INDIAN EARTHWORMS.

VI. *NELLOSCOLEX*, gen. nov.

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The types of *Woodwardia burkilli* are characterized by an anterior homoeosis of one segment of all reproductive organs, which, together with other characteristics, shows that these worms are more closely related to species of *Tonoscolex* than to any of the Woodwardiellas. Differences from known species of *Tonoscolex* are such as to indicate advisability of generic or at least subgeneric separation. Unfortunately in this case as well as in others mentioned in preceding papers, material available for study has been limited and of an importance (as types) or in such poor condition that a satisfactory account cannot be given of important structures or characteristics. Accordingly again, diagnosis can only be tentative, subject to revision when further material can be studied.

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Nelloscolex, gen. nov.

Diagnosis.—Quadrithecal, spermathecal pores on or close to 6/7-7/8 Male pores on xvii, in short seminal grooves restricted to xvii. Female pores paired, on xiii. Setae lumbricine, ventral setae of xvii lacking. Clitellum annular, on xiii-xvi. First dorsal pore on 8/9-9/10. Unpigmented.

All septa, at least from 6/7, present. Gizzard large, in vi. Calciferous tissue in vertical lamellae within paired, lateral pouches in ix-xii that are not constricted off from the gut. Intestine begins in xiv (?), typhlosole present. Last hearts in xii (four pairs of latero-oesophageal hearts ?). (Excretory organs enteronephric meganephridia ? and exonephric micronephridia ?). Testes in ix and x; seminal vesicles in x and xi. Prostates strap-shaped. Ovaries in xii.

Genotype.—*Woodwardia burkilli* Michaelsen 1907

Distribution.—Western Burma and Assam.

Remarks.—Distinguished from *Tonoscolex*, for the present, by the restriction of the short seminal grooves to xvii and the more primitive condition of the calciferous glands.

Like the quadrithecal species of *Lampito*, the species of *Nelloscolex* and *Tonoscolex* may have been derived from an ancestral form with penial setae, loss of which explains the absence of ventral setae on the male pore segment.

Shifting of certain reproductive organs such as prostates and male pores from one segment to another has been recorded in several Megascolecid genera (*Pheretima, Diplocardia*) or has been assumed in theorizing

on earthworm phylogeny, but location of testes in ix and x and of ovaries in xii is, so far as can be discovered from available literature, unknown elsewhere in the Megascolecidae. In the absence of embryological and other evidence it is impossible to do more than guess as to how this shifting has been brought about. It is obvious however that organs other than the reproductive structures are one segment further forward than usual in the Megascolecidae ; spermathecal pores on 6/7-7/8 rather than 7/8-8/9, last hearts in xii rather than xiii, first intestinal segment xiv rather than xv. In these circumstances rather than postulate a translocation of organs from one segment into another a better guess would appear to be a total loss of one segment in front of the spermathecal region.

In some species of *Dichogaster* the first segment is small and the intersegmental furrow between the first and second segments is lacking or when recognizable so only in part. In a Ceylonese Megascolecin species, *Notoscolex decipiens*, intersegmental furrow 1/2 has entirely disappeared, but the setae of ii are present, at least in part. If a similar loss of segmental boundaries between i and ii (both internally and externally) took place in a common ancestral form of *Nelloscolex* and *Tonoscolex* and was then followed by reduction in size of the combined metamere and loss of setae belonging to segment ii the condition characteristic of these two genera would be obtained. *Nelloscolex* may represent an ancestral stage from which *Tonoscolex* is to be directly derived by constriction from the gut of the calciferous pouches. This suggestion is advanced but tentatively in absence of information regarding the nephridia.

Nelloscolex burkilli (Michaelsen).

1907. *Woodwardia burkilli*, Michaelsen, *Mitt. Mus. Hamburg* XXIV, p. 152 (Type locality Buthidaung, Akyab district, Burma. Types in the Indian and Hamburg Museums).

1909. *Woodwardia burkilli*+ *W. burkilli* Michaelsen, *Mem. Ind. Mus.* I, pp. 108, 162.

1923. *Woodwardia burkilli*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 185.

Material examined.—From the Hamburg Museum :

1 aclitellate specimen and fragments of another specimen labelled, " V 71766 *Woodwardia burkilli* Michlsn. Burma. W. Akyab Dist. J. H. Burkill ".

From the Indian Museum :

1 clitellate, undissected specimen labelled, " *Woodwardia burkilli* Michlsn. Earthworms from damp spot in high forest, west. Buthidaung, Akyab district. 17 Jan. 1907. J. H. Burkill ".

External characteristics.—The prostomium is prolobous. Secondary annuli are present on vii-x, a slight trace of a postsetal secondary furrow on vi. Nephropores not found. Setae begin on ii ; *a* and *b* lacking (or invisible) on vii, viii, xvii, very closely paired on the clitellar segments ; *ab*<*cd*. The first definitely functional dorsal pore is on 9/10, a pore-like but apparently imperforate marking on 8/9. The clitellum is yellowish not protuberant, annular, extending from 12/13 to 16/17 ; intersegmental furrows and dorsal pores lacking but sites of the pores indicated by pit-like depressions, setae present.

The spermathecal pores are very small, but larger than the male and female pores, in *ab*, on 6/7-7/8.

The female pores are on xiii, just anterior and slightly median to *a*.

A male genital shield is marked off, at least in part, by a fine greyish translucent line in the epidermis. The body wall is slightly depressed along the midventral line, the depression extending across xvii and the anterior half of xviii. On each side of this depression but on xvii there is a slightly protuberant area, elliptical but so short as to be almost circular, extending anteroposteriorly between the pre- and postsetal secondary furrows which are displaced anteriorly or posteriorly and laterally to just beyond *b*, the areas almost in contact midventrally. From a point about at the middle of each of these areas a seminal groove extends posteriorly almost but not quite in a straight line to 17/18 which is dislocated posteriorly. Behind the postsetal secondary furrow is a short transverse furrow present only ventrally and which does not pass into 17/18 on either side. The male pores have not been identified definitely but are probably represented by greyish translucent pits near the anterior ends of the seminal grooves.

Internal characteristics.—Septum 6/7 is slightly thinner than 7/8, but no septa are especially muscular.

The gizzard is in vi. The gut widens gradually in xxii-xxiii (oesophageal valve ?). The oesophagus is deeply constricted and moniliform in viii-xii, the lateral pouches not shut off from the oesophageal lumen and with vertical lamellae. The typhlosole is large, lamelliform, reaching in xxii-xxiii to the floor of the gut.

The last pair of hearts is in xii.

Small clusters of micronephridia (?) are visible in xii-xvi. In each of the segments near the tail there is a pair of (enteronephric ?) meganephridia.

Male funnels are free in ix and x, characterized by a brilliant spermatozoal iridescence. There is very little testicular coagulum in either male segment. The seminal vesicles are small, acinous, vertically placed structures, in x and xi, on the posterior faces of 9/10 and 10/11. The prostates are friable, flattened and strap-like, extending through xvii-xxii, both margins deeply incised by the septa. The duct is translucent and emerges from the median margin of the gland in xviii, in that segment bent into tiny U-shaped quirks, then passing straight anteriorly into xvii where it is covered over by diagonal muscle fibres. About half way to 16/17 the duct curves around towards the midventral line and then passes into the parietes, the anterior portion with a shape like an interrogation mark.

The spermathecae are relatively large, in vi and viii, the diverticula of the anterior spermathecae in vii. The ampulla is translucent. The duct is slender, somewhat shorter than the ampulla from which it may be clearly marked off. The diverticulum is longer than the duct, with brilliant spermatozoal iridescence, the seminal chamber rather ellipsoidal but narrowing ectally to a very short stalk with no iridescence, passing into the median face of the duct near the parietes.

Remarks.—The clitellum may be in an early stage of regression.

Michaelsen (1909, p. 163) maintains that the grooves on the male held are not seminal grooves since prostatic and male pores are not separate (deferent ducts opening into the ental portion of the prostatic

ducts). Stephenson (1923, p. 186) characterizes the grooves as pseudo-spermatic but is not consistent for in the same work (p. 159) he calls grooves of *Drawida sulcata* that are quite unconnected with the male pores and possibly only artefacts, seminal furrows.

In *burkilli* the male pores are in clear cut, definite grooves as in species of *Tonoscolex*. In this latter genus the grooves are not transient structures but are present even in older juveniles as well as aclitellate worms, and further are so characteristic as to be of major importance for specific characterisation. The function of these grooves is unknown, in absence of observations on copulation, but since the male pores are always located in these characteristic furrows it seems quite likely that the spermatozoa do pass along the grooves in a copulatory transfer to the spermathecae of another worm. The grooves accordingly have been termed " seminal grooves " and a similar practice will be followed in other genera or species in which similar conditions prevail. A separate term scarcely appears to be necessary merely because prostatic and deferent duct pores are or are not distinct.

Nelloscolex strigosus, sp. nov.?

Material examined.—From the Indian Museum :

1 clitellate, macerated specimen labelled, " Dumpep, Khasi Hills, Assam. Dr. S. L. Hora ".

External characteristics.—Length 97 mm. Diameter 2 mm. Unpigmented ; clitellum reddish. Secondary annulations are lacking or unrecognizable, hence no possiblility of confusion in segmental enumeration. The prostomium is proepilobous, almost prolobous.

Setae begin on ii : *ab* and *cd* apparently about equal, *ab* possibly a trifle smaller in some regions, size of *aa* relative to *bc* variable in different regions and indeterminable on xx (ratios not accurately determinable on account of maceration). Setae *a* and *b* of xvii, *a* on the right side of vii, *b* on the right side of viii, and *a* on the left side of viii are lacking. A minute greyish marking on viii at site of seta *b* may represent a pit from which the seta has dropped out.

The first dorsal pore is probably on 8/9 though this aperture is certainly not as large as that on 9/10.

The clitellum is annular and extends from 12/13 to 16/17 ; intersegmental furrows and dorsal pores lacking, setae present.

The spermathecal pores are on 6/7-7/8, on or very slightly lateral to *a*.

The female pores are anterior and only very slightly median to *a*.

On xvii a transversely placed, anteroposteriorly short, fairly deep depression extends laterally, on each side, into *bc*, with a slightly protuberant and firm marginal rim. The posterior margin in *aa* is slightly concave anteriorly, the anterior margin also slightly concave in *aa* but posteriorly. From the anterior margin in *ab*, on each side there is a rather conspicuous protuberance into the depression. On the posterior faces of each of these protuberances there is a tiny, vertically placed seminal groove, passing from a point about at the ventral level of the body dorsally nearly to the roof of the depression. Male pores were not definitely identified, but the prostatic duct was dissected out from the

parietes on the right side, leaving a tiny aperture at the dorsal end of the seminal groove.

Internal anatomy.—None of the septa are thickly muscular ; 6/7 and several succeeding septa funnel-shaped, the apices of the funnels directed posteriorly.

The rather rounded gizzard is in vi. The intestine apparently begins in xvi(?). In xii there is a pair of large swellings laterally on the oesophagus, each hemiovoidal and with the long axis longitudinal, not quite reaching either 12/13 or 13/14. Somewhat similar but less well developed swellings are present in xi-ix, the size decreasing anteriorly. In the posterior portion of viii there may be rudiments of similar swellings.

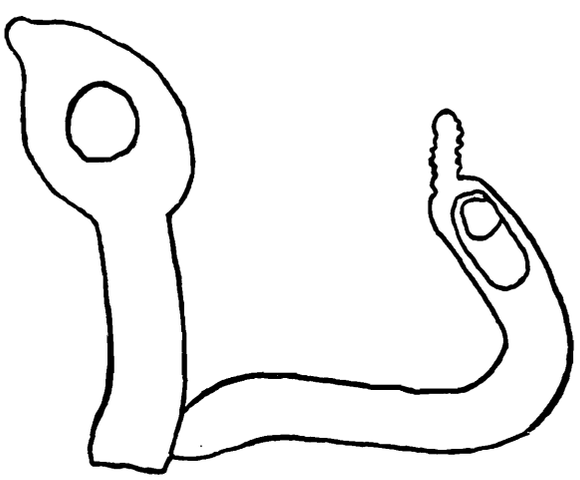
The last pair of hearts is in xii.

The male funnels are in ix and x. The seminal vesicles are small and acinous, in x and xi. The prostates are very thin, flattened against the parietes in xviii-xx, the median margin smooth, the lateral margin with deep incisions.

The duct is bent ectally into a U-shaped loop, the ental half slender, the ectal half thickened and with muscular sheen.

The ovaries are small, that on the right side containing only five mature ova. In xiv there is a pair of small ovisacs (?).

The spermathecal ampulla (text-fig. 1) is small, not much wider than the duct which may be slightly bulbous ectally. The diverticulum which passes into the duct close to the parietes is tubular and longer



TEXT-FIG. 1. Spermatheca of *Nellosoolex striyosus*, sp. nov. × *ca* 95.

than the combined lengths of duct and ampulla. One spermatheca was removed and cleared. The lumen in both duct and diverticulum is rather wide but reduced by ridges which are circular in the diverticulum and longitudinal in the duct, the ridges lacking in the entalmost portion of the diverticulum, and in the duct ectal to the diverticular junction. There is no spermatozoal iridescence but in the ental portion of the diverticulum there is a ball of opaque material, a hard sphere of transparent material imbedded in a softer opaque mass, a similar ball within the ampulla. The appendix shown at the ental end of the diverticulum in the figure presumably is an abnormality.

Remarks.—The coelomic cavities are filled with a sticky coagulum that is adherent to the body wall and to the gut. Washing out this

coagulum may have resulted in loss of nephridia. Excretory organs have not been definitely identified.

N strigosus can be distinguished at present from *N burkilli* only by characteristics of the spermathecae (greater length of the spermathecal diverticulum relative to lengths of ampulla and duct) and of the male areas on xvii. There is however some indication that the spermathecae of the type may be abnormal, while differences in the male field that appear to be striking at first glance may after all be of little if any importance or significance (possibly due to a different stage of development or manner of contraction on killing). The calciferous portion of the oesophagus of the type of *strigosus* certainly appears to be different from that of *burkilli* but requires further study on better material and more adequate characterisation.

In the closely related genus, *Tonoscolex*, characteristics of importance for specific definition are mainly of the spermathecae and the male region on xvii. *Nelloscolex* may be similar to *Tonoscolex* in this respect also, but until many more specimens have been studied, it will be of little use to attempt to determine whether variations (in particular those noted on the three types just studied) are of individual or specific value.

Nelloscolex sp.

Material examined.—From the Indian Museum :

1 clitellate, fairly well preserved specimen labelled, " Dumpep, Khasi Hills, Assam. Dr. S. L. Hora".

External characteristics.—Length 46 mm. Diameter 1½ mm. Unpigmented, clitellum light yellowish. Prostomium prolobous. There are no secondary annulations, hence no possibility of confusion in segmental enumeration. The first dorsal pore is on 8/9.

The setae begin on ii and are enlarged on the posteriormost segments ; on xx, *ab* slightly larger than *cd*, *aa* and *bc* about equal, *aa* a trifle larger than *bc*, *dd* smaller than one-half the circumference ; *a* and *b* lacking on xvii, on vii, and the left side of viii, *a* present on the right side of viii.

The clitellum is annular and extends from 12/13 to 16/17 ; intersegmental furrows and dorsal pores lacking, setae present.

The spermathecal pores are two pairs, on the anteriormost margins of vii and viii, in *ab*. Each pore is surrounded by a protuberant but small, annular lip, the protuberance with an appearance of a transversely placed porophore of elliptical outline.

The female pores are on xiii, each pore slightly anterior and median to *a*.

On xvii, on each side, there is a slightly protuberant, fairly sharply demarcated area of epidermal thickening, rather elliptical in outline, the long axis longitudinal, extending from *a* into *bc* and from 16/17 or slightly posterior to 16/17 to 17/18. On each area is a seminal groove, in line *b*, the groove nearly straight. On the midventral region between the two male pore areas the body wall may be very slightly thickened and is crossed transversely by three slight furrows. The seminal grooves reach approximately to the level of the anteriormost and posteriormost of these the slight furrows. The minute male pore is at the anterior

end of the seminal groove (confirmed by dissecting prostatic duct out of body wall, right side).

Internal anatomy.—Septum 6/7 and several succeeding septa are funnel shaped, the apices of the funnels directed posteriorly; 7/8 and the next few septa slightly strengthened.

The well developed gizzard is in vi. Calciferous pouches are represented by slight lateral swellings of the oesophagus in ix-xii and possibly also in the posterior portion of viii. The intestine begins in xiv.

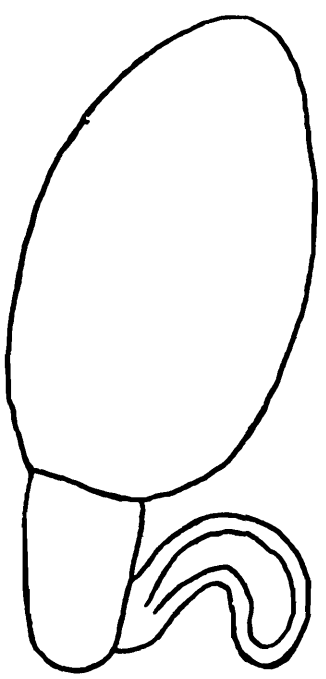
The last pair of hearts is in xii.

In segments xi-xxiii on the parietes, on each side, about in *bc*, or *cd*, there is a single, rosette-like clump or cluster of nephridial tubules. From xxiv posteriorly for several segments no nephridia are visible, but more posteriorly there are much smaller clusters, on the parietes, in the region of *cd*.

Male funnels and testes are in ix and x. The seminal vesicles are small, acinous bodies in x and xi, those of x about half the size of the vesicles of xi. The prostates are strap-shaped, extending through xviii-xxiv, the lateral (dorsal) and median (ventral) margins deeply constricted by the septa, the lateral margins with slighter marginal incisions. The duct emerges from the gland in xx and passes anteriorly almost straight into xvii where it bends mesially to pass into the parietes, gradually widened ectally and with slight muscular (?) sheen.

In xiv there is a pair of ovisacs.

The spermathecae (text-fig. 2) are in vi and viii; the ampulla large, duct short, almost confined to the parietes. The diverticulum which passes into the duct within or close to the parietes is slightly longer



TEXT-FIG. 2. Spermatheca of *Nelloscolex* sp. × *ca.* 95.

than the duct but much shorter than the ampulla, bent into a U-shaped loop, rather slenderly club-shaped, not marked off externally into stalk or seminal chamber, the lumen gradually narrowed ectally. There is no spermatozoal iridescence visible in the diverticulum.

Remarks.—This specimen is the only one examined in which the first intestinal segment could be definitely determined.

Excretory organs are not well preserved, having been imbedded in coelomic coagulum. In washing out the coagulum it is possible that some of the nephridia were flooded away.

The relative shortness of the spermathecal diverticulum, the (apparent) segmental location of the spermathecal pores and characteristics of the male field on xvii may be of sufficient value, if constant, to warrant erection of a new species. Distinction from *strigosus* is however impossible until the latter is more adequately characterized.