INDIAN EARTHWORMS.

XIII. The genus *Moniligaster*.

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Contens.

Introduction.

Some years ago Dr. Wilhelm Michaelsen proposed to issue a taxonomic monograph on the earthworms somewhat along the lines of his volume on the Oligochaeta in *Das Tierreich* (volume X), but subsequently decided on a joint production by several authors. Among the groups assigned to the writer of the present article was the family Moniligastridae. Although the original project was abandoned because of the financial depression, work on the Moniligastridae has been carried on as opportunity arose and circumstances permitted. The preliminary work on this revision was to have been completed by examination of such types as are in European Museums while on leave of absence in 1940. This plan had to be abandoned as a result of the war. Only one portion of the work, namely, that on the genus *Moniligaster*, has been advanced to a stage to warrant publication. As there is little possibility of the completion of the work on the remainder of the family for some years to come, the section on *Moniligaster* is being included in the series on Indian genera.

All the specimens assigned to the genus, as well as those hitherto unidentified, have been studied except the one from Tiger Shola (possibly in the Hamburg Museum), the one formerly in the Cambridge University Museum (present whereabouts unknown), the several specimens from Ponmudi and Bonaccord in Travancore (if still in existence probably in the Hamburg Museum), and the type specimen of *M. deshayesi* (in the Paris Museum). As a rule inspection of types is necessary for a revision of the older species of earthworms, but as a result of Michaelsen's examination of the type and of Aiyer's work on the Travancore material further study of the type of *M.deshayesi* is probably unnecessary.

As previous work on Indian genera was based on limited material, several questions as to the taxonomic value of characteristics of certain structures remain unanswered. Although three species, including two new, are known only from aclitelate material, it is probable that the structures of taxonomic importance are sufficiently developed in them to enable recognition of specific characteristics.

During the course of earlier work on species of the closely related genus, *Drawida*, with a more extensive series of material it was found that the prostatic capsule has a characteristic shape which is not subject, as a rule, to appreciable intra-specific variation. Furthermore it was found that the relationship of the male deferent duct to the longitudinal musculature was also not subject to intra-specific variation. Assuming the characteristics of these two organs to be similarly valid as criteria of specific distinction in the genus *Moniligaster*, it has been possible to separate forms hitherto referred to two species into five species, and three new species have also been discovered. All the species, with one possible exception, are known only from very limited areas; the combined areas of all the species are also restricted.

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Systematics.

Genus **Moniligaster** Perrier.

1872. *Moniligaster*, Perrier, *N. Arch. Mus. Paris*, VIII, p. 130. (Genotype *M. deshayesi* Perrier 1872.)
1889. *Moniligaster* (part), Vaillant, *Hist. Nat. Annel.* III, (1) p. 179. (Including only the genotype.)
1894. *Moniligaster* (part), Bourne, *Quart. J. Mic. Sci.* XXXVI, p. 359. (Including only the genotype.)
1895. *Moniligaster* (part), Beddard, *Monog.* p. 196. (Including only the genotype.)
1900. *Moniligaster*, Michaelsen, *Das Tier.* X, p. 112.
1909. *Moniligaster*, Michaelsen, *Mem. Ind. Mus.* I, p. 150.
1922. *Moniligaster*, Stephenson, *Proc. Zool. Soc. London*, 1922, p. 141.
1923. *Moniligaster*, Stephenson, *Oligochaeta*, in *Faun. Brit. Ind.*, p. 121.
1930. *Moniligaster*, Stephenson, *The Oligochaeta*, p. 814.

Diagnosis.—Bithecal, spermathecal pores transversely placed slits on 7/8 in region of *cd*. Male pores transversely placed slits on 10/11 in *bc*. Female pores minute, on 11/12 in or close to *ab*. Clitellum extends over x-xiii at least. Nephropores begin on iii, usually dislocated dorsally on vii, viii and xii[1], from xiii posteriorly in part and irregularly dislocated

[1] Further information is needed with regard to dorsal dislocation of pores on vii, viii and xii in *gravelyi*. For the present, types of *gravelyi* are regarded as slightly aberrant individuals with respect to a tendency which seems to be fairly uniform throughout the genus, the aberration being a retention of or reversion to an ancestral condition.

dorsally or ventrally to *ab*, functional pores present on x. Body-wall thickened laterally. Pigmentation blue. Gizzards four to six, in successive segments in region of xiii-xxiii. Intestine begins in region of xxv-xxxii. Last hearts in ix. Testis sacs in 9/10. Vas deferens long and looped, an ental portion slender. Prostatic duct 2-4 mm. long and more or less bulbous ectally. Segment xi reduced to a horseshoe-shaped ovarian chamber. One (?) or two atrial glands associated with each spermatheca, each gland branched in a more or less regularly dichotomous fashion, the branches and terminal tubules closely compacted into an ellipsoidal to disc-shaped body with mamillated surface.

Distribution.—Western portion of southernmost part of Indian Peninsula; Travancore and Cochin, British Indian area of Courtallam in Tinnevelly District, Palni and Nilgiri Hills, and Tirumalai Hills (Chittoor district, Madras Presidency). The significance of the single record from the Tirumalai Hills is unknown. Even if the Tirumalais represent its northern limit the *Moniligaster* area is small, the north-south extent being less than that of the *Hoplochaetella* area.

Remarks.—Several characteristics that could have been included in the generic definition as applicable to all known species of the genus have been omitted as there is evidence to indicate that these apply equally to all other Moniligastrid genera[1]. Among these are the following: prostomium prolobus and attached to the roof of the buccal cavity at or behind the region of 1/2; setae lumbricine and paired; dorsal pores lacking; clitellum annular, male and female pores included; reproductive apertures on or close to inter-segmental furrows, spermathecal and male pores anterior to female pores in the order named; gizzards oesophageal but posterior to the ovarian segment, closely crowded, low but lamelliform ridges in a post-gizzard portion of the oesophagus, possibly containing tissues with the function of a calciferous gland, paired entero-segmental organs on an anterior portion of the post-gizzard section of the gut, absence of a typhlosole; location of the last pair of hearts in the segment next but one in front of the ovarian chamber (or ovarian segment if not reduced to a chamber), the single dorsal blood vessel, lateral hearts, paired extra-oesophageal vessels lateral to the hearts and opening posteriorly into a sub-neural trunk; mega-nephric excretory organs with very small pre-septal funnels; testes in paired, dorsal sacs suspended in an inter-segmental septum (or in two successive septa as in *Desmogaster*), much elongated male deferent ducts opening through capsular prostates to exterior on or close to inter-segmental furrow behind that corresponding to septum bearing testis sacs, presence of paired longitudinally placed ovisacs which are outgrowths dorsal to the posterior wall of the ovarian segment or chamber, spermathecal ducts slender and coiled, spermathecal ampullae attached dorsally to the posterior face of a septum (or septa).

Pigment when present in species of *Moniligaster* is always blue, located in the circular muscle layer. This pigment can be completely

[1] As has already been pointed out elsewhere the Syngenodrilinae must be excluded from the family Moniligastridae. A discussion of the problem of Syngenodrilin relationships so far as the Moniligastridae are concerned has been prepared and will be published later.

bleached out by preservation in alcohol. It is therefore quite possible that in those forms in which the colour is unknown, blue pigment may also have been present. Clitellar colouration seems to be characteristically red or light yellowish in each species but further information is needed as to the appearance in life and post-mortem changes that may occur in alcohol or formalin.

Relative widths of the major inter-setal intervals have been regarded in the past as of systematic importance. So far as can be determined from the rather limited material available, variation in widths of these intervals relative to each other is so great as to prevent its use in taxonomic work on species of *Moniligaster* at least.

A glance at the specific diagnoses will be sufficient to indicate the necessity, at least for the present, of dissection of worms in determination of specific identity.

In 37 specimens in which the location of gizzards was recorded, there are four to six gizzards as follows: four gizzards 21 specimens, five gizzards 12 specimens, six gizzards 4 specimens. Segmental locations of gizzards will probably prove to be of little, if any, taxonomic value in this genus at least, as a result of intra-specific variation.

In the Moniligastridae, gizzards have hitherto been regarded as intestinal, but this is incorrect. The cuticular lining of the oesophagus is continued through the gizzards into a post-gizzard portion of the gut which has closely crowded, low, lamelliform ridges as in the calciferous portion of the oesophagus in species of *Pheretima*, and which opens into the intestine proper through a valve as in the Megascolecidae and other earthworms. Unfortunately in many of the specimens examined the valve is distended by the soil on which the worm feeds while the intestine itself may be deeply contracted or constricted so as to have somewhat the appearance of a valve or even of a pre-valvular portion of the oesophagus. In these circumstances recognition of boundaries, especially in those individuals in which the gut is macerated, is difficult if not impossible. The segment of intestinal origin appears at present to be characteristic but much more information with regard to this matter is needed.

All species of *Moniligaster*, and probably other Moniligastrid genera as well, are characterised by the presence of a pair of longitudinal blood vessels which run on or close to the ventral parietes from the anterior most portion of the body to a region behind the ovarian chamber where they gradually decrease in size and disappear from sight, with asymmetrical connectives in the region of the ovarian segment to the sub-neural trunk. Judging from the appearance in some specimens, it might be more accurate to describe this system as composed of a longitudinal vessel on each side which opens into the sub-neural trunk, a short posterior parietal vessel opening into the anterior trunk as it turns mesially to join the sub-neural. Although opening into the sub-neural trunk much as in *Pheretima* and certain other genera, the trunks in Moniligastrids are not, except perhaps in the pharyngeal region, in contact with or even close to the oesophagus, and furthermore are lateral to the hearts. These trunks have been referred to as extra-oesophageals which may perhaps be unfortunate in view of the lack

of information regarding the origin or function of these trunks as in the extra-oesophageals of Megascolecid or Lumbricid worms. In view of this past usage, and to avoid invention of an inapt term for the Moniligastrid trunks the use of " extra-oesophageal " will be retained until such time as studies of the method of development or of the function in circulation of the blood have indicated the nature of these vessels.

For specific identification in this genus not only is a dissection necessary but the external glandular layer must be carefully removed from the prostatic capsule as the conformation of the capsule appears at present to be the only important criterion of specific identity, and characteristic shapes may be concealed from view by the outer glandular layer. Condition of the capsule appears to be variable. In some worms the capsule is definitely muscular while in other individuals of the same species the capsule is composed of brittle, almost transparent material. Possibly we have here to do with a cyclic sexual change in structure. Of less importance but still essential, especially in the case of new species, is a determination of the relationship of the male deferent duct to the longitudinal muscular layer (*i.e.*, whether or not the vas passes underneath the longitudinal muscle in x prior to its junction with the prostate)

In a thin-walled chamber within an ectal portion of the prostatic duct there may be a copulatory structure in then ature of a penis. In one species this appears to be a definite organ (not temporary as when formed by eversion of an ectal portion of the duct or of an invagination), protrusible to the exterior and with a thick muscular wall. In another species only a low annulus was found. In other species an ectal chamber is apparently not marked off, and there is no definite penis though an ectal portion of the duct may be everted to function as a temporary penis. In view of the possibility of these structures being of some taxonomic importance, studies of the male genital terminalia are desirable.

As a result of immaturity of types and lack of sufficient material it has not been possible to determine whether a species has only one atrial gland, or if the two distinct glands of the juvenile stage are merely enclosed in a common sheath. Even if this distinction does not appear to be of very great importance further information should be accumulated, especially in view of the limited number of criteria now available for specific identification.

The only difference between *Moniligaster* and *Drawida* is the presence in the former of branched glands on the spermathecal atria. In view of the close relationship indicated by this similarity Michaelsen (1908, p. 137) suggested that " It might even be justifiable to unite these two genera, to include the genus *Drawida* without restriction in a genus *Moniligaster sensu lato*, or to regard *Moniligaster sensu stricto* and *Drawida* as sub-genera of a genus *Moniligaster sensu lato* " In the absence of evidence to indicate a diphyletic or polyphyletic origin of the *Moniligaster* group, generic status may as well be retained for the present, if only for reasons of convenience. (*Vide* Stephenson 1930 pp. 908, 909).

Attention has already been directed in previous articles to the necessity for caution in the identification of immature individuals of *Drawida*,

and such caution is even more necessary in the identification of Moniligastrids from the *Moniligaster* area where worms still generically unrecognizable (unless sectioned, and possibly, even then indeterminable) may reach a fairly large size. In this connection the question may be raised if some of Bourne's species of doubtful status have not been mistakenly transferred to *Drawida*.

According to Michaelsen (1908, p. 137), *Moniligaster* has been derived from *Drawida* by the development on each lobe of a bifid spermathecal atrium similar to that found in certain South Indian species such as *D. ghatensis* Michaelsen, 1910 or *D. robusta* (Bourne, 1886), of a characteristic branched gland. At present this does not seem to be impossible, and it may be noted that at least the two species just mentioned have functional nephridia in x as determined by the presence of open nephropores[1]. Stephenson (1922, p. 141) disagreed with Michaelsen's derivation and preferred " to read the series if indeed it is a series in the reverse direction ", deriving *Drawida* from *Moniligaster* by reduction in size and eventual disappearance of the glands and atrium. In this connection it may be noted that those species of *Drawida* with a bilobed spermathecal atrium in shape much like that of the common atrial duct and individual gland ducts of *Moniligaster* were not regarded by Stephenson as primitive. On the contrary those species of *Drawida* which he considered to be the most primitive have a simple (*i.e.*, not bifid) spermathecal atrium. The zoogeographical distribution of the Moniligastrids as known to-day certainly seems to be more in accord with Michaelsen's than with Stephenson's derivation.

Key to species of Moniligaster.

1. *a.*	Vas deferens penetrates into longitudinal muscle layer prior to junction with prostate ..	2.
b.	Vas deferens passes directly into prostate without penetrating into longitudinal muscle layer ..	4.
2. *a.*	Outer (coelomic) glandular layer covers prostatic capsule ; capsule not flattened latero-mesially	3.
b.	Outer glandular layer not covering prostatic capsule, and lacking mesially and laterally ; capsule flattened latero-mesially	*M. stephensoni.*
3. *a.*	Prostatic capsule spheroidal ..	*M. aiyeri.*
b.	Prostatic capsule ovoidal to anvil-shaped	*M. horsti.*
4. *a.*	Spermathecal atria confined to vii	5.
b.	Spermathecal atria in vii and viii	6.
5. *a.*	Leaflets present on vas deferens, thickened portion of vas short ..	*M. deshayesi.*
b.	Leaflets lacking, thickened portion of vas long	*M. gravelyi.*
6. *a.*	Prostate and duct bound to parietes in a C-shaped figure, capsule ovoidal	*M. michaelseni.*
b.	Prostate and duct not so bound to parietes, capsule not ovoidal	7.
7. *a.*	Prostatic capsule reniform, not nodulated ..	*M. perrieri.*
b.	Prostatic capsule shortly tubular and U-shaped, with irregularly placed nodulations	*M. beddardi.*

[1] In numerous species of *Drawida* nephropores are closed with sexual maturity, if not before, and the nephridia become reduced in size, or disappear.

Moniligaster aiyeri, sp. nov.

Material examined.—From Prof. K. S. P. Aiyer: 1 clitellate specimen labelled, "*Moniligaster* species, to be described. Muthukkuzhi, Travancore, 4,000 ft.", and 3 dissected anterior fragments of aclitellate specimens presumably from the same locality.

External characteristics.—Length 456 mm. Diameter 13 mm. Number of segments, *ca.* 310. Pigmentation unrecognizable (alcoholic preservation). The body wall is slightly thickened laterally. In sections the thickening is recognizable only in the circular muscle layer, the thickened region extending from slightly below *c* well into *dd*, the distance from *d* definitely greater than *bc*. The body is shortly elliptical in cross section behind the clitellar region. The prostomium is prolobous.

Setae are small but black and readily recognizable, closely paired, the lateral couples slightly more so than the ventral; on xix-xx, *aa* and *bc* about equal (2) or *aa* slightly smaller than *bc* (2). On the type only *a* and *b* of the right side are visible on ii, while the lateral couple is unrecognizable or lacking on the left side of iii.

Nephropores begin on iii and from xiii posteriorly may be dislocated dorsally or ventrally to *ab* but quite irregularly as follows: dorsally, vii, viii, xii, xiii-xiv-right, xv, xvii-left, xix-left, xxi-right, xxiii-xxiv-left, xxvii, xxix-right, xxxii-right, xxxiv-right, xxxv-left, xxxvi-left, ventrally, xiii-left, xiv-left, xvi-right, xviii-left, xxii-left, xxiv-right, xxv, xxvi-right, xxx-right, xxxi-right, xxxii-left (type); dorsally, vii, viii, xii, xviii-left, xix-right, xxiii-right, xxvi-left, xxix, xxx-right, xxxii-left, xxxiii-left, xlii, xliii-right, xliv-right, xlvi-left, ventrally, xiii-right, xxi, xxiv-left, xxvii-left, xxx-left, xxxi-right, xxxiv-right, xxxvii-left, xl-right, xlvi-right; dorsally, vii, viii, xii, xiii-right, xv-xvi-left, xvii, xix-right, xx-left, xxiii-right, xxvi-right, ventrally, xiv-left, xvi-right, xxii-xxiv-left; dorsally, vii, viii, xii, xiv-left, xix-right, xxii-left, xxiii, right, xxxiii-left, xxxv-xxxvi-right, xxxvii-xxxix-left, xli-right, xliv ventrally, xiv-right, xviii, xix-left, xxiv-left, xxv-right, xxxii-left, xxxiii-right, xxxiv-left, xxxix-right, xlv-right. Nephropores of x are functional.

The clitellum is annular, extending across x-xiii and slightly on to xiv, clitellar colouration light yellow. The epidermis of x-xiii is markedly thickened, of xiv and probably also of ix slightly thickened.

Spermathecal pores are transversely placed slits on 7/8 in the region of *cd*, the margins of the apertures tumescent and slightly wrinkled. Removal of the atrial duct from the parietes leaves an aperture in the epidermis about as large as that left by removal of the prostatic duct in the same way.

Male pores are transversely placed elliptical apertures on 10/11 with median margins slightly nearer to *b* than the lateral margins are to *c*. Through each aperture of the type there is protuberant to the exterior an antero-posteriorly flattened, soft, penis-like structure with a transversely slit-like aperture on the ventral face. Removal of the prostatic duct from the parietes leaves an elliptical opening in the epidermis about two mm. wide. In the paratypes the protuberance may be lacking and when present is variable as to shape and location of the pore.

Female pores are minute, on 11/12, on *b*.

No genital markings.

Internal anatomy.—None of the septa is thickly muscular, 6/7-8/9 strengthened but transparent or translucent.

Gizzards are in xvi-xxi (type), xvii-xx (1), xvii-xxi with some special muscularity in xvi and xxii (1), xviii-xxiii (1). The post-gizzard portion of the oesophagus extends through nine or ten segments, the (calciferous ?) ridges longitudinal, regularly zig-zagged. A definite valve is present. Intestine begins in xxxi (1) or xxxii (1). Entero-segmental organs are quite large in xxiv-xxx (type) but gradually decrease in size from xxx posteriorly. No typhlosole.

The vascular system is much like that of *M. deshayesi* except that the anterior commissures arise from the extra-oesophageals just behind 8/9 and passing through 8/9 open into the hearts of ix just lateral to the median plane. The hearts of viii unite just above the dorsal level of the gut and from the median region a single, short vessel passes up to open through the ventral face into the dorsal trunk (relationships of hearts of viii and anterior commissures in this species the same as of the hearts of ix and the posterior commissures of *M. deshayesi*). The subneural passes forwards to a point just in front of the subpharyngeal ganglia. Nephridia are present in x.

One or both testis sacs dislocated posteriorly under the ovarian chamber. Septum 9/10 is attached to the equator of the testis sac but no constriction is recognizable. The entalmost portion of the vas, about 5 mm. long is rather thick, the next 100 mm. relatively slender and just underneath the testis sac in a cluster of hair-pin loops part of which may be in x. The next portion of the vas is much thicker, 1210 mm. long, looped, the cluster of loops entirely in ix and larger than the testis sac. Emerging from this cluster the vas passes (twice ?) around the heart of ix, through 9/10 and into the longitudinal musculature, passing laterally under a wide but thin band of muscle (4 specimens), emerging again into the coelomic cavity and passing straight upwards into the prostate through a vertical cleft in the glandular layer on the anterior face. The prostates are mushroom-shaped, the diameter of the spheroidal head slightly less than, or about as great as, the length of the duct. The approximately spheroidal capsule is muscular, thick, opaque and lined internally with a white material which is raised into irregular ridges which considerably reduce the size of the lumen. The duct is 3-4 mm. long, with thick neck and slightly bulbous ectal portion concealed from view by strong muscle bands, the wall thickly muscular, the lumen slit-like in cross section and usually nearer the median side. On the wall of the passage are several vertical ridges of which two are especially large and close together. The wall of the ectal chamber is thin, in the paratypes the lumen is practically filled by a short, thick penis which is circular in cross section and with a wall mainly of circular muscle.

The spermathecal duct is 20 mm. long and apparently passes into the base of the posterior atrial gland, but after removal of connective tissue the duct can be traced on to the median face of the common duct.

Two atrial glands with the usual mammillate surface, one on each side in vii, and the other in viii, the posterior about 9 mm. long, and the anterior about 7 mm. long. Ectally the two glands appear to be united but can be separated after removal of the investing tissues. The common duct of the atrial glands is thick (2-2½ mm. antero-posteriorly, flattened latero-mesially), short (height from parietes 1-1½ mm.), the ental bifurcations (individual ducts of the glands) very short and only recognizable after removal of basal portions of the glands (*vide* fig. 1, which shows a similar type of duct). Within the atrial duct and attached broadly by a dorsal base is a rather conical, soft and wrinkled structure the ventral tip of which is barely visible through the spermathecal pore after separation of the margins. On the conical protuberance there are several vertical fissures one of which is deeper than the others and contains at its upper end, near the bifurcation of the duct, a minute pore which may be the opening of the spermathecal duct. The lumen of the atrial duct is large, its wall with several, low, vertical ridges.

Segment xi is closed off to form a horse-shoe-shaped ovarian chamber. Ovisacs extends into xvi or xvii, and have a thick wall. The lumen is filled with a yellowish coagulum in which no ova are recognizable. A few free ova are present in the ovarian chamber. The type has certainly not reached the climax of sexual development, and is probably post-sexual.

Remarks.—It was impossible to determine the segmental location of the atrial glands in the dissected paratypes, but Prof. Aiyer was kind enough to write that he had noted from one of his dissections that both glands were in vii on the right side while on the left side the glands were separated from each other by 7/8. The little evidence available indicates that the glands are usually separated by 7/8.

Brown discs are present in coelomic cavities of anterior segments in two specimens.

M. aiyeri belongs to a hitherto unrecognized group of species in which the vas deferens, prior to junction with the prostate, penetrates into the longitudinal muscle layer, and is distinguished from other species in that group by the characteristic prostates.

Diagnosis.—Male pores with centres nearer *b*. Pigmentation ? Clitellum light yellowish. Length 456 mm. Diameter 13 mm.

Gizzards in xvi-xxiii. Intestine begins in xxxi (±1 ?). One or both testis sacs dislocated posteriorly under ovarian chamber. Vas deferens very long (1,300 mm.), loops of slender portion in ix and x, thickened portion in a cluster of loops in ix which is larger than the testis sac, passing laterally in x underneath a band of longitudinal musculature and then emerging to pass into the anterior face of prostate. Prostates mushroom-shaped, thickness of head and length of duct about equal length of gland and duct 6-8 mm., capsule spheroidal. Atrial glands usually in vii and viii, common atrial duct thick and short.

Distribution.—Known only from the type locality, Muthukkuzhi, Travancore, at 4,000 feet.

Moniligaster beddardi, sp. nov.

1924. *Moniligaster perrieri* (part), Stephenson, *Rec. Ind. Mus.* XXVI, p. 322. (Excluding all except specimens from Kodaikanal referred to below.)

Material examined.—From the Indian Museum : 4 small juveniles, 1 aclitellate and 4 clitellate (1 dissected) specimens labelled, " *Moniligaster perrieri* Michaelsen. Kodaikanal, 6,900-7,200 ft. Palni Hills, S. India. Aug. 1922. Dr. S. W. Kemp. W 707/1." From the Rev. Father Münch S. J. : 1 aclitellate anterior fragment labelled, " Shembaganur, Madura district. 25th September 1936."

External characteristics.—Length 320-347 mm. Diameter 14-16 mm. The aclitellate Kodaikanal specimen is 270 mm. long and 9 mm. thick, the diameter of the Shembaganur fragment 11 mm. Pigmentation blue, dense, restricted to the dorsum except anterior to the clitellum and on one specimen at the hind end, the pigmented portion rather sharply demarcated with boundary close to region of *cd*. The pigment of the circular muscle layer is unrecognizable in sections through the ventrum. The body wall is thickened laterally beginning some distance behind the clitellum though this thickening is not always recognizable. In one specimen the body wall in *dd* is thicker than in *cc*. In an anterior region extending to some distance behind the clitellum the body is almost circular to shortly elliptical in cross section. Posteriorly the body is markedly flattened dorso-ventrally and elongately elliptical in cross section. The prostomium is of the usual Moniligastrid prolobous type.

Setae are small, closely paired, deeply retracted in the anterior portion of the body when they are invisible or only occasionally recognizable. Behind the clitellum the relative widths of the major inter-setal intervals are variable ; on the Kodaikanal aclitellate specimen *bc* is one half mm. wider than *aa* while on the Shembaganur fragment *aa* is one half to one mm. wider than *bc*.

Nephropores begin on iii and are functional on x, on vii, viii and xii usually dislocated dorsally, behind xii irregularly dislocated dorsally or ventrally to *ab*. On one clitellate specimen the pores of vii are dislocated only slightly or not at all, the left pore of vii of another specimen in *cd*. On the Shembaganur fragment dislocations are as follows : dorsal, vii, viii, xii, xx, xxii, lxix on the right side, vii, viii, xii, xviii, xxvi, xxvii, xxix, xxxv, xli on the left side ; to *ab*, xxxv, xl, xlv, lxii, lxx, lxxix, lxxxvi, xciii, xciv, cviii on the right side, xxii, xxx, xxxiv, xxxvi, xxxix, xliv, xlv, lx-lxv, lxxiii, lxxv, lxxxiv-lxxxvi, lxxxix, xc, xcvii, ci, cv, cxi, on the left side.

The clitellum is on x-xiii, annular, and of a creamy yellow colour. Blue pigment is present in the circular muscle layer of the clitellar segments, at least dorsally, but is unrecognizable externally because of the thickness of the clitellar epidermis.

Spermathecal pores are transversely placed slits on 7/8, in the region of *cd*, about as large as the male pores.

Male pores are transversely placed slits on 10/11, in the median half of *bc*, or perhaps reaching slightly lateral to mid *bc* on some of the Kodaikanal specimens.

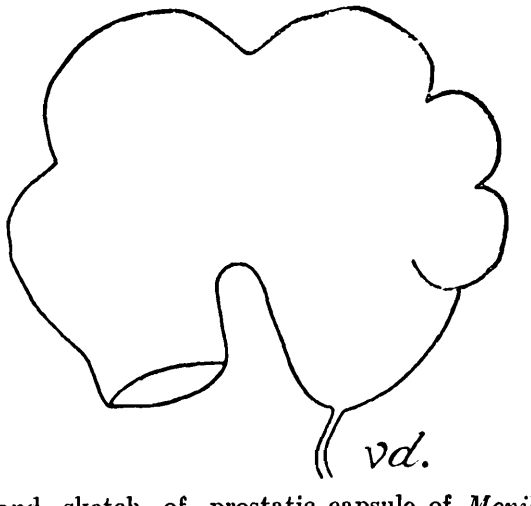
Female pores were not actually seen but are probably on 11/12, in or close to *ab*.

Internal anatomy.—Septa 5/6-8/9 are strengthened with muscular fibres but are translucent; a variable number of post-gizzard septa muscular.

The inner wall of the oesophagus in the region of vi-xii is provided with irregular, low and rounded, longitudinal ridges. The gizzards are in xv-xix, xvi-xx, xvii-xxi, xviii-xxi, xviii-xxii, or in xix-xxii. The inner wall of the oesophagus in most of the post-gizzard portion, except at the mid-ventral and mid-dorsal lines is provided with rather irregular, low, lamelliform, vertical, white ridges. The intestine begins in xxxi (specimen with gizzards in xvii-xxi). No typhlosole (2 specimens). Contents of the gut are black. Entero-segmental organs are present as usual.

Hearts are present in vi-ix and are median to the extra-oesophageal trunks. Paired commissures from the extra-oesophageals are present on the posterior faces of 8/9 and 9/10. The sub-neural is recognizable anteriorly to a point slightly in front of the sub-pharyngeal ganglia. Nephridia are present in x.

The testis sacs at first appear to be entirely in x but an anterior portion of each sac is contained within a posteriorly directed pocket of 9/10, the sacs unconstricted by the septum. The vas deferens is looped in a hair-pin fashion, some of the loops 3 mm. long, the loops in the pocket of 9/10 and on the anterior face of the septum forming a cluster that may be as large as or even larger than the testis sac, the heart of ix passing through the ventral portion of the cluster. An ental portion 46 mm. long is slender, followed by a slightly thicker region 16 mm. long, the widened portion 490 mm. long (measurements without stretching or straightening out some of the kinks at apices of the loops). Emerging into x the vas is close to but not in contact with the ventral parietes to which it is connected by transparent tissue, sinuous but not looped, then passing straight upwards to the ventrally directed anterior end of the prostate. In two specimens a fairly wide strand with strong muscular appearance passes across the ventral por-



TEXT-FIG. 1. Free hand sketch of prostatic capsule of *Moniligaster beddardi* after removal of external glandular layer. Nodulations on external surface not shown. *vd.*, vas deferens.

tion of the vas in x so that the vas appears at first glance to be within the parietes, but the strand appears to be diagonal and the vas is not

actually in contact with the ventral parietes. The prostate at first appears to be latero-mesially flattened and of a reniform type like that of *M. perrieri*, but removal of the external glandular layer discloses a quite different and characteristic shape. The capsule (text-fig. 1) is short U-shaped, the ventrally directed limbs almost in contact, the duct passing into the ventral end of the posterior limb, the vas into the anterior limb. The U-shape is not regular as the result of development of slight bulges or lobes (nodulations) which are most obvious on the capsules of the previously dissected specimen. If straightened out the capsule would be a somewhat irregular tube probably 5 mm. or slightly less in length. The capsule is muscular and lined internally with a layer of soft white material raised into several fairly high ridges. The coelomic portion of the duct is probably about 2 mm. long but is bound to the parietes by diagonal muscle strands, and is far from being as conspicuously protuberant into the cavity as in *M. perrieri*. The duct is bulbous ectally but the neck region is thicker than in *M. perrieri* and about as thick as the posterior limb of the prostatic capsule excluding the external glandular layer. In the neck the lumen is small, widened ectally and irregular as a result of the presence of longitudinal ridges. Within the parietes the lumen is of about the same width as the male aperture but is abruptly widened just above the level of the ventral parietes. This chamber is shut off from the wide lumen of the ental part of the bulb by a horizontal partition. At the centre of the ventral face of the partition is a small aperture into the more ental chamber of the bulb and around this aperture is a ring of tissue which in the previously dissected specimen is so high as to form a definite, rather short, conical, thick penis.

The spermathecal duct is 22 mm. long. The atrial glands are in vii and viii (each specimen), each gland a rather flattened disc of elliptical outline, about 6 mm. long, bound down around and concealing from view its own duct. The coelomic portion of the common atrial duct is fairly stout, thickened entally, the inner lining ridged, a circular ridge around a tiny tubercle which bears the aperture of the spermathecal duct.

Segment xi is reduced to a horse-shoe-shaped ovarian chamber. Ovisacs may extend as far back as xvii but are usually turned upwards in xii or xiii.

Remarks.—None of the clitellate worms is sexual, free ova lacking in the ovarian chamber and ovisacs, though ovaries may be large. Ovisacs may be yellowish or reddish but appear to be contracted, the lumen of the sac filled with a felted mass of white fibres in the interstices of which there may be particles of yellowish debris but no free ova (a few free ova in sacs of previously dissected specimen ?). The female funnel is represented by a marked thickening of the posterior wall of the ovarian chamber in the form of a vertically placed disc about 5 mm. high with irregular, low but thick, rounded ridges. Ventrally the median margin of the disc is folded over laterally so that only a small ventral portion of the disc is really funnel-like.

In one of the smaller juveniles the spermathecal atria and prostates are just barely protuberant into the coelomic cavities above the parietal

level. The vas deferens does not pass into the parietes. Gizzards are in xiii-xvii. Identification of immature juveniles is at present impossible.

One of the clitellate worms is an anterior fragment. A small terminal portion of each of the other clitellate specimens is unpigmented, almost triangular in outline dorsally and ventrally, with anus at the pointed tip, and is of about ten segments. These short portions appear to be regenerates.

The dissection was completed in the specimen opened by Stephenson. The aclitellate and clitellate specimens were opened, and one prostatic capsule of each examined.

M. beddardi is distinguished from *M. perrieri* by the characteristic U-shaped and lobed prostatic capsule, the larger size, and possibly also by the restriction of pigmentation to the dorsum, and from *M. michaelseni* sp. nov. by the shape and lobing of the prostatic capsule, vertical erection of prostate into the coelomic cavity (not bound to parietes) and possibly also by the absence of red colour in the clitellum. (As all types of *M. beddardi*, *M. michaelseni*, and of *M. aiyeri* have been preserved for some time in alcohol the differences in clitellar colouration appear to be characteristic.)

Diagnosis.—Male pores in median half (?) of *bc*. Pigmentation restricted to dorsum. Clitellum light yellowish. Length 320-347 mm. Diameter 14-16 mm.

Gizzards in xv-xxii. Intestine begins in xxxi (± ?). Vas deferens long (550 mm.), loops of slender portion in a posteriorly directed pocket of 9/10, loops of thickened portion in a vertical cluster in the pocket and on anterior face of 9/10, passing directly into the anterior end of the prostate. Prostatic capsule tubular, *ca.* 5 mm. long, about as thick as neck of duct, bent into a short U-shaped, vertically placed figure with ends of limbs ventrally; surface with several low, rounded nodulations; duct bound to parietes. Atrial glands in vii and viii, common atrial duct rather stout and thickened entally.

Distribution.—Kodaikanal and Shembaganur, Palni Hills at elevations of 6,500 to 7,200 feet. (Shembaganur is said to be 500 feet below Kodaikanal.)

Moniligaster deshayesi Perrier.

1872. *Moniligaster deshayesi* Perrier, *N. Arch. Mus. Paris* VIII, p. 130. (Type locality unknown. Originally supposed to have been in Ceylon. Type in the Paris Museum.)
1889. *Moniligaster Deshayesi*, Vaillant, *Hist. Nat. Annel.* III, (1), p. 180.
1894. *Moniligaster deshayesi*, Bourne, *Quart. Jour. Mic. Sci.* XXXVI, p. 373. (Diagnosis.)
1895. *Moniligaster deshayesi*, Beddard, *Monog.* p. 199.
1897. *Moniligaster deshayesi*, Michaelsen, *Mitt. Mus. Hamburg* XIV, pp. 6 and 11.
1900. *Moniligaster deshayesi*, Michaelsen, *Das Tier.* X, p. 112.
1903. *Moniligaster Deshayesi*, Michaelsen, *Die Geogr. Verbr. Olig.* p. 65.
1909. *Moniligaster deshayesi*, Michaelsen, *Mem. Ind. Mus.* I, pp. 107, 136 and 149. (After examination of type.)
1910. *Moniligaster Deshayesi*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX, (5), pp. 9 and 54.
1911. *Moniligaster deshayesi*, Cognetti, *Ann. Mag. Nat. Hist.* (8) VII, p. 494.
1913. *Moniligaster deshayesi var. minor*, Michaelsen, *Mitt. Mus. Hamburg* XXX, p. 78. (Type locality Chimungi, Travancore. Types in the Hamburg Museum.)

1923. *Moniligaster deshayesi* (part), Stephenson, *Oligochaeta* in *Faun. Brit. Ind.*, p. 121. (Excluding *M. deshayesi* Stephenson 1915.)
1926. *Moniligaster deshayesi*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 250.
1929. *Moniligaster deshayesi* + *D. travancorensis* (*part*, 2 specimens from Tenmalai), Aiyer, *Rec. Ind. Mus.* XXXI, pp. 44 and 49.

Material examined.—From Prof. K. S. P. Aiyer ; 4 aclitellate specimens labelled, "*Moniligaster deshayesi*. Tenmalai. Aug. 1936.", and two juveniles (undissected) labelled, "*D. travancorensis* Mich. Tenmalai. 11th September 1926 ". From the Madras Museum : 1 aclitellate, dissected specimen labelled, "*Moniligaster deshayesi* E. Perrier. Nedumangad, Travancore ". From the Hamburg Museum : 1 clitellate specimen labelled, "*Moniligaster deshayesi* Perr. Travancore. Pittny." (this specimen is probably from Anachardie, *vide* Michaelsen 1910, p. 54), and 1 clitellate specimen labelled, "*Moniligaster deshayesi* Perr. *var. minor* Mich. Travancore, Chimungi. Shunkara Narayana *leg* ". From the Indian Museum : 1 aclitellate and 1 clitellate, dissected specimens labelled, "*Moniligaster deshayesi*, E. Perr. Anachardie, Travancore. R. S. N. Pillay. ZEV 4147/7 ", 1 juvenile anterior fragment labelled, "*Moniligaster deshayesi* E. Perr. On the way to Shenbagadevi Falls, Courtallam. H. S. R. 24th October 1924, W 3199/1 ".

External characteristics.—Blue pigmentation is recognizable in small regions in spite of the alcoholic preservation. The prostomium is prolobous (4). Lateral thickenings of the body wall are practically unrecognizable externally and in sections, but the musculature of the ventral portion of the body appears to be thicker than the dorsal portion (clearly visible on Tenmalai juveniles). Behind the clitellar region the cross section of the body is short elliptical. Nephropores begin on iii and are functional on x, from xiii posteriorly dislocated dorsally or ventrally to *ab* but quite irregularly as follows : dorsally, vii, viii, xii, xv-right, xix-left, xx-right, ventrally, xvi-right, xviii-right, xix-right, xxi-right, xxii-xxv-left, xxx-right, xxv-right, xxxix-left ; dorsally, vii, viii, xii, xiii-left, xiv-right, xv, xviii, xix-right, xxv-left, xliii-left, xlv-left, ventrally, xiii-right, xiv-left, xvii-left, xix-left, xx-left, xxii-left, xxvi-right, xxx-left, xxxi-right, xxxiv, xxxv-left ; dorsally, vii, viii, xii-left, xxi-right, xxv-right, xxvii-right, xxviii-right, ventrally, xiii, xiv-left, xxxi-left, xxxii-left, xxxvi-right, xxxvii-left ; dorsally, vii, viii, xii ; dorsally, vii, viii, xii, ventrally, xvii, xviii-left, xix-right, xxii, xxiii-right, xxiv-left, xxv-right, xxvii, xxxiii-right (Anachardie specimen) ; dorsally, vii, viii, xii (Courtallam specimen) ; dorsally, vii, viii, xii, xviii, ventrally, xiii-left, xvii-right, xx-xxi-right, xxii-left, xxiv-left, xxvi-right, xxvii-left, xxviii-right, xxx, xxxi-right, xxxiv, xxxv-xxxvi-left, xxxvii, xxxix-right, xl-right, xli-right, posteriorly many are displaced to *ab* (Pittny specimen) ; dorsally, vii, xii, ventrally, xiii-right, xiv-left, xv-right, xvii-left, xviii-right, xix, xxi-left, xxiii-left, xxvii-left, xxviii-left, xxix-right, xxx-right, xxxii (Chimungi specimen). In the last worm the left nephropore of ix is dislocated ventrally to *ab*. On Tenmalai juveniles the nephropores of vii-viii and xii are dorsal except on right side or left side of xii ; all pores[1] of vii-viii and xii dorsal on the two Anachardie specimens from the Indian Museum.

Clitellar colouration is unrecognizable, possibly as a result of the method of preservation. The epidermis of one specimen is markedly

[1] Opacity or adherence of cuticle, folding or twisting of body, etc., may render determination of nephropore locations difficult or impossible in certain regions. Locations are usually determined on each specimen posteriorly as far as the last segment mentioned.

thickened on x-xiii. The clitellar colouration, when visible (1 Anachardie specimen, 1 Pittny specimen, 1 Chimungi specimen), is dark red and extends across x-xiii or the pre-setal portion of xiv in addition (Pittny specimen).

Spermathecal pores are transversely placed slits of 7/8 in or just median to *cd*.

Male pores are transversely placed slits on 10/11, with centres on or close to mid *bc*. On one specimen an ectal portion of the prostatic duct is everted as a short, columnar, translucent, soft protuberance bearing a tiny, transverse slit-like aperture on its ventral face.

Female pores are minute, on 11/12, on or close to *b*.

Genital markings are lacking but a semi-circular area just in front of and just behind each male pore of the clitellate specimens lacks the red clitellar colouration and is white. Similar areas are recognizable on the Tenmalai worms even in the absence of clitellar colouration.

Internal anatomy.—Septa 5/6-8/9 are muscular, 7/8-8/9 slightly thicker than the others. Several post-gizzard septa are muscular.

Gizzards are located as follows: xiii-xvi (1, Tenmalai juvenile), xiv-xvii (2, Nedumangad and a Tenmalai juvenile), xiv-xviii (1, Tenmalai), xv-xviii (2, Anachardie), xv-xviii and rudimentary in xix (1, Tenmalai), xvi-xix (2, Tenmalai and the Pittny specimen), xvi-xx (1, Tenmalai). The inner wall of the oesophagus in xx-xxv is provided with closely crowded, vertically placed, white, lamelliform ridges slightly zig-zagged and of variable height, lacking at the region of the mid-dorsal and mid-ventral lines (2, Anachardie specimens). In both of the Anachardie worms the oesophagus is straight. The intestine begins in xxvi (somewhat doubtfully in one Nedumangad specimen), xxvii (1, Anachardie specimen with gizzards in xv-xviii) or xxviii (1, Anachardie specimen with gizzards in xv-xviii). Entero-segmental organs are present, in a specimen with the last gizzard in xviii beginning in xix but small in xix-xx, large from xxi posteriorly for several segments and then decreasing in size posteriorly. No typhlosole (6 specimens).

The single dorsal blood vessel is continued anteriorly on to the pharyngeal bulb. The ventral vessel is continued forwards to the sub-pharyngeal ganglia where it bifurcates, the branches passing dorsally along the circumpharyngeal nerve commissures. The sub-neural trunk is slender and scarcely recognizable from ix anteriorly, but after receiving a commissure from the extra-oesophageal of the left side in vi is larger than elsewhere from this segment to just in front of the sub-pharyngeal ganglia. Extra-oesophageal trunks are lateral to the hearts, gradually decreasing in size posterior to x and unrecognizable behind xv-xvii, with a commissure to the sub-neural in x or xi (two sides asymmetrical) with a commissure to the dorsal vessel in v (two sides asymmetrical as regards size and antero-posterior location in segment), passing latero-dorsally anterior to v. Paired hearts are present in vi-ix (4 specimens), all opening into the ventral trunk. Hearts of vi-vii and possibly also of viii open directly into the dorsal trunk. Just above the level of the dorsal face of the gut each heart of ix is slightly constricted and beyond the constriction has a thin, translucent or transparent wall. The transparent portions of these hearts unite mesially

below the level of the dorsal trunk. Into the thin, transverse commissure between the hearts and slightly lateral to the median plane there opens on each side the posterior commissure from the extra-oesophageal trunk. A short vessel passes straight up to the dorsal trunk in the median plane from the transverse commissure between the hearts of ix. The anterior commissures from the extra-oesophageal trunks arise just behind 8/9 and are firmly bound by strong but transparent tissue to the posterior face of 8/9, apparently opening directly into the dorsal trunk just behind 8/9. In vii a large vessel from the extra-oesophageal passes on to the spermathecal atrium. One or two large blood vessels pass along the prostate with the vas deferens, one of these apparently from the extra-oesophageal or from the posterior commissure close to its junction with the extra-oesophageal.

One or both testis sacs are usually dislocated posteriorly underneath the ovarian chamber. If a sac is not displaced posteriorly the equatorial attachment of 9/10 is usually indicated by a very slight constriction, and the sac is about equal in ix and x. The vas is slender as it emerges from the testis sac and is twisted into a number of hair-pin loops immediately underneath the sac and then passes into and downwards through a vertical column of "leaflets" Emerging from the column median to the heart of ix and close to the ventral parietes the vas passes around the heart of ix, through 9/10 and straight on to the prostate without penetrating into the musculature, the portion ectal to the leaflets being 15-20 mm. long. Short loops of the nephridium of x on the posterior face of 9/10 close to the ventral parietes may easily be mistaken for a portion of the vas unless the latter is carefully traced from its emergence at the bottom of the column of leaflets. In several specimens some of the hair-pin loops of the slender ental portion of the vas deferens as well as several of the leaflets appear to be in x. In some cases however a thin membrane, presumably a portion of 9/10, can be discovered behind the protuberances. The posterior dislocation of the testis sac produces a considerable posterior pocketing of 9/10 with a portion of the leaflet column contained within the pocket as well as the anterior portion of the testis sac. Prostates are 12-15 mm. long, *ca.* 1 mm. thick, rather rod-like, dark red, slightly and very gradually narrowed ectally, short elliptical to almost circular in cross section. The vas disappears from sight into the prostate slightly below the ental end. The capsule is thin and transparent or nearly so. The inner lining of the capsule is a soft, dark red tissue raised into irregularly criss-crossed ridges which may meet at the central axis. These ridges mark chamber-like cells, of which five to seven or even more may be seen in a single transverse section. Passing ectally, ridges and chambers are smaller, eventually disappearing. The prostatic duct is about 2 mm. long with strong muscular appearance, slightly narrower than the prostate entally, and somewhat widened passing ectally. The main lumen of the duct in a considerable ental portion is definitely crescentic. In the longitudinal ridge producing this crescentic appearance is a narrow canal. Ectally the ridge disappears and the lumen widens, an ectal chamber though apparently lacking one or two circular ridges may be fairly conspicuous.

The spermathecal duct is 10-16 mm. long. Spermathecal atria are in vii (6 specimens). The duct passes into, or at least on to the posterior limb of the atrial duct slightly ental to the crotch, the portion of the spermathecal duct in vii 3-4 mm. long and with several short loops. Delicate tissue binds the two atrial glands together, usually in such a way that one gland is dorsal to the other.

Parasites.—Several nematodes were found in the coelomic cavities of the anterior-most segments. In post-genital segments thicker and more transparent nematodes are present in the coelomic cavities. In a posterior portion of the body the larger nematodes are each contained within a spheroidal cyst on the parietes.

Remarks.—The description given above is of the aclitellate Tenmalai specimens except where otherwise indicated. The horseshoe-shaped ovarian chambers are filled with a yellowish debris which is also present in the somewhat contracted ovisacs. The worms are doubtless slightly post-sexual.

After removal of the external glandular layer of the prostates in one of the Anachardie specimens, small, rather circular, translucent and very slightly raised spots are visible on an ental portion of the capsule. The translucent appearance of these spots is due to local thinning of the layer lining the capsule. The prostate of the Chimungi specimen is twisted in a rather zig-zagged or slightly spiral fashion and is about 5 mm. long. This worm is distinguished from others referred to *M. deshayesi* only by its dwarf size (114×4 mm.) and the correspondingly shortened prostates.

Prostates may be bent into a J or U-shape or twisted in a rather spiral fashion or may be almost straight. Except in one specimen the glands are dark red. In alcoholic specimens the red colouration may leach out from the glands and stain the parieties in contact with the glands.

Lateral thickenings of the body wall may be much more obvious on some of the specimens than on the Tenmalai forms.

The individual stalks of the atrial glands may be longer than the united common stalk.

In the Tenmalai juveniles (labelled *D. travancorensis*) the ovisacs are mere threads, testis sacs small and only slightly behind 9/10, prostates (together with ducts) only about 3 mm. long. Leaflets are unrecognizable in one specimen (preservation poor internally), but so are the loops of the vas of the ordinary type. In the second specimen leaflets as well as mammillae are just recognizable on the surface of the atrial lobes. In the first specimen the spermathecal atria are rudimentary and only slightly T-shaped. In both worms the atria are confined to vii.

Diagnosis.—Male pores with centres on or near mid *bc*. Clitellum red. Length 114-160 mm. Diameter 4-8 mm.

Gizzards in xiv-xx. Intestine begins in xxvii (±1 ?). One or both testis sacs dislocated posteriorly under ovarian chamber. Vas deferens with loops of slender portion in posterior pocket of 9/10 (and in x ?), thickened portion about 20 mm long, passing through centre of a cluster of leaflet-like glands—each gland a fine, convoluted tubule opening into the vas—and directly into prostate slightly below ental end, leaflets in pocket of 9/10 and ix (in x ?). Prostates rod-like, 12-15 mm. long, red

lining of capsule raised into criss-crossed ridges. Spermathecal atria in vii, common atrial duct slender.

Distribution.—Travancore (Anachardie, Nedumangad, Chimungi, Tenmalai) and Courtallam, *ca.* 15 miles from Tenmalai (Tinnevelly district) up to elevations of 4,000 feet. No information has been available during the last 30 years to indicate that Michaelsen's conclusion regarding the supposed Ceylon provenance of the type of the species is incorrect.

Moniligaster gravelyi Stephenson.

1915. *Moniligaster deshayesi* (part), Stephenson, *Mem. Ind. Mus.* VI, p. 57. (Including only var. *gravelyi*. Type locality of *gravelyi* Trichur, Cochin. Type in the Indian Museum.)

1923. *Moniligaster deshayesi* (part), Stephenson, *Oligochaeta* in *Faun. Brit. Ind.*, p. 121. (Including only *M. deshayesi* var. *gravelyi* Stephenson 1915.)

1925. *Moniligaster deshayesi*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 48.

Material examined.—From the Indian Museum : 1 juvenile, dissected specimen labelled, "*Moniligaster deshayesi* var. *gravelyi* Stephenson. Type. Trichur, 3,000 ft., Cochin State, 1-4.x.1914. F. H. Gravely. ZEV 6913/7." From the Madras Museum : 1 aclitellate, dissected specimen labelled, "*Moniligaster deshayesi* E. Perrier. Kavalai, Cochin Forest. Sept. 1914."

External characteristics.—Pigmentation unrecognizable, the "reddish brown" appearance noted by Stepehnson (1925) probably an alcoholic artefact. The body wall is thickened laterally. The prostomium is of the usual moniligastrid prolobous type (2 specimens).

Setae, when visible, are closely paired, fine, unrecognizable on some of the anterior segments and elsewhere though this may be due in part to the condition of the specimen.

Nephropores begin on iii and are functional on x. Pores are not dislocated dorsally on vii and viii or the left side of xii of the Kavalai specimen or vii-right side and viii of the Trichur specimen ; dislocated dorsally on the right side of xii (Kavalai specimen) or both sides of xii (Trichur specimen), and ventrally to *ab* as follows : xiii-right, xvii-right, xix-xxi-right, xxv, xxvi-xxvii-right, xxix-left, xxx-right (Kavalai specimen). Behind the clitellar region an occasional pore is dislocated dorsally (Trichur specimen).

A clitellum is unrecognizable externally but the epidermis of ix-xiv at the dorsal incision appears to be slightly thickened (Kavalai specimen).

The spermathecal pores are transversely placed slits on 7/8 just median to *c*.

Male pores are transversely placed slits on 10/11, in *bc*, quite definitely nearer to *b* than to *c*, each aperture surrounded by a rather wide, finely wrinkled, annular band that may have been formed by a slight evagination of the ectal end of the prostatic duct.

Female pores are possible on 11/12 on or near *b*.

Internal anatomy.—Septum 6/7 is thickly muscular, 7/8-8/9 very thickly muscular, much more so than in *M. deshayesi*.

The gizzards are in xiii-xvii (Kavalai specimen) or xv-xviii (Trichur specimen). On the inner wall of the post-gizzard portion of the oesophagus, except at the mid-dorsal and mid-ventral lines there are closely crowded, vertically placed, slightly lamelliform, white ridges. The

intestine begins in xxv (2 specimens). No typhosole (2 specimens). Entero-segmental organs are present.

The last hearts are in ix. Anterior commissures from the extra-oesophageals are visible from behind 8/9 but are covered over with a fairly thick layer of tissue and probably are within the septum. Extra-oesophageal trunks are lateral to the hearts. Nephridia are present in x.

The vas deferens is long, an ental portion slender and in two clusters of hair-pin loops, one in ix and one in x. Emerging from the more ectal of these clusters the vas is thickened and looped in an elongately hair-pin fashion, part of the loops in x and part in ix, the cluster of loops larger than the testis sac. The heart of ix passes into the ventral portion of the cluster of loops. Passing through 9/10 the vas disappears from sight on the prostate *ca.* 2 mm. below the ental end without first passing into the parietes. The prostate is flattened and rather strap-like, with slight incisions of the lateral margins, *ca.* 10 mm. long, $2\frac{1}{2}$ mm. wide and 1 mm. thick or slightly less. Ectally the gland is slightly and gradually narrowed. The capsule, after scraping off the external glandular layer, also appears at first to be strap-shaped but with nodulated surface and incised margins, some of which are quite deep. The lumen is relatively quite small and in at least a considerable portion of the capsule with an appearance of being twisted backwards and forwards in a fairly regular zig-zagged fashion, the limbs of the loops transverse to the long axis of the capsule. The prostatic duct is *ca.* $1\frac{1}{2}$ mm. long, with muscular appearance, a short and slender neck, and an ectal bulbous portion which is partly imbedded within the parietes. A horizontal partition appears to divide the cavity of the bulb into two chambers. The aperture in the partition is small, slit-like, and surrounded by an annular ridge.

The spermathecal duct has a muscular (?) appearance. Spermathecal atria are confined to vii. The atrial stalk (coelomic portion) is slender, passing into a single (?) gland with characteristic mamillated surface.

Segment xi is reduced to a horseshoe-shaped ovarian chamber. Ovisacs extend into xiv (Kavalai specimen).

Parasites.—Several nematodes were found in the coelomic cavities of the Kavalai specimen.

Remarks.—Except when otherwise indicated the account given above is based on the Kavalai specimen. As a result of the rather poor external condition of this worm setae are almost unrecognizable. Failure to recognize dorsal dislocations of the nephropores on this specimen may also be due to the condition of the sdecimen rather than to the absence of such dislocations.

The ovarian chamber and ovisacs (Kavalai worm) are not sexual but a strong (spermatozoal ?) iridescence characterizes the testis sacs. The ovisacs of the Trichur specimen are tiny rudiments in xii.

The internal organs of the Kavalai worm were brittle, and what remained of the spermathecal atrium crumbled into fragments while attempting to discover if the usual two glands were bound together in a common investment of connective tissue. Discrete glands are unrecognizable in both specimens.

Accurate characterization of the prostate must await further study of more material, but from the dissection of a single gland of the Kavalai worm it is clear that the muscular capsule is a slender tube looped in a regularly zig-zag fashion with the limbs of the loops in contact and bound together in such a way as to produce an appearance of a flattened and strap-shaped organ. In the Trichur specimen margins of the prostates are deeply incised but the looping here appears to be more irregular (external glandular layer firmly adherent to capsule and removed in part only with difficulty).

M. gravelyi is clearly distinguished from *M. deshayesi* by the absence of " leaflets " on the male deferent ducts as well as by the characters of the prostates. If there is only one atrial gland on each side this will further serve to distinguish *M. gravelyi* from *Moniligaster* sp. from Parambikulam (*vide* below). Further possible distinctions are slenderness and looping of the capsule.

Diagnosis.—Male pores in median half of *bc* (?). (Nephropores of vii, viii and xii not usually dislocated dorsally ?) Pigmentation? Clitellum ? Length 118 mm. Diameter 6 mm.

Gizzards in xiii-xviii. Intestine begins in xxv (±?). Vas deferens long, loops of both slender and thickened portions in ix and x, passing directly into prostate towards ental end. Prostates *ca.* 10 mm. long, 2½ mm. wide and 1 mm. thick, with a flattened, ectally narrowed, rather strap-shaped appearance, capsule slenderly tubular and looped in a more or less regularly zig-zag fashion with limbs of loops short and closely bound together (?). Atria confined to vii (only one atrial gland on each side ?) ; common atrial duct slender.

Distribution.—Trichur and Kavalai, Cochin State, South India, at elevations of *ca.* 3,000 feet (elevation of Kavalai, according to Dr. Gravely, 1,300-3,000 feet).

Moniligaster horsti, sp. nov.

Material examined.—From the Madras Museum : 1 juvenile specimen and 2 aclitellate anterior ends labelled, " Bungitappal. The Kundahs, Nilgiri District, May 1928. E. Barnes."

External characteristics.—Diameter 9 mm. Pigmentation unrecognizable (alcoholic preservation). The body wall is thickened laterally. The prostomium is prolobous.

The setae which begin on ii are small but with black and readily recognizable tips, closely paired, *c* and *d* a trifle more closely than *a* and *b* and probably slightly smaller than the ventral setae ; on xvii-xx *aa* slightly smaller than *bc*.

Nephropores begin on iii and from xiii posteriorly may be dislocated dorsally or ventrally to *ab* but quite irregularly as follows : dorsally, vii, viii, xi-left, xii, xiii-right, xx-xxi-right, xxii-xxiii-left, xxv-right ; ventrally, xiv-right, xvii-right, xxvii-left, xxxi-left, xxxix-left, xl-left, xliii-xliv-left ; dorsally, vii, viii and xii (other dislocations not noted). Nephropores of x are functional.

The spermathecal pores are transversely placed slits on 7/8 just median to *c*.

Male pores are transversely placed slits on 10/11, with centres about mid *bc*.

Female pores are minute, on 11/12, on *b*.

Internal anatomy.—Septa 5/6-8/9 are slightly muscular. Some of the post-gizzard septa are slightly strengthened with muscular fibres.

Gizzards are in xiv-xvii (juvenile) or xv-xviii, with some special muscularity of the gut in xiv of one specimen. A post-gizzard portion of the oesophagus has a thickened wall and on the inner face numerous, closely crowded, low, longitudinally placed and zig-zag, white ridges which are lacking on the intestinal wall. Valves were not definitely identified but the intestine appears to begin in xxviii (1 specimen) or xxx (1 specimen). No typhlosole (2 specimens). Entero-segmental organs are present.

The last pair of hearts is in ix. Paired commissures from the extra-oesophageal trunks are present on the posterior faces of 8/9 and 9/10. Extra-oesophageal trunks are lateral to the hearts.

Testis sacs at first appear to be confined to x but an anterior end of each sac is in a posteriorly directed pocket of 9/10, the sacs unconstricted by the septum. The vas deferens is long, an ental portion slender, looped in hair-pin fashion, the cluster of loops nearly twice the size of the testis sac. The loops at first appear to be in ix but are covered over by a transparent sheet of tissue which is continuous mesially and laterally with septum 9/10. No leaflets. After passing around the heart of ix and through 9/10 the vas penetrates into the longitudinal muscle layer just lateral to the nerve cord and then passes laterally, emerging into the coelomic cavity just in front of the prostate into the anterior margin of which and near the parietes it passes. The prostate gland is *ca.* 3½ mm. long, ovoid in shape, and with the long axis longitudinal. The capsule is anvil-shaped, the bluntly rounded end posterior, the more pointed anterior end directed slightly ventrally. The capsule is opaque and muscular, the lumen very irregular due to the projection into it (especially dorsally) of high, short ridges of the lining, some of the ridges so high and short as to be almost finger-like. The duct which passes into the ventral face of the posterior end of the capsule is bulbous, narrowed entally and just at the parietes, the coelomic portion slightly more than 2 mm. long, nearly circular in transverse section, the lumen transversely slit-like in section, narrowed abruptly half-way towards the capsule and then widened again entally. Muscle strands from the body wall are attached to the duct. Nephridia are present in x.

Spermathecal ampullae are slightly distended and translucent. The duct has a white (muscular ?) sheen and is about 15 mm. long. One atrial gland is in vii and one in viii on each side (2 specimens), the glands erect and reaching to, or nearly to, the dorsal parietes, slightly flattened, 5-6 mm. long, 2-2¼ mm. wide and 1-1½ mm. thick. A slight annular basal constriction marks off each gland into two portions, the ental about twice the length of the ectal part. The common duct is a longitudinally placed body partially buried in the parietes with longitudinal ridges on the inner wall. The spermathecal duct at first appears to pass into the anterior face of the stalk of the posterior gland but can be dissected off to the junction of the two stalks.

The ovarian chamber is horseshoe-shaped. The ovisacs extend into xiii or xv.

Parasites.—A number of nematodes was found in the coelomic cavities of vii, viii and ix of one of the specimens. These parasites have been forwarded to the British Museum for study.

Remarks.—The juvenile worm is macerated in a short region behind the gizzards. Male and spermathecal apertures of the juvenile specimen are minute, the genital organs rudimentary, the ental ends of the prostates and atrial glands just protuberant into the coelomic cavities from the parietes. Ovarian chambers of other specimens are not sexual, and the ovisacs are juvenile.

In the Bungitappal worms one of the taxonomically most important characters is the penetration of the vas into the longitudinal musculature. It is extremely unlikely that this feature will be changed on attaining full maturity. Prostatic capsules seem to have attained definitive shape and appear to provide adequate means of distinction from other species having the male deferent ducts similarly buried within the longitudinal musculature. The diagnosis is of course incomplete and provisional.

Diagnosis.—Male pores with centres at or close to mid *bc*. Pigmentation ? Clitellum ? Length ? Diameter 9 mm.

Gizzards in xiv-xviii. Intestine begins in xxix ($\pm$1 ?) ? Vas deferens very long, the cluster of loops nearly twice the size of the testis sac, loops mostly in ix but covered over by a thin sheet that is attached mesially and laterally to 9/10, passing laterally in x within the longitudinal musculature, emerging to pass into the prostate anteriorly. Prostatic capsule ovoidal to anvil-shaped, *ca.* 3½ mm. long, the more pointed end directed antero-ventrally, and the duct into the ventral face of capsule posteriorly. Atrial glands in vii and viii, coelomic portion of common atrial duct a longitudinally placed body.

Distribution.—Known only from the type locality, Bungitappal, in the Nilgiri Hills, at an elevation of 8,000 feet. (The type locality could not be found on any maps available locally, but Dr. Gravely writes that "Bungitappal is a point about 8,000 feet high, on the Kundah range of the Nilgiris in South India.")

Moniligaster michaelseni, sp. nov.

Material examined.—From the Madras Museum : 1 undissected, clitellate specimen labelled, "Kodaikanal, *ca.* 6,000-6,800 ft., Palni Hills, 17-27.ix.1930. Gravely.", and 1 clitellate (?) specimen labelled, "Kodaikanal, *ca.* 6,000-6,800 ft., Palni Hills. April-May 1929. Gravely."

External characteristics.—Length 175 mm. (clitellate specimen) and 274 mm. Diameter 16 mm. (clitellate specimen) and 9 mm. Pigmentation dark bluish in the dorsum. The body wall is thickened laterally. The buccal region is everted and softened but the prostomium appears to be prolobous (2 specimens).

Setae are small and closely paired, invisible on ii and on some of the clitellar segments (1) and also elsewhere on the other worm ; on xvii-xx (1) *aa* slightly greater than *bc*.

Nephropores begin on iii and from xiii posteriorly may be dislocated dorsally or ventrally to *ab* but quite irregularly as follows : dorsally,

vii, viii, xii, xix-left, xx-left, xxi-left (?), xxiii-left, ventrally, xiii-left, xvi-left, xviii-right, xxiv-left, xxv-left, xxix-left (1); dorsally, vii, viii, xii, xiv-right, xx-left, xxii-right, xxvi-left, xxvii-right, xxx-left, xxxii-right, xxxiii-right, ventrally, xvii-left, xxi-right, xxv-right, xxvii-left, xxviii-left, xxxi-right, xxxiii-left, xxxiv-left, xl. Nephropores on x are functional.

The clitellar colouration is reddish and extends from a posterior portion of ix on to xiv (1). On the second specimen only the faintest trace of a reddish clitellar colouration is visible.

Spermathecal pores are wide transversely placed slits on 7/8, extending from *d* mesially. On the anterior and posterior margins of the apertures there are fine, longitudinally placed furrows.

Male pores are transversely placed slits on 10/11 in the median part of *bc*, reaching mesially to *b*. On the first specimen the ectalmost portion of each prostatic duct is slightly everted to form a low annular lip around the male pore, the lip wrinkled and soft. Just anterior and just posterior to the lips of each male pore, on the anterior and posterior portions of x and xi, there is a smooth, whitened, transversely placed area of crescent shape (1 only).

Female pores are minute, on 11/12, on *b*.

Internal anatomy.—Septum 9/10 is tough but membranous and transparent; 5/6-8/9 muscular but slightly translucent, some of the post-gizzard septa strengthened with muscular fibres.

The gizzards are in xviii-xxi (1) or xvi-xx. A valve is unrecognizable but a post-gizzard portion of the gut to xxviii or xxx has a thickened wall and, on its inner face, numerous closely crowded, rather irregular, longitudinally placed whitish ridges. This portion of the gut, with a structure like that of the post-gizzard section of the oesophagus in other Moniligastrid species is accordingly considered to be oesophageal even though a valve is unrecognizable (probably because of distention by the dark, almost black soil). No typhlosole (2 specimens). Entero-segmental organs are present from xxii or xxiii posteriorly.

The last pair of hearts is in ix. There is a pair of commissures from the extra-oesophageal trunks on the posterior faces of 8/9 and 9/10. Extra-oesophageal trunks are lateral to the hearts. Nephridia are present in x.

A testis sac may at first appear to be wholly in x though an anterior portion is in a posteriorly directed pocket of 9/10, the testis sacs unconstricted by the septum. The vas deferens is long, with the elongately hair-pin-shape loops in a vertically placed cluster underneath the testis sac, and the ental portion of the vas slender. The cluster of loops is about as large as the testis sac or larger and appears to be in ix, but is actually covered over by a transparent sheet of connective tissue which is continuous (or appears to be so) mesially and laterally with septum 9/10. No leaflets. After passing around the heart of ix and through 9/10, the vas drops on to the floor of the coelomic cavity to which it may be bound but without passing into the longitudinal muscle layer, and with a few very short loops in x. The vas passes into the prostate slightly below the ental end and is slightly thickened just prior to its entrance. The prostate (including the duct) is 5-6 mm. long and

slightly more than 2 mm. thick in the widest portion, bent into a C-shape, with the concave side facing antero-laterally. The duct emerges from the parietes and passes posteriorly on the floor of the coelomic cavity and then is bent around mesially and anteriorly. The duct and gland are of about equal length, the duct bulbous and thickest ectally, almost conical, with strong diagonal muscle bands to the basal portion, and with a rather slender short neck. The gland and capsule are almost ovoidal, slightly flattened, and narrow ectally. The capsule is thick and muscular, lined with soft pinkish material in several high, longitudinal ridges, and with a large lumen. In the basal portion of the duct the lumen is large and transversely slit-like, with its inner wall provided with vertical ridges, or the lumen may be H-shaped in cross section with one side definitely thicker.

The spermathecal duct is 18 mm. long, and has a white muscular appearance; it is coiled underneath the ampulla and passes into the dorsal face of the common atrial duct between the two glands. One atrial gland is in vii and one in viii on each side (2 specimens). The gland is ovoidal and about $3\frac{1}{2}$ mm. long, and its stalks at first appear to be very short, but the basal portion of the gland is bound down around the ental part of the stalk. The common duct of the glands is short but the coelomic portion resting on the parietes is a longitudinally placed body noticeably longer than thick or high. The wall is muscular, with the annular ridges on the inner face and a wide lumen.

Segment xi is closed off to form a horseshoe-shaped ovarian chamber which is sexual. From the posterior margin of the chamber a sheet of tissue (septum ?) passes to the dorsal parietes. In the first specimen the right ovisac is rudimentary, whitish and without ova, the left ovisac reaching into xviii. In the other worm the ovisacs extend only into xv.

Remarks.—The shorter specimen may have lost a considerable length of its posterior portion at some time but the narrowed, almost pointed, and rather soft tail does not show any definite evidence of autotomy or of regeneration aside from shape, size and a possible lack of pigment. The tail end of the other specimen is bluntly rounded. The second specimen appears to be sexual in spite of the faint colouration of the clitellar segments. The gut had been ruptured in both specimens as a result of crowding into small tubes.

M. michaelseni is distinguished from *M. perrieri* by the shape of the prostatic capsule, the relation of the gland to the prostatic duct, and by the prone position of prostate and duct on the parietes.

Diagnosis.—Male pores in median half of *bc.* Clitellum red. Pigmentation restricted to dorsum ? Length 175-274 mm. Diameter 9-16 mm.

Gizzards in xvi-xxi. Intestine begins in xxix ($\pm$ 1 ?). Vas deferens long, the cluster of loops as large as, or larger than, the testis sac, and in ix covered over by a thin sheet that is attached mesially and laterally to 9/10, and passing directly into prostate slightly below ental end. Prostates 5-6 mm. long, gland and duct of about equal length, bent into a C-shape with concavity antero-laterally, and bound to the parietes; capsule rather flattened and ovoid. Atrial glands in vii and viii, the coe-

lomic portion of the common atrial duct being a longitudinally placed body.

Distribution.—Known only from the type locality, Kodaikanal, Palni Hills, at an elevation of 6,000 feet or more.

Moniligaster perrieri Michaelsen.

1907. *Moniligaster perrieri* Michaelsen, *Mitt. Mus. Hamburg* XXIV, p. 146. (Type locality-Kodaikanal, Palni Hills, South India. Types in the Indian Museum.)
1909. *Moliligaster perrieri*, Michaelsen, *Mem. Ind. Mus.* I, pp. 107 and 150.
1910. *Moniligaster perrieri*, Michaelsen, *Abh. Nat. Ver. Hamburg* XIX (5), p. 9.
1923. *Moniligaster perrieri* (part), Stephenson, *Oligochaeta* in *Faun. Brit. Ind.*, p. 123. (Excluding Travancore worms, from Bonaccord and Ponmudi.)
1924. *Moniligaster perrieri* (part), Stephenson, *Rec. Ind. Mus.* XXVI, p. 322. (Including only one specimen from Neutral Saddle.)
1925. *Moniligaster perrieri*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 48.

Material examined.—From the Indian Museum : 1 dissected specimen labelled, "*Moniligaster perrieri* Michlsn. Type. Kodaikanal, Palni, Hills, 7,000 ft. June 1907. J. R. Henderson. ZEV 2902/7.", 1 undissected specimen labelled, "*Moniligaster perrieri* Michlsn. Type. Kodaikanal, Palni Hills, 7,000 ft. June 1907. J. R. Henderson. ZEV 2903/7.", and 1 macerated anterior fragment labelled, "Under stones in dense jungle near Neutral Saddle, 4,200 ft. Palni Hills, S. India. 14 Sept. 1922. S. Kemp. W 1109/1." From the late Dr. Michaelsen : 1 dissected specimen labelled, "*Moniligaster perrieri* Michlsn. Palni Hills. J. R. Henderson." From the Madras Museum : 1 aclitellate and 3 clitellate, dissected specimens labelled, "*Moniligaster perrieri* Michlsn. Sirumalais. June 1914. Under stone near a stream. Colour dark blue."

External characteristics.—Length 105-160 mm. (types), 100-140 mm. (Tirumalai specimens). Diameter 4 mm. Pigmentation now unrecognizable in all specimens. The prostomium is always of the characteristic Moniligastrid prolobous type. The body wall is thickened laterally.

Nephropores begin on iii, and from xiii posteriorly they may be dislocated dorsally or ventrally to *ab* but quite irregularly as follows : dorsally, vii, viii, xiv on the right side, vii (viii ?), xii, xiii, xv, xvi, xx, xxi, xxiii on the left side, ventrally xv, xx, xxiii, xxv, xxx, xxxi, xxxix, xxxv, xlii on the right side, ix, xxx, xxxii on the left side (Michaelsen's paratype, right pore of xii in *cd*) ; dorsally, vii, viii, xi, xii, xiv, xx on the right side, vii, viii, xii, xiii, xv, xxii on the left side, ventrally xv, xix on the right side, xiv on the left side (type) ; dorsally, vii, viii, xii (Indian Museum paratype). Nephropores of x are functional.

Clitellar colouration is unrecognizable, but the epidermis is markedly thickened on x-xiii or xiv and posteriorly on ix at the mid-dorsal incision (types and Tirumalai specimens).

Spermathecal pores are transversely placed slits on 7/8 just median to *c* or reaching laterally to or nearly to *d* (Tirumalai specimens).

Male pores are transversely placed slits on 10/11, slightly lateral to *b* but in median half of *bc* (types) or nearer mid *bc* (Tirumalai specimens). A small region immediately in front of and behind each male pore may be finely furrowed, the grooves longitudinal, the anterior areas obviously though only slightly depressed (types).

Female pores are on 11/12 in *ab* (types and one Tirumalai specimen) on or just lateral to *b* (Tirumalai specimens).

Internal anatomy.—Gizzards are in xiv-xvii (Indian Museum paratype) ; xv-xviii (Neutral Saddle) ; xiii-xvi, xiv-xviii, or xv-xix

(Tiru-malai specimens). On the inner wall of the oesophagus in xxi-xxvi there are numerous, closely crowded, rather irregular but longitudinally placed, white ridges (types). Between these ridges in one of the specimens there are clusters of fine white granules, probably calcareous. The intestine begins in xxviii (two types, one Tirumalai specimen and the Neutral Saddle specimen). No typhlosole. Entero-segmental organs are present.

Hearts are present in vi-ix. Paired commissures from the extra-oesophageals are on the posterior faces of 8/9 and 9/10. Extra-oesophageals are lateral to the hearts. Nephridia are present in x.

Testis sacs are apparently not dislocated posteriorly behind the ovarian chamber. A short ental portion of the vas deferens is slender, coiled in short hair-pin loops just under the testis sac, the remainder of the duct thickened and in longer hair-pin loops on the anterior face of 9/10. Passing through 9/10 the vas is fairly close to, but not in contact with, the parietes though connected therewith by transparent tissue, slightly sinuous but not markedly looped, passing directly into the anterior end of the prostate. The thickened portion of a male deferent duct of one Tirumalai specimen is 405 mm. long. The prostate is reniform, concave side ventrally, antero-posteriorly directed (occasionally twisted around on the neck so as to be transversely placed), slightly-flattened latero-mesially, 3-4 mm. long, 1-1½ mm. thick latero-mesially or dorso-ventrally. The capsule is muscular (type, transparent in Tirumalai specimens) with its surface fairly smooth, *i.e.*, without nodulations. The duct passes into the hilus (concavity of the ventral side) and approximately midway between the anterior and posterior ends. The capsular lining is raised into several conspicuous ridges, the aperture of the vas on the end of a slightly conical protuberance, and the opening into the duct at the centre of a tiny tubercle. The prostatic duct is 2-3 mm. long (coelomic portion), a short ental portion slender, the remainder of the coelomic portion of the duct markedly bulbous and conspicuously protuberant into the coelomic cavity. To the lateral face of the bulb near the parietes there are attached several rather weak diagonal muscle strands. In the neck the lumen is small and transversely slit-like in cross section, rapidly widened passing ectally and irregular as a result of the presence of longitudinal ridges. Within the parietes the lumen is slit-like and of about the same width as the male aperture, but abruptly widened just internal to the parietes. A horizontal partition shuts off this cavity from the one in a more ental part of the bulb, but the method of communication between the two chambers was not determined. The ectal chamber is presumably lined with cuticle as the walls have a smooth glistening appearance.

The spermathecal duct is 12-15 mm. long (Tirumalai specimens). Atrial glands are in vii and viii (types, Neutral Saddle and Tirumalai specimens). The rather stout common atrial duct appears to be thickened entally but this appearance is due in part to the fact that the glands cover over and conceal from view the origin of the individual ducts. The lining of the common duct is ridged.

Parasites.—In the ovisacs of one of the Tirumalai specimens there are cysts, probably protozoan. A fairly large, encysted nematode was seen in the coelomic cavity of one of the types.

Remarks.—There is nothing in the literature to indicate that the pigmentation is restricted to the dorsum, in fact quite the contrary as Michaelsen notes with reference to the colour, "dorsally darker than ventrally" (1908, p. 150).

Setae are closely paired, the lateral setae of the Tirumalai specimens more closely than the ventral. Setae of Tirumalai specimens are ornamented near the tips with several closely crowded, transversely placed rows of fine teeth.

Female pores are invisible on one of the types but the sites of the pores are indicated by tiny but relatively rather conspicuous tubercles.

Internal organs had been partly removed in earlier dissections so that redetermination of gizzard locations in two types is impossible.

In the Indian Museum paratype the outer (coelomic) glandular layer of the prostate has a slight reddish tinge which is either lacking or was not observed in certain worms.

The three types are probably post-sexual, the ovarian chambers and ovisacs being distended by a yellowish debris in which ova are unrecognizable. The ovarian chamber of the Neutral Saddle specimen (which is probably a fairly late juvenile) is not sexual, the ovisacs also being juvenile. As a result of maceration the connective tissue binding the branches of the atrial glands into ellipsoidal bodies in the Neutral Saddle specimen is perfectly transparent though still remarkably tough, the terminations of the branches clearly visible, and the connective tissue extending into the interior of the gland along the branches.

In view of the restricted distribution, apparently characteristic of most species of *Moniligaster*, the occurrence of *M. perrieri* in the Tirumalai Hills of Chittoor district, some distance from the type locality, seems unusual. Unfortunately the Tirumalai specimens or the specimen from Neutral Saddle, could not be studied simultaneously with the types of *M. perrieri* but the laboratory notes on the prostates of worms from the two localities are almost identical.

Diagnosis.—Male pores in median half of *bc*. Clitellum ? Pigmentation on ventrum as well as dorsum ? Length 100-160 (—210 ?) mm. Diameter 4 (—5 ?) mm.

Gizzards in xiii-xix. Intestine begins in xxviii. Vas deferens long (405+mm.) loops in a vertical cluster on the anterior face of 9/10, passing directly ventral to the anterior end of prostate. Prostatic capsule reniform, concave side ventrally and longitudinally directed, slightly flattened latero-mesially, 3-4×1-1½ mm.; duct passing into ventral face of capsule about midway between anterior and posterior ends. Atrial glands in vii and viii, common atrial duct rather stout and thickened entally.

Distribution.—Kodaikanal, Neutral Saddle (Palni Hills, at elevations of 4,200-7,000 ft.) and the Tirumalai Hills (exact locality and elevation unknown).

Moniligaster stephensoni, sp. nov.

1924. *Moniligaster perrieri* (part), Stephenson, *Rec. Ind. Mus.* XXVI, p. 322. (Including only Vanderavu specimens and one specimen from Kodaikanal.)

Material examined.—From the Indian Museum : 1 dissected and 4 undissected, aclitellate specimens labelled, " *Moniligaster perrieri* Mich. Vanderavu, *ca.* 7,400 ft. Under stones in stream in jungle. Palni Hills. S. India. Aug. 1922. S. Kemp W 1106/1", and 1 aclitellate, macerated specimen labelled, " *Moniligaster perrieri* Michaelsen. Kodaikanal, 6,900-7,200 ft. Palni Hills, S. India. Aug. 1922. Dr. S. W. Kemp, W 707/1."

External characteristics.—The dissected specimen is incomplete posteriorly but is 90 mm. long and 8 mm. thick. Undissected specimens from Vanderavu are 60-92 mm. long and 4-5 mm. in diameter. The Kodaikanal specimen is about 165 mm. long and 7 mm. thick. Pigmentation now unrecognizable. The body is slightly flattened dorso-ventrally behind the clitellar region, and the body wall is thickered laterally. The buccal cavity of each of the Vanderavu specimens is everted, but the prostomium appears to be prolobous, and characteristically so on the Kodaikanal specimen.

Setae are fine, closely paired, unrecognizable, or recognizable only with difficulty, anteriorly. On the 8 mm. specimen $aa<bc$ on the post-genital segments but on the smaller worms *aa* and *bc* may be about equal.

Nephropores begin on iii and are functional on x, dislocated dorsally on vii, viii and xii (except that one pore of xii of a Vanderavu specimen is in *cd*, the right pore of vii and both pores of viii in or close to *cd* on the Kodaikanal specimen). On the largest Vanderavu specimen pores are dislocated as follows : dorsally xiv-left, xvii-right, xx-xxi-left ; ventrally to *ab*, xv-right, xvi-left, xviii-right, xxi-left, xxiii, xxv-left, xxix-left, xxxviii-right. On the Kodaikanal specimen left pores of ix and x are in *ab*.

Spermathecal pores are transversely placed slits on 7/8 in the region of *cd*.

Male pores are large transverse slits on 10/11, in *bc* with centres nearer to *b* than *c*.

Female pores are probably on 11/12, on or close to *b*.

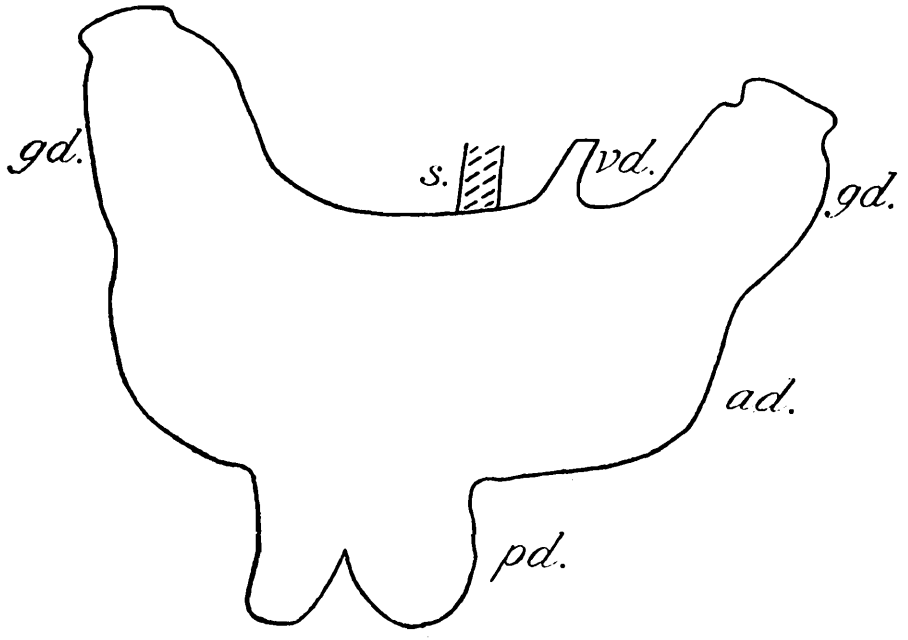
Internal anatomy.—Septa 5/6-8/9 are muscular ; several post-gizzard septa, as many as nine in the largest Vanderavu worm, are muscular.

Gizzards are in xiv-xix (one Vanderavu specimen) or xvii-xxii (Kodaikanal specimen). In the other two dissected Vanderavu specimens some unusual contraction appears to have driven the gizzards forward so that the first gizzard appears to be in front of the ovarian chamber. The post-gizzard portion of the oesophagus is markedly sigmoid, the inner wall provided with closely crowded, longitudinal, white ridges. The intestine appears to begin in xxx (specimen with gizzards in xiv-xix) or in xxxiii (Kodaikanal specimen). No typhlosole. Entero-segmental organs are present.

Hearts are present in vi-ix and are median to the extra-oesophageal trunks. Commissures from the extra-oesophageals are on the posterior faces of 8/9 and 9/10. Nephridia are present in x.

Testis sacs at first appear to be wholly in x but the anterior ends are in posterior pockets of 9/10, the sacs unconstricted by the septum.

The vas deferens is long, a short and slender ental portion in a small cluster of loops just under the testis sac and in the pocket of 9/10, the widened portion in a cluster of hair-pin loops on the anterior face of 9/10 that is nearly as large as the testis sac. Emerging into x the vas passes into the parietes and laterally underneath a fairly wide strand of longitudinal muscle, emerging just anterior to the prostate and passing up and into the anterior face of the prostate just above the ectal margin of the external glandular layer. The prostates are latero-mesially flattened and rather disc-like, with convex dorsal surface, the ventral side slightly concave and symmetrical with regard to the attachment of the duct. The external glandular layer extends further ventrally on the anterior and posterior surfaces than on the median and lateral faces,



TEXT-FIG. 2. Camera lucida sketch of a spermathecal atrium of a specimen of *Moniligaster* sp. from the Palni Hills after removal of atrial glands.

ad., common atrial duct; *gd.*, duct or stalk of a single gland; *pd.*, parietal portion of common duct; *s.*, septum; *vd.*, vas deferens: × *ca.* 39.

so that portions of the lateral and median faces of the capsule are exposed. The capsule is muscular and lined with a layer of soft material that is raised into a few ridges. A very short ental portion of the duct is slender and with the sheen of a muscle, the lumen in this neck narrow and slit-like in section. Ectally the duct is widened and bulbous, with numbers of strong muscle bands attached to the lateral face of the bulb, and the lumen in this portion irregular as a result of the presence of vertical ridges.

One atrial gland is in vii and one in viii on each side. The common atrial duct is slender, erect in vii just anterior to 7/8.

The horseshoe-shaped ovarian chamber contains a few loose and apparently ripe ova. Ovisacs are sexual and extend into xvi.

Remarks.—The account given above is mainly based on the previously dissected worm which appears to be mature in spite of apparent lack of a clitellum, epidermis of x-xiii thickened though recognizable only at the dorsal incision. In one other Vanderavu specimen and the Kodaikanal specimen the prostates appear to be of a characteristic form

though small. In another opened specimen the prostates just protrude through the parietes into the coelomic cavity. In all opened specimens the vas passes into the longitudinal musculature and is not again visible in the coelomic cavity in juvenile prostates.

A horizontal partition and penis in an ectal portion of the bulb of the duct (as in *M. beddardi*) are lacking, but the passage into the neck is constricted by an annular ridge.

M. stephensoni belongs to a group of three species in which the vas deferens passes into the parietes and under the longitudinal muscle prior to its junction with the prostate, and is distinguished from the other two species of the group by the latero-mesially flattened disc-shaped capsule.

Diagnosis.—Male pores with centres nearer *b*. Pigmentation ? Clitellum ? Length 92-165 mm. Diameter 7-8 mm.

Gizzards in xiv-xxii. (Intestine begins in region of xxx-xxxiii ?) Vas deferens long, loops of slender portion in a posterior pocket of 9/10, loops of thickened portion in a cluster in ix that may be as large as the testis sac, passing laterally in x underneath a strand of longitudinal muscle, emerging to pass into the anterior face of the prostate just above the ectal margin of the glandular layer. Prostatic capsule disc-shaped, latero-mesially flattened, with convex dorsal surface and slight concavity at centre of ventral face, external glandular layer lacking on portions of lateral and median faces of capsule ; duct to ventral face of capsule midway between anterior and posterior ends. Atrial gland in vii and viii, common atrial duct slender and erect in vii.

Distribution.—Vanderavu and Kodaikanal, in the Palni Hills, at elevations of 6,900-7,400 feet.

Moniligaster sp.

1915. *Moniligaster deshayesi* (part), Stephenson, *Mem. Ind. Mus.* VI, p. 57. (Excluding var. *gravelyi*.)

1923. *Moniligaster deshayesi* (part), Stephenson, *Oligochaeta* in *Faun. Brit. Ind.* p. 121. (Including only *M. deshayesi* Stephenson 1915, specimens, from Parambikulam only.)

Material examined.—From the Indian Museum : 1 aclitellate and 1 clitellate, dissected specimens labelled, " *Moniligaster deshayesi* E. Perrier. Parambikulam, 1,700-3,200 ft., Cochin State. 16-24.9.14. F. H. Gravely. ZEV 6595/7."

External characteristics.—The prostomium is retracted but is of the characteristic Moniligastrid prolobous type (2 specimens).

Nephropores begin on iii and are functional on x, dislocated dorsally on vii, viii, xii, except on the left side of vii and viii of the clitellate specimen, dislocated dorsally on the right side of xiii and xiv of one specimen.

The clitellum has a light yellowish colouration.

Interna anatomy.—Gizzards are in xv-xviii (2 specimens). The inner wall of the post-gizzard portion of the oesophagus except at the mid-dorsal and mid-ventral lines is provided with closely crowded, low and lamelliform, white ridges. The intestine begins in xxv (2 specimens). No typhlosole. Intestinal contents are black. Entero-segmental organs are present.

Hearts are present in vi-ix and are median to the extra-oesophageal trunks. Anterior commissures from the extra-oesophageals appear to be on the posterior face of 8/9 but are bound to the septum by strong tissue.

The vas deferens is long, in a cluster of elongately hairpin-shaped loops and does not pass into the parietes in x though transparent tissue from the vas passes ventrally to the body wall. The vas disappears from sight on the prostate slightly below the ental end. No leaflets. The prostates are about 10 mm. long (mature specimen), slightly and gradually widened passing entally, circular in cross section ectally, elliptical in section entally. The margins are not incised but there are slight nodulations of the surface. The lining of the capsule is raised into an irregularly criss-crossed network of ridges which may meet and unite centrally. The duct is slightly less than 2 mm. long, the ental half with sheen as of muscle and small, slit-like lumen, the ectal portion bulbous but not thicker than the gland, lumen wide and irregular as a result of the presence of vertical ridges. A horizontal partition in the bulb was not found.

Spermathecal atria are in vii, two distinct lobes clearly recognizable, each with its own individual duct (clitellate specimen). The common atrial duct is slender, 2-3 mm. long.

Segment xi is reduced to a horseshoe-shaped ovarian chamber.

Remarks.—The citellate specimen appears to be slightly post-sexual, with no free ova in the ovarian chamber but with ovisacs distended by a yellowish debris. The second specimen is juvenile, the ovisacs being small rudiments in xii.

Prostates of the clitellate specimen differ from those of *M. gravelyi* in the absence of deep marginal incisions of the capsule, the smooth surface (slight irregularities appear to be due to twisting or crowding by other organs), and the regularly elliptical to circular cross section. Prostates of the second specimen have a few slight marginal incisions, and may be more like those of *M. gravelyi* but the external glandular layer is strongly adherent to the capsule.

Both specimens are clearly distinguished from *M. deshayesi* by the absence of leaflets on the vas deferens. The clitellate worm appears to differ from *M. gravelyi* in characteristics of the prostatic capsule which are of sufficient importance to indicate that the worm belongs to a distinct species. The juvenile worm should perhaps be referred to *M. gravelyi* but is really too immature for specific identification.

The specimens referred to below could not be secured for examination. In view of the possibility that these specimens do not belong to the species to which they were referred they have been excluded from the preceding portion of the paper.

Moniligaster sp.

2.

1909. *Moniligaster perrieri* (part), Michaelsen, *Mem. Ind. Mus.* I, p. 150. (Specimen from Tiger Shola.)

Quite possibly correctly identified.

3.

1913. *Moniligaster perrieri*, Michaelsen, *Mitt. Mus. Hamburg* XXX, p. 78. (Specimens from Ponmudi and Bonaccord, Travancore, at elevations of 500-750 M.)

1929. *Moniligaster perrieri*, Aiyer, *Rec. Ind. Mus.* XXXI, p. 15.

Possibly *M. aiyeri* ?

4.

1924. *Moniligaster perrieri* (part), Stephenson, *Rec. Ind. Mus.* XXVI, p. 322. (Including only Cambridge Museum specimen.)

Present location of this specimen, if still in existence, is unknown. It is not in the Cambridge Museum or in the British Museum. The diameter is only slightly greater than that of *M. beddardi.* The description of the prostate as sausage-shaped and bent on itself, together with the information that the prostates are longer than in those specimens now referred to *M. beddardi,* may or may not be evidence for a similar identification[1].

REFERENCES.

Michaelsen, W., 1908.—The Oligochaeta of India, Nepal, Ceylon, Burma and the Andaman Islands. *Mem. Ind. Mus.* I.

Stephenson, J., 1922.—Contributions to the morphology, classification, and zoogeography of Indian Oligochaeta. *Proc. Zool. Soc. London,* 1922.

Stephenson, J., 1930.—*The Oligochaeta.* (Oxford).

[1] Dr. L. Cernosvitov has been kind enough to check over the material in the British Museum, and writes that the only specimen of *perrieri* is labelled as follows : " *Moniligaster perrieri* 1925.5.12.95. Kodaikanal, S. India. Indian Museum. Ex. W 707/1." This obviously is not the Cambridge specimen but is from the batch that contained the types of *beddardi* as well as a specimen of *stephensoni.*