ducts of a side pass posteriorly between the anterior prostatic duct and the lateral gland. In xviii one duct turns back on itself and passes into the posterior face of the anterior prostatic duct, apparently without enlargement, to an ejaculatory bulb, though covered over with rather tough tissue close to the prostatic duct. The other duct passes straight to the anterior face of the posterior prostatic duct. Tracing the course of the vasa deferentia in these worms is remarkably easy because of their superficial location on the parietes. Penial setae are present on the median faces of both anterior and posterior prostatic ducts. Seminal vesicles of x (?) are large. In xi there is a pair of masses (of testicular coagulum ?) exactly similar in appearance to the vesicles of x but without recognizable attachment to a septum. Possibly all of these supposed vesicles are merely masses of testicular coagulum.

A cuticular lining of the spermathecal duct is separated off from the duct wall to the ampulla. Paired spermathecal diverticula are ventrally directed, with very short stalks, each diverticulum with two

to five ellipsoidal masses of spermatozoa. The copulatory setal glands are in paired clusters (three to five) in viii and ix, passing to the parietes posteriorly round the spermathecal ducts. The glands are short. Coelomic sacs, if present, are unrecognizable. A copulatory setal follicle projects conspicuously into the coelomic cavity on the median face of each gland stalk.

Remarks.—The types were " In bad condition " in 1920 and the condition is certainly no better now.

Several specimens, including an undissected type, cannot now be referred with certainty to *anomala* as they differ from the majority of the types in characteristics that may prove to be of taxonomic value. The diagnosis is of course based on the type series, after exclusion of one specimen, but to facilitate comparison with the account given above the divergent worms are described herewith. In all of these forms, including the types of *anomala*, the gizzard certainly appears to be in vii but this location is determined by counting forwards from ix and a very delicate septum may have been ruptured in dissection so as to be unrecognizable. Septum 6/7 was not found or identified with certainty, two pre-gizzard septa characterized by the presence on their anterior faces of nephridial clusters are, presumably, to be regarded as 4/5 and 5/6. In these circumstances the segmental location of the gizzard requires confirmation.

According to Stephenson (1920, p. 226) *anomala* is more primitive than other species then known because of the segmental location of the male pores in the setal circles, and the greater separation of the spermathecal pores, possibly also because of the presence of testis sacs. Not mentioned but probably also to be regarded as primitive are the paired spermathecal diverticula. Testis sacs are presumably cylindrical or of the type found in *khandalaensis*, but in view of the condition of the types when studied by the author they must be described from properly preserved specimens.

The excluded type.—A small, short transversely placed genital marking of elliptical outline is present immediately lateral to each male porophore. Corresponding to each of these markings there is a fairly large gland on the parietes internally, strongly adherent to the lateral face of the prostatic duct. These glands are larger than either of the median or lateral glands in the other types. Parietal glands of the usual sort (*i.e.*, not opening externally on genital markings but associated with prostatic ducts or male porophores) are entirely lacking here.

Penisetal follicles are visible on the median faces of the prostatic ducts of xvii and xix without dissection (usually glandular tissue must be cleared away from the immediate vicinity of the ducts before the follicles become visible). Four penial setae from one side of xix were obtained. Discrete follicles are unrecognizable, two setae may be functional and two reserve. Shafts are nearly straight, the tips flattened on one side and convex on the opposite side, without ornamentation. Lengths: 0·13, 0·19, 0·21, and 0·30 mm.

The Mysore Specimens. External characteristics.—Length 65-90 mm. Diameter 4 mm. Pigmentation red, fairly dense but restricted

to the anterior and posterior ends, possibly leached out by alcohol elsewhere. The first dorsal pore is on 4/5 (3) or 5/6 (1).

Setae begin on ii on which segment there is a nearly complete circle. Mid-ventral gaps are small, mid-dorsal gaps much wider but variable, some of the dorsalmost setae possibly unrecognizable because of small size or deep retraction. Formula : 39/iii, 38/viii, 53/xii, 60/xx, viii/6, ix/8, xvii/0, xviii/14, xix/0.

The clitellum is annular and extends from just anterior to the setae of xiii to just behind the setae of xvi ; intersegmental furrows and dorsal pores lacking, setal circles present.

Quadrithecal, spermathecal pores minute and superficial, transversely slit-like pre-setal on viii and ix, each pore at or near the centre of a small, circular area delimited by a slight furrow, the posterior margins of the porophores just in front of the setal circle of viii or in or just behind the setal circle of ix. Apertures of the follicles of six copulatory setae form an irregular circle around each spermathecal pore. Postero-lateral and antero-median to each spermathecal porophore there is usually a tiny tubercle with a central aperture of the follicle of a copulatory seta.

The single female pore is median and pre-setal.

Male pores are minute, each pore at the tip of a very tiny, conical protuberance from a point slightly postero-median to the centre of a circular porophore with soft central region and tough peripheral portion. The porophores are fairly widely paired, on xvii and xix, a central portion more or less deeply but not regularly depressed, or the whole porophore may be nearly flat. In the latter case the median margin is marked off by a slight furrow while the lateral margin is protuberant.

One specimen has a transversely placed genital marking of elliptical outline on 24/25, left side, extending antero-posteriorly nearly to the setae of xxiv and xxv and latero-mesially between *f* and *a*. A fairly deep groove demarcates a peripheral rim from the convex central portion.

Internal anatomy.—Septa 9/10 and 11/12 are close to 10/11 and either apposed to it peripherally or connected with it by very short, cylindrical bands of delicate connective tissue, the condition of the specimens preventing a more exact characterization.

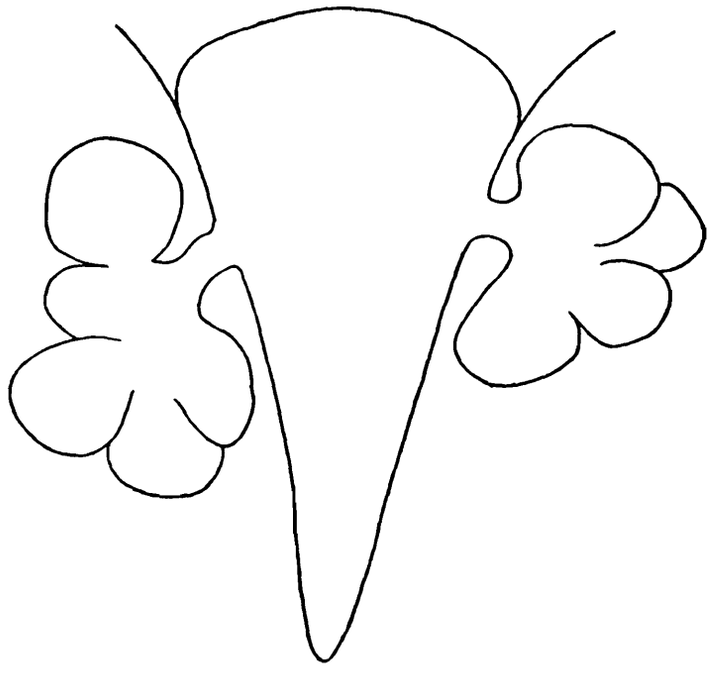
The large gizzard is in vii (2). No intestinal caeca. Typhlosole not noted, nor segment of intestinal origin.

The last pair of hearts is in xii (2). Paired commissures in the anterior portion of xiv pass ventrally and into extra-oesophageal trunks. Other portions of the circulatory systems were not in a satisfactory condition for study.

Seminal vesicles are paired in ix, x and xii, the vesicles of x being on the anterior face of 10/11. An ental portion of the prostatic duct is translucent, an ectal portion about 3 mm. long muscular and thickly spindle-shaped. Within the body wall and on the median face of each prostatic duct is a tiny cord of tissue containing five or six setae. In xix the setae are 0·38-0·40 mm. long, almost straight, the tip slightly more pointed than on the copulatory setae and without ornamentation.

Spermathecal ampullae, distended by a hard material, are four to six times as long as the duct. The latter is fairly wide entally, gradually narrowed ectally and very slender within the parietes, and opens into the

ampulla by a slit-like aperture. Diverticula are paired, median and lateral, each diverticulum with a very short stalk and three or more seminal chambers.



Hoplochaetella anomala ?—Spermathecal duct and diverticula of a specimen from Mysore State. ×*ca* 47.

Associated with each spermatheca are five or six glands, each gland about 2 mm. long and with a slender duct about 1 mm. long which is slightly widened as it passes into the parietes. Associated with each gland and protuberant into the coelomic cavity is a muscular follicle containing a single copulatory seta. The shaft is nearly straight except for a slight curvature of the entalmost portion and a slight bend at the extreme tip, and tapers gradually at the ectal end to a rather bluntly rounded termination. Of two setae the tips are hollowed in a spoon-like fashion. An ectal region is ornamented with longitudinal rows of four to six transversely placed, jagged ridges, a light spot just in front of each ridge as if a bit of the shaft had been gouged out. Length: in viii, 0·65-0·73 mm.; in ix, 0·64-0·70 mm.

The genital marking gland is sessile on the body wall.

Parasites.—Nematodes are present in the coelomic cavities of all dissected specimens. A much larger nematode was found in the gut of one specimen.

Remarks.—Efforts to trace the deferent male ducts in two of the specimens were failures. In a third worm the deferent ducts were traced into xviii from whence one was followed posteriorly into xix but junctions with prostatic ducts were not found. Laboratory notes on glands of the prostatic region are unsatisfactory but are presented for whatever they may be worth. "Associated with each prostate and passing into the body wall just in front of each prostatic duct is a conspicuous glandular mass flattened against the parietes of xvii-xviii of xix-xx or xxi, of variable shape, marginally incised by the septa, without recognizable duct, the wall of the coelomic portion delicte and easily ruptured releasing hard balls which look almost like sperm balls."

The Panchgani Specimens. External characteristics.—Length 28 and 50 mm. Diameter 2½ and 3 mm. Pigmentation unrecognizable (alcoholic preservation). Prostomium epilobous, without transverse furrow at posterior end of tongue. First dorsal pore on 4/5 (2). The clitellum is annular, extending from just in front of the setae of xiii to just behind the setae of xvi ; intersegmental furrows and dorsal pores lacking, setae present.

Setae are lacking ventrally on xvii and xix but there are six setae (2) on xviii between the male pore lines, *a* and *b* of both sides of viii and ix in normal positions (2) but *c-f* or *g* of viii are dislocated anteriorly in a transverse row about midway between the setal circle and 7/8 while the same setae of ix are arranged in circle around the posterior spermathecal pores.

Spermathecal pores are minute and superficial, on *c*, or in *cd*, the anterior pores midway between the displaced setae of viii and 7/8 and accordingly nearer to the intersegmental furrow than the setal circle, the posterior pores on or very close to the setal circle of ix.

The female pore is median and presetal (2).

The minute male pores are on *c* or just lateral to it, towards the median margins of small, transversely placed depressions of short elliptical to oval outline and appear to be very slightly behind the setal circles of xvii and xix. Each depression (male porophore) is within an indistinctly demarcated, whitish area of slight tumescence, the areas of a segment reaching nearly into contact mesially on one specimen, and perhaps in contact on the other worm.

A transversely placed area of whitish tumescence in *bb* (one worm only) extending from the setal circle of xx nearly to the setae of xxi is either a genital marking or a tumescence containing two markings (the latter, if present, unrecognizable).

Internal anatomy.—Two very delicate, transparent septa are attached to the gut anterior to the seminal vesicles of ix and presumably are 7/8-8/9. The next recognizable septum passes to the gut just in front of the gizzard and since it bears the posterior pair of vertically placed masses of nephridial tubules is presumably to be regarded as 5/6. No trace of 6/7 has been found. Septa 9/10, 10/11 and 11/12 apparently pass to the parietes normally.

The gizzard certainly appears to be in vii (2). The intestine begins in xvi (2). The typhlosole is simple and lamelliform, terminating six or seven segments in front of the hind end. The last hearts are in xii (2).

Seminal vesicles of ix and xii are large, x and xi filled with sticky material in which vesicles and membranes are unrecognizable. Male deferent ducts of a side pass into xviii between the anterior prostatic duct and the lateral parietal gland, one deferent duct continued into xix, the other turning back into xvii. The deferent ducts are probably not thickened prior to junction with the prostatic ducts though covered with soft (glandular ?) tissue. Just median and lateral to each prostatic duct, and protuberant from the parietes into the coelomic cavity is a vertically placed, ellipsoidal, hollow gland with a thick but soft wall.

Genital marking glands are two short, low masses of elliptical outline, longitudinally placed, sessile on the parietes, separated from each other by the nerve cord.

The spermathecal ampullae are not bound down around the ental ends of the ducts. The lumen in the thickened ental portion of the duct is slit-like in transverse section. Each spermatheca has two diverticula, one median and one lateral, each diverticulum ventrally directed and with three to five shortly ellipsoidal to spheroidal, iridescent masses of spermatozoa. Each of these masses presumably represents a seminal chamber, all of the chambers of a side apparently opening into the duct through a common aperture. Two or three chambers of each diverticulum are always quite definitely smaller than the others and may occasionally lack spermatozoal iridescence.

Copulatory setal follicles are protuberant into the coelomic cavity. The major portion of the setal shaft is straight, an ental portion curved like the handle of a walking stick. The tip is convex on one side and flat or very slightly concave on the opposite side. Ornamentation is lacking (18 setae of one worm and 14 of the other). The glands are short, about 1 mm. long (not including the duct). Coelomic sacs, if present, are unrecognizable.

Remarks.—The specimens are in such poor condition that setal counts and recognition of certain external characteristics are impossible. The intestine is completely disintegrated behind the clitellum for a considerable distance, lymph glands (if present) quite unrecognizable throughout, nephridia (except for the clusters on the anterior faces of 4/5 and 5/6) unrecognizable, characteristics of testis sacs (if present) indeterminable. The circulatory system, however, with the exception of the absence of hearts of xiii, is as usual in the genus. Penial setae were not found though looked for carefully.

The Panchgani worms are distinguished from the types of *anomala* by the absence of genital markings on xviii, the presence (1) of more closely paired genital markings on 20/21, and the absence of ornamentation on copultory setae and possibly also by absence of penial setae.

Absence of ornamentation on copulatory setae at present appears to be a useful criterion for specific distinction as this characteristic has been noted hitherto only in *H. stuarti* from which the present worms are obviously clearly distinct. The taxonomic value of the other differences from the types of *anomala* is unknown. In any case the erection of a new species is not to be considered as the specimens disintegrated during the course of examination so as to be useless as types.

Diagnosis.—Male pores in line with setal circles of xvii and xix, in *cd*, towards the median margins of transversely placed, short depressed porophores of elliptical outline in *bh*. Spermathecal pores pre-setal on viii (about midway between setal circle and 7/8 ?) and in or close to the setal circle of ix, on or close to *c*. Genital markings (when present) post-setal on xviii, in line with male porophores. Setae: 36-44/viii, 40-46/xii, viii/4, xvii/0, xviii/6-8, xix/0; some or all of *c-f* dislocated anteriorly on viii (and posteriorly on ix ?). Pigmentation ? Length 85 mm. Diameter 3 mm.

Gizzard in vii ? Last hearts in xii. Lymph glands ? Testis sacs ? Seminal vesicles present in x. Ejaculatory bulbs ? Parietal glands in xvii and xix, one median to and one lateral to each prostatic duct. Genital marking glands sessile. Spermathecal diverticula paired, with short stalks, ventrally directed, each diverticulum with 2-5 seminal chambers (?). Copulatory setae ornamented ; glands short, in clusters of 2-5 behind each spermathecal duct (coelomic sacs ?).

Distribution.—Known only from the type locality, Belgaum, Bombay Presidency.

Hoplochaetella bifoveata Stephenson.

1917. *Hoplochaetella bifoveata* Stephenson, *Rec. Ind. Mus.* XIII, p. 398. (Type locality—Talewadi, near Castle Rock, N. Kanara district, Bombay Presidency. Type in the Indian Museum.)
1922. *Erythraeodrilus kempi* var. *bifoveatus*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 437.
1923. *Erythraeodrilus kempi* var. *bifoveatus*, Stephenson, *Oligochaeta*, in *F. B. I.*, p. 462.

Material examined.—From the Indian Museum : 1 clitellate dissected specimen labelled, " *Hoplochaetella bifoveata* Stephenson. Type. Talewadi near Castle Rock, N. Kanara district, Bombay Presidency. Oct. 1916. Dr. S. W. Kemp. W 129/1 ".

External characteristics.—Spermathecal pores are on porophores of the usual type, on viii, about in *bc*, the anterior pores about midway between the setal circle and 7/8, the posterior pores slightly in front of 8/9. Dislocated setae are as follows : on vii, apparently none ; on viii, *a* of right side slightly anterior, within a discrete tubercle which is in contact with the spermathecal porophore, in addition three setae in each anterior spermathecal porophore (presumably *b-d* or *a-c*) ; on ix, *c-d* of left side and *b-c* or *c-d* of right side very slightly anterior to the circle and on a single area on each side of slight epidermal tumescence.

Male pores are minute and superficial, each pore towards the median margin of a small, transversely placed, translucent area of elliptical outline, the porophores just in front of and just behind the sites of 17/18 and 18/19.

Genital markings are unpaired, approximately median and symmetrical, transversely extended, reaching nearly to or slightly beyond the male pore lines, the anterior marking about equidistant from setal circles of xvi and xvii and accordingly across 16/17, the posterior marking pre-setal on xx, dislocating 19/20 anteriorly. Central and marginal areas demarcated as in *affinis*. A ventral area extending from the setae of xvi to 20/21 is smooth and with no intersegmental furrows. There are two ventral setae on xviii.

Internal anatomy.—Lymph glands of the *khandalaensis* type are probably present.

Glandular material is present around the ectal portion of each prostatic duct near the parietes, possibly in the form of a complete or incomplete annular collar.

Spermathecal diverticula lack spermatozoal iridescence and are small, short and digitiform, (ventrally directed ?). The number is variable; a single diverticulum on each side of the duct, one diverticulum on one side of the duct and none on the other side, two diverticula on each side closely crowded together, two on one side of the duct and none on the other. Copulatory setal glands are short, 1½-2 mm. long, in three pairs of sacs, the anterior pair in vii. Copulatory setal follicles on the anterior or median faces of gland stalks are slightly protuberant above the parietal level. Copulatory setae are ornamented with short transverse rows of a few small teeth, a short ental portion of the shaft curved like the handle of a walking stick.

Remarks.—The epidermis is damaged in the spermathecal region and some of the internal structures are lacking, the gut in poor condition, and the glands around prostatic ducts fragmented. Genital markings are like those of *affinis* but the spermathecae are like those of *kempi*.

The species, if really distinct, is very close to *kempi*, and can be distinguished at present only by the symmetrical locations of the genital markings. If *bifoveata* is to be suppressed, the asymmetrical condition characteristic of the types of *kempi* is, presumably, a rather common abnormality.

Hoplochaetella inornata Stephenson.

1917. *Hoplochaetella inornata* Stephenson, *Rec. Ind. Mus.* XIII, p. 395. (Type locality—Talewadi, near Castle Rock, North Kanara district, Bombay Presidency. Type in the Indian Museum.)

1923. *Erythraeodrilus inornatus*, Stephenson, *Oligochaeta*, in *F. B. I.*, p. 459.

Material examined.—From the Indian Museum: 1 clitellate specimen labelled, "*Hoplochaetella inornata* Stephenson. Type. Talewadi, near Castle Rock, N. Kanara district, Bombay Presidency. Oct. 1916. Dr. S. W. Kemp. W 130/1".

External characteristics.—On 4/5 at the mid-dorsal line there is a pore-like marking, possibly perforate, and a functional dorsal pore is certainly present on 5/6.

Ventral setae are lacking on xvii and xix, seven setae on xviii between male pore lines, no setae on viii in setal circle between spermathecal pore lines. No setae are dislocated on vii and ix, and tumescences as in *kempi* are lacking. On viii dislocated setae are as follows: on anterior left spermathecal porophore 1, right porophore 2, on posterior left spermathecal porophore 2, right porophore 3, *e* of the right side slightly posterior and at centre of a tiny tumescence of circular outline.

Spermathecal pores are minute and superficial, each pore at or near the centre of a small, transversely placed slightly tumescent short area of elliptical outline, the pores in *bd*, about equidistant from the setal circle, posterior pores a trifle more median than the anterior.

The single female pore is median and pre-setal.

The minute male pores are about in *ce*, each pore at the centre of a nearly circular abruptly depressed area. A marginal portion of each porophore is not depressed but slightly tumescent, forming a fairly

definite rim around the depression. One or more additional pores may be present on each porophore but are not definitely identifiable.

Internal anatomy.—The typhlosole is a simple lamella.

Extra-oesophageals, supra-oesophageal, dorsal trunk, commissures and hearts are, so far as can be determined, as in *khandalaensis*. No subneural. Latero-parietal vessels not seen. The kidney-shaped mass in xv mentioned by Stephenson is the first lymph gland much enlarged.

The usual clusters of nephridia are present on the anterior faces of 4/5 and 5/6, and probably also on the parietes in ii-iii.

The vasa deferentia of a side pass posteriorly in contact with each other, turning laterally to pass around the anterior prostatic duct and then mesially in xviii where one bends forward while the other continues posteriorly but first ventrally. The posteriormost portion of each duct is modified into a large, spheroidal (muscular ?) bulb on the anterior face of the posterior prostatic duct and the posterior face of the anterior duct, the prostatic ducts much narrower ectal to the junction with the male deferent ducts. Penial setae are present in xix but were not found in xvii. The single seta removed is practically straight and unornamented.

The spermathecae are 4+ mm. long, the slender ectal portion of the duct 1 + mm., the thick portion of the duct about 1 mm. in length. The ampulla is bound down around the ental end of the duct so that the latter appears to be invaginated into the ampullary lumen as a rather conspicuous annulus. A layer of transparent material on the annulus and lining the duct probably is the cuticle. In the thickened portion of the duct the lumen is irregular as a result of the presence of several longitudinal and fairly high ridges. In the ectal portion of the duct the lumen is circular in section. There is but a single circle of diverticula on each spermatheca, an occasional diverticulum slightly more ectal than the others. The diverticula, characterized by spermatozoal iridescence, are short and ellipsoidal, ventrally directed, and without a recognizable stalk exterior to the duct. Twelve diverticula were counted on one spermatheca of which three are more or less deeply bifid ectally.

Copulatory setal glands are about 2 mm. long, the ducts 1 + mm. long in two coelomic sacs, with the wall of the sacs very thin and transparent. The bluntly rounded ental end of a copulatory setal follicle projects slightly above the parietes in front of each gland. One follicle was removed. The single copulatory seta is ornamented, an ental portion curved into an arc somewhat like that of the handle of a walking stick.

Remarks.—This species differs from both *khandalaensis* and *powelli* in the absence of genital markings and of seminal vesicles in x, in the larger setal numbers, and in the presence of male seta on xviii. Were it not for the setal differences one might be justified in raising a question as to the type being a slightly abnormal specimen of *khandalaensis* (or perhaps even *powelli*).

Diagnosis.—Male pores in *ce*, at or near centres of small porophores at the posterior margin of xvii and anterior margin of xix. Spermathecal

pores on viii, in *bd*, midway between the setal circle and furrows. Setae 84/v, 80/ix, 84/xii, 85/xx, viii/0,[1] xvii/0, xviii/7, xix/0; *a-c*, *d* or *e* of viii dislocated anteriorly and posteriorly onto spermathecal porophores. First dorsal pore on 4/5 (?). Pigmentation red? Length 101 (+?) mm. Diameter 6 mm.

Gizzard in vi. Last hearts in xiii. Unpaired lymph glands from xv posteriorly. Testis sacs formed by peripheral fusion of septa 9/10-11/12. Vasa deferentia just prior to junctions with prostatic ducts enlarged to form spheroidal ejaculatory bulbs. Parietal glands in xvii-xix, three on each side, just median to the prostatic ducts, largest in xviii. Spermathecal diverticula ventrally directed, short, ellipsoidal, occasionally bifid, 12 (more or less) in a single circle. Copulatory setae ornamented, glands short, in two coelomic sacs, in viii.

Distribution.—Known only from the type locality, Talewadi, in North Kanara district, Bombay Presidency.

Hoplochaetella kempi Stephenson.

1917. *Hoplochaetella kempi* Stephenson, *Rec. Ind. Mus.* XIII, p. 392. (Type locality—Talewadi, near Castle Rock, North Kanara district, Bombay Presidency. Types in the Indian Museum.)

1923. *Erythraeodrilus kempi*, (part), Stephenson, *Oligochaeta*, in *F. B. I.*, p. 460. (Excluding *var. bifoveata*.)

Material examined.—From the Indian Museum: 8 clitellate (1 dissected) specimens labelled, "*Hoplochaetella kempi* Stephenson. Types. Talewadi, near Castle Rock, N. Kanara District, Bombay Presidency. Oct. 1916. Dr. S. W. Kemp. W 68/1".

External characteristics.—Two of the shortest specimens are probably incomplete posteriorly. Another specimen, apparently complete, is *ca.* 70 mm. long. Most of the worms are about 4 mm. thick. Pigmentation is now unrecognizable. Dorsal pores are unrecognizable anterior to the clitellum on most specimens but a pore is almost certainly present on 4/5 on two worms.

The clitellum is reddish brown, not protuberant or slightly constricted, intersegmental furrows lacking, sites of dorsal pores occasionally indicated by slight depressions but pores probably occluded, setae present; annular, extending posteriorly to 16/17 or to just behind the setae of xvi, and anteriorly to just in front of the setal circle of xiii. An anterior portion of xiii of variable length is white.

The single female pore (8) is median and slightly pre-setal.

Spermathecal pores are minute and superficial, all four pores open and clearly visible on every specimen, in *ac*, the anterior pores midway between the setal circle of viii and 7/8 or slightly nearer to the setal circle, the posterior pores slightly nearer to 8/9 than the anterior pores are to the setal circle. Spermathecal pores are located on transversely placed areas of slight tumescence and probably of shortly elliptical

[1] No setae in ventral portion of setal circle between longitudinal spermathecal pore lines.

outline, margins indistinctly demarcated. Dislocated setae are shown below.

Specimen	Setae associated with tumescences	Dislocated Setae		Male setae on
	vii	viii	ix	xviii
1	*a-c* of left side, *a* of right side.	left 3 right 2	*c-d* of left side, *c* of right side.	2
2	*a-b* both sides	left 3 right 3	Surface damaged	4
3	*a-b* both sides	left 3 right 3 *d* of each side slightly displaced anteriorly and on a tumescence.	*b* both sides	2
4	*a-c* of left side, *a-b* of right side.	left 4 right 3 *d* of right side on tumescence and slightly anteriorly.	*a-b* both sides	4
5	*a-b* both sides	left 3 right 3	*c*(?) of left side, *c-d* of right side, *a-b* follicles empty ?	4
6	*a-d* of left side, *a-b* of right side.	left 3 right 3	*a-c* both sides	0?
7	*a-b* both sides	left 3 right 3	*c-d* both sides, *b* of left side present, left *a* and right *a-b* follicles empty ?	4
8	*a-b* of left side, *a* of right side.	left 3 right 3	*b* of right side (?) damaged surface.	4

Several ventral setae are lacking on the left side of vii of every worm, the corresponding setae of the right side present.

Several (probably not as many as on vii) ventral setae are usually lacking on the right side of ix lateral to the setae on tumescences and occasionally fewer setae are also lacking on the left side.

Setae on tumescences of vii and ix may be dislocated anterior to the setal circle but usually so slightly that the displacement is scarcely recognizable.

Dislocated setae of viii are anterior, apertures of follicles on the spermathecal porophores.

Male porophores are small, transversely placed, translucent areas of short elliptical outline. On four specimens the porophores are definitely segmental, anterior to 17/18 or its site and posterior to 18/19 or its site. On two or three specimens the anterior porophores appear to be across sites of 17/18, the posterior porophores on xix. On another worm all of the porophores appear to be across the sites of the intersegmental furrows. Male pores are minute, each pore at or very slightly median to the centre of a porophore, *ca* in *ac*.

Genital markings are transversely placed and shortly elliptical in outline. Each marking comprises a central portion and a marginal band, a considerable inner portion of the marginal band depressed and translucent while the central area is white and opaque. Markings are located as follows : (1) on 16/17 and pre-setal on xx, anterior marking

slightly asymmetrical towards the right side, the posterior marking on the left side and with centre lateral to the male pore line; (2) pre-setal on xx only, right side, centre about on the male pore line; (3) pre-setal on xvii and xx, anterior marking on the right side, posterior marking on the left side, centres lateral to the male pore lines; (4) anterior marking practically symmetrical and mainly pre-setal on xvii, posterior marking pre-setal on left side of xx and with centre median to male pore line; (5) pre-setal on xvii and xx, anterior marking on the right side, posterior marking on the left side, centres lateral to the male pore lines; (6) as on 5 except that the centre of the posterior marking is about on the male pore line; (7) as on 5; (8) as on 5 except that the markings appear to be equally across 16/17 and 19/20.

Internal anatomy.—The gizzard is in vi (2). The intestine begins in xvi (2), the oesophageal valve posteriorly in xv and just reaching into xvi. The typhlosole begins abruptly in xxii (2) and is a fairly high, simple lamella, very gradually decreasing in height posteriorly, ending abruptly in lxxv (specimen with 94 segments).

The dorsal blood vessel (single) is continued on to the pharyngeal bulb. A supra-oesophageal trunk is first visible in an anterior portion of ix and terminates posteriorly by dividing into two vessels passing to the posteriormost calciferous glands. Extra-oesophageals have been traced from 4/5 to the posteriormost calciferous glands. No subneural. A posterior latero-parietal vessel is present on each side in xv-xvi, completely concealed from view by nephridia, and unrecognizable posteriorly. Just in front of 14/15 the vessel rises from the parietes and after uniting with the commissure of xiv passes through 13/14 and joins the extra-oesophageal just as the latter turns laterally towards the calciferous glands. Commissures of xiv are large and join the dorsal trunk just behind 13/14. Hearts of x-xiii are latero-oesophageal, all commissures and hearts of viii-xiii passing into the ventral trunk, and paired vessels from dorsal trunk in v-vii not traced to ventral trunk. Lymph glands are present from xv (2) posteriorly, and are very small anteriorly, relatively quite large towards the hind end.

Mega-nephridia begin in xiv but in xiv-xix the loops (5) are about half the length of those behind xix. In another specimen (3) mega-nephridia of xiv-xix are, at least in part, or perhaps even wholly, lacking. In posterior segments the neck portion of a mega-nephridium is very slender and rather long so that the funnel is held out some distance in front of the septum. On the neck just behind or slightly behind the funnel there are usually two to four clusters of coelomic corpuscles. Each cluster of corpuscles is adherent to a funnel-shaped structure provided with filamentous processes resembling cilia and a short stalk passing to the neck. Cilia of the main funnel often project beyond the funnel margin and are usually in brush-like bunches, eight having been noted on several funnels. Micro-nephridia are numerous enough to cover practically the entire body wall in segments xiii-xvi. The usual clusters are present on the anterior faces of 4/5 and 5/6 and on the body wall in ii and iii.

No seminal vesicles in x. Male deferent ducts have not been successfully traced throughout, but they almost certainly pass into the anterior

faces of posterior prostatic ducts and the posterior faces of the anterior ducts. On the median face of each prostatic duct, sessile on the body wall and markedly protuberant into the coelomic cavity but concealed from view by micro-nephridia, is a gland shaped like a half collar with concave side laterally. On the lateral face of each prostatic duct is a smaller but also protuberant, vertically placed, rather flattened gland, likewise concealed by micro-nephridia, possibly continuous within the parietes with the other gland. In 3 specimens a single glandular collar surrounds the prostatic duct except for a small space postero-laterally. On the median face of each posterior prostatic duct are penial setae in two (or possibly three ?) follicles. Three setae dissected out from one side are 0·30-0·32 mm. long and practically straight. Two of these setae are ornamented near the tips by short, transverse serrate ridges. The other seta is unornamented. Only one seta was secured from the other side and this was also unornamented.

A pair of small, collapsed, sac-like structures on the posterior face of 13/14 are probably the rudiments of structures usually called ovisacs.

Spermathecae are about $2\frac{1}{2}$ mm. long, the ducts about 1 mm. long. The ampulla is bound down around the ental end of the duct which has the appearance of being invaginated into the ampullary lumen as a rather flattened annulus covered with a transparent layer of material that is possibly the cuticle. Diverticula are usually ventrally directed, with very short and slender stalks practically confined to the tissues of the duct and short ellipsoidal seminal chambers with spermatozoal iridescence,—in two groups as follows: 0+1, 1+1, 1+2, 1+2 (specimen 5); 2+3, 3+3 (2 with common stalk), 2+3 (2 with little or no iridescence), 2+3 (3); 2 or 3 in each group (1 and 2).

Follicles of copulatory setae are muscular, the bluntly rounded ental ends protuberant above the parietes on the median face of the glands but within the parietes the seta passes into the posterior face of the gland stalk. The gland is short, 1 mm. or a trifle longer and much thicker than the duct. There is one gland for each dislocated seta on viii as well as for each seta of the tumescences. Definite coelomic sacs have not been seen but thin bits of tissue adherent to the glands are possibly the fragments of coelomic sacs in which case there are probably three pairs, one each in vii-ix. Copulatory setae are ornamented.

Genital marking glands are sessile, flattened, though definitely protuberant into coelomic cavities, and are larger than the genital markings. One gland came easily out of the body wall, leaving a smooth margin in the parietes and with the opaque central portion of the genital marking on the ventral face of the glandular mass.

Remarks.—Dorsal pores are not recognizable or identifiable as patent apertures on some of the specimens, even after removal of the cuticle, posterior as well as anterior to the clitellum.

Although penial setae were not found in xvii it is impossible to conclude that they are lacking. The glandular tissues around the prostatic ducts are so brittle that dissection is difficult. The glands in the coelomic cavity associated with a prostatic duct may be merely lobes of a single gland forming an annulus around the duct within the parietes.

Distinction of hearts from commissures by colour appears to be impossible. In one specimen the commissures of xiv and of viii-ix are as white as the hearts of x-xiii.

Prior to removal of the cuticle only one aperture is recognizable on the male porophores. After removal of cuticle (1 specimen) one or two additional pit-like markings, possibly apertures, are visible. As the cuticle was slightly adherent to the porophores and required some slight force to lift it off, the pits may be the result of damage to the epidermis.

As the peculiar asymmetry in location of the genital markings (and in loss of certain ventral setae of vii) is constant in the type series, it may be a characteristic of the species, in which case *bifoveata* is distinct. However, if the asymmetry is merely a local or common variation *bifoveata* can probably be suppressed.

Diagnosis.—Male pores (on or) in front of 17/18 and behind 18/19, in *ac*, at or near centres of transversely placed, translucent areas of shortly elliptical outline. Spermathecal pores on viii, in *ac*, anterior pores in front of setal circle, posterior pores slightly nearer to 8/9 than the anterior pores are to the setal circle. Genital markings transversely placed and of elliptical outline, centres usually on or lateral to the male pore lines, pre-setal on xvii (or on 16/17) and xx (or on 19/20), anterior marking usually on right side, posterior marking on left side, two markings usually present. Setae 52/v, 56/x, 45/xx, viii/0, xviii/2-4; some or all of *a-d* of vii and ix on tumescences, three setae on each side of viii dislocated anteriorly on to spermathecal porophores close to spermathecal pores. First dorsal pore on 4/5 (?). Pigmentation red ? Length 70-103 mm. Diameter 4-4½ mm.

Gizzard in vi. Last hearts in xiii. Unpaired lymph glands from xv posteriorly. Testis sacs formed by peripheral fusion of septa 9/10-11/12. Parietal glands; a half-collar on the median face of each prostatic duct, a smaller lobe on the lateral face. Genital marking glands sessile. Spermathecal diverticula with shortly ellipsoidal seminal chambers and very slender stalks almost confined to duct, (median and lateral ?) groups, usually of 2-3. Copulatory setae ornamented; glands short, in six coelomic sacs (?), in vii-ix.

Distribution.—Known only from the type locality, Talewadi, in North Kanara district, Bombay Presidency.

Hoplochaetella khandalaensis (Stephenson).

1924. *Erythraeodrilus khandalaensis* Stephenson, *Rec. Ind. Mus.* XXVI, p. 350. (Type locality—Khandala, Bombay Presidency. Types in the Indian Museum.)

1925. *Erythraeodrilus khandalaensis*, Stephenson, *Proc. Zool. Soc. London*, 1925, p. 898.

1926. *Hoplochaetella khandalaensis*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 265.

Material examined.—From the Bombay Natural History Museum: 11 clitellate specimens labelled, "Andheri, Thana district. 10.10.38. C. McCann". 2 aclitellate specimens labelled, "Andheri, Salsette Island. 14.8.38. C. McCann.", and 90 juvenile or aclitellate specimens labelled, "Andheri, Salsette Island, Thana district. 13.8.38. C. McCann".

External characteristics.—Length 85-155 mm. Diameter 4-6 mm. Pigmentation red, restricted to the dorsum; gradually fading out

posteriorly; ventrum white. Pigment is lacking, invisible or scarcely recognizable on rather indefinite, mid-segmental stripes of irregular outline bearing the setae, the stripes of a segment not continuous mid-dorsally. The prostomium is epilobous, one half to three quarters; a transverse furrow at the posterior margin of tongue probably always lacking, an apparent transverse furrow occasionally visible, and having more the appearance of a fortuitous crease than of a definite furrow. The first dorsal pore is on 4/5 (8), 5/6 (1), or 6/7 (1). Definitely pore-like but apparently non-functional markings are often present anterior to the first definitely functional pore.

Setae begin on ii. A mid-ventral gap may be lacking on ii-iii or even iv, and is small on the remaining pre-clitellar segments as well as on segments just behind the clitellum, never large, usually no greater than 3*ab*. A mid-dorsal gap is usually present throughout (occasionally lacking on ii-iv), larger than the ventral gap and more variable in width. Setal numbers of several clitellate specimens are indicated in the table below. Ventral setae of vii and ix are not usually dislocated although *a* of ix is dislocated anteriorly on one side of one specimen. The ventralmost setae of viii are displaced, usually to positions surrounding the anterior spermathecal pores (8 clitellate specimens), but may be dislocated posteriorly only (1 specimen, with three setae close to each posterior spermathecal pore and no setae around anterior pores) or both anteriorly and posteriorly (2 specimens with one or two setae close to each spermathecal pore). Externally the ventralmost setae of xvii-xix appear to be lacking on clitellate as well as aclitellate specimens and most juvenile worms, but on two of the smallest juveniles there are visible, just median to each male pore, two tiny black dots, each doubtless the tip of a seta. The dots are not at the surface and follicular apertures are unrecognizable under best optical conditions. It appears as if the tip of the seta is covered over by cuticle and a very thin layer of epidermis. Internally (in both juvenile and clitellate specimens) there is on the median face of each prostatic duct, after removal of nephridia and glandular material, a pair of modified setae.

Setal formulae.

ii	iii	viii	xii	xx
32	44	51	56	53
28	47	49	60	50
39	49	53	60	62
40	47	50	57	54
38	48	49	66	52

The clitellum is annular, extending from 12/13 to 16/17 or nearly to, or towards, each of those furrows; intersegmental furrows and dorsal pores lacking, setae present. Thickening of epidermis anteriorly and posteriorly near 12/13 and 16/17 is recognizable at the mid-dorsal incision while it is almost unrecognizable externally.

Quadrithecal, spermathecal pores minute and superficial, pre-setal and post-setal on viii, about equidistant from the setal arc, slightly

nearer the arc than to the intersegmental furrows, in *ac* usually close to *b*. Each pore is located at or near the centre of a small, transversely placed marking of shortly elliptical outline with greyish translucent centre and a slightly raised, opaque, marginal band. Associated with each anterior spermathecal porophore (or as previously indicated) are minute apertures, the combined openings of follicles of copulatory setae and the accompanying stalked glands, the apertures on the centres or rims of the markings or more rarely external to the markings. Spermathecal and gland apertures, always open, are recognizable on juvenile and aclitellate as well as on clitellate specimens. The spermathecal openings can be distinguished from the other pores by the slightly larger size and the absence of a seta or of a black appearance within the parietes due to visibility of tip of seta through transparent tissues.

The single female pore (11) is median and pre-setal, at the centre of a whitened area of circular to short elliptical (and then transversely placed) outline.

Male pores (combined apertures of prostatic ducts, male deferent ducts and penisetal follicles ?) are minute and superficial apertures, about on *b* or in *bc* (as of xx), always open, even on juveniles, each pore at or near the centre of a transversely placed, greyish, translucent area of short elliptical outline. Even with the best optical conditions further pores are unrecognizable but the epidermis of the porophores is very soft and easily ruptured. Exact location of the areas and pores is impossible, even on the juveniles as intersegmental furrows 17/18-18/19 are unrecognizable mid-ventrally. On some juveniles the pores appear to be quite definitely on sites of the furrows and are at least in line with the furrows when the latter are first visible laterally. On other juveniles the anterior pores appear to be just as definitely on xvii though only slightly in front of sites of 17/18. More rarely the posterior pores appear to be on the anterior margin of xix. On clitellate specimens each male porophore has a slightly raised, narrow, whitish marginal rim. A median area between setal circles of xvii and xix, bearing the male porophores is depressed in a regularly concave fashion.

The single genital marking (103 specimens) is median, in the region between the setae of xix and xx. Intersegmental furrow 19/20 is unrecognizable mid-ventrally on aclitellate and clitellate specimens but when first visible laterally is usually dislocated posteriorly by the genital marking. On the smallest juveniles the furrow is complete mid-ventrally and a rudiment of the genital marking with a distinct opening is definitely segmental and midway between the setae of xix and 19/20. On clitellate worms the genital marking is circular or nearly so, with a narrow, whitish and slightly raised, marginal band and a central area that is greyish or brownish, smooth and hard. Just in front of the centre of each marking is a small, transversely placed slit with whitened margins which may be smooth and firm or slightly tumescent, wrinkled and soft.

On nine of the clitellate specimens there is a median region of slight epidermal thickening, extending from 19/20 on to xxvi, xxvii or xxviii and laterally about to *c* on each side anteriorly, gradually narrowed posteriorly. On six of these worms there is a post-setal area of similar

appearance on vii, in *cc.* On two specimens there are visible, on these latter areas, numbers of dark dots which appear as quite minute pores.

Internal anatomy.—All septa are present, at least from 4/5 posteriorly, 4/5-8/9 funnel-shaped with oesophageal apices directed posteriorly; all septa membranous and transparent or slightly translucent; 9/10 and 11/12 in contact towards the periphery except ventrally with 10/11, the three septa presenting an appearance in the pinned out specimen as of a single muscular septum.

The gizzard is in vi (12). The cuticular lining of the gut is continued at least into vii and is thickened in the gizzard. The inner wall of the oesophagus is provided with low, white, longitudinal ridges; anterior to the gizzard the ridges are thicker while posterior to the gizzard ridges may be irregularly creased, interrupted or modified so as to present the appearance of short and thick villi or even of vertical ridges of variable length. Calciferous glands, four pairs in x-xiii (12), are antero-posteriorly flattened, reniform, with hilus mesially, in the posterior portions of the segments, reaching below the level of the ventral face of the gut but not reaching up to the level of the dorsal face of the gut. Each gland is provided with a rather short, but fairly thick stalk, which passes to the ventral face of the gut at the extreme lateral margin. Ducts open directly into the oesophageal lumen by small, circular pores. The intestine begins in xvi (12), the oesophageal valve at region of attachment of 15/16 or slightly behind. Intestinal caeca (dorsal, lateral or ventral) are lacking. The typhlosole begins rather abruptly in the region of xxiv-xxv (though continuous with a lower ridge that reaches into xvi) and is a low, simple, nearly straight lamella, at first triangular in cross section, decreasing in height posteriorly and unrecognizable behind cviii (in a worm with 122 segments) or in the last 12-16 mm. of worms that are 150 mm. long. There are no supra-intestinal glands.

The dorsal blood vessel (single) is continued on to the pharyngeal bulb. The large supra-oesophageal, not firmly adherent to the gut, is first recognizable just behind 8/9 and terminates in the posterior portion of xiii by dividing into two branches each of which passes latero-ventrally on to the posterior face of a calciferous gland just below the dorsal pole and is then continued nearly to the ventral pole. In each of segments x-xii large branches from the supra-oesophageal pass similarly on to the posterior faces of the calciferous glands. The ventral trunk is continued to the region of the sub-pharyngeal ganglia where it bifurcates, the branches passing laterally. Extra-oesophageal trunks are first recognizable laterally just behind the nephridial masses of ii or iii where they are formed by the union of two vessels from the body wall dorsally. Each trunk is continued postero-ventrally, apparently receiving in the region of iii or iv a single commissure from the ventral vessel and in v a large vessel from the pharyngeal bulb. Anteriorly on 4/5 the trunk passes up to the level of the ventral face of the gizzard from whence it is continued posteriorly at about the same level, giving off in x-xii short vertical branches to the ventral poles of the calciferous glands, turning up in xiii to pass into the ventral pole of the calciferous gland. A small, posterior, latero-parietal vessel, recognizable at least as far back as xxi, passes upwards in the coelomic cavity of xiv and after receiving a com-

missure from the dorsal trunk runs anteriorly to open into the extra-oesophageal just as the latter turns towards the calciferous gland. Commissures in xiv may be dark and red throughout, or white throughout, or dark in a ventral portion and white in a dorsal portion of variable length, each commissure emerging from the dorsal trunk just behind 13/14 and giving off one or two branches to the dorso-lateral aspect of the oesophagus. The thickness of the commissure may be approximately the same throughout or a ventral portion may be slenderer. No sub-neural.

The last pair of hearts is in xiii (12). Commissures of ix are about as large as the hearts of x-xiii, commissures of viii slightly smaller. All commissures or hearts of viii-xiii pass into the ventral trunk. Anterior to viii commissures between dorsal and ventral trunks are lacking or unrecognizable. Dorsally each heart of x-xiii bifurcates, the bifurcations unusually short, the posterior branch passing to the dorsal trunk, the still shorter anterior branch into the calciferous gland vessel of the supra-oesophageal trunk. Blood has been found in all of these bifurcations excepting only in the anterior branch of the heart of x which, accordingly, may not be a vascular tube. Posteriorly in xiv there is usually visible one or a pair of vessels passing from the dorsal trunk to the dorso-lateral aspect of the oesophagus.

Beginning from xv (12) there is in each segment, attached to the dorsal blood vessel and the anterior face of the septum, a transversely placed lymph gland. A median portion of the gland just over the dorsal blood vessel in posterior segments may be thin and translucent, in which case the appearance at first glance is that of a pair of glands. In six specimens the anteriormost gland (in xv) is filled with a brownish granular material closely packed into a fairly tough disc. In one of the worms slight manipulation of the gland was sufficient to rupture the very delicate wall and release the disc. Posteriorly similar brownish material is often present in the glands, usually in two small, discrete, lateral masses. Larger masses of brownish material may be lateral or median, usually only one in each gland.

Mega-nephridia are long loops, reaching in xx and posteriorly nearly to the mid-dorsal line, located on the parietes in the anterior halves of the segments or just behind the septa, the small pre-septal funnels close to the ventral parietes in the region of *ad*, the slender pre-septal neck regions rather long. Smaller and perhaps modified mega-nephridia are usually present in xiv-xix, the size increasing posteriorly, but are occasionally unrecognizable. On the anterior faces of 4/5 and 5/6 there are fairly large, paired, vertically placed clusters of micro-nephridial tubules. Ducts of the posterior clusters have not been traced beyond the parietes ventrally in v. In ii and iii or iii and iv there are paired transversely placed bands of closely crowded tubules on the parietes, the bands similar to those of species of *Eutyphoeus* though the tubules here are not so closely crowded. From iv or v to a post-prostatic region the parietal micro-nephridia are small, numerous, and rather uniformly distributed. In aclitellate worms the integument is visible but in clitellate specimens the tubules are thickened and slightly elongated and practically cover the coelomic face of the body wall. Posteriorly the tubules are also numerous but less uniformly distributed, in some

specimens at least more numerous and closely crowded dorsally. A definite arrangement appears to be lacking though there seems to be a tendency for the tubules to be attached in three or four transverse rows in each segment.

Coelomic cavities of x and xi are reduced by approximation and (except ventrally) peripheral fusion of septa to form a sort of testis sac which is usually filled with coagulum. Paired seminal vesicles are present in ix, x, and xii (10), the smaller, middle vesicles attached to the anterior face of 10/11, one of the vesicles of ix lacking in two specimens. Prostates are tubular and may reach as far back as xxxv. The glands are tubular, looped back and forth in a regularly zigzagged fashion, the lumen small and slit-like in transverse section. In juvenile worms the prostates are confined to xvii and xix but are also looped. An ental portion of the duct, 3-4 mm. (anterior prostates) or 5-6 mm. long (posterior prostates), is slender. In xvii and xix the ducts are thickened to form spindle-shaped, muscular bulbs with marked sheen, each bulb *ca.* 2 mm. long, the lumen in the bulb relatively very small and circular in transverse section. Within the body wall the duct is again slender and is imbedded in adherent glandular (?) material. On the posterior face of each anterior duct and the anterior face of each posterior duct, close to the ectal end of the spindle-shaped enlargement and within the parietes or covered over by glandular material, is a thick-walled, almost spheroidal muscular bulb. The male deferent ducts have not been traced throughout; posteriorly they are covered over by diagonal muscle fibres, nephridia and glandular material. Both ducts of a side pass lateral to the anterior prostatic ducts and, so far as can be determined, into xviii. Apparently one duct then turns forward to pass into the posterior face of the muscular bulb on the posterior face of the prostatic duct, the other deferent duct passing into the anterior face of the corresponding bulb on the posterior prostatic duct, the muscular bulbs probably ejaculatory and in the nature of local thickenings of the vasa deferentia. (Deferent ducts were broken, each time, in attempting to remove the glandular material in which they are imbedded. In one of the clitellate worms deferent ducts are characterized by a marked iridescence. From xviii, where the rupture usually occurs in the dissection, similar iridescent tubes pass anteriorly or posteriorly into the ejaculatory bulbs on the prostatic ducts. In a juvenile worm deferent ducts of both sides were traced from the posterior ejaculatory bulbs anteriorly into xvi, but the other duct was broken on each side though a short piece still remained continuous with the bulb.

Protuberant into the coelomic cavities just median to the ectal ends of the prostatic ducts, on each side, is a longitudinal row of three glandular bodies, one each in xvii-xix, those of xviii often much larger than the others (coelomic portion 3 mm. long). Each of these bodies is soft, the lumen filled with a loose coagulum, the three of a side apparently continuous with each other within or close to the parietes.

The spermathecal duct is shorter than the ampulla, circular in cross section, with muscular sheen, quite slender ectally, gradually widened entally and especially so near the ampulla from which it is clearly distinguished though not always obviously, as an ectal portion of the ampulla may be bound down around an ental part of the duct. Slightly

ectal to the ampulla and on the thickest portion of the duct there is a circle of 8-17 diverticula. Each diverticulum is usually elongate but sinuous in a rather zigzagged fashion, bound to the duct with the distal end ventrally. A major portion of each diverticulum is characterized by a spermatozoal iridescence that is lacking in a very slightly narrower proximal portion which might be regarded as a stalk. The connective tissue which binds the diverticula to the duct may conceal the stalk portions from view so that there is visible at first glance only a circle of small, apparently ovoidal to shortly ellipsoidal seminal chambers but the tissue can be dissected off without especial difficulty. In addition to these longer diverticula there may be two or three shortly ellipsoidal seminal chambers with stalks confined to the tissues of the spermathecal duct, or a diverticulum may be bifid distally. Thus one spermatheca has eight diverticula of which one is bifid and two are sessile seminal chambers. The lumen of the duct (relative to the thickness of the wall) is small, even in the thicker ental portion and is circular to slit-like in transverse section. A fairly large ball of densely packed spermatozoa may be present in an ectal portion of the ampulla, seated on the aperture into the duct, and smaller, softer masses of spermatozoa in shape similar to that of the diverticula may be present just beneath the ball. Occasionally the lumen of the thick ental portion of the duct is filled with spermatozoa and in this case the lumen is enlarged and irregular rather than slit-like.

Between the two spermathecae of a side there is a cluster of glands, usually enclosed in a single coelomic sac. Each gland is 3-5 mm. long, elliptical in cross section with (relatively) very small and eccentric lumen, transversely slit-like to circular in section. From each gland a slender duct 1-2 mm. long and with marked (muscular ?) sheen passes into the parietes. On the anterior face of the stalk of each gland, within the parietes and opening into the duct is a shortly ellipsoidal to ovoidal, thick-walled (muscular) follicle, containing a single copulatory seta. The ental end of a follicle is just visible above the parietes. Behind each posterior spermatheca there is usually on the ventral parietes a mass of tissue that appears to be the wall of a small, collapsed, coelomic sac (*cf.* sacs of vii in *suctoria*).

On the median face of each prostatic duct and within the parietes, hence visible only after removal of the glandular material, there are two penial setae imbedded in a muscular (?) mass. It is not clear from the preparations that have been made whether there are two follicles each containing a single seta or one follicle containing two setae.

The sausage-shaped gland of the median genital marking is 12-13 mm. long, reaching as far back as xxviii when not bent anteriorly or curled up around the gut, and is nearly 2 mm. in diameter. A soft outer layer can be easily scraped off revealing a tough-walled (muscular ?) capsule about 0·5 mm. in diameter, very slightly widened at extreme ental end, with central lumen slit-like in transverse section. There is no stalk or duct. Occasionally a gland can be pulled out from the parietes without rupture and in this case only a portion of the genital marking surrounding the aperture is removed from the epidermis.

On the posterior face of 13/14 there is usually present a pair of small vesicles presumably the same as those which Stephenson referred to

as ovisacs. The vesicles usually contain one or more aggregates of brown granules. An ordinary sigmoid seta is included in one of these masses of brown granules. The function of the organs is unknown but is possibly more like that of the pseudovesicles in certain species of *Pheretima*, than of an ovisac.

Remarks.—An aclitellate specimen, with a reddish discolouration of the clitellar segments and brilliant spermatozoal iridescence on the male funnels but no iridescence in the seminal chambers of the spermathecae is probably post-sexual.

Even with best optical conditions nephropores are unrecognizable.

Absence of mega-nephridia in xiv-xix of certain specimens may be the result of maceration.

Types of *khandalaensis* are not fully sexual, clitellum " hardly distinguishable " and with spermathecal ducts of the same length as the ampullae (a condition characterizing most aclitellate and juvenile specimens from Andheri).

Diagnosis.—Male pores on or close to sites of 17/18 and 18/19 about in *bc*, at or near centres of paired, transversely placed, translucent areas of shortly elliptical outline all of which are within a median depression reaching antero-posteriorly to levels of setal circles of xvii and xix. Spermathecal pores on viii, in *ac*, about equal distances before and behind the setal circle and slightly nearer the circle than to intersegmental furrows. Genital marking post-setal on xix but dislocating 19/20 posteriorly, with single slit-like pore (occasionally an extra marking on xvi). Setae : 28-40/ii, 44-49/iii, 49-53/viii, 56-66/xii, 50-62/xx, viii/0, xvii-xix/0 ; ventralmost setae of viii dislocated, usually anteriorly and in circles around spermathecal pores. Pigmentation red. Length 85-155 mm. Diameter 4-6 mm.

Gizzard in vi. Last hearts in xiii. Unpaired lymph glands from xv posteriorly. Testis sacs formed by peripheral fusion of septa 9/10-11/12. Seminal vesicles present in x. Vasa deferentia just prior to junctions with prostatic ducts enlarged to form spheroidal, ejaculatory bulbs. Parietal glands, in xvii-xix, three on each side, just median to the prostatic ducts. Genital marking gland tubular, sausage-shaped, 12-13 mm. long. Spermathecal diverticula ventrally directed, elongate and sinuous, occasionally bifid, 8-17 in a single circle. Copulatory setae ornamented ; glands long, in two coelomic sacs in viii.

Distribution.—Bombay, Andheri, Lonavla, Khandala in the Bombay Presidency.

Forma **dichordarius** (Stephenson).

1924. *Erythraeodrilus khandalaensis* f. *dichordarius*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 352.

1925. *Hoplochetella khandalaensis* f. *dichordarius*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 265.

Material examined.—From the Bombay Natural History Museum : 4 juvenile specimens labelled, " Andheri, Salsette Island, Thana district. 13.8.38. C. McCann ".

External characteristics.—Each of these worms has an additional genital marking, post-setal on xvi and midway between the setal circle and 16/17, the marking similar to that on xix. Combined apertures of copulatory setal follicles and stalked glands are around the anterior spermathecal pores only.

The anterior genital marking gland (sausage-shaped) is not quite as well developed as the posterior. Both glands are short.

Remarks.—Except as noted above the external characteristics and internal anatomy are the same as in juvenile specimens of the typical forms.

In addition to the specimens mentioned above, another worm from the same tube has an anterior, median genital marking but lacks the posterior marking.

Distribution.—Bombay, Andheri, and Mahableshwar in the Bombay Presidency.

Hoplochaetella mullani (Stephenson).

1924. *Erythraeodrilus mullani* Stephenson, *Rec. Ind. Mus.* XXVI, p. 348. (Type locality—Matheran, Bombay Presidency. Types in the Indian Museum.)
1926. *Hoplochaetella mullani*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 265.

Material examined.—From the Indian Museum: 7 clitellate (1 dissected) specimens labelled, "*Erythraeodrilus mullani* Stephenson. Types. Matheran near Bombay. Oct. 1921. Prof. J. P. Mullan. W 1136/1."

External characteristics.—Spermathecal pores are minute and superficial, in *ac*, probably on or close to *b*, each pore in the setal circle, at or near the centre of a rather indistinctly demarcated, transversely placed area of slight epidermal tumescence. The ventral setae of viii and ix are arranged in more or less regular circles around the spermathecal pores, the pore slightly nearer the two or three median setae of the circle than to the lateral setae. One or two additional setae may be more or less markedly displaced, the follicle aperture of each of these dislocated setae in a small, tumescence of circular outline.

Dislocated Setae.

Specimen.	On spermathecal porophores.		On individual, circular porophores.	Location of genital marking.	REMARKS.
	viii	ix			
1	2-4	4-3	*e-f* left side and *d-e* right side of ix anteriorly.	Presetal on xviii, left side.	Type.
2	5-4	5-5	*a* right side of viii, and both sides of ix anteriorly.	Presetal on xix, left side.	Complete dissection.
3	4-5	5-5	*f* right side of ix anteriorly.	Presetal on xix, left side.	
4'	5-5	5-5	*f* left side of viii posteriorly, *f* both sides of ix anteriorly.	Presetal on xix, left side.	Opened.
5	4-5	4-5	*f* right side of ix anteriorly.	Presetal on xix, left side.	
6	5-5	5-5	*f* both sides of ix anteriorly.	On 18/19 (?) left side.	
7	5[1]-5	4-5	*e* left side and *f* right side of ix anteriorly.	Postsetal on xvii, right side.	

(1) On this specimen there are two apertures of copulatory setal follicles in which no setae are visible the spermathecal pores not certainly distinguishable from the follicle apertures on the left anterior spermathecal porophore. This is the first time that follicle apertures have been noted with no setae therein. Associated with this porophore there are five copulatory setal glands internally. The setae must be unusually deeply retracted or discharged.
(2)The first number of each couple in the second and third columns is of the left side.

The clitellum is annular.

Male porophores are paired as usual, each porophore small, circular or almost so in outline, depressed. The two porophores of a segment (and also a genital marking) may be contained within a common shallower depression or all four porophores as well as the genital marking may be included within a single shallow depression. In either case the porophores of a segment are separated from each other by a longitudinal median ridge. Male pores, clearly visible, are at or near the centres of the porophores. Additional pores have not been found. Ventral setae are lacking on xvii and xix, two to four (rarely six ?) setae present ventrally on xviii between the male pore lines.

Genital marking locations are shown in the table above. At the centre of each marking is a tiny, slit-like aperture, the margins of the aperture in contact so that traction on the skin is necessary to see the pore. One unusually large genital marking has a narrow opaque raised rim, a translucent, slightly depressed central portion, the margin of the aperture slightly tumescent, opaque and white. The genital marking may be in contact with a porophore but is never located on a porophore.

Internal anatomy.—The gizzard is in vi (2). The intestine begins in xvi (2). The typhlosole begins rather gradually in xxii (1), is continued anteriorly for a short distance as a very low ridge, triangular in cross section for a short distance, then lamelliform, decreasing gradually in height posteriorly, in a terminal region very low, apparently interrupted at the septal constrictions, unrecognizable behind cxiv (a specimen with 132 segments).

The circulatory system is as in *khandalaensis*, with latero-oesophageal hearts in x-xiii, commissures of xiv joining a latero-parietal vessel and then uniting with the extra-oesophageal just prior to passage on to the posterior calciferous glands, no subneural trunk. Lymph glands, unpaired are present (2) in xv and in the posteriormost portion but are unrecognizable elsewhere, the gland in xv of each specimen distended by brownish material.

Nephridia as usual, with vertically placed clusters on the anterior faces of 4/5 and 5/6, and on the parietes in ii-iii. Mega-nephridia behind xx have masses of the coelomic corpuscles on the preseptal necks immediately behind the funnels, but secondary funnels or funnel-like structures are unrecognizable.

Rudimentary seminal vesicles are present in x (1). Both vasa deferentia of a side pass into xviii lateral to the anterior prostatic duct, one continuing straight on into xix, the other turning on itself to pass anteriorly into xvii. A terminal portion of each duct is enlarged into an ovoidal ejaculatory bulb with a muscular sheen, adherent on the ectalmost portion of the spindle-shaped muscular region of the prostatic duct (the remainder of the prostatic duct ectally much slenderer, of a dull white appearance without sheen). On the median face of each prostatic duct and conspicuously protuberant into the coelomic cavity (3 specimens) there is a single parietal gland, usually somewhat collar-shaped and reaching around to the anterior and posterior faces of the duct. The gland appears to be solid but when broken off close to the parietes a circular aperture is seen just antero-median to the

prostatic duct. Penial setae are present in both xvii and xix in at least two follicles, one on the median face of the prostatic duct and one within glandular material. A penial seta from the follicle on the median face of a prostatic duct of xix is 0·28 mm. long, nearly straight, the tip flat on one side, convex on the other side and ornamented with several transversely placed, serrate ridges.

The genital marking gland is sausage-shaped, 5-6 mm. long, about 1 mm. thick. An outer layer of soft material, more than two-thirds of the thickness of the gland, is easily scraped away revealing a slender rod-like capsule of dull, opaque appearance. The lumen is transversely slit-like in section, small, extending almost to the ental end of the gland.

The anterior spermathecae are in vi, the posterior in ix (2). The spermathecal ampulla apparently is not bound down around the ental end of the duct, the interior of the ampulla and of the thickened portion of the duct filled with a sticky material that is very difficult to remove. The lumen in the ental portion of the duct is large, elliptical in cross section. In the thin, ectal portion of the duct an outer layer is dull white, a middle layer with brilliant (muscular ?) sheen. Iridescent sperm masses are in ellipsoidal seminal chambers of various sizes, ventrally directed. There are always two groups of seminal chambers, the number of chambers in a group varying from two to six. The number of apertures opening into the spermatheca is less than the number of the seminal chambers, but the exact number of openings was not determined. In each of four spermathecae there are at least three openings. On each of the four spermathecae, in addition to the two groups of seminal chambers there is a single, isolated chamber.

Copulatory setal glands are contained in two pairs of coelomic sacs, in viii and ix. The glands are tubular, the lumen very small, the ducts much slenderer, short and almost confined to the parietes, the glands, *ca.* 1½ mm. long. On the median face of each gland stalk and rather conspicuously protuberant above the parietes there is a follicle of a copulatory seta. The setae are ornamented.

Diagnosis.—Male pores in line with setal circles of xvii and xix, at or near centres of rather closely paired porophores. Spermathecal pores in *ac*, usually on or close to *b*, in setal circles of viii and ix. Genital marking asymmetrically placed, pre-setal on xvii, xviii or xix, centre on or lateral to male pore lines, with tiny, central, slit-like aperture. Setae: 70/v, 77/x, 76/xii, 61/xix, xvii/0, xviii/2-4 (+?), xix/0; *a-d*, *e*, or *f* of each side of viii-ix in a more or less regular circle around each spermathecal pore or in discrete porophores. Pigmentation red ? Length 110-120 mm. Diameter 7 mm.

Gizzard in vi. Last hearts in xiii. Unpaired lymph glands present from xv (?) posteriorly. Septa 9/10-11/12 united peripherally to form unpaired testis sacs. Seminal vesicles of x rudimentary. Vasa deferentia just prior to junctions with prostatic ducts enlarged to form ovoidal ejaculatory bulbs. Parietal glands half-collar-shaped, one on the median face of each prostatic duct. Genital marking gland tubular, sausage-shaped, 5-6 mm. long. Spermathecal diverticula two (?) groups of ventrally directed ellipsoidal seminal chambers and one (or more ?)

isolated seminal chamber (s). Copulatory setae ornamented; glands short, in paired coelomic sacs in viii and ix.

Distribution.—Matheran, and Lonavla in the Bombay Presidency.

Hoplochaetella powelli (Stephenson).

1925. *Erythraeodrilus powelli* Stephenson, *Proc. Zool. Soc. London*, 1925, p. 898. (Type locality—Bombay. Types in British Museum.)

Material examined.—From the Bombay Natural History Society; 2 clitellate specimens labelled, "Panchgani, Satara district. September 1939, C. McCann."

External characteristics.—Length 102-108 mm. Diameter 6 mm. A slight pigmentation of brownish appearance (alcoholic preservation) is recognizable on the dorsum behind the clitellum. The prostomium is epilobous, *ca.* $\frac{1}{2}$, with no transverse furrow at the posterior end of the tongue. The first dorsal pore is on 4/5 (2) but one specimen has a pore-like, though apparently non-functional marking on 3/4. The clitellum is annular and extends from the setae of xiii to or nearly to 16/17; intersegmental furrows lacking, sites of dorsal pores indicated by slight depressions, setae present.

Setae begin on ii and are lacking ventrally on xvii and xix, probably also on xviii. On viii, setae *a-c* or *d* are dislocated anteriorly into arc-shaped rows (with concave sides anteriorly) behind the anterior spermathecal pores.

Spermathecal pores are minute and superficial, in *bc*, on viii, the posterior pores midway between 8/9 and the post-setal secondary furrow, the other pores slightly more anterior to the setal circle than the posterior pores are from 8/9. Each pore is at the centre of a rather indefinite transversely placed area of tumescence.

The single female pore is median and presetal (2).

The male pores are probably in or close to *cd*, each pore more or less on the site of an intersegmental furrow (17/18-18/19 not recognizable ventrally), at or close to the centre of a transversely placed, slightly depressed, opaque, white area of shortly elliptical outline. Removal of cuticle from the male genital area leaving the surfaces of the porophores in perfect condition, was possible on one specimen. No apertures, aside from the male pores, are recognizable. A ventral region surrounding the male porophores is characterized by a slight brownish discolouration.

Genital markings are paired, each marking transversely placed, of shortly elliptical outline[1]. A central aperture, slightly larger than the male pores, appears to be on or close to the site of an intersegmental furrow and is within a flat, slightly depressed area which is surrounded by a thick, raised, marginal band. The markings are five to six intersetal intervals wide, and the centres are usually lateral to the male pore lines. One specimen has three pairs of markings on 19/20-21/22, more closely paired posteriorly, the median margins of the posteriormost markings more or less on *a*. A single marking on 16/17 is asymmetrical

[1] Stephenson (1926, p. 265) mentions presence of paired genital markings on xviii, as well as asymmetrical markings on the same segments. Worms with these markings should be re-examined, as well as those with markings in the setal circles.

and with centre slightly to right of the midventral line. The other worm has paired markings on 19/20-20/21 and a single, symmetrically placed marking on 16/17 but the latter has two apertures which are median to the male pore lines.

Internal-anatomy.—The gizzard is in vi (2). The intestine begins in xvi (2). The typhlosole is simple, lamelliform and terminates about 8 mm. from the hind end, interrupted in the last four segments.

The last pair of hearts is in xiii (2). The circulatory system, so far as can be determined, is like that of *khandalaensis*. In xv there is a large, transversely placed, lymph gland (2) but further glands are not recognizable except in the posteriormost portion of the body.

The excretory organs are, so far as can be determined, as in *khandalaensis*. Mega-nephridia, however, have not been definitely identified anterior to xx or xxi.

Coelomic cavities of x and xi are reduced to testis sacs by approximation and peripheral apposition of septa 9/10-11/12. Seminal vesicles of ix and xii are large. None were found in x. Male deferent ducts have been traced into xviii where one turns anteriorly, the other continuing into xix. Just in front of each posterior prostatic duct and behind each anterior duct there is a translucent mass which is probably the gelatinized remnant of a rather spheroidal muscular enlargement of the terminal portion of a male deferent duct. In xvii-xix on the parietes on each side there is a longitudinally placed whitish mass into the anterior and posterior portions of which the prostatic ducts pass. In xviii a sausage-shaped protuberance from the mass is especially conspicuous, with shorter protuberances in xvii and xix, one just median to each prostatic duct. The posterior portions of the male deferent ducts and the penial setae are buried within the glandular mass.

Two or three penial setae are present just median to each prostatic duct but the number of follicles was not determined. The setal shafts are almost straight, or with a very slight curvature to one side at the extreme ental end, 0·33-0·37 mm. long, 0·015-0·020 mm. thick at a rather nodule-like region about midway between the ectal and ental ends. The tip may be bluntly rounded (worn) or pointed, one side convex, the opposite side flat or very slightly hollowed. Ornamentation is of a few, transversely placed, short rows of fine teeth.

Genital marking glands, are short sausage-shaped, 1-2·5 mm. long. The lumen is central and as in *khandalaensis* an outer glandular (?) layer comes easily away from a tough digitiform capsule. In the worm with a symmetrically placed genital marking on 16/17 there is a gland corresponding to each aperture.

The spermathecal ampulla is bound down around the ental end of the much shorter duct. The lumen in the widened ental portion of the duct is transversely slit-like in section. The diverticula are ectally directed, rather digitiform but sinuous, bound down to the duct, occasionally bifurcated or even trifid, closely crowded into a single circle, interrupted once, usually on the posterior face of the duct.

The copulatory setal glands, in paired coelomic sacs, are about 2 mm. long, approximately 0·5 mm. of the duct coelomic. The setal, follicles are small, latero-mesially flattened, only slightly protuberant

above the parietes on the anterior faces of the gland ducts. Copulatory setae are 0·57-0·61 mm. long, the shafts nearly straight, except for slight arching of the entalmost portion. The tip may be bluntly rounded (worn ?) or sharp with one side convex and the opposite side flat or very slightly concave. Ornamentation consists of short transverse rows of fine teeth.

Posterior to the clitellum and in the body wall at the mid-dorsal line there is a conspicuous, red stripe.

Remarks.—Although these worms at first appeared to be well preserved the internal organs are so macerated that recognition of an anterior portion of the typhlosole, the anteriormost meganephridia and seminal vesicles of x is impossible. Accurate setal counts are also impossible. The muscular portions of the prostatic ducts are reduced to a yellowish slime, a spheroidal mass of somewhat similar appearance associated with each prostatic duct and imbedded in the opaque glandular mass of xvii-xix almost certainly indicating presence of muscular thickenings of the male deferent ducts. Curiously, non-muscular portions of the prostatic ducts are fairly well preserved.

H. powelli has been known hitherto only from the original account of a series of eight specimens which have not been available for study. The genital markings and their glands are like those of the Panchgani worms but in the type series there is only a single pair of markings constantly located on 19/20. Further differences from the present worms are : intestinal origin in xv, and the slightly smaller number of anteriorly displaced setae on viii. The latter does not appear to be of importance at present and the more anterior intestinal origin, in view of the uniformity elsewhere throughout the genus and the possibility of a mistake in determination, certainly requires confirmation. Further comparison between the present worms and the types is impossible because of gaps in our knowledge of the latter : nothing is known of the circulatory system except that the last hearts are in xiii, male deferent ducts were not traced to junction with the prostatic ducts, lymph glands and penial setae were not mentioned and copulatory setae were not examined. In these circumstances identification of the Panchgani specimens as *powelli* must be regarded as more or less tentative.

Diagnosis.—Male pores on or close to sites of 17/18 and 18/19, in region of *bd*, each pore at or near centre of a transversely placed, depressed porophore of shortly elliptical outline. Spermathecal pores on viii, in or near *bc*, slightly anterior to the setal circle and to 8/9. Genital markings paired, on (16/17) 19/20 (20/21-21/22), each with central aperture on or close to site of intersegmental furrow and on or lateral to male pore lines (except on 16/17). Setae : 42/v, 50/ix, 52/xii, 48/xx, xvii/0, xviii/?, xix/0, some or all of *a-c*, or *d* of viii dislocated anteriorly. Pigmentation red ? Length 102-120 mm. Diameter 5-6 mm.

Gizzard in vi. Intestine begins in xvi ? Last hearts in xiii. Lymph glands, unpaired, from xv posteriorly ? Testis sacs formed by peripheral fusion of septa 9/10-11/12. (Seminal vesicles of x rudimentary ?). Vasa deferentia just prior to junctions with prostatic ducts enlarged to form spheroidal ejaculatory bulbs. Parietal glands in xvii-xix as in *khandalaensis* ? Genital marking glands sausage-shaped, 1-2½ mm.

long. Spermathecal diverticula ventrally directed, elongate and sinuous, occasionally bi-or trifid, 10-12, in a circle with one hiatus. Copulatory setae ornamented, glands short, in two coelomic sacs in viii.

Distribution.—Bombay, Panchgani, (Satara district), in the Bombay Presidency.

Hoplochaetella stuarti (Bourne).

1886. *Perichaeta stuarti* Bourne, *Proc. Zool. Soc. London*, 1886, p. 667. (No types. Type locality—Yercaud, South India, at elevations of about 5,000 feet.)
1889. *Perichaeta stuarti*, Bourne, *Journ. As. Soc. Bengal* LVIII, p. 110. (Salem record in previous paper mistaken.)
1890. *Hoplochaeta stuarti*, Beddard, *Proc. Zool. Soc. London*, 1890, p. 57.
1895. *Perichaeta stuarti*, Beddard, *Monog.* p. 368.
1900. *Hoplochaetella stuarti*, Michaelsen, *Das Tierreich* X, p. 322.
1903. *Hoplochaetella Stuarti*, Michaelsen, *Die geogr. Verbr. Olig.* Berlin, p. 108.
1909. *Hoplochaetella stuarti*, Michaelsen, *Mem. Ind. Mus.* I. p. 111.
1910. *Hoplochaetella stuarti*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), p. 12.
1917. *Hoplochaetella stuarti*, Stephenson, *Rec. Ind. Mus.* XIII, p. 354.
1921. *Hoplochaetella stuarti*, Michaelsen, *Mitt. Mus. Hamburg* XXXVIII, p. 34.
1923. *Hoplochaetella stuarti*, Stephenson, *Oligochaeta*, in *F. B. I.*, p. 468.
1925. *Hoplochaetella stuarti*, Michaelsen, *Zool. Jahrb. Syst.* LI, p. 305.

Material examined.—From Prof. C. R. Narayan Rao; 5 softened, clitellate specimens labelled, "Nandydroog, S. I."

External characteristics.—Length: 115, 118, 125 and 127 mm. Diameter, 4-5 mm. Prostomium epilobous but without transverse furrow at posterior end of tongue. Pigmentation unrecognizable, possibly leached out by preservative. The clitellum is dark red.

Setae begin on ii and are small, often definitely paired dorsally. Mid-dorsal gaps in the setal circles are usually larger than the mid-ventral gaps. Setal formulae are shown below. Setae are lacking mid-ventrally on xvii and xix between the male porophores, but are all present mid-ventrally on xviii. Setae *a* and *b* of vii-ix are usually present in normal positions but *c*, *d*, *e*, and occasionally *f* and *g* of vii-viii are displaced.

Setae.

ii	iii	viii	xii	xx	vii	viii	xviii
28	35	43	51	48	3	4	7
22	35	44	52	53	3	4	7
..	..	37	46	46	4	4	10
24	35	40	51	50	4	4	7
25	35	45	49	56	4	4	9

The first dorsal pore is on 3/4 (1), or 4/5 (4), but with a pore-like though apparently non-functional marking on 3/4 on two of the specimens.

The clitellum is annular and extends from just behind the setae of xiii to 16/17 or nearly to 16/17; intersegmental furrows and dorsal pores lacking, setae present.

Quadrithecal, spermathecal pores minute and superficial, post-setal on vii and viii, about in *df*. Each spermathecal pore is at or near the centre of an indistinctly demarcated, very slightly tumescent area of slight epidermal modification, the outline approximating to shortly

elliptical (transversely placed). The anterior margins of the porophores are at or very close to the setal circles while the posterior margins do not reach to the posterior intersegmental furrows. Accordingly the spermathecal pores are nearer to the setae than the furrows. On four specimens the displaced setae of vii and viii are posterior to the setal circle and in the neighbourhood of the spermathecal pores. On one of these worms four setae on the left side of ix are displaced ; *b* and *c* anteriorly, *d* and *e* posteriorly. On the fifth worm a single seta on the right side of viii (*c* ?) is displaced anteriorly, the other displaced setae are behind the setal circle. Each anteriorly displaced seta is at the centre of a tiny tubercle of circular outline. The spermathecal apertures are a trifle larger than the other openings and more conspicuous, having a very slightly swollen and whitish marginal rim. Other apertures may be close to the spermathecal pores and on the spermathecal porophores or, rarely, one may be more distant and on its own area of slight epidermal modification.

The female pore is median and pre-setal (5).

Male pores, two pairs on xvii and xix in line with the setae of their segments and in *ce* or *f*, are minute, each pore at or near the centre of a translucent area of epidermal modification. Each of these porophores is rather deeply retracted into the parietes, producing an appearance as of an invagination with a fairly large and rather squarish aperture more or less in the region of *cg*. On one specimen the median and lateral margins of each anterior depression are nearly in contact with each other so as to produce the appearance of a secondary male aperture that is longitudinally slit-like. The male pores are open, short, and transversely elliptical in shape. With the best optical conditions there are visible on the porophores still smaller and circular markings which appear to be pores. Traction on the margins of the depressions or on the porophores themselves is necessary in order to recognize the pores and yet even slight traction ruptures the soft tissues of the porophores. On one worm pores are quite unrecognizable, the number of pores on the other specimens apparently variable as indicated below, the pores usually posterior to the male openings, occasionally antero-median. (Locations of male pores, as well as of spermathecal apertures, as determined externally, have been confirmed by dissecting prostatic and spermathecal ducts out of the parietes from the coelomic side.)

Gland pores on male porophores.

xvii.		xix.	
Left.	Right.	Left.	Right.
2	3	1	3
2	3	2	3
1	1	1	1
3	3	2	2

On re-examining these worms a year or so later these pores are unrecognizable. The epidermis of the porophores in most of the specimens has however been damaged.

Genital markings are lacking.

Internal anatomy.—Some of the septa anterior to 8/9 are either lacking, or rudimentary and represented only by slight shreds or cords, or else so fragile and macerated that they were destroyed in the course of opening and pinning out the specimens.

The gizzard probably belongs to segment vii or vi, the exact location not being determinable as a result of the softening and destruction of septa anterior to 8/9. Calciferous glands are four pairs in x-xiii (5), attached by short stalks to the oesophagus ventro-laterally. Glands may all be of about the same, size or those in xii may be larger than the others, or the glands may decrease slightly in size from xiii anteriorly. The intestine begins in xvi (5). Dorso-laterally on the gut in the region of the posterior prostate, in each of three segments there is a pair of small, thin-walled caeca flattened against the intestine. The prostates are adherent to the gut in this region, the intestinal wall is considerably macerated, and the septa are so fragile that it has not been possible to locate the caeca segmentally. A fairly large typhlosole is present, beginning one or two segments in front of the anteriormost caeca.

The last pair of hearts is in xiii (5). Anterior to 8/9 four pairs of vessels are given off from the dorsal trunk but only the pair belonging to viii can be traced to the ventral vessel. Lymph glands have not been found even in the posteriormost segments.

Parietal micro-nephridia are unrecognizable behind xx, probably as a result of the maceration, and are only doubtfully recognizable in some of the pre-clitellar segments. Mega-nephridia, though also somewhat macerated, are quite obviously present from xx posteriorly, reaching on either side almost to the mid-dorsal line.

Male funnels are characterized by a brilliant spermatozoal iridescence. Testis sacs ? Seminal vesicles are three pairs in ix, x and xii, the vesicles in x attached to the anterior face of 10/11 (5). The prostatic ducts are 5-9 mm. long, the ental portion of each duct slender and occasionally looped in a fairly regularly zigzagged fashion with the limbs of the loops short and in contact with each other. Ectally the duct is thickened and spindle-shaped, with a marked muscular sheen. The male deferent ducts of a side pass posteriorly in contact with each other but without uniting. From xvii the ducts are at least in part concealed from view by diagonal muscles, nephridia, blood vessels, etc., but this covering tissue, perhaps as a result of the maceration, can be removed more successfully than in *H. khandalaensis*. Both ducts of a side are lateral to the prostatic ducts of xvii and pass into xviii. Here one duct turns abruptly on itself and passes forwards into the posterior face of the anterior prostatic duct without enlargement. The other deferent duct may be looped in a rather regular fashion in xviii and xix and passes into the anterior face of the posterior prostatic duct, also without muscular enlargement. Four prostatic ducts were removed from the body wall, and after removal of connective and glandular tissue were cleared and examined microscopically to trace the course of the deferent ducts. Two of these preparations were successful. The vas deferens after penetrating the muscular wall of prostatic duct, turns ventrally for a short distance before opening into the lumen of the duct.

The ectalmost portion of the duct is lined with cuticle which appears to be thicker than the external cuticular layer and breaks off from the outer cuticle so as to leave a thickened rim at the end of the duct. The cuticular lining of the duct with this rim has a test-tube-like shape.

Protuberant rather conspicuously into the coelomic cavities of xvii and xix immediately lateral and median to each prostatic dust is a rather ovoidal, soft, thin-walled gland. Stalks are unrecognizable and the glands could not be traced through the parietes. Only slight manipulation is necessary to rupture the glands releasing from a fairly large lumen, white, loosely flocculent material. Presumably these glands open to the exterior through the male porophores by the pores mentioned above. Glands in xviii, as in *khandalaensis*, are lacking but the body wall of xviii is modified mid-ventrally.

On the median face of each prostatic duct and within the body wall are two or three setae, probably in two distinct follicles. These setae are 0·22-0·34 mm. long, slender and straight. Setae of xvii are rounded at the tips and without ornamentation, setae of xix with tips slightly hollowed out to produce a rather spoon-like concavity but without further ornamentation.

The spermathecal duct is nearly as long as or longer than the thin-walled ampulla from which it is clearly distinguished although this may not be immediately externally slender in the parietes, gradually widened entally and in the region of the diverticular junctions nearly as wide as the ampulla, with a marked muscular sheen, even in the slender ental portion. The lumen is wide in the region of the diverticular junctions and shortly elliptical to almost circular in section or somewhat irregular, slightly narrowed entally, gradually narrowed still further ectally and becoming slit-like in transverse section. The diverticula form a completely annular band about 1 mm. wide around the duct just below the ampulla. At first glance this band appears to consist of two circles of rather finger-shaped diverticula, an ental circle with the diverticula directed towards the ampulla, and an ectal circle with the diverticula directed ventrally, the components of both circles bound to the duct by delicate connective tissue. On scraping away the diverticula a single circle of apertures through the duct into the lumen becomes visible, the circle containing 15-22 openings. (The size of these openings varies and some of the smallest openings may have been missed out.) Considering the structure opening into the interior of the duct through one of these apertures as a single diverticulum it may then be described as follows: doubly glove-shaped with one group of irregularly and shortly digitiform seminal chambers (3-4) reaching upwards along the duct and another group of similar but usually very slightly longer chambers reaching downwards along the duct, both groups opening into the duct lumen by a common stalk. The seminal chambers are characterized by a brilliant spermatozoal iridescence which is lacking or markedly diminished proximally.

Associated with each spermatheca is a group of short-stalked, tubular glands, the stalks quite slender but with a marked muscular sheen. Each gland is $1\frac{1}{2}$-$2\frac{1}{2}$ mm. long, with (relatively) small and central (or nearly so) lumen, circular in cross section. Each cluster of

glands is enclosed in a transparent, thin-walled sac. In a worm with dislocated setae in ix a cluster of glands is present in that segment.

Associated with each stalked gland is a spindle-shaped setal follicle that projects fairly conspicuously into the coelomic cavity. Each follicle has a thick wall and a slight muscular sheen. The common passage to the exterior from gland and follicle is lined with a tube of thickened cuticle which is widened for a short distance in an ental portion of the parietes. In this widened section of the tube is the tip of the copulatory seta. The tube has a thickened rim at its aperture and a test-tube-like appearance as in the case of the cuticular lining of the prostatic duct.

Copulatory setae are nearly straight, the shafts curved slightly to one side at the ental ends, gradually narrowed ectally but with rather bluntly rounded terminations (worn ?). Setae of vii are 1·02-1·08 mm. long, while those of viii are 0·88-0·96 mm. long. No ornamentation is visible. One of the displaced follicles of segment ix contains two setae, 0·82 and 0·99 mm. long, similar in appearance to the copulatory setae.

Parasites.—Nematodes are present in the testis sacs of one specimen.

Remarks.—Except as may have been noted differently above, the external characteristics and internal anatomy are as in *khandalaensis*.

In the specimens of *khandalaensis* described on a previous page some softening has taken place and hence it is possible to strip off from the coelomic face of the body wall a peritoneal layer together with adherent blood vessels and nephridia and thus expose the longitudinal musculature. A quite similar appearance of the body wall in post-prostatic segments of the South Indian specimens just described is probably due to a more extensive maceration with consequent fragmentation and loss of part of the peritoneum and attached structures. This explains the inability to recognize micronephridia in posterior segments of the body.

Bourne's preliminary description of the species is incomplete as well as partly erroneous, and was not corrected or amplified. The status of the species, and also of the genus erected for it by Beddard in 1890, remained doubtful until fairly recently. Michaelsen, after examination of a single, damaged and previously dissected specimen from the type locality, concluded that his worm was referable to Bourne's species. Michaelsen's account is not as detailed as is now necessary, but his specimen apparently differs from those described above as follows: more posterior location of the first dorsal pore, on 7/8; location of male pores on tiny papillae borne on protuberant porophores; presence of hearts in xiv; small size of mega-nephridia, presence of post-clitellar micro-nephridia; shorter (relative to length of ampulla) spermathecal ducts[1]. Although these differences, at least in part, appear at first to be of taxonomic importance, in reality they may not be so. The protuberant male porophores may represent only an everted condition of the rather deep depressions mentioned above. The hearts of xiv are probably anterior commissures from the dorsal trunk to the extra-oesophageal

[1] Possibly also by a more posterior location of the spermathecal pores. Michaelsen merely notes that the pores are " eine, deutliche, wenn auch kurze Strecke vor den Intersegmental-furchen " from which it might be concluded that the pores are nearer to the furrows than to the setal circles.

system—a similar mistake in identification of commissural vessels in xiv was made by Stephenson. The small size of the mega-nephridia is possibly to be explained as a result of maceration and consequent loss of portions of the tubules (nephridia were unrecognizable doubtless also as a result of maceration in all except a short postclitellar portion of Michaelsen's worm) as is the absence of micro-nephridia in postclitellar portions of the Nandydroog worms. Dorsal pores anterior to 7/8 may have been unrecognized. Relative shortness of spermathecal duct is probably not of taxonomic value. Exact location of the spermathecal pores in Michaelsen's worm is unknown. In view of the uncertainty as to these points the diagnosis below is based only on the Nandydroog worms.

Diagnosis.—Male pores in *cf*, in line with setal circles of xvii and xix, at or near centres of circular areas of greyish translucence located in region of *a-h*. Spermathecal pores post-setal on vii and viii, nearer to setal circles than intersegmental furrows, in *df*. Setae : 22-28/ii, 35/iii, 37-45/viii, 46-52/xii, 46-56/xx, vii/4, viii/4, xviii/7-10 : *c-e* of vii-viii usually, *f* and *g* occasionally, dislocated posteriorly. Pigmentation ? Length 115-127 mm. Diameter 4-5 mm.

Gizzard in vi ? Intestinal caeca dorso-lateral, 3 pairs (in xxv or xxvi-xxviii ?). Last hearts in xiii. Lymph glands ? Testis sacs ? Seminal vesicles present in x. Parietal glands in xvii and xix, one just median and one just lateral to each prostatic duct, opening to exterior by minute apertures on male porophores (?). Spermathecal diverticula doubly glove-shaped, 15-22, in a single circle ; each diverticulum with 6-12 irregularly digitiform seminal chambers part of which are directed ectally and part entally. Copulatory setae unornamented ; glands short, in four coelomic sacs, one in front of each spermatheca.

Distribution.—Yercaud, Salem district in the Madras Presidency ; and Nandydroog, Mysore State, South India.

Hoplochaetella suctoria Stephenson.

1917. *Hoplochaetella suctoria* Stephenson, *Rec. Ind. Mus.* XIII, p. 388. (Type locality—Sanvordem, Portuguese India. Types in Indian Museum.)

1923. *Erythraeordrilus suctorius* (*part*), Stephenson, *Oligochaeta*, in *F. B. I.*, p. 464. (Excluding var. *affinis*.)

Material examined.—From the Indian Museum : 1 juvenile and 4 aclitellate specimens labelled, " *Hoplochaetella suctoria* Steph. Types. Under stones near river subject to tidal influence, Sanvordem, Portuguese India. 11.ix.16. S. Kemp. W 67/1."

External characteristics.—The first dorsal pore is on 4/5 (3). Pigmentation now quite unrecognizable.

Some of the ventral setae of vii-ix are dislocated on each specimen as follows.—(1) posteriorly on vii, anteriorly on viii-ix, displaced setae removed in previous dissection ; (2) *a* of both sides of vii posteriorly, *a* of both sides of viii anteriorly, *b-d* of left side and *b* of right side slightly anteriorly, *a-d* of left side, and *c-e* of right side of ix anteriorly ; (3) *a-b* of both sides of viii anteriorly, *a-d* left side and *a-e* right side of ix anteriorly ; (4) *a* of both sides of vii posteriorly, *a* of both sides of viii anteriorly, *b-c* of both sides slightly anteriorly, *d* of left side and *b-d* of right side of ix anteriorly ; (5)—(juvenile) *a-b* of left side and *a* of

right side of vii posteriorly, *a-c* of both sides of viii anteriorly, *c-d* of both sides of ix anteriorly. Dislocated setae are usually in fairly straight transverse rows. Setae are lacking ventrally on xvii-xix (5).

Spermathecal pores are minute and superficial, of about the same size as the apertures of the setal follicles and distinguishable only by absence of setae. The anterior pores are just antero-lateral to *b*, just lateral to *b*, or just lateral to *c*, usually anterior to setal arc, the posterior pores on or close to *b*, definitely in front of 8/9 but nearer that furrow than to the post-setal secondary furrow.

Male pores are minute and superficial, towards the median margins of transversely placed areas of greyish translucence, more or less in line with 17/18 and 18/19 which are lacking ventrally on all specimens, xviii probably slightly shortened ventrally. Each male porophore may have a slightly raised opaque marginal band. On the juvenile specimen only three male pores are recognizable and immediately median to each of two pores is a black dot, presumably, the tip of a penial seta.

Genital markings are sharply demarcated, each with a greyish translucent central portion and a slightly raised, wide, opaque marginal band. The markings are located as follows: (1) anterior pair on xvii, extending from 17/18 nearly to 16/17, longitudinally placed or slightly diagonal, posterior marking on right side probably post-setal on xix dislocating 19/20 posteriorly, logitudinally placed; (2) paired markings on xvii not reaching levels of 16/17 or 17/18, transversely placed but so shortly elliptical as to be almost circular, posterior marking median, posterior margin mid-ventrally at level of setal circle, anterior margin definitely behind level of setal circle of xix, possibly pre-setal on xx (dislocating 19/20 anteriorly ?); (3) anterior marking median, from 16/17 nearly to 17/18, posterior markings longitudinally or diagonally placed and equally on xix and xx (?); (4) paired markings on xvii, transversely placed, probably slightly more post-setal than pre-setal, posterior marking median and post-setal on xix (?); (5) lacking or unrecognizable. Centres of anterior paired markings are lateral to male pore lines, centres of posterior paired markings more or less on male pore lines. Mid-ventral interval between anterior paired markings *ca.* 1 mm. and between posterior paired markings *ca.* ½ mm. Except in one specimen unpaired median markings are so shortly elliptical in outline as to be almost circular but on the exceptional individual the marking is transversely extended so as to approximate to the condition in *affinis*,—the marking is however slightly asymmetrical with relation to the male pore lines.

Internal anatomy.—The gizzard is in vi (2). The oesophagus is widened in ix, narrow in x-xv and with low, longitudinally placed, white ridges on the inner wall. Calciferous glands are rather reniform with concave sides mesially, a stalk passing from the hilus to the gut. Glands appear to be solid in section due to the close crowding of the vertical lamella. The intestine begins in xvi (2), the oesophageal valve posteriorly in xv and anteriorly in xvi.

The typhlosole begins in xxii-xxiv (1) and is unrecognizable behind cxviii (1 specimen with 145 segments), it is triangular in cross section anteriorly, lamelliform posteriorly, and gradually decreases in size still further posteriorly.

Hearts of x-xiii are latero-oesophageal as in *khandalaensis*. A fairly large vessel joins the dorsal trunk just behind 13/14 on each side and on the ventro-lateral aspect of the gut turns anteriorly to run towards the extra-oesophageal. Mid-segmentally in xiv a pair of slightly smaller vessels from the dorso-lateral aspect of the gut joins the dorsal trunk. A supra-oesophageal trunk is recognizable only in part and ends in xiii as in *khandalaensis*. A posterior laterero-parietal vessel is present on the parietes lateral to the prostatic ducts in xix-xv or xiv but has not been traced to the gut. Extra-oesophageals are recognizable from 5/6 to xi. No subneural (2). An unpaired lymph gland lies across the dorsal trunk just in front of each septum from xv posteriorly (2). Towards the hind end the glands are bilobed.

Nephridia are as in *khandalaensis*, with large paired, vertically placed clusters of tubules on the anterior faces of 4/5 and 5/6. Nephridia of ii and iii appear to be closely crowded into paired, vertically placed, small bands on the parietes.

A pair of tough, small, vertically ovoidal bodies on the anterior face of 10/11 just below the calciferous glands of one specimen may be rudimentary seminal vesicles. Deferent male ducts were not traced throughout but are recognizable in xvii where they pass lateral to the anterior prostatic ducts. One deferent duct turns to pass into the posterior face of the anterior duct while the other passes into the anterior face of the posterior duct, in both cases just within the parietes and covered over by delicate tissue. On the median face of each prostatic duct there are two penisetal follicles, each containing one seta. Setae are nearly straight, without ornamentation and sculpturing of tips, the latter tapering but not to a sharp point. These setae are usually broken or crushed in removal but are about 0·2 mm. long and 0·01 mm. thick. Two follicles from the region of one prostatic duct were removed but without possibility of identification as an *a* or *b*. Of the two setae, one is slightly thicker in the middle portion than the other and resembles a nodulus. There may be some glandular material in the parietes around prostatic ducts, but definite glands protuberant into coelomic cavities are lacking as in *khandalaensis*.

A fairly long, parietal portion of the spermathecal duct is slender and circular in cross section, the coelomic portion gradually widened entally but flattened on two sides so that the transverse section is elongately elliptical, the lumen is slit-like, and the wall thick. The ampulla is bound down around the ental portion of the spermathecal duct to the level of attachment of diverticula, and the entalmost portion of the duct protuberant into the ampullary lumen as a high, thick annulus. The inner wall of the spermathecal duct and the outer surface of the annular projection into the ampullary lumen have an unusually smooth appearance due to the presence of a transparent layer that looks like cuticle. The diverticula are shortly digitiform and are arranged in a single circle, with the free ends directed ventrally, eighteen were noted on one spermatheca. No spermatozoal iridescence.

Glands of the genital markings are low sessile masses on the parietes, with the longitudinal muscular layer interrupted (1). In another worm

glandular masses were only doubtfully recognized, and, if present, are not as well developed.

In each of segments vii, viii and ix there is a pair of sacs protuberant into the coelomic cavities, one on either side of the nerve cord. These sacs are flattened out on the parietes in both specimens, and may thus appear to be somewhat like enlarged nephridial tubules. Each sac, except in vii, contains the stalked, digitiform glands passing to the parietes along with the displaced setae. Several glands were removed, each with a setal follicle adherent to the duct of the gland, but the ectal portions were broken so that the manner of union was not observed. Sacs of vii are transversely placed over ventral portions of setal circles.

Remarks.—Two specimens had been dissected previously, one with considerable damage to the internal organs and the ventral surface in the spermathecal region. Dissection of the latter was completed so far as possible, the other (the type) was left intact, while a complete dissection was made of an anterior portion of a third specimen.

The "transversely elongated, almost linear" prostatic pores are merely porophores-areas of greyish translucence of the epidermis towards the median margin of which the minute real male pores are recognizable under favourable conditions. Discrete openings of peni-setal follicles, if present, are unrecognizable with even under the best optical conditions. The supposed spermathecal pores described and figured in the original account of the species are artefacts and quite unrecognizable after removal of the cuticle. Anterior pores are not on porophores (though these might be recognizable on clitellate specimens) but each of the posterior pores appears to be located at or near the centre of a transversely placed area of very slight epidermal thickening with shortly elliptical outline. There is no transverse groove on any of the specimens.

Although it seems fairly certain that the structures identified as male deferent ducts are actually so, this identification requires confirmation especially in view of Stephenson's failure to find connections with posterior prostatic ducts. Characteristics of parietal glands in the prostatic region, such as number, shape and location, appear at present to have taxonomic value. Absence of such glands, or perhaps of lobes or extensions into the coelomic cavities seems to be characteristic of *suctoria*, but in view of the immaturity of all of the types this requires confirmation from sexual material.

A diagnosis based on a short series of five immature specimens with considerable variation in important characteristics (*e.g.*, location of genital markings) will probably be rather unsatisfactory.

Diagnosis.—Male pores on or close to sites of 17/18 and 18/19, towards median margins of transversely placed, translucent areas of shortly elliptical outline. Spermathecal pores on viii, on or just lateral to *bc*, slightly anterior to the setal circle and 8/9. Genital markings on xvii and on region between setal circles of xix and xx, paired in one (or both ?) of these regions, centres of paired markings on or lateral to male pore lines. Setae: 66/v, 66/ix, 63/xii, 60/xxi, viii/0, xvii-xix/0; *a* dislocated posteriorly on vii, some or all of *a-e* dislocated anteriorly on viii and ix. Pigmentation red ? Length 140 mm. Diameter 6 mm.

Gizzard in vi. Last hearts in xiii. Unpaired lymph glands from xv posteriorly. Testis sacs formed by peripheral fusion of septa 9/10-11/12. (Seminal vesicles present in x (Parietal glands, if present, not protuberant into coelomic cavities ?). Genital marking glands sessile on the parietes. Spermathecal diverticula shortly digitiform, ventrally directed, 15-20 in one circle. Copulatory setae ornamented; glands (short ?) in four coelomic sacs, an additional pair of sacs in vii.

Distribution.—Known only from the type locality, Sanvordem in Portuguese India.

Hoplochaetella sp.

1917. *Hoplochaetella affinis* (part), Stephenson, *Rec. Ind. Mus.* XIII, p. 399. (Excluding all specimens except those from Vareeg Islet.)

1923. *Erythraedrilus suctorius* var. *affinis* (part), Stephenson, *Oligochaeta*, in F.B.I. p. 466. (Exclusions as above.)

Material examined.—From the Indian Museum; 1 aclitellate, damaged but undissected specimen labelled, "*Hoplochaetella affinis* Stephenson. Vareeg Islet, S. side of Mormugao Bay, Portuguese India. August 16. Dr. S. W. Kemp. W 125/1."

External characteristics.—Spermathecal pores are on porophores of the usual type, on viii, in *cf*, the anterior pores very slightly in front of the setal circle, the posterior pores perhaps a bit further in front of 8/9. Dislocated setae are as follows: on vii, none; *a* on both sides of viii anteriorly, and in addition two or three setae on each side, presumably *bc* or *bd*, slightly displaced to the anterior spermathecal porophores; on ix *a-b* of both sides anteriorly.

Genital markings unpaired, median, transversely extended, pre-setal on xvii (or on 16/17) and xx.

Internal anatomy.—The gizzard is in vi. Calcareous crystals are present in the calciferous glands. The typhlosole terminates in xciii. The circulatory system is as in *khandalaensis*, lymph glands present posteriorly. Excretory system as usual with bands of tubules on parietes in ii-iii and clusters on the anterior faces of 4/5-5/6.

Male deferent ducts have not been traced but cords like deferent ducts pass into the anterior faces of the posterior prostatic ducts and the posterior faces of the anterior ducts within the parietes. Parietal glands in region of prostatic ducts not noticed. Genital marking glands sessile on the parietes, about 3 mm. in diameter.

Spermathecae are 5—6 mm. long, the thick portion of the duct *ca.* 1 mm. and the thin portion of the duct *ca.* $1\frac{1}{2}$ mm. in length. Spermathecal diverticula are ventrally directed, shortly digitiform, and in two groups. Spermatozoal iridescence is lacking, and the diverticula could not be traced through the duct to discover if each digitiform structure opened into the duct by a discrete pore. In ix one spermatheca has two diverticula or a single bifid diverticulum on each side; the other spermatheca has three diverticula on one side and two on the other. In viii one spermatheca has one bifid diverticulum on one side, and a quadrifid diverticulum on the other which may have the appearance of four closely crowded diverticula; the other spermatheca has two diverticula on one side and three on the other.

Copulatory setal glands are in coelomic sacs passing to the parietes just behind each spermatheca, five in each anterior sac, two in each, posterior sac. No sacs in vii. The glands are 5-6 mm. long, the ducts about 1 mm. long.

Remarks.—The epidermis of the male genital region is roughened. At the time of killing the body wall had widely ruptured in a lateral region at xxv and again dorsally in region of xv-xvi, the gut completely lacking in a region from xv-lii, and the other structures less extensively damaged.

Except for size the specimen is more like the type of *bifoveata* than that of *affinis*.

B. BIPROSTATIC SPECIES.

At least two, possibly three, biprostatic species will have to be recognized eventually. Unfortunately all of the biprostatic specimens that have been available for study are in poor condition, and no species can be satisfactorily characterized. In these circumstances it is impossible to ascertain if the biprostatic forms are closely related or whether the biprostatic condition has arisen independently. The entrance of the male deferent duct into the prostatic duct on the posterior face of the latter seems to indicate a derivation from a quadriprostatic condition with two pairs of male pores, but the presence of ventral setae normally on xviii and xix requires presumably an origin from some ancestral, quadriprostatic form prior to modifications of ventral setae of xviii and xix.

Hoplochaetella kinneari (Stephenson).

1915. *Erythraeodrilus kinneari* (*part*) Stephenson, *Mem. Ind. Mus.* VI, p. 100. (Excluding one type with widely paired spermathecal pores and genital marking on 16/17. Type locality—Castle Rock, North Kanara district, Bombay Presidency. Types in the Indian Museum.)

1917. *Erythraeodrilus kinneari* (*part*), Stephenson, *Rec. Ind. Mus.* XIII, p. 402. (Excluding dissected type with genital marking on 16/17 and Kemp's specimen.)

1923. *Erythraeodrilus kinneari* (*part*), Stephenson, *Oligochaeta*, in *F. B. I.*, p. 463. (Exclusions as above.)

Material examined.—2 (1 dissected) clitellate, macerated specimens labelled, "*Erythraeodrilus kinneari* Stephenson. Types. Castle Rock, N. Kanara District, Bombay Presidency Lt. Col. J. Stephenson. W 26/1."

External characteristics.—Each minute pore is at the centre of a protuberant, post-setal porophore of almost circular outline (possibly shortly elliptical and transversely placed), with centre about on *c*.

Genital markings, present on one specimen only, are paired, circular or almost so, post-setal on xviii, centres about on *c*, reaching mesially to *b*, a tiny central portion depressed and with the appearance of a pore.

Internal anatomy.—Septa 9/10-11/12 are not united peripherally.

The gizzard is in vi. Calciferous glands are small, even in xii-xiii. The intestine begins in xvi (1). The simple, lamelliform typhlosole begins in the region of xxii-xxiv.

The usual clusters of nephridia are present on the anterior faces of 4/5-5/6. The last hearts are in xii. Lymph glands, if once present, are now unrecognizable.

Seminal vesicles of x are large. The male deferent duct passes lateral to the prostatic duct in xvii, then turning mesially enlarges to form an ovoidal (muscular ?) ejaculatory bulb opening into the posterior face of the prostatic duct. Penial setae are present on the median face of the prostatic duct. One seta is 0·25 mm. long, 0·012 mm. wide at region of greatest thickness approximately at middle of the shaft, nearly straight except for slight bends at the ectal and ental ends, both bends toward the same side, without ornamentation.

The spermathecal diverticula are paired, each diverticulum consisting of several closely crowded seminal chambers aggregated in such a way as to form a flat disc opening into the duct by a single short stalk, the chambers radiating peripherally like the spokes of a wheel. Two clusters of (2 and 3) short copulatory setal glands are present in iii, one cluster between each two spermathecae of a side. A copulatory setal follicle projects conspicuously into the coelomic cavity from in front of each gland. The single seta examined is ornamented.

Genital marking glands are sessile and only slightly protuberant into the coelomic cavity.

Remarks.—As a result of the maceration little can be learned from these specimens. The spermathecal pores are not definitely recognizable but may be located on viii in *bc*, the anterior pores slightly in front of the setal circle, the posterior pores a little further behind the circle. None of the setae of vii and ix appears to be dislocated or placed on tumescences. On the dissected type, *a* of each side of viii seems to be present and in normal position. Ventral setae appear to be lacking on xvii but present normally on xviii and xix.

Diagnosis.[1]—Male pores midway between setal circle of xvii and 17/18, more or less on *c*, each pore at the centre of a protuberant circular porophore. Spermathecal pores on viii (in *bc* just in front of and slightly behind the setal circle ?). Genital markings (when present) paired, post-setal on xviii, more or less in line with and as large as the male porophores. Setae : 46/vi, 53/ix, 40/xix, viii/2, xvii/0, (*b-c* or *d* dislocated on viii ?). First dorsal pore on 3/4 (?). Pigmentation red ? Prostomium prolobous ? Length 120 mm. Diameter $3\frac{1}{2}$ mm.

Gizzard in vi. Last hearts in xii. Lymph glands ? Unpaired, sub-oesophageal testis sacs in x and xi ? Seminal vesicles of x large. Male deferent ducts just prior to junctions with prostatic ducts enlarged to form ovoidal ejaculatory bulbs. (Parietal glands ?). Genital marking glands sessile on the parietes. Spermathecal diverticula paired, each a stalked, flat disc with (12) closely crowded, radially directed seminal chambers. Copulatory setae ornamented ; glands short, 2-3 on each side of vii (in coelomic sacs ?).

Distribution.—Known only from the type locality, Castle Rock, in N. Kanara district, Bombay Presidency.

[1] Certain statements are included in the diagnosis in view of the fact that the original description was based on the type with paired genital markings on xviii (Stephenson, 1917, p. 403.)

Hoplochaetella sp.

1915. *Erythraeodrilus kinneari* (*part*) Stephenson, *Mem. Ind. Mus.* VI, p. 100. (Excluding all except the specimen with genital markings on 16/17.)
1917. *Erythraeodrilus kinneari* (*part*), Stephenson, *Rec. Ind. Mus.* XIII, p. 402. (Excluding all except the specimen with genital marking on 16/17.)
1923. *Erythraeodrilus kinneari* (*part*), Stephenson. *Oligochaeta*, in *F. B. I.*, p. 463. (Excluding all except the specimen with genital marking on 16/17.)

Material examined.—From the Indian Museum; 1 clitellate, dissected, macerated specimen labelled, "*Erythraeodrilus kinneari* Stephenson. Types. Castle Rock, N. Kanara District, Bombay Presidency. Lt. Col. J. Stephenson. W 26/1."

Remarks.—Spermathecal pores are widely separated, more or less in *de*, the anterior pores slightly in front of 7/8, the posterior pores probably in the setal circle of viii. There are no disclocated setae on vii-ix. Spermathecal porophores on vii, seen by Stephenson (who failed to recognize the spermathecal pores or the nature of the markings) are now practically unrecognizable.

Male porophores are similar to those of *kinneari* but are more widely separated, the male pores more or less in *df*. There are four setae on xvii, between the male pore lines, all ventral setae of xviii-xix probably present.

The single genital marking is on the left side, on 16/17, the centre of the marking slightly median to the male pore line. The gland is inconspicuous, sessile on the parietes.

Ejaculatory bulbs are lacking ? The male funnels may be unpaired sub-oesophageal testis sacs.

There is no ornamentation on the single copulatory seta that was examined.

The location of the anterior spermathecal pores on vii seems to be sufficient justification for regarding this specimen as specifically distinct from the two types of *kinneari* considered above. The specimen is in very poor condition and, lacking several organs, is quite unfit to serve as the type of a new species.

Hoplochaetella sp.

1917. *Erythraeodrilus kinneari* (*part*) Stephenson, *Rec. Ind. Mus.* XIII, p. 402. (Excluding all except Kemp's specimen.)
1923. *Erythraeodrilus kinneari* (*part*), Stephenson, *Oligochaeta*, in. *F. B. I.*, p. 463. (Excluding all except Kemp's specimen.)

Material examined.—From the Indian Museum; 1 clitellate, dissected specimen labelled, "*Erythraeodrilus kinneari* Stephenson. Castle Rock, N. Kanara District, Bombay Presidency. Dr. S. W. Kemp. W 65/1."

Remarks.—No setae are displaced on vii-ix, nor any located on tumescences. There are about seven setae on vii and ten setae on viii between the spermathecal pore lines. There are four setae on xvii between the male pore lines. All ventral setae of xviii-xix appear to be present.

The spermathecal pores are widely separated, the anterior pores on vii slightly in front of 7/8, the posterior pores in the setal circle of viii, the posterior pores being one setal and intersetal interval further laterally than the anterior pores.

The single genital marking is pre-setal, on the left side of xvii, of about the same size as the male porophores, the centre slightly median to the male pore lines.

Calciferous glands are present in xiii as usual.

The male deferent ducts appear to be slightly widened as they join the prostatic ducts on the posterior faces. The genital marking gland is inconspicuous, and sessile on the parietes.

Each spermatheca has two elongate diverticula, pendent ventrally, each diverticulum with two or three shortly ellipsoidal seminal chambers.

The location of the spermathecal pores is similar to that of the worm just considered above but the spermathecal diverticula are so different as to indicate specific distinction. Hearts of xiii are present according to Stephenson (though now quite unrecognizable as such) and this, if correct, would be further evidence of specific distinction. Unfortunately the specimen is in a very poor condition and quite unfit to serve as the type of a new species.

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