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Four new earthworm species from the highlands of Cameroon with description of a new genus *Okudrilus* gen. n. (Oligochaeta: Eudrilidae & Acanthodrilidae)

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ABSTRACT

Examining a small collection of earthworms from the highlands of Cameroon resulted in clarifying the taxonomic status of *Eminoscolex franzi* Zicsi & Csuzdi, 1986 stat. n. and discovering a new eudrilid genus *Okudrilus* gen. n. containing three new species: *O. monticolus, O. sulcatus* and O. *nyosensis* spp. n. The new genus is similar to *Metascolex* Michaelsen, 1903; however, it differs from it in the position of the gizzard, the structure of the ovo-spermathecal system and furthermore in the presence of penial setae. It also resembles *Vomia* Segun, 1976 but differs from it in the metandric condition of the male genitalia and the long backward running vesicles. Apart from the new eudrilid taxa the material also contained a new acanthodrilid species, *Dichogaster (Diplothecodrilus) asymmetrica* sp. n., characterised by the asymmetric position of its spermathecal duct-ampulla junction. All members of this new genus were collected in North West Region, with *O. monticolus* endemic to the summit grasslands of Mount Oku, and is possibly threatened by climate change, and soil degradation through overgrazing and fire.

KEY WORDS: Afrotropical Region, Cameroon, Mount Oku, earthworms, Eudrilinae, new genus, new species.

INTRODUCTION

Knowledge of Africa's earthworm fauna is patchy. Several countries are dealt with by only a dozen studies, such as the Ivory Coast (Csuzdi & Tondoh 2007), and a number of countries lack earthworm records entirely (e.g. Mali) or have only a few records, such as Burkina Faso (Csuzdi 2000). The only African country that can be regarded as being well studied is the Republic of South Africa (e.g Plisko 2006, 2012*a*, 2012*b*, 2013*a*, 2013*b*).

Cameroon is among the relatively better sampled African countries, with the first earthworm species having been reported in 1891 (*Paradilus purpureus* Michaelsen, 1891). This was followed by a series of papers by Michaelsen (1902, 1903, 1910, 1915, 1937), Cognetti (1909), Dahl (1957) and recently Clausen (2004), Birang *et al.* (2004) and Norgrove *et al.* (2008) reporting altogether 56 earthworm species from the country. This number is less than that recorded for the smaller Ivory Coast (58 species, Csuzdi & Tondoh 2007), and the Democratic Republic of the Congo (67 species Csuzdi unpublished), and is only slightly higher than the half as large Ghana (48 species Csuzdi unpublished). This suggests that the earthworm inventory of the relatively well studied Cameroon is still incomplete.

We describe a collection of earthworms made in the Central, North West and South West Regions of Cameroon, which is found to consist almost exclusively of undescribed species, including a genus new to science.

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MATERIAL AND METHODS

Earthworms were collected from October to November 2008 and May to August 2012. Localities sampled for earthworms in Cameroon included: Ndikiniméki (797–831 m), Central Region; Awing (1576–2082 m), Bambili (~2280 m), Nyos (1041 m), Wum (1230 m), Elum (1026 m), and multiple localities throughout Mount Oku (1200–3011 m), North-West Region; and Nyasoso and adjacent Mount Kupe (868–2064 m), South West Region (Fig. 1). Earthworms were collected by MTK and TMD-B through digging and hand-sorting or looking under stones, either haphazardly or during surveys for soil-dwelling herpetofauna. Some were presented by local farmers. The specimens were killed and preserved in 75% ethanol. Samples were identified at the Natural History Museum, London. Type material is deposited in the Natural History Museum, London (NHM) and the Hungarian Natural History Museum (HNHM).

The following abbreviations are used in the text: L: = length; D: = diameter.

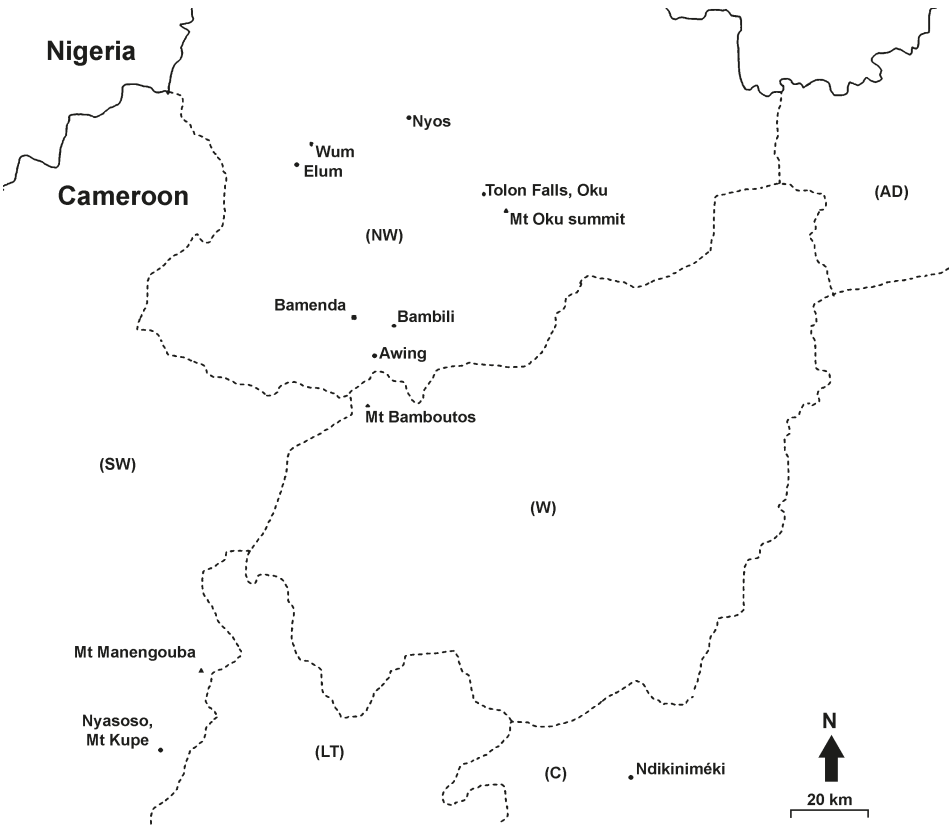


Fig. 1. Map showing sample localities for earthworms, plus locations of mountains (Manengouba and Bamboutos). Letters in parentheses indicate geopolitical regions of Cameroon (SW = South West, NW = North West, W = West, C = Central, LT = Littoral, AD = Adamaua).

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TAXONOMY

Family Eudrilidae Claus, 1880
Subfamily Eudrilinae Claus, 1880
Genus *Eminoscolex* Michaelsen, 1896

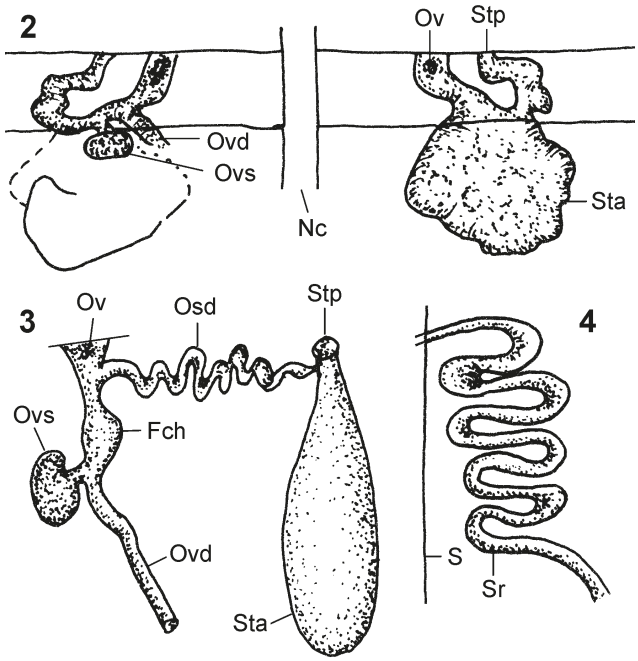
Eminoscolex franzi Zicsi & Csuzdi 1986 **stat. n.**

Figs 2–4

Eminoscolex steindachneri Cognetti, 1909; Sims 1971: 531.
Eminoscolex steindachneri franzi Zicsi & Csuzdi, 1986: 198.

Material examined: CAMEROON: North-West Region, Hills above Lake Bambili 2280 m, leg. M.T. Kouete & T. Doherty-Bone, 24.v.2012 (NHM 2013.438 1 ex., HNHM AF/5572 2 ex.), North-West Region, Oku, below Tolon Falls, 1675 m, leg. T. Doherty-Bone, 19.v.2012 (NHM 2013.439 1 ex.), North-West Region, Lake Awing, 2082 m, leg. M.T. Kouete & T. Doherty-Bone, 23.v.2012 (NHM 2013.440 1 ex.).

Remarks: *Eminoscolex steindachneri franzi* was described by Zicsi and Csuzdi (1986) from the Republic of Congo (Sibiti, Brazzaville and Kindamba). It was thought to be similar to *E. steindachneri* Cognetti, 1909 from Cameroon (no closer locality given). However, an examination of the ovospertmathecal system of *steindachneri* and *franzi* shows clearly that they belong to different species (Figs 2, 3). Another difference is in the structure of the sperm reservoir, which is simple moniliform in *steindachneri* and highly undulated in *franzi* (Fig. 4). Habitats where these specimens were collected were in areas disturbed by cultivation or grazing.



Figs. 2–4. (2) *Eminoscolex steindachneri,* spermathecal apparatus, after Cognetti (1909 fig. 10); (3) *Eminoscolex franzi,* spermathecal apparatus; (4) *Eminoscolex franzi,* sperm reservoir. Abbreviations: Fch = fertilization chamber, Nc = nerve cord, Osd = ovo-spermathecal duct, Ov = ovarium, Ovd = oviduct, Ovs = ovisac, S = septum, Sr = sperm reservoir, Sta = spermathecal ampulla, Stp = spermathecal pore.

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TABLE 1

Distinguishing characters of the genera *Metascolex* Michaelsen, 1903, *Okudrilus* gen. n. and *Vomia* Segun, 1976.

	Gizzard	Testes	Vesicles	Ovo-spermathecal system	Penial setae
Metascolex	5	11	long	separate	absent
Okudrilus gen n.	6	11	long	interconnected	present
Vomia	6	10, 11	short	interconnected	present

Okudrilus Csuzdi & Sherlock gen. n.

Etymology: Referring to Mount Oku, North-West Region, Cameroon—the highest mountain in the region and a collecting locality of all three the new species. Gender: masculine.

Diagnosis: Eudrilinae with closely paired setae and paired male pores close to 17/18. Spermathecal pores preclitellar, paired between *a–a*. Female pores paired in 14 close to 14/15 near *d*. Oesophageal gizzard in 6, intestinal gizzards absent. Dorsal blood vessel simple throughout. Paired calciferous glands in 12 and unpaired chylous-sacs in 10, 11. Male genital apparatus metandric with long, backward-running vesicles. Excretory system holoic, vesiculate. Ovo-spermathecal apparatus paired with ventral interconnecting duct. Simple penial setae present.

All species in this genus are known only from highland areas above 1000 m in the North West Region.

Type-species: *Okudrilus monticolus* sp. n.

Remarks: *Okudrilis* gen. n. is similar to *Metascolex* Michaelsen, 1903 in the paired genital pores and metandric condition of the male genitalia; however, *Okudrilis* differs from it in the position of the gizzard (it is in 5 in *Metascolex* and 6 in *Okudrilus*), in the interconnected ovo-spermathecal system and furthermore by the presence of penial setae. *Okudrilis* with its paired calciferous glands in 12 and paired genital pores resembles *Vomia* Segun, 1976 as well, but differs from it in the metandric condition of the male genitalia and the long backward-running vesicles (Table 1).

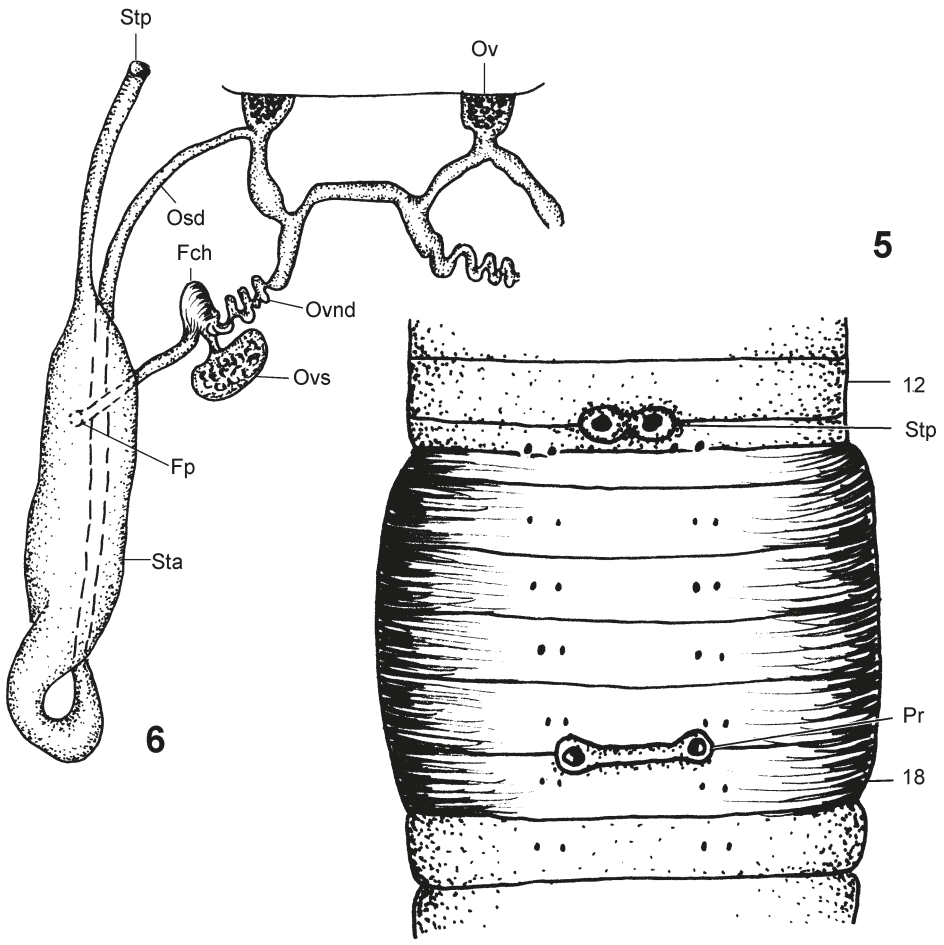
Okudrilus monticolus Csuzdi & Sherlock sp. n.

Figs 5, 6

Etymology: From Latin *monticolus* (*adj.*) (mountain dweller) in reference to the type locality, the summit of Mount Oku.

Diagnosis: L: 150–190 mm, D: 5–7 mm. Colour reddish-brown, paler on ventrum. Head epilobous, setae closely paired. Clitellum annular on ½13–18. Prostatic pores in 17/18 *a–a*, spermathecal pores 12/13 between *a–a*, female pores on 14 close to 14/15 in *d*. Gizzard in 6, calciferous glands in 12, chylus-sacs in 10, 11. Testes in 11, vesicles in 12 long, running back to 45. Ovo-spermathecal apparatus paired, spermathecal ampulla elongated, apically continues in an ovo-spermathecal duct communicating with the ovarian capsule. The right and left ovarian duct interconnected by a small channel. Prostates without copulatory sacs. Simple penial setae 4 mm in length and 0.03 mm in diameter.

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Figs 5, 6. *Okudrilus monticolus* sp. n.: (5) ventral view of the clitellar region; (6) ovo-spermathecal apparatus. Abbreviations: Fch = fertilization chamber, Fp = female pore (exits close to intersegment 14/15), Ov = ovarium, Osd = ovo-spermathecal duct, Ovnd = ovarian duct, Ovs = ovisac, Pr = prostate pore, Sta = spermathecal ampulla, Stp = spermathecal pore.

Description:

External characters:

Holotype: Preserved length 190 mm, diameter after clitellum 7 mm. *Segment number*: 274. *Paratype*: (aclitellate) 155 mm in length, 5 mm in diameter. *Segment number*: 268. *Colour*: Preserved dark reddish-brown between setae *d–d*, paler on ventrum. *Head*: Epilobous, ½ closed. *Dorsal pores*: Lacking. *Setae*: Closely paired, setal ratio aa:ab:bc:cd:dd = 11.2:2:8:1:36. *Nephridial pores*: Begin on segment 2, somewhat dorsal to setal line *d*.

Clitellum: Highly glandular, annular on segments ½13–18. *Prostatic pores*: Ventral on a spectacles-shaped papilla in 17/18, aligned with setal line *a–a*. *Female pores*: Small dots on 14, close to the intersegmental furrow 14/15 just below setal line *d*. *Spermathecal*

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pores: Paired on a spectacles-shaped papilla in intersegmental furrow 12/13 between setae *a–a* (Fig. 5).

Internal characters:

Muscular gizzard: In 6, well-developed, cylindrical. *Septa*: 6/7, 11/12 thickened, 7/8–10/11 highly strengthened. *Calciferous glands*: Paired in 12, large curved like a goat-horn, chylus-sacs in 10, 11. *Dorsal blood vessel*: Simple throughout. *Hearts*: In 9–11, large moniliform. *Testes* and *sperm funnels*: In 11 enclosed in an oval sperm-reservoir. *Seminal vesicles*: Long, running alongside the intestine from 12 to 45. *Ovo-spermathecal apparatus*: Ovaries in 13 enclosed in an ovarian capsule pendant from septum 12/13. This ovarian capsule medially continuing in an ovarian duct becoming undulating before joining the fertilisation chamber bearing a pendant ovisac. From the fertilisation chamber a straight oviduct leads to the female pore. The ovarian capsule laterally communicates with an ovo-spermathecal duct joining apically to the elongated and muscular spermathecal ampulla. The spermathecal ampulla joins a one-third as long spermathecal duct opening into the spermathecal pore in 12/13. The left and right ovarian ducts communicate by a small interconnecting channel (Fig. 6). *Prostates*: Long simple tubes without bursa copulatrix or bursa propulsoria. *Penial setae*: Simple with blunt tip, *c*. 4 mm long and 0.03 mm in diameter, almost smooth except for the apex which bears fine granulation.

Holotype: CAMEROON: North-West Region, summit of the Oku Mt, 2867-2922 m, 15.vi.2012, T. Doherty-Bone (NHM 2013.441).

Paratype: Same data as Holotype (NHM 2013.442 1 preadult ex.).

Remarks: The new species differs from the other two *Okudrilus* species in the position of the spermathecal pores located in intersegmental furrow 12/13 (11 in *O. sulcatus,* 12 in *O. nyosensis*) and furthermore in the structure of the ovo-spermathecal apparatus. Habitat consists of loamy soil in high elevation (>2000 m) sub-alpine grassland.

Okudrilus nyosensis Csuzdi & Sherlock sp. n.

Figs 7, 8

Etymology: From the type locality, adjacent to Lake Nyos where the holotype was collected.

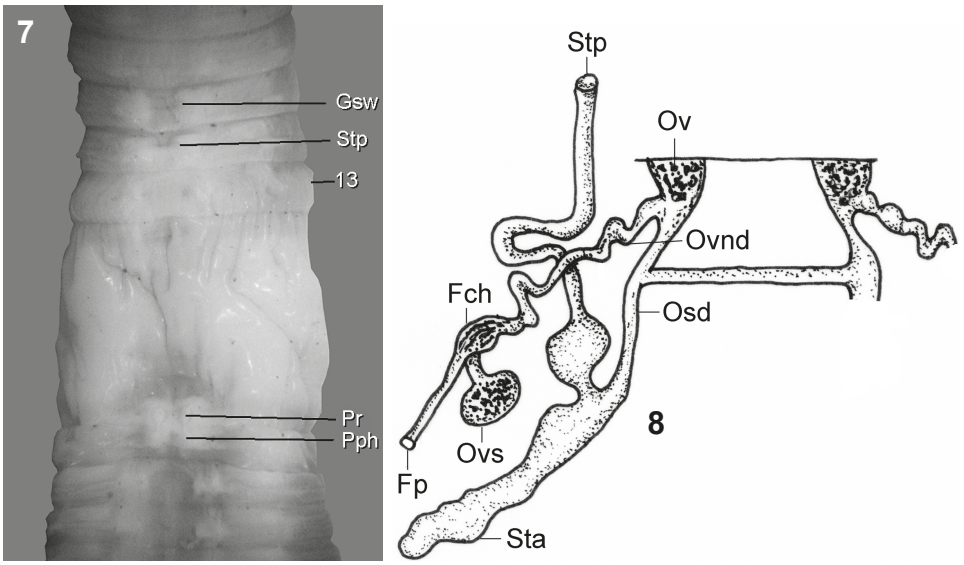
Diagnosis: L: 82 mm, D: 3 mm. Colour red-violet, paler on ventrum. Head epilobous, setae closely paired. Clitellum annular on ½14–17. Prostatic pores postsetal in 17 *a–a*, spermathecal pores 12 between *a–a*, female pores on 14 close to 14/15 in *d*. Gizzard in 6, calciferous glands in 12, chylus-sacs in 10, 11. Testes in 11, vesicles in 12 long running back to 22. Ovo-spermathecal apparatus aired, spermathecal ampulla elongated tube, laterally continues in an ovo-spermathecal duct communicating with the ovarian capsule. The right and left ovarian duct interconnected by a small channel. Prostates without copulatory sacs. Simple penial setae 7 mm in length and 0.02 mm in diameter.

Description:

External characters:

Holotype: Preserved length 82 mm diameter after clitellum 3 mm. *Segment number*: 168. *Colour*: Preserved reddish-brown, paler on ventrum. *Head*: Epilobous, ¾ closed. *Dorsal pores*: Lacking. *Setae*: Closely paired, setal ratio aa:ab:bc:cd:dd = 6:1.2:4:1:20.

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Figs 7, 8. *Okudrilus nyosensis* sp. n.: (7) ventral view of the clitellar region; (8) ovo-spermathecal apparatus. Abbreviations: Fch = fertilization chamber, Fp = female pore, Gsw = genital swelling, Ov = ovarium, Osd = ovo-spermathecal duct, Ovnd = ovarian duct, Ovs = ovisac, Pph = porophore, Pr = prostate pore, Sta = spermathecal ampulla, Stp = spermathecal pore.

Nephridial pores: Begin on segment 2, somewhat dorsal to setal line *d*.
Clitellum: Annular on segments ½ 14–17. *Prostatic pores*: Postsetal on 17 situated on a pair of slightly elevated papilla. The prostatic pores on both sides are connected by a straight seminal groove with small porophores on 18 in setal line *a–a*. *Female pores*: Small dots on 14, close to the intersegmental furrow 14/15 just below setal line *d*. *Spermathecal pores*: Paired on a small glandular elevation in 12 between setae *a–a* (Fig. 7). *Glandular swellings*: One pair on 11 around setae *ab* connected with the spermathecal pore on both sides by slightly curved grooves.

Internal characters:
Muscular gizzard: Large in 6. *Septa*: 7/8 slightly thickened, 8/9–11/12 moderately strengthened. *Calciferous glands*: paired in 12, large curved, chylus-sacs in 10, 11. *Dorsal blood vessel*: Simple throughout. *Hearts*: In 9–11, moniliform. *Testes* and *sperm funnels*: In 11 enclosed in an oval sperm-reservoir. *Seminal vesicles*: Long, running alongside the intestine from 12 to 22. *Ovo-spermathecal apparatus*: Ovaries in 13 enclosed in an ovarian capsule pendant from septum 12/13. The ovarian capsule laterally continuing in an ovarian duct becoming undulating before joining the fertilisation chamber bearing a pendant ovisac. From the fertilisation chamber a straight oviduct leads to the female pore. The ovarian capsule medially communicates with an ovo-spermathecal duct joining laterally the elongated and muscular spermathecal ampulla. The spermathecal ampulla bears ectally a spherical dilatation which continues in a long spermathecal duct opening into the spermathecal pore. The left and right ovospermathecal ducts communicate by a small interconnecting channel (Fig. 8). *Prostates*: Long simple tubes without bursa copulatrix or bursa propulsoria. *Penial setae*: Simple, smooth, *c*. 7 mm long and 0.02 mm in diameter.

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Holotype: CAMEROON: North-West Region, Lake Nyos 1041 m, 28.v.2012, M.T. Kouete & T. Doherty-Bone (NHM 2013.443)

Remarks: The new species differs from the other two *Okudrilus* species in the position of the spermathecal pores located in segment 12 (12/13 in *O. monticolus,* 11 in *O. sulcatus*) and furthermore in the structure of the ovo-spermathecal apparatus. The habitat where this species was collected was in subsistence agriculture, with a canopy cover estimated ~ 60 and 80 % and largely consisting of avocado, guava and raffia trees. There were also cocoyam, yam and ground nuts.

Okudrilus sulcatus Csuzdi & Sherlock sp. n.

Figs 9, 10

Etymology: From Latin *sulcatus* (sulcate), in reference to the long seminal grove connecting the prostatic pores and the single porophore.

Diagnosis: L: 70–81 mm, D: 2–2.5 mm. Colour reddish-brown, paler on ventrum. Head epilobous, setae closely paired. Clitellum annular on 14–17. Prostatic pores in 17/18 *a–a*, spermathecal pores praesetal on 11 between *a–a*, female pores on 14 close to 14/15 in *d*. Gizzard in 6, calciferous glands in 12, chylus-sacs in 10, 11. Testes in 11, vesicles in 12 long running back to 33. Ovo-spermathecal apparatus paired, spermathecal ampulla elongated, laterally continues in an ovo-spermathecal duct communicating with the ovarian capsule. The right and left ovo-spermathecal duct interconnected by a small channel. Prostates without copulatory sacs. Simple penial setae 4,4 mm in length and 0.025 mm in diameter.

Description:

External characters:

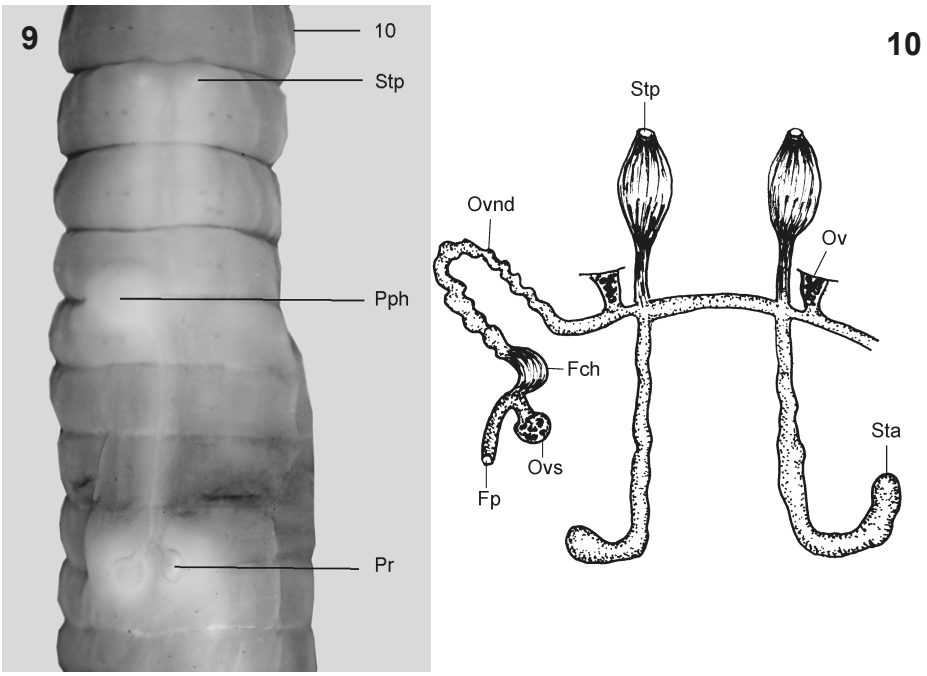
Holotype: Preserved length 81 mm diameter after clitellum 2 mm. *Segment number*: 138. *Paratype*: (tail truncated) 70 mm in length 2.5 mm in diameter. *Segment number*: 81. *Colour*: Preserved reddish-brown, paler on ventrum. *Head*: Epilobous, ¾. *Dorsal pores*: Lacking. *Setae*: Closely paired, setal ratio aa:ab:bc:cd:dd = 5.5:1.5:3.5:1:17. *Nephridial pores*: Begin on segment 2, somewhat dorsal to setal line *d*.

Clitellum: Annular on segments 14–17. *Prostatic pores*: Ventral on two spherical papillae in 17/18, aligned with setal line *a–a*. The prostatic pores are connected by an invert Y-shaped seminal groove with the single asymmetrically placed porophore on 13/14. *Female pores*: Small dots on 14, close to the intersegmental furrow 14/15 just below setal line *d*. *Spermathecal pores*: paired on 11 near to the intersegmental furrow 10/11 between setae *a–a* (Fig. 9).

Internal characters:

Muscular gizzard: In 6, large, cylindrical. *Septa*: 8/9–11/12 slightly thickened. *Calciferous glands*: Paired in 12, chylus-sacs in 10, 11. *Dorsal blood vessel*: Simple throughout. *Hearts*: In 9–11, moniliform. *Testes* and *sperm funnels*: In 11 enclosed in a spindle-shaped sperm-reservoir. *Seminal vesicles*: Long, running alongside the intestine from 12 to 33. *Ovo-spermathecal apparatus*: Ovaries in 13 enclosed in an ovarian capsule pendant from septum 12/13. This ovarian capsule laterally continuing in an undulating ovarian duct joining the fertilisation chamber bearing a pendant ovisac. From the fertilisation chamber a straight oviduct leads to the female pore. The ovarian

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Figs 9, 10. *Okudrilus sulcatus* sp. n.: (9) ventral view of the clitellar region; (10) ovo-spermathecal apparatus. Abbreviations: Fch = fertilization chamber, Fp = female pore, Ov = ovarium, Ovnd = ovarian duct, Ovs = ovisac, Pph = porophore, Pr = prostate pore, Sta = spermathecal ampulla, Stp = spermathecal pore.

capsule medially communicates with a short ovo-spermathecal duct joining laterally to the elongated spermathecal ampulla. The spermathecal ampulla joins a spermathecal duct becoming spindle-shaped before opening into the spermathecal pore. The left and right ovarian ducts communicate by a small interconnecting channel (Fig. 10). *Prostates*: Long simple tubes without bursa copulatrix or bursa propulsoria. *Penial setae*: Simple, smooth, 4.4 mm long and 0.025 mm in diameter.

Holotype: CAMEROON: North-West Region, Wum, 1230 m, 2005, L. Norgrove (HNHM AF/5573).

Paratype: CAMEROON: North-West Region, near Elum,1026 m, 30.v.2012, M.T. Kouete & T. Doherty-Bone (NHM 2013.444 1 ex.).

Remarks: This species differs from the other two *Okudrilus* in the position of the spermathecal pores located in segment 11 (12/13 in *O. monticolus,* 12 in *O. nyosensis*) and furthermore in the structure of the ovo-spermathecal apparatus. The holotype was collected on a *Chromolaena odorata* two years fallow. The paratype was collected in an area used for subsistence agriculture.

Genus *Parascolex* Michaelsen, 1900
Parascolex rosae (Michaelsen, 1891)

Paradrilus rosae Michaelsen, 1891: 26; Rosa 1891: 389; Michaelsen 1897: 48.
Parascolex rosae: Michaelsen 1900: 408; 1903: 166; Sims 1987: 387.

Material examined: CAMEROON: South-West Region, Nyasoso and adjacent forest, Mount Kupe, 868–2064 m, unknown datum, S. Echalle (NHM 2013.445-446 2 preadult fragment), Ndikiniméki, Central Region, 797 m, 20.xi.2008, T. Doherty-Bone (NHM 2013.447 1 ex.).

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Remarks: *Parascolex rosae* is one of the largest eudrilid species, measuring up to 470 mm. It is quite common in Western Cameroon reported from Barombi, Buea, Kita, Moundamé (Mundame), Victoria (Limbe), and also from Bioko, Equatorial Guinea (Michaelsen 1900, 1903; Rosa 1891).

Family Acanthodrilidae Claus, 1880
Subfamily Benhamiinae Michaelsen, 1897
Genus *Dichogaster* Beddard, 1889
Subgenus *Diplothecodrilus* Csuzdi, 1996

Dichogaster (Diplothecodrilus) asymmetrica Csuzdi & Sherlock sp. n.

Figs 11–14

Etymology: The specific epithet refers to the asymmetrical position of the spermathecal duct.

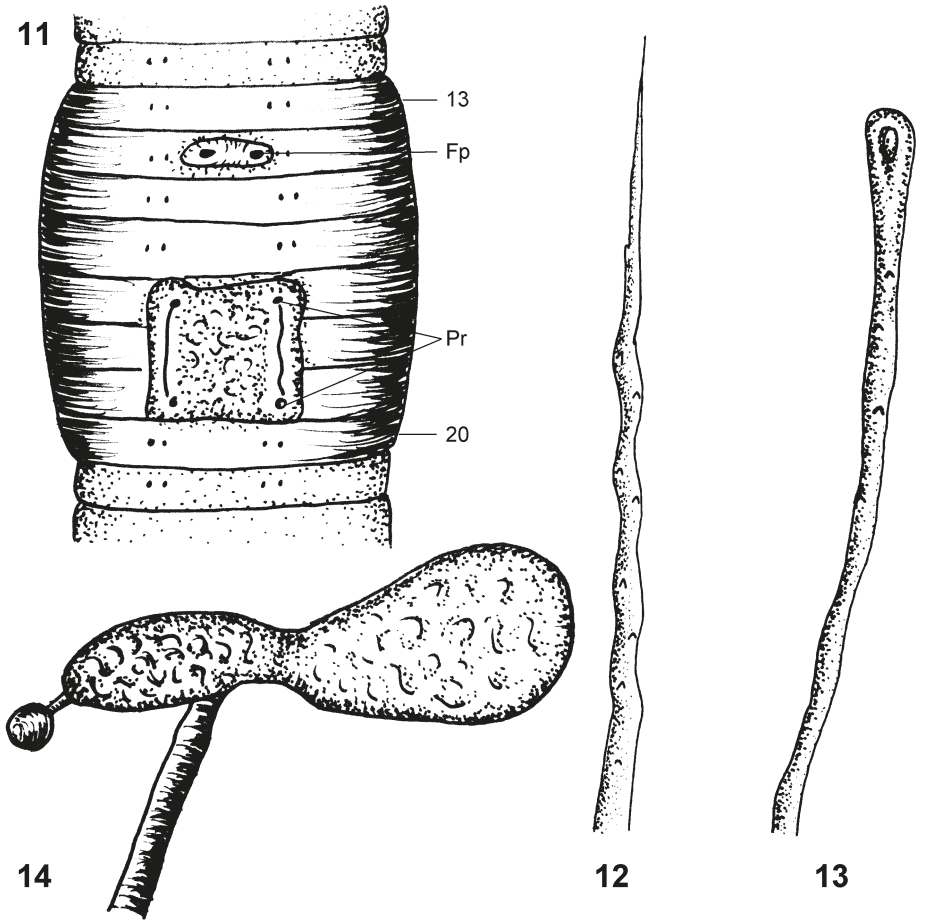
Diagnosis: L: 65–70 mm, D: 2–2.5 mm. Colour slightly reddish on dorsum, pale on ventrum. First dorsal pore in 5/6. Clitellum 13–20. ♀ 14 paired, between *a–a*. Prostatic pores 17, 19. Spermathecal pores 7/8, 8/9, spermathecae with a subdivided ampulla, and an asymmetrically attached duct. The lower ampulla part bears a unilocular diverticulum. Gizzard large in 5–6, last pair of hearts in 12. Excretory system meroic with 6 meronephridia on each side. Penial setae are of two types, larger L: 2.3 mm D: 0.006 mm, tip slightly undulated, tapering. Ornamentation scattered small teeth. Smaller seta L: 2.1 mm D: 0.006 mm, tip spoon-shaped, ornamentation minute teeth.

Description:

External characters:
Syntypes: L: 65–70 mm, D: 2–2.5 mm, the number of segments was uncountable due to the poor condition of the specimens. *Colour*: Alive unknown, preserved reddish on dorsum, pale on ventrum. *Prostomium*: Schizolobous. *First dorsal pore*: In 5/6. *Setae*: All ventral, setal arrangement on segment 14 aa:ab:bc:cd:dd=6:1:7:1:30, after clitellum not seen. *Clitellum*: Circular extends over segments 13–20. *Male field*: Oblong with prostatic pores paired on 17, 19 in the setal line *a*. *Male pores*: On 18, in the seminal groves. *Female pores*: Paired on 14 in between setae *a–a* (Fig. 11). *Spermathecal pores*: Paired in 7/8, 8/9 in the setal line *a*.

Internal characters:
Septa: 9/10–12/13 slightly thickened. *Gizzards*: Large in 5 and 6. *Calciferous glands*: Three pairs in segment 15–17, their size slightly increasing backwards. *Excretory system*: Meroic, with 6 meronephridia on each side. *Hearts*: Paired in segments 10–12. *Typhlosole*: Lamellar, but due to the poor preservation of the intestine its beginning can not be determined. *Sperm funnels*: 10, 11. *Seminal vesicles*: Small in 11, 12. *Prostatic glands*: Two pairs in 17 and 19; those in 17 are larger, in 19 smaller. *Penial setae*: Of two types, the longer about 2.3 mm long and 0.006 mm wide in the middle, ectal third undulated, tip acute, ornamentation consists of small teeth (Fig. 12). The smaller seta 2.1 mm long, diameter 0.006 mm in the middle, ectal third slightly undulated, tip spoon-shaped, ornamentation minute teeth (Fig. 13). *Spermathecae*: Two pairs in segment 8 and 9. The ampulla subdivided with smaller ectal and larger ental part. The duct as long as the ental ampulla part joins asymmetrically at the junction of the two ampulla parts.

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Figs 11–14. *Dichogaster* (*Diplothecodrilus*) *asymmetrica* sp. n.: (11) ventral view of the clitellar region; (12) ectal third of the larger penial seta; (13) ectal third of the smaller penial seta; (14) spermatheca. Abbreviations: Fp = female pore, Pr = prostate pore.

The ectal ampulla part bears a small unilocular diverticulum (Fig.14.).

Syntypes: CAMEROON: North-West Region, summit of Mt. Oku, 2867–2922 m, 15.vi.2012, T. Doherty-Bone (NHM 2013.448-450 3 ex., HNHM AF/5574 1 ex.).

Remarks: *Dichogaster* (*Diplothecodrilus*) *asymmetrica* sp. n. belongs to the *bolaui* species group (Csuzdi 2010) characterized by the presence of dimorph penial setae; however, it differs from all other species in this group by the asymmetric shape of the spermathecae.

Habitat as for *Okudrilus monticolus*. As this species is smaller and less conspicuous than *O. monticolus* (hence, it has a lower likelihood of collection), the authors are more uncertain as to its occurrence in other habitats on Mount Oku.

The subfamily Benhamiinae is regarded by some authors (e.g. Blakemore 2013) as belonging to the family Octochaetidae, Michaelsen 1900. However, both morphological and molecular data show that Octochaetidae in its classical sense is polyphyletic and

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Benhamiinae is related to the classical Acanthodrilidae species (see Csuzdi 2010; James & Davidson 2012); therefore, we maintain Benhamiinae in Acanthodrilidae.

DISCUSSION

Of the four new species presented herewith, *Okudrilus monticolus* sp. n. has not been found in forest or below 2 000 m, despite digging surveys across Mount Oku and the Highlands of Cameroon (Doherty-Bone *et al.* 2011, this study). It is likely to be endemic to the subalpine summit grasslands of Mount Oku. Other endemic species in this habitat include two anuran amphibians (Amiet 2004; IUCN 2011) and several plants (Maisels *et al.* 2000). These grasslands are subject to degradation by fire and livestock grazing (Maisels *et al.* 2000) and are thought to be at risk from climate change. Thus *O. monticolus* could be considered threatened with extinction, and at the very least categorized as "vulnerable" by the IUCN (the two endemic anurans are considered "critically endangered"). The other two species of *Okudrilus* so far described have been collected in habitats already subject to substantial subsistence agriculture, and it is likely they occur elsewhere in the Bamenda Highlands. As uncertainties exist as to the broader distribution of these species, assessing conservation status is not possible until more directed surveys have taken place.

Okudrilus is likely to occur also in the highlands of Nigeria (i.e. Oban Hills, Obudu Plateau) as well as additional mountains in Cameroon, notably in Adamaua Region. As earthworms are relatively simple to sample, this genus could be a convenient group to test hypotheses of the biogeography of the Cameroon Volcanic Line (i.e. Smith *et al.* 2000). More extensive and systematic sampling of earthworms in additional localities could thus yield a useful array of material that might be subjected to phylogeographic analyses.

Dichogatser (Diplothecodrilus) asymmetrica sp. n. has been collected together with *O. monticolus* sp. n. and did not show up in the lower forested regions. As it lacks intensive red-violet pigmentation, it perhaps belongs to the endogeic polyhumic ecological group and prefers grassland vegetation, and similarly to *O. monticolus* might be threatened by grazing and especially fire.

This relatively haphazard collection of earthworms, coinciding with surveys of fossorial vertebrates has yielded four species new to science and provided additional distribution data for other species. This discovery is typical of biodiversity research in Cameroon, where descriptions and study of highland taxa often lag behind those of lowland counterparts (Stuart 1986). This has often resulted in prioritizing conservation in the latter as opposed to the former to prevent biodiversity loss. As earthworms are significant components of soil ecosystems, and contribute to ecosystem services relevant to food security, further surveys of the earthworms of Cameroon are recommended in order to better understand the distribution and responses to changes in land management and climate.

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