Descriptions of two new earthworm species, *Iridodrilus abujaensis* and *Iridodrilus furcothecata* (Eudrilidae: Oligochaeta: Annelida) from Nigeria

S.O. Owa
Department of Biological Sciences, Ogun State University, Ago Iwoye, Nigeria

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Two new eudriline earthworm species, *Iridodrilus abujaensis* and *Iridodrilus furcothecata* are described from collections made around the Federal Capital Territory and Wukari, Nigeria. They are distinguished by the forms of their external papillae, seminal vesicles, ovospermathecal systems and other characters.

Twee nuwe erdwurmspesies van die Eudrilidae, nl. *Iridodrilus abujaensis* en *Iridodrilus furcothecata*, wat in die Federal Capital Territory en Wukari in Nigerië versamel is, word beskryf. Hulle is uitkenbaar aan die vorm van hul uitwendige papille, seminale vesikels, ovospermatekale stelsels en ander eienskappe.

Earthworm collection trips were made to many parts of Nigeria including the Federal Capital Territory and Wukari during the rainy seasons of 1986–88. Some of the earthworms collected were found to be new to science and are described here as new species, *Iridodrilus abujaensis* and *Iridodrilus furcothecata*.

With the rich collection of diverse *Iridodrilus* species the anatomy and diagnostic features of the genus have become clearer. As a result, Owa (1994,) redescribed the type species, *I. roseus* Beddard, 1897, and argued against the dissolution of the genus *Iridodrilus* Beddard, and against the transfer (Sims, 1985, 1987) of *I. roseus* to the genus *Heliodrilus* Beddard. Owa (1994) further argued for the retention of the genera *Heliodrilus* and *Iridodrilus sensu* Beddard with some modification of their diagnoses which were also restated. As that paper is comprehensive enough it will not be necessary to repeat the arguments here.

Method

The earthworms were collected by digging and handsorting from farmlands. Digging was done to a depth of about 30 cm as earthworms were not normally found below that depth. The specimens collected were preserved in formo-acetic alcohol (F.A.A.) which was renewed during the first 24, and 48 or 72 h. Further renewal of preservative was made if murkiness developed in the specimen bottles indicating deterioration. The specimens were studied under a dissecting microscope and dissected using micro-dissection instruments.

Taxonomy

***Iridodrilus abujaensis* n.sp.**
(Figures 1–4, Tables 1–2)

Type locality: Abuja and the Federal Capital Territory of Nigeria. Some geographic and ecologic data relating to that zone are shown in Table 1.

Materials: One clitellate and 10 aclitellate specimens were collected from Suleja, 17 clitellate and 21 aclitellate specimens from Daku. The Daku specimens were from a clayey and marshy farmland on the bank of the River Tapa at Daku. Five clitellate and 10 aclitellate specimens were collected from Burara, and three aclitellate specimens from Abuja. All these locations are within or close to the Federal Capital Territory. The holotype and four syntypes are deposited at the Natural History Museum, Obafemi Awolowo University, Ile-Ife, Nigeria. Other syntypes are kept in the author's laboratory.

Table 1 Some geographic and ecologic data relating to Abuja, the type locality for *Iridodrilus abujaensis* n. sp.

Latitude	9° 0′ N
Longitude	7° 9′ E
Altitude above the sea level	229 m
Mean annual rainfall	1397 mm
Mean number of raindays	110
Mean annual temperature	27°C
Mean annual maximum temperature	32°C
Vegetational Zone	deciduous savanna
Soil classification (F.A.O)	ferruginous tropical soil on crystalline acid rock (U.S.D.A.: ultisol)
Soil texture	sandy loam

Data from Barbour *et al.* (1982).

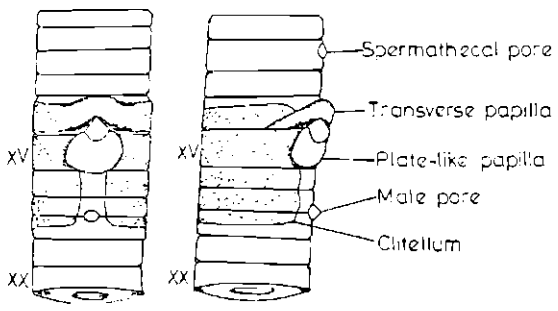

Figure 1 *Iridodrilus abujaensis* sp. n. The clitellar region.

Description

External characters (Figure 1)

The mean length of the specimens is 141,0 ± 1,4 mm, range 130–160 mm. The mean widest diameter, at the preclitellar

region is 5,2 ± 0,3 mm, range 5,0–5,5 mm. The mean number of segments is 182 ± 6, range 174–188. The segments are triannulate.

The prostomium is epilobous.

The body colour is creamy white. The skin is not translucent; viscera are not visible through the skin. There is little difference in colouration between the anterior and posterior regions, or between the ventral and the dorsal sides. The clitellum is pink when fully formed.

The setal arrangement is eudriline. Setae *a* and *b* are widely paired, *c* and *b* closely paired (i.e. setal distance *ab* > *cd*.

The clitellum (Figure 1) is saddle-shaped. The lower border reaches as low as setal line *a*.

The male pore is unpaired, midventral on a low, broad, conical papilla in 17/18 intersegmental furrow.

The female pores are inconspicuous but traced internally to the equator of segment XIV, and between setal lines *c* and *d*.

The spermathecal pore, although not externally open, is indicated by a low tumid papilla in the anterior portion of segment XII.

The papilla system (apart from those described above) consists of two components. The midventral but transversely oriented papilla within setal lines *aa* is in segment XIV. The second is tablet-shaped within *bb*, having an anterior-pointed apex that leans against the transverse papilla (Figure 1). Paired papillae are absent. Segments XIII and XVI are excluded from the papillar system.

The nephridiopores are paired near the anterior borders of segments, just behind the intersegmental furrows, between setal lines *c* and *d*, from segment III backwards.

Dorsal pores are absent.

Internal characters

The first few septa 4/5 – 10/11 are thick, muscular and concave to the front. Septa 11/12 – 13/14 are thin. Others are membranous.

The alimentary system is a straight tube. The pharynx, in segments II–IV, is suspended by thick protractor and retractor muscles. An unpaired ventral oesophageal sac occurs in each of segments X and XI (none in IX). A pair of dorsolateral oesophageal ('calciferous') glands occurs in segment XII, (not XIII). The intestine begins in segment XIV. Four intestinal gizzards occur in segments XIX–XXII. Typhlosole and chloragogens are absent.

Tubular lateral hearts exist in segments VII–XI and XIII, but not observed in segment XII.

The male reproductive system is holandric, with a pair of testes in testes sacs in each of segments X and XI. The testes sacs are matchet-shaped and are occluded by the ventral oesophageal sacs. Emanating from the testes sacs, the anterior and posterior vasa deferentia meet in segment XII and pass contiguously backwards to segments XVIII. They then pass laterally along about a third of the length of the corresponding euprostate glands before penetrating the glands. Euprostate glands are tubular, finger-like, traversing as far back as segment XXVI in spite of their looping and coiling (Figure 4). There is a pair of seminal vesicles in each of segments XI and XII. In the specimens dissected each

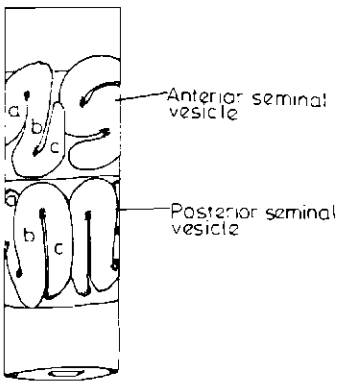

Figure 2 *Iridodrilus abujaensis* sp. n. The seminal vesicles on the gut; a, b, c, are continuous loops of the vesicles.

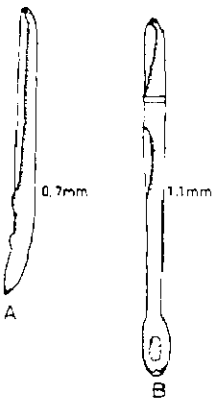

Figure 3 (**A**) *Iridodrilus abujaensis* and (**B**) *Iridodrilus furcothecata* spp. n. The penial setae.

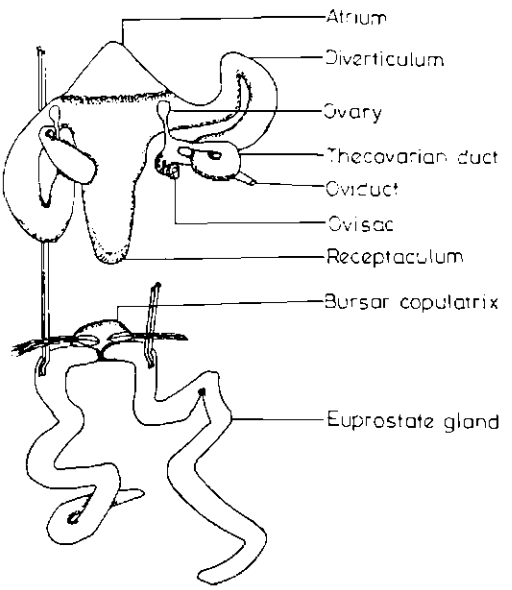

Figure 4 *Iridodrilus abujaensis* sp. n. Ovospermathecal and posterior male systems.

seminal vesicle is longer than its segment and yet did not traverse many segments. It is therefore looped twice to form a z-shape (Figure 2). The anterior and the posterior seminal

vesicles are similar in size.

Two pairs of slender iridodrilid penial setae, (Figure 3A) occur at the anterior border of the euprostate glands, buried in the bursa copulatrix. The two on either side are enclosed in separate penial setal sacs which are, however, controlled by a common retractor muscle, inserted on the body wall in segment XVII.

A bursa copulatrix is present in addition to the penial setae. It is responsible for the boss-like papilla of 17/18 intersegmental furrow.

The ovospermathecal system is iridodrilid. The spermathecal pore in segment XII opens into a triangular spermathecal atrium which is continuous with a thicker bellow-like and elongated spermathecal receptaculum (Figure 4). In segment XIII the receptaculum gives off a pair of tubular diverticula which are reflexed on themselves and are longitudinal in orientation. The apex of each diverticulum narrows abruptly to form a thecovarian duct that is generally coiled and looped before connecting with the fertilization chamber.

The ovaries, in membranous ovarian sacs, are paired, oval in shape, amd are connected by rather thick ovarian ducts to the fertilization chambers. Oviducts issuing from the latter pass posterio-laterad to open at the female pores in segment XIV between setal lines *c* and *d*.

Excretory system is metanephric, exonephric and holonephric. The first pair of nephridia occurs in segment III. Nephridia in the clitellar region are similar to the others.

Remarks

(i) *Significant intraspecific variation*. The specimens from Suleja have three distinct intestinal gizzards which on careful septal analysis occupy four segments, i.e. two gizzards may have fused. The Daku specimens bear four distinct gizzards occupying four segments. They are otherwise similar in other characters.

(ii) *Differential diagnosis*. The presence of a bursa copulatrix in *I. abujaensis* sp. n. is a character shared with *I. roseus* as re-described, (Owa 1994). But in *I. roseus*, unlike in *I. abujaensis*, penial setae are rarely present. *I. abujaensis* is thus the first *Iridodrilus* species described that regularly bears both sperm intromittent organs. In the new species the penial setae are buried in the bursa. The papillae of *I. abujaensis* differentiate it from its other congeners. Other comparisons with the other congeners are shown in Table 2.

Etymology. The new species is named after its type locality Abuja.

***Iridodrilus furcothecata* sp. n.**
(Figures 3, 5–7)

Type locality: Wukari, a town in the southern part of Gongola state of Nigeria. Wukari is in the guinea savanna,in the middle belt of Nigeria, latitude 7,8° N, longitude 9,8° E, altitude 230 m above sea level, mean annual rainfall 1143 cm, mean number of rain days 70, mean annual temperature 27° C and mean maximum temperature 33°C.

Materials: Seven adult and 21 immature specimens were collected from fallow farmland and from under mango trees on 10 October 1985. The holotype and a syntype are deposited in the Natural History Museum, Obafemi Awolowo University, Ile-Ife, Nigeria (formerly University of Ife).

Description

External characters (Figure 5)

The mean length of the earthworms is 105 ± 30 mm. The mean widest diameter (at clitellar region) is 2,5 ± 1 mm. The number of segments is 146 ± 9. The longest length of segment occurs in preclitellar region around segment X. No segmental secondary annulation.

The prostomium is epilobous.

The colour of the specimens, preserved in preservative, is light grey to cream colour. The blood vessels are visible through the body.

Setae *a* and *b* are widely paired, *c* and *d* closely paired;

Table 2 Discrimination table for *Iridodrilus* species that most closely resemble *I. abujaensis* n. sp.

Character	*I. codon.*	*I. condyl.*	*I. abins.*	*I. abujaensis*	*I. furcothecata*
Length (mm)	70–80	60–80	90–125	130–160	75–144
Widest diameter (mm)	3–4	3–3,5	3,5–4,0	5,0–5,5	1,5–3,5
No. of segments	89–155	91–96	111–172	174–180	137–154
Body colouration	pale brown	pale yellow	light grey	cream white	light grey
Skin translucence	translucent	translucent	fairly opaque	opaque	translucent
Lowest clitellar margins	*d*	*b*	*a*	*a*	*ab*
Some components of the papillae system	paired components	knob and plate	crescent and plate	crescent and plate	one pair
External spermathecal pore in	XII	11/12	XII	XII	XII
Intestinal gizzards	XIX–XXII (4)	XVIII–XX (3)	XX–XXII (3)	XIX–XXI (4)	XIX–XXI (3)
Spermathecal atrium begins in segment:	X	XII	XII	XII	XII
Spermathecal receptaculum	elongated	oblong	transverse	elongated	confined
Receptacular diverticulum	tubular, not reflexed	baggy, reflexed	baggy, reflexed	tubular looped	like furcae
Bursa copulatrix	absent	absent	absent	present	absent

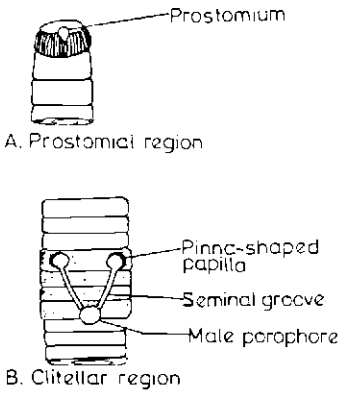

Figure 5 *Iridodrilus furcothecata* sp. n. External diagnostic features: (**A**) prostomial end and (**B**) clitellar region.

ab > *cd*; *ad* = ½*c*.

The clitellum is annular, affecting ½XII – ½XVI. Clitellum is wider than the neighboring segments. Ventrally and dorsally intersegmental grooves are fairly distinct in the clitellar region.

The paired female pores are inconspicuous but traced internally to midsegment XIV.

The spermathecal pore is on a low papilla in the second half of segment XII, just in front of 12/13 septum.

The male pore is single in 17/18 intersegmental furrow; it is located in a shallow crater-like depression in the centre of an atoll-like papilla. From the male pore a pair of divergent, V-shaped seminar grooves passes forwards to a pair of papillae that occurs between setal lines *ab* in segment XIV.

Nephridiopores exist between setal lines *cd* on anterior end of segments, just behind intersegmental furrows, from segment V backwards.

Dorsal pores are absent.

Only the papillae on segment XIV are paired; those and the male papillae in 17/18 intersegmental furrow are the only papillae on the body.

Accessory copulatory pouches are absent.

Internal characters

The first septum is 4/5. Septa 6/7 – 9/10 are thick, muscular and concave forward. Septa 10/11 and 11/12 are less thick, less muscular and concave forward. Others are membranous and transverse.

The buccal cavity occupies segments I–II. The pharynx in III–VI is well supported by dilator muscles. Oesophageal gizzard is absent. An unpaired ventral oesophageal sac occurs in each of segments X–XI (= 2). Dorsolateral oesophageal sacs ('Calciferous glands') are paired in segment XII. The oesophagus and intestine are narrow in segments X–XVI. The intestine begins in segment XVI, widens and continues backward without typhlosole or chloragogenous cells. Three intestinal gizzards exist in segment XIX–XXI.

Blood flows forward in the dorsal blood vessel which passes along the dorsal surface of the gut. The junction between this dorsal vessel and each of its segmental para-enteric branches is characteristic (Figure 6): there is a small oval vascular bulb which is longitudinal in orientation; the para-enteric vessel issues from the posterior end of the bulb,

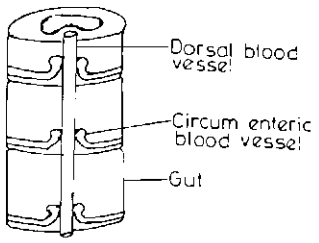

Figure 6 *Iridodrilus furcothecata* sp. n. Blood vascular branches.

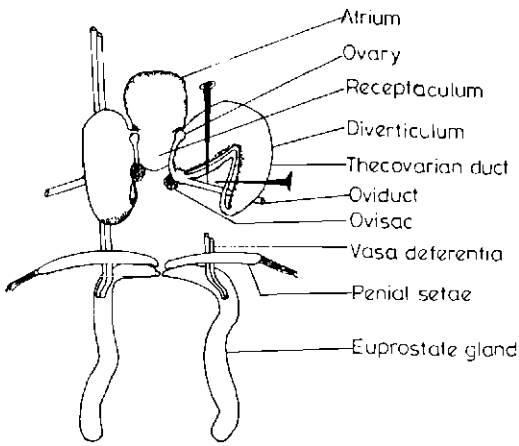

Figure 7 *Iridodrilus furcothecata* sp. n. Gonadal diagnostic features. The right side of the spermatheca is displayed.

passes diagonally backward and laterad, and surrounds the gut at the posterior quarter of the segment, close to the intersegmental septum. Only one pair of circumenteric blood vessels exists per segment. Prominent, tubular lateral hearts occur in each of segments VII–X. None was observed in XI. The more posterior lateral hearts in segments XII–XIV are smallish and sacculate.

The male system is holandric. The anterior pair of testes in segment X and the posterior pair in XI are on the anterior faces of septa 10/11 and 11/12 respectively, close to the ventral parieta. They are smallish and enclosed in testes sacs. The anterior seminal vesicles arise in segment XI but extend to segment XII as cream-white, flattish, elongate structures without intersegmental grooves. The posterior seminal vesicles arising in segment XII, extend to segment XV as white, cream-coloured, flattish, elongate structures with definite but shallow (non-moniliform) intersegmental grooves. From the testes on either side, a pair of vasa deferentia arises which meets in segment XII and passes contiguously as twin ducts under the oviduct and to the corresponding euprostate glands in segment XVII. The vasa deferentia run along a quarter of the length of the euprostate before penetrating the gland. The paired euprostate glands are tubular and of almost uniform diameter. Intersegmental grooves on the euprostate are shallow; the glands are not moniliform. In segment XVIII they converge medially to the male pore at 17/18 intersegmental furrow. Euprostate glands reach from segment XVIII to XXVI.

Two pairs of penial setae (Figure 3B) occur in the anterior borders of the euprostate glands. Enclosed in setal

sacs which are controlled by retractor muscles that originate from 18/19 furrow, the penial setae are arrowhead-shaped, with permanently rolled edges.

The ovospermathecal system (Figure 7) is of the typical iridodrilid type. The spermathecal pore opens to a somewhat dorso-ventrally compressed, parabolic atrium of segment XII which communicates with the receptaculum in segment XIII. The receptaculum is transversely oriented, inextensive but confined to segment XIII. The receptaculum is on the ventral parieta. The paired iridodrilid receptacular diverticula arise towards the posterior end of the receptaculum, thus appearing like posterior bifurcae. But the homology with the diverticula is seen in the sharp narrowing of the diverticula apices into thecovarian ducts that run ventrad along the diverticula to the fertilization chambers. Thus the spermatheca is inverted Y-shaped. The ovaries are located in the anterior borders of the margins between the atrio-receptaculum and its diverticula. A pair of fine, relatively long stalk-like ovarian ducts connects the ovaries to the paired fertilization chambers which are located on the posterior end of the margin, close to the ventral parieta. These ovarian ducts do not meet below the atrium. The fertilization chambers are connected by short ducts to the ovisacs where fertilized eggs are stored. From the chambers the oviducts pass latero-posteriad to open out as female pores between setal lines *c* and *d* in mid-segment XIV.

Excretion is by holonephric, exonephric, metanephridia. Nephridia in the gonadal region are similar to others.

Differential diagnosis

Discrimination of *Iridodrilus furcothecata* n. sp. against other existing species is shown in Table 2.

Etymology

The specific name *furcothecata* derives from the furca-like nature of the spermathecal diverticula.

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