TWO NEW EARTHWORM GENERA *YORUBADRILUS* AND *NEMERTODRILOIDES* AND FIRST RECORD OF *MALODRILUS* MICHAELSEN, 1903 (OLIGOCHAETA: EUDRILIDAE) FROM NIGERIA

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ABSTRACT: Two new earthworm genera and species, *Yorubadrilus ogbomosoensis* and *Nemertodriloides agoiwoyeensis* from Ogbomoso and Ago-Iwoye respectively are described. Also the earthworm genus *Malodrilus* is here reported for the first time in Nigeria. *Yorubadrilus* and *Nemertodriloides* belong to the subfamily Pareudrilinae, lacking both calciferous glands and ventral oesophageal sacs, while *Malodrilus* belong to the sub-family Eudrilinae. *Yorubadrilus ogbomosoensis* is similar to the genus *Chuniodrilus* in having the same positions for their spermathecal and male pores i.e. mid-ventral in furrow 12/13 and 17/18 respectively, the pores are however, paired in *Yorubadrilus*, but single in *Chuniodrilus*. Also the spermathecae is diverticulate in *Yorubadrilus* but not in *Chuniodrilus*. The genus *Nemertodriloides* is compared with *Nemertodrilus* with which it shares spermathecal pores in 13/14 and holandric male system, however while *Nemertodriloides* has penial setae and forms ovospermatheca, *Nemertodrilus* lacks penial setae and only has an approximation of the ovarian and spermathecal systems. A new species of *Malodrilus, M. jebbaensis* was collected from Jebba, Kwara State, Middle Belt of Nigeria. Again, contrary to the earlier definition of the genus, *M. jebbaensis* sp n. possesses a pair of penial setae. This record shows that the genus *Malodrilus*, which had been earlier described as been restricted in distribution to East Africa may also have a spread towards the West African Region.

KEY WORDS: Earthworm, *Malodrilus jebbaensis*, *Yorubadrilus ogbomosoensis*, *Nemertodriloides agoiwoyeensis*, Eudrilidae, Pareudrilinae

There has been an intensive work on the eudrilid earthworms of Nigeria. Several workers, (Kinberg, 1866; Beddard, 1890, 1891, 1893, 1897; Michaelsen, 1892, 1910, 1937, 1915; Sims, 1971; Segun, 1976a,b, 1977, 1978, 1980; and Owa, 1992, 1993, 1994a,b,c, 1995a,b, 1996a,b,c, 1997, 1998a,b) have described, recorded and reported about twenty genera and more species from Nigeria. The present collections include two genera that new to science and one other which is being reported for the first time from Nigeria.

The genus *Malodrilus* was erected by Michaelsen, with *M. neumanni* Michaelsen, 1903 being the type species. He also described *M. buaraensis* Michaelsen, 1938 and *M. gardullaensis* Michaelsen, 1903. The present record is, however, the first from Nigeria.

The two other genera, *Yorubadrilus* and *Nemertodriloides* described here are new to science and were collected during a regional survey of the southwestern part of Nigeria.

MATERIALS AND METHODS

The earthworm samples used for this work were from Okada (Edo State), Jebba (Kwara State), Ogbomoso (Oyo State) and Ago-Iwoye (Ogun State) all in

Nigeria, during a sampling study of earthworm diversity and abundance in southwestern Nigeria.

Earthworms were collected using digging and hand sorting method (Reynolds, 1977; Owa, 1992) which allowed determination of soil volume with little loss of worms which may migrate in other directions when the alternative chemical extraction methods are employed. Soil-blocks, 30 cm deep were dug, below which earthworms are not normally found, were dug. The soil block was placed on wooden sorting trays; the soil was broken loose to expose the earthworms, which due to the light are betrayed by their movements, and were picked up. Collecting or digging the soil in blocks helped reduce damage to the earthworms during digging. The earthworms were killed and preserved in formo-acetic-alcohol (F.A.A).

RESULTS AND DISCUSSION

Three earthworm species belonging to two (2) new genera and one (1) genus being reported for the first time from West Africa are here described. The taxonomic description and remarks with relation to earlier existing taxa are also provided.

Yorubadrilus ogbomosoensis gen. *nov.*

Type Locality: Ogbomoso, Southwestern, Nigeria (8°07'N, 4°14'E). The specimens were collected from a marshy terrain along the Ogbomoso end of the Oyo-Ogbomoso Highway. There were signs of logging for bamboo trees around the collection area.

Material: Eight individuals, five clitellates and 3 aclitellates, were collected.

Type material: The type material is reposited at the British Museum of Natural History. The syntype is deposited at the Natural History Museum, Olabisi Onabanjo University, Ago-Iwoye.

External Diagnosis

The prostomium is epilobous. The mean length is 105 mm (101-112 mm); the mean diameter at the pre-clitellar region is 2.5 mm; the mean number of segments is 184 (182-188). Setae arrangement lumbricine; setae is simple and pointed. Dorsal pores are absent.

The clitellum is annular, covering 4 segments (XV-XVIII); normal eudriline character. The worm is not heavily pigmented, however, the pre-clitellar region is brownish, clitellar region is pinkish, while towards the posterior end the colouration tends towards dark grey.

There is a pair of male pores, located in furrow 17/18, embedded in a tumid fossa and is mediad to **aa.** The spermathecal pores are paired ventrally, on a raised papilla, in 12/13 furrow and is position in line **aa** (Fig. 1). The female pores not easily seen externally but internally are located in segment XV in **cd.**

Internal Diagnosis

Intestinal characters: The intestine begins at segment XV. There is an oesophageal gizzard which extends over segments V and VI; intestinal gizzard are lacking. The content of the intestine was fine sand and tiny organic crumbles, which shows the worm is likely limnic. Calciferous glands and ventral oesophageal pouches are absent. Intestinal caeca and typhlosole are also lacking.

Blood vessels: The last heart is in segment XI. Subneural vessel is present but supraoesophageal blood vessel is absent.

Male system: The testes are naked, holandric. Two pairs seminal vesicles present, and in segments XI and XII. A pair of thin slender penial setae is present. The penial setae are the coiled type and lacks ornamentation. There is a central pouch (lumen) in segment XVII to which the penial setae sac and euprostates take root. Euprostate is tubular, with central lumen (Fig. 2); its pore is united internally with the male pore in furrow 17/18.
Ovarian system: The ovarian system is closely associated with the spermathecal system but does not form ovospermathecae. The paired ovary is fused with the spermathecal diverticula (Fig. 2) and is located and opens in segment XV.
Spermathecal system: There is a single, diverticulated spermatheca, which is iridodriloid. The diverticulae are large and conspicuous and project from both sides of the spermatheca. The spermathecal atrium is muscular and thick. The spermathecal receptaculum is unpaired and is slightly constricted towards the end.
Excretory system: The excretory system is holonephridial and consistently megenephridial along the length of the species.
Remarks: The genus *Yorubadrilus* belongs to the subfamily Pareudrilinae in lacking the characteristic ventral oesophageal sacs (VOS) and calciferous glands. The genus shares a few similarities with the genus *Chuniodrilus*. Though the locations of their spermathecal and male pores are the same, i.e. located mid-ventral in furrow 12/13 and 17/18 respectively, the pores are however, paired in *Yorubadrilus* but single in *Chuniodrilus*. However, while the spermatheca is diverticulated in *Yorubadrilus* it is adiverticulated in *Chuniodrilus*. Also, while gizzards are intestinal in *Chuniodrilus,* gizzard is oesophageal in *Yorubadrilus*. The only other eudrilines (*Eminoscolex* and *Vomia*) sharing the features of the new genus (*Yorubadrilus*) are members of the sub-family Eudrilinae, having calciferous glands and ventral oesophageal sacs which are lacking in *Yorubadrilus*.
Etymology: The genus *Yorubadrilus* is named after the Yoruba speaking people of southwestern Nigeria, the study area from which the genus was collected; while the species is named after Ogbomoso, its type locality.

Nemertodriloides agoiwoyensis gen. et sp. nov.

Type locality: Ago-Iwoye, Ogun State, Nigeria (6°90'N, 3°92'E).
Material: Three clitellate and 1 juvenile specimen were collected.
Type material: The type material is reposited at the British Museum of Natural History. The syntype is deposited at the Natural History Museum, Olabisi Onabanjo University, Ago-Iwoye.
External diagnosis

Prostomium is epilobous. Dorsal pores are absent. This species lacks pigmentation. Mean number of segments is 120 (80-156); mean length is 35mm (27-45mm). Setal arrangement is lumbricine; **ab=cd**. The clitellum is annular and covers 4 segments (X-XIII).

There is a mid-ventral, single male pore in XVII. Prostatic pores not visible externally but internally are united with male pores. Spermathecal pore is single, located in furrow 13/14 and in line **ab** (Fig. 3)**.** Female pore is single located in segment XIV on blister-like papilla, and is mediad to **ab.**
Internal diagnosis
Intestinal characters: Only oesophageal gizzard is present and is located in segment VI. Calciferous glands and ventral oesophageal sacs are absent. The

intestine begins in segment XIV. Typhlosoles are absent. No intestinal caeca were found.

Blood vessels: Suproeasophageal blood vessel absent; subneural and dorsal blood vessels are present. Last heart is in segment XI.

Male system: Testes is holandric and enclosed in relatively large sacs. There are two pairs of large and conspicuous seminal vesicles in segments XI and XII. The vasa deferentia are equally conspicuous and large, while the left and right converge to single male pore. The euprostates are tubular and curved to form sickle-shape (Fig. 4). There is a pair of penial setae, which are simple and pointed, they lack ornamentation.

Ovospermathecal system: Ovarian system intimate with a single spermathecal system forming ovospermatheca. Ovaries are sacculate, located in segment XIV and opening in the same segment. The ovospermathecal forms a ring around the gut (Fig. 4).

Remarks: The earthworm *Nermatodriloides eyinwaensis* is placed in the family Eudrilidae, since it shows a close approximation of the spermatheca to the ovarian system, forming ovospermatheca; and subfamily Pareudrilinae, since it lacks both ventral oesophageal sac and calciferous glands.

There are a few similarities between *Nemertodriloides* and its nearest neighbour, *Nemertodrilus*.

(a) Both genera have the spermathecal pores located in furrow 13/14

(b) They are also both holandric.

However, the arrangement of the ovospermatheca is quite different in them. In *Nemertodrilus* there is an approximation of the ovarian system to the spermatheca (Beddard, 1891), however, in *Nemertodriloides* the ovarian system are closely intimate with the spermathecal system; thus while *Nemertodrilus* does not form ovospermatheca, *Nemertodriloides* does. *Nemertodiloides* also has penial setae which are lacking in *Nemertodrilus*.

Etymology: The species is named after the type locality, Ago-Iwoye, while the genus is named after the genus *Nemertodrilus*; thus the name *Nemertodriloides agoiwoyensis*.

***Malodrilus jebbaensis* sp. *nov*.**

Type locality: Jebba, Kwara State in the Middle Belt of Nigeria. The town is on the bank of the River Niger. The samples of *Malodrilus jebbaensis* were collected along a terrain flooded by the River Niger during the raining season, but was relative well drained during the sampling period.

Material: 3 adult and 1 juvenile specimens were collected.

Type material: The holotype is reposited at the British Museum of Natural History. Syntype is deposited at the Natural History Museum, Olabisi Onabanjo University, Ago-Iwoye, Nigeria.

External Diagnosis

The prostomium is prolobous. The mean length is 104mm; mean widest diameter at the pre-clitellar regions is 3.0 mm; mean number of segments is 208 (198-218). The setal arrangement is lumbricine. Setal distance **ab>cd**.

The clitellum is annular, covers segments XIII-XVI (i.e. 4 segments, eudriline character). There is no dorso-ventral flattening at the posterior end. The dorsum is coffee brown in colour, venter is lighter. There is more pigmentation anteriorly than posteriorly, thus it is darker anteriorly than posteriorly.

Male pores are paired, located in furrow 17/18 and mediad to **aa.** The spermathecal pores are also paired, located in furrow 14/15 (Fig. 5), combine internally with the female pore and mediad to **aa.** A pair penial setae present.

Internal Characters

The intestine begins at segment XI. There is a gizzard in segment V; none in the intestinal region. A pair of calciferous glands is in segment XII. Three ventral oesophageal sacs are present in the characteristic segments IX-XI. Supraoesophageal blood vessel is absent but subneural canal is present. Last heart is in segment XII. The male system is holandric, testes are enclosed in sac. Euprostate are tubular and cover several segments. Prostate confluence with male pore. The ovary is enclosed in sac, located in segment XIV and combined with the spermatheca to form an ovospermathecal system (figure 6), opening in 14/15 furrow. The spermathecae is paired and adiverticula. Spermathecal receptacula paired, each combined with the ovary and ovisac of its side. The excretory apparatus is holonephridial and meganephridial.

Remarks: The genus *Malodrilus* has been compared variously with *Eudrilus* and *Eminoscolex* (Table 2).

Members of the genus which have been earlier described are *M. neumanni* Michaelsen, 1903 (Type species); *M. buaraensis* Michaelsen, 1938; *M. gardullaensis* Michaelsen, 1903.

One feature in *M. jebbaensis* which is atyipical with the genus *Malodrilus* is the presence of penial setae in the former. Though possession of penial setae is atypical of the genus, creating a new genus for *M. jebbaensis* may insinuate splitting, since all other features are in consonance with the definition of *Malodrilus*. A cue is taken from the typical population of *Iridodrilus roseus* which lacks penial setae a feature present in all other members of the genus *Iridodrilus*. Yet even then a Middle Belt population of *I. roseus* has been reported as possessing reduced penial setae (Owa, 1994). In a similar manner even the widely distributed *Polytoreutus* which in East and Central African populations lack penial setae, has been found in West African populations to possess paired penial setae (Owa, 1998). This has led to describing the West African populations under synonyms as *Agrotoreutus*, *Parapolytoreutus* and *Digitodrilus* (Segun, 1976, 1980). It is becoming clearer that the possession of penial setae could be an ecophenotypic character in certain genera.

Relationship between *Eudrilus*, *Malodrilus* and *Eminoscolex*:

It is doubtful if a separation of these three is not artificial. From Table 2, *Malodrilus* with ovospermathecal pores located on 14/15 furrow is distinct from *Eudrilus* only by the location of the ovospermathecal pores in 13/14. The single segment difference between them may have resulted from embryological processes as the ovary is constant in segment XIII (characteristic of the Eudrilidae) but opening in segment XIV.

Spermathecal mobility seems to be a feature of many Eudrilidae. If the mobile spermathecae fuse with corresponding oviducts in segment XIV, *Malodrilus*, results as the stronger spermathecal duct is superposed on the feebler, sometime atrophied, oviduct. Similarly, if the mobile spermathecae fuses with ovarian system in segment XIII, the dominant spermathecal duct captures the atrophied oviduct, resulting in the common ovospermathecal duct in XIII or 13/14, i.e. *Eudrilus*. In the third scenario, the mobile spermatheca is located in segment XII, tangentially fused with the ovarian system in segment XIII, but the spermathecal duct unable to capture the oviduct. This results in the separation of the oviduct from the spermathecal duct, as in *Eminoscolex*.

The possibility of congenicity of *Eudrilus*, *Malodrilus* and *Eminoscolex* will thus explain their similarities in a few other ways:

a) All three have the diagnostic coffee brown colouration, due to heavy melanin pigmentation;
b) All three have similar size range; and
c) Behaviourally, all three produce granular cast of similar particle size range.

Thus very probably, the three are congeneric.

Differences between *Malodrilus*, *Eudrilus*, *Eminoscolex*

Malodrilus is clearly distinct from the other two congeners by the positions of its calciferous glands (segment XII) and spermathecal pores (furrow 14/15). However, like *Eudrilus*, the ovarian and spermathecal systems of *Malodrilus* are combined and share a common pore. But in *Eminoscolex* the spermathecal and ovarian systems are distinctly separate though linked and the left and right spermathecal systems are connected by a circumoesophageal tubular ampulla (receptaculum seminis) which are lacking in Eudrilus and Malodrilus, since the spermatheca on both sides of their bodies are not interconnected.

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Table 1. Geographic and edaphic features of the type localities of the described earthworms.

Feature	Jebba, Kwara State	Okada, Edo State	Ogbomoso, Oyo State	Ago-Iwoye, Ogun State
Location	9°12'N, 4°83'E	6° 43'N, 5° 23'E	8° 07'N, 4° 14'E	6.90 3.92
*Altitude	76	76	458	76
MARF (mm)	1143	1397	1397	1779
NRD	90	170	110	110
MAT (°C)	27°C	26°C	26°C	26
MAMT (°C)	34°C	31°C	31°C	31
Vegetation	Guinea Savanna	Secondary and moist lowland forest	Secondary forest	Secondary forest
Soil class.	Hydromorphic and alluvial soil	Ferralsols: Red-Yellow	Ferruginous tropical soils on crystalline acid rocks	Ferralsols: Red-Yellow
Soil text.	Silt	loamy sand	Sandy loam	Sandy loam

Keys:
* in metre above sea level
MARF: Mean annual rainfall.
NRD: Number of rainy days.
MAT: Mean annual temperature.
MAMT: Mean annual maximum temperature.
Soil class: Soil classification.
Soil text: Soil textural type.

Table 2: Differences among the three genera *Malodrilus*, *Eudrilus*, *Eminoscolex*.

Feature	***Malodrilus***	***Eudrilus***	***Eminoscolex***
Calciferous gland	*XII*	*XIII*	*XIII*
Spermathecal pores	*In furrow 14/15*	*In furrow 13/14*	*In furrow 12/13*
Spermathecae in relation to female apparatus	*Combined*	*Combined*	*Separate*
Circumoesophageal receptaculum	*Absent*	*Absent*	*Present*

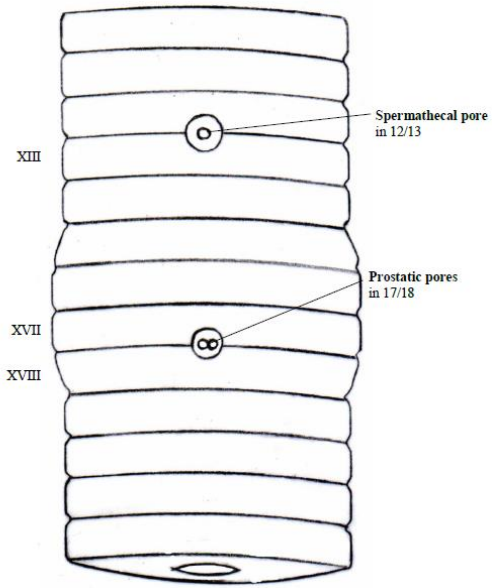

Figure 1. External diagnostic features of *Yorubadrilus ogbomosoensis*.

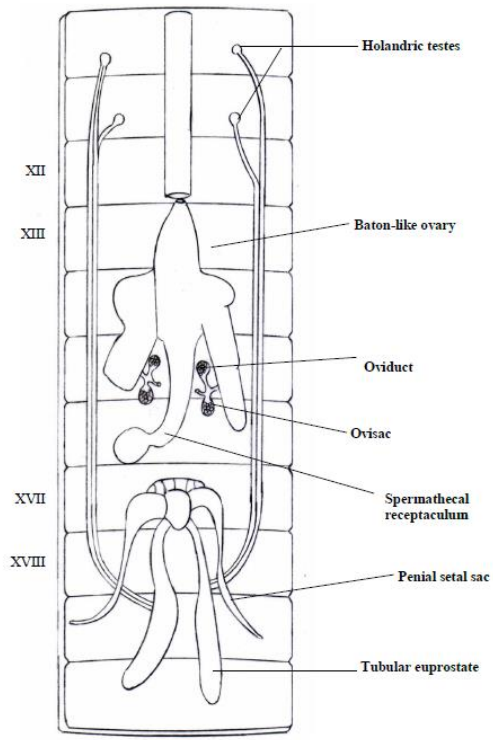

Figure 2. Internal diagnostic features of *Yorubadrilus ogbomosoensis*.

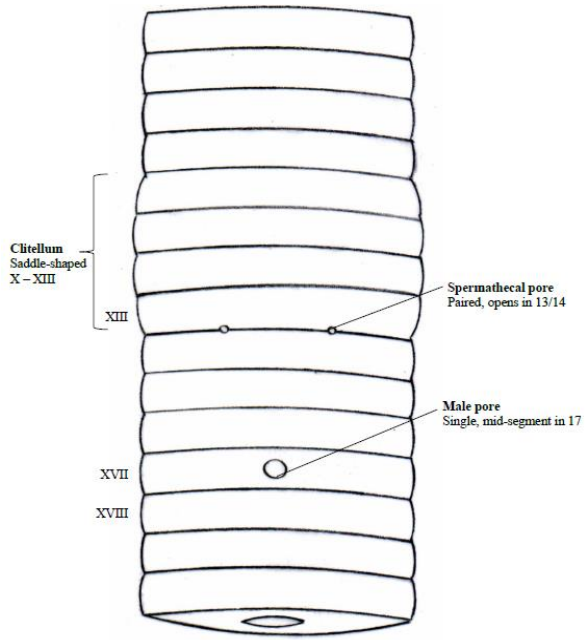

Figure 3. External diagnostic features of *Nemertodriloides iwoyensis*.

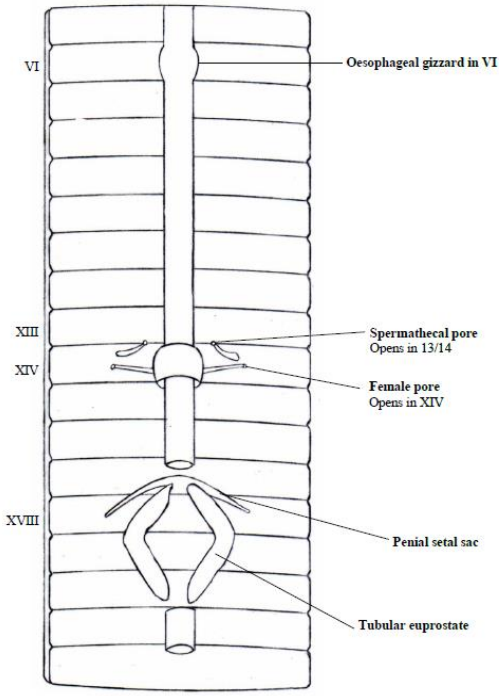

Figure 4. Internal diagnostic features of *Nemertodriloides iwoyensis*.

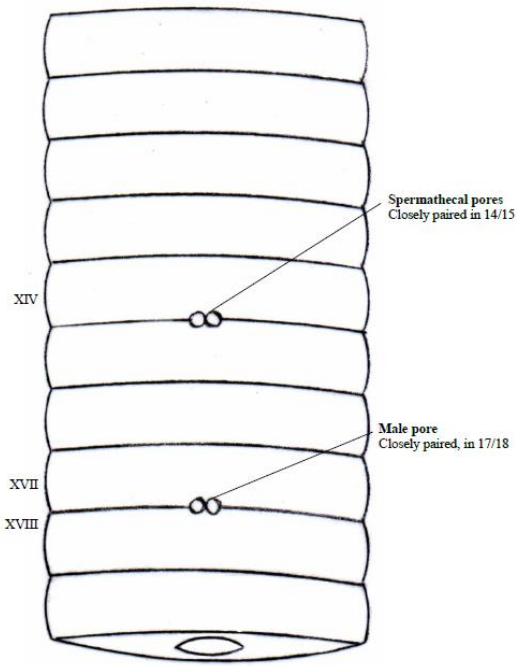

Figure 5. External diagnostic features of *Malodrilus jebbaensis*.

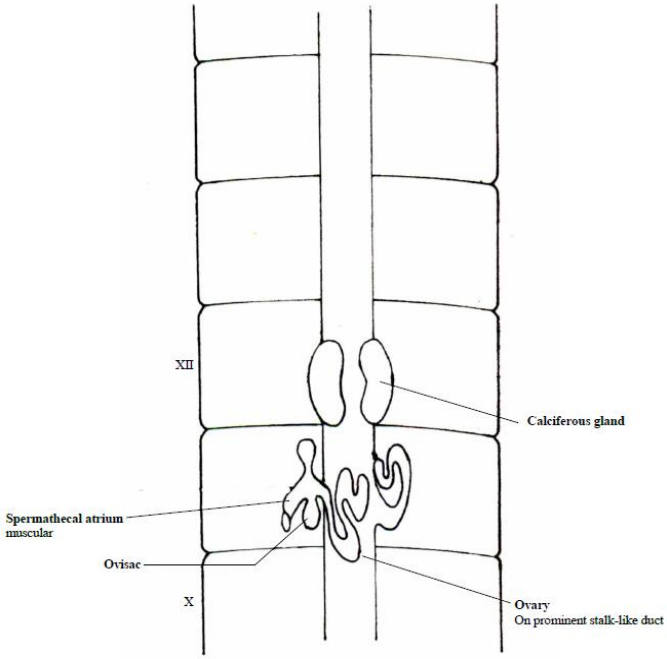

Figure 6. Internal diagnostic features of *Malodrilus jebbaensis*.