



## The first earthworm collections from Nicaragua with description of two new species (*Oligochaeta*)

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### Abstract

In August 2009 the Natural History Museum London, Hungarian Natural History Museum and Systematic Zoology Research group, Entomological Museum in Leon and The Society for Environmental Exploration, mounted the first earthworm collection expedition to Nicaragua. No native earthworm species had previously been recorded for this country. This paper lists 18 new species records for the Country with the description of two new taxa to science: *Eutrigaster (Graffia) azul* sp. n. and *Eutrigaster (Graffia) nicaraoui* sp. n. New data on the species *Eutrigaster (Eutrigaster) oraedivitis* Cognetti, 1904 is also presented here.

**Key words:** Earthworms, Nicaragua, *Eutrigaster*, new species

### Introduction

Knowledge of the Latin American earthworm fauna is currently patchy. Some countries such as Brazil and Ecuador have, to some extent, been sampled; the species total for Brazil currently stands at 305, that for Ecuador and Columbia at 139 (Brown & Fragoso, 2007). By contrast the earthworm assemblages of other South American countries such as Uruguay and Paraguay are virtually unknown.

To date, the study of the diversity, range and ecology of earthworms has been largely neglected across all of the Central American countries. Prior to this paper, a mere 96 species records existed collectively for the whole of Central America. The least studied country of which being Nicaragua. In fact not one native species record existed for this country, the only records coming from specimens seized at customs in the 1960's, 1970's and 1980's (Gates 1965, 1972, 1982). This amounted to two species records and one generic record, all of which were peregrine species: *Pontoscolex corethrurus* (Müller, 1857), *Drawida barwelli* (Beddard, 1886) and a *Dichogaster* sp.

For such an important animal group this is a huge omission, especially as neighbouring countries in South America are known to have a rich and diverse fauna (Brown & Fragoso 2007).

In August-September 2009 The Natural History Museum in London, The Society for Environmental Exploration London, The Hungarian Natural History Museum and The Entomological Natural History Museum in Nicaragua embarked on a short project to produce the first meaningful earthworm species records for Nicaragua.

Some additional material from Rio San Juan collected in 2007 by Hungarian Natural History Museum's scientists Dr. O. Merkl, N. Balint and T. Németh was donated to the authors and is also included.

### Material and methods

In each locality sampled, a north south orientated transect, consisting of 3 equidistant slabs of soil (mon), were dug. Each slab measured 30cm x 30cm x 20cm, and the soil was hand sorted for worms. A microhabitat (micro) search

was then conducted for a monitored time period. This search involved looking in rotten logs, under leaf litter, logs, stones and debris, and in the fronds of any low lying plants. A mustard solution was applied to the ground in a number of cases; however this was not found to be overly successful. If bromeliads (brom) were present in the canopy then a bromeliad search was carried out and worms collected. This was not for a measured time but an effort was made to sample ten representative bromeliads for each site. Any additional worms found were collected and labelled as opportunistic finds. GPS locality data, soil temperature and altitudes were collected in all cases.

For preservation worms were anaesthetised in 30% alcohol. Then where possible they were straightened with 96%, and all were placed in vials of 96% alcohol. This alcohol was changed after a few hours to avoid dilution and subsequent degradation of the material.

Samplings were carried out at the following localities (Fig. 1):

**S**—Sapoa near the Costa Rican border - Farmland and scrub land. N 11° 10.077', W 85° 39.818'. Leg. E. Sherlock, S. Lee & S. Mcphee, 28-29/08/2010

**C**—Cardenas - Farmland, grassland and primary forest. N 11° 13.197', W 85° 33.280'. Leg. E. Sherlock, S. Lee & S. Mcphee, 30-31/08/2010

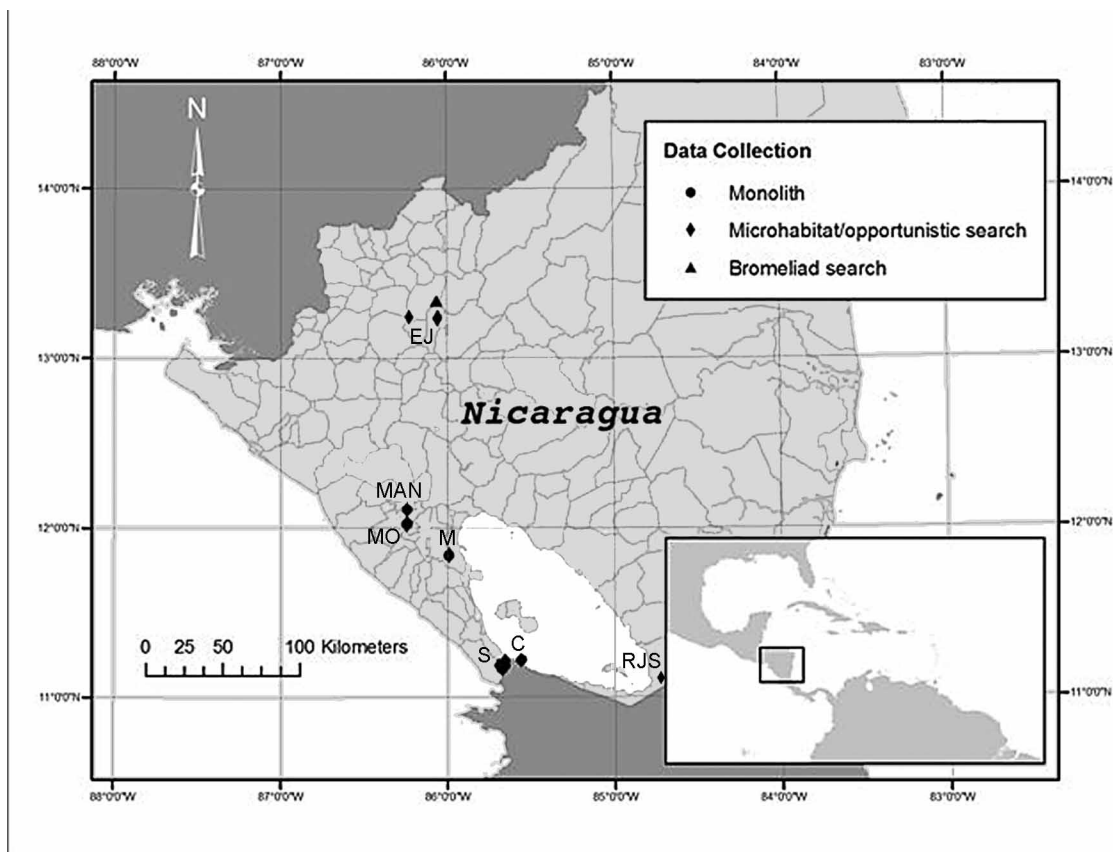
**M**—Reserva Natural Volcan Mombacho - Cloud and dwarf forest. N 11° 50.037', W 85° 58.748'. Leg. E. Sherlock, S. Lee & S. Mcphee, 03/09/2010, 07/09/2010

**EJ**—Reserva Silvestre Privada El Jaguar - Cloud forest. N 13° 14.298' W 86° 03.083'. Leg. E. Sherlock, S. Lee & S. Mcphee, 08-09/09/2010

**MO**—Reserva Silvestre Privada Montibelli - Coffee plantations, primary forest and organic waste site/ vermiculture. N 12° 1.264', W 86° 13.988'. Leg. E. Sherlock, S. Lee & S. Mcphee, 13/09/2010

**MAN**—Managua - Banana plantations, garden. N 12° 5.852' W 86° 14.249'. Leg. E. Sherlock, S. Lee & S. Mcphee, 11-12/09/2010

**RSJ**—Rio San Juan, Refugio Bartola. N 10° 58.346', W 84° 20.341'. Leg. Dr. O. Merkl, N. Balint & T. Németh, 15–25.06.2007



**FIGURE 1.** Map of Nicaragua with sampling points marked.

**Family Acanthodrilidae Claus, 1880*****Dichogaster (Diplotheodrilus) affinis* (Michaelsen, 1890)**

*Benhamia affinis* Michaelsen, 1890: 9.

*Dichogaster affinis*: Michaelsen 1900: 345, Blakemore 2008: 188 (for complete synonymy).

*Dichogaster (Diplotheodrilus) affinis*: Csuzdi 1996: 357.

**Material.** BMNH 2010.118. Locality: **MO**, 1 ex. (micro).

***Dichogaster (Diplotheodrilus) annae* (Horst, 1893)**

*Benhamia annae* Horst, 1893: 32.

*Dichogaster annae*: Michaelsen 1900: 347, Cognetti 1905a: 38, Blakemore 2008: 191 (for complete synonymy).

*Dichogaster (Diplotheodrilus) annae*: Csuzdi 1995: 112; 1996: 357.

**Material.** BMNH 2010.33, 2010.38-39, 2010.41-42, 2010.46-47. Locality: **M**, 20 ex. (micro/mon/brom), BMNH 2010.67-70. Locality: **MO**, 3 ex. (micro).

***Dichogaster (Diplotheodrilus) bolavi* (Michaelsen, 1891)**

*Benhamia bolavi* Michaelsen, 1891: 9.

*Dichogaster bolavi*: Michaelsen 1900: 340, Cognetti 1905a: 40, Blakemore 2008: 194 (for complete synonymy).

*Dichogaster (Diplotheodrilus) bolavi*: Csuzdi 1996: 358.

**Material.** BMNH 2010.121-125. Locality: **MAN**, 5 ex. (micro).

***Dichogaster (Diplotheodrilus) tristani* Cognetti, 1907**

*Dichogaster tristani* Cognetti, 1907: 791.

*Dichogaster pithayana* Michaelsen, 1912: 123.

*Dichogaster (Diplotheodrilus) tristani*: Csuzdi 1996: 357, Brown & Fragoso 2007: 65.

**Material.** BMNH 2010. 90. Locality: **EJ**, 1 ex. (micro).

**Remarks.** *D. (Dt.) tristani* is a native species in Central America described from Costa Rica. This is its first Nicaraguan record.

***Eutrigaster (Eutrigaster) oraedivitis* Cognetti, 1904**

(Fig. 2)

*Eutrigaster oraedivitis* Cognetti, 1904: 2, Cognetti 1905a: 36.

*Dichogaster oraedivitis*: Michaelsen 1912: 120.

*Eutrigaster oraedivitis*: Sims 1987: 432.

*Eutrigaster (Eutrigaster) oraedivitis*: Csuzdi 1996: 359.

Non *Dichogaster oraedivitis*: Talavera & Bacallado 1983: 6, Talavera 1992: 346.

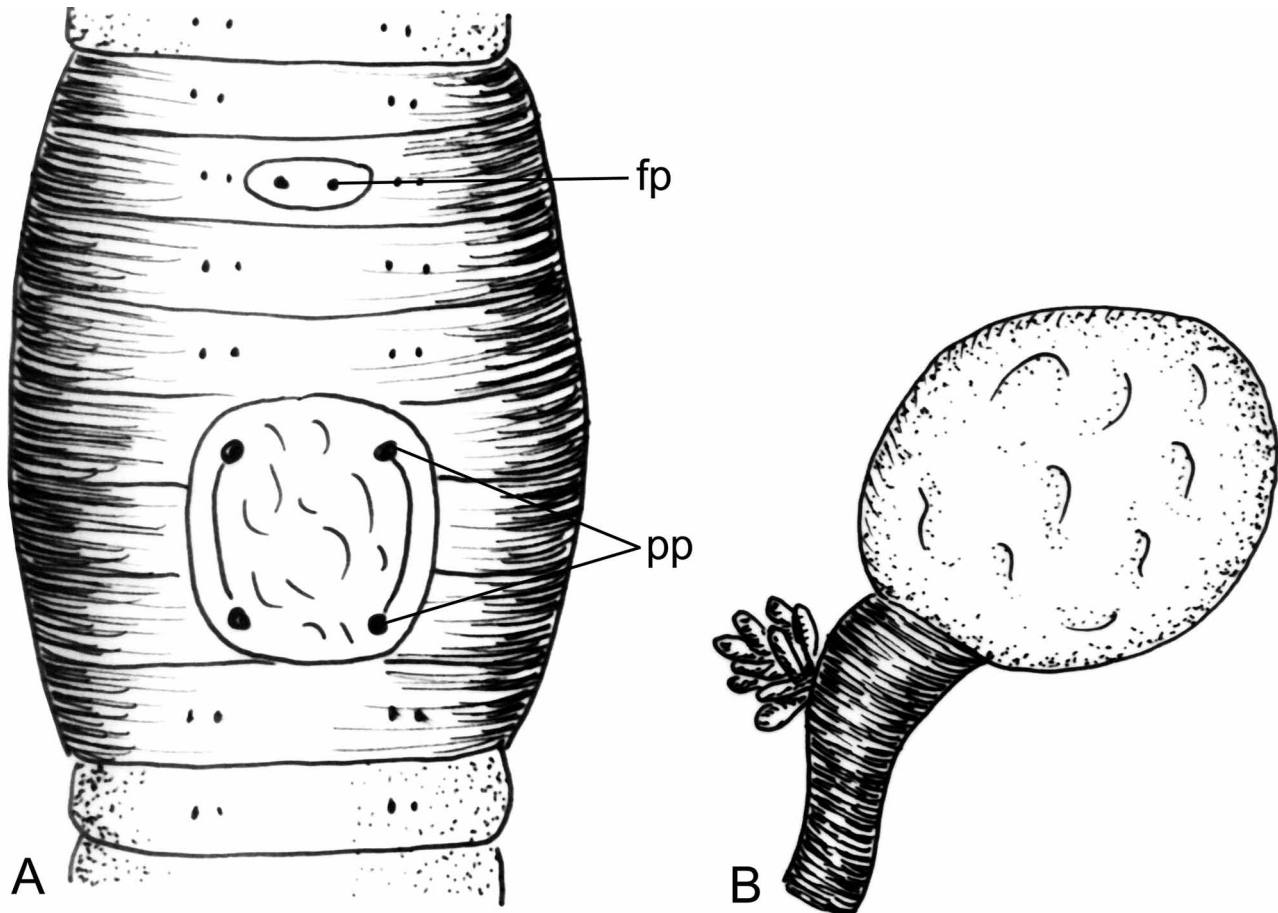
*Dichogaster kepo* Righi & Merino, 1987: 540. **syn. nov.**

**Material.** BMNH 2010.75, 2010.92. Locality: **EJ**, 2 ex. (micro).

**Diagnosis.** *L.* 79–83 mm, *D.* 4–5 mm. *No.* segments: 132–146. Pigmentation pale with praeclitellar reddish hints on dorsum. First dorsal pore in 12/13. Clitellum 13–20. ♀ 14 paired, in between *a–a*. Prostatic pores 17, 19. Spermathecal pores 7/8, 8/9, spermathecae with egg-shaped ampoule, and a duct which entally bears a racemose diverticulum. A thick proventriculus in 5, gizzards in 6–7, last pair of hearts in 12. Meronephridia 5-6 on each side, penial setae lacking.

**Remarks.** This is the first report of *E. (E.) oraedivitis*, the generotype of *Eutrigaster*, since the original description. This new material from Nicaragua completely agrees with the description of the Costa Rican types by Cognetti (1904). Dissecting the animal, the large shining proventriculus in 5 was quite obvious and it is easy to understand why Cognetti regarded *Eutrigaster* as having three gizzards.

In 1987, Righi & Merino described a new species, *Dichogaster kepo*, from Costa Rica. Their description and furthermore the figures of the male field and the spermathecae are highly similar to those of *E. oraedivitis*. They seemingly overlooked the existence of *E. oraedivitis*, which had even been revised in the very same year by Sims (1987), and they did not mention it among the possible similar species of *D. kepo* in their paper.



**FIGURE 2.** *Eutrigaster (Eutrigaster) oraedivitis* Cognetti, 1904. A. Ventral view of the clitellar region, B. Spermatheca. *fp* = female pores, *pp* = prostatic pores.

### *Eutrigaster (Graffia) azul* Sherlock & Csuzdi new species

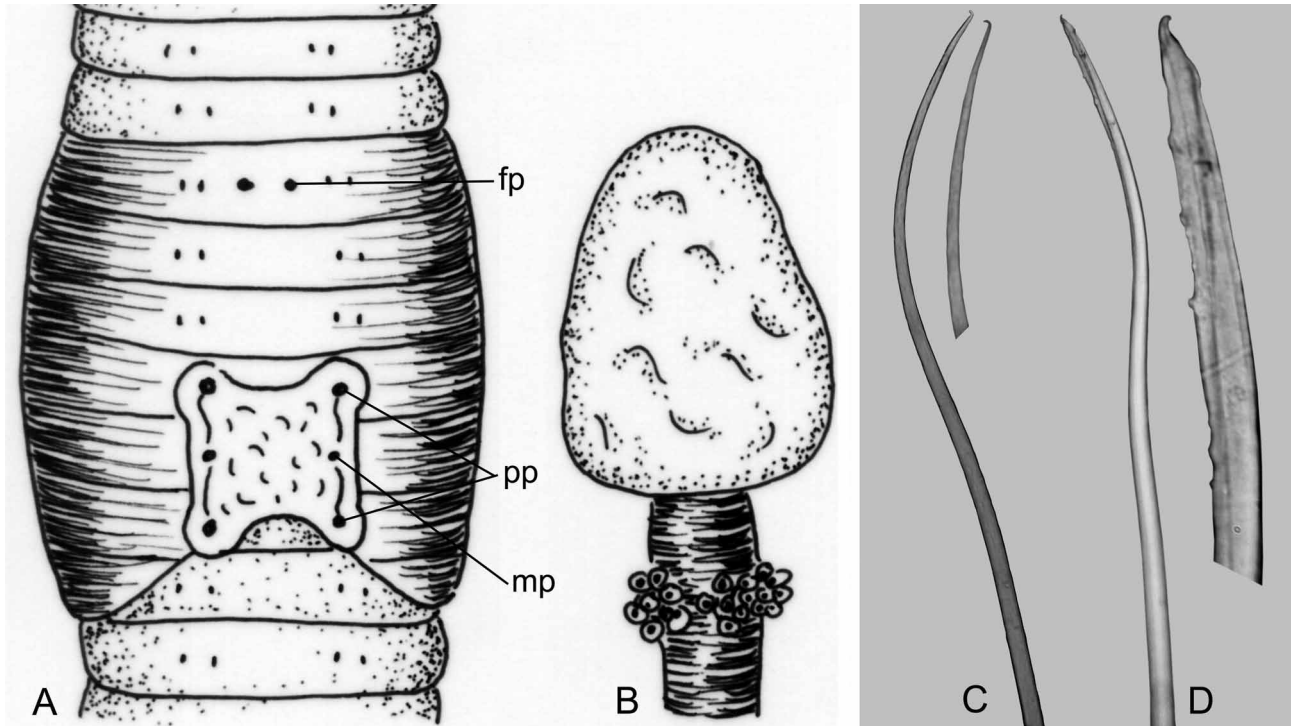
(Fig. 3)

**Material.** *Holotype.* BMNH 2010.91. Nicaragua, El Jaguar (N 13° 14.29', W 86°03.083') Rotting log in Cloud forest. Leg. S. Lee, S. McPhee and E. Sherlock, 09.09.2009. *Paratype.* HNHM AF/5471, Nicaragua, El Jaguar (13°14.368' N, 86°03.044' W). Within Bromeliad. Leg. E. Sherlock, S. Lee & S. McPhee.

**Etymology.** The specific epithet refers to the characteristic blue colour; *azul* = *blue* (spanish). It is also the title of one of the main books written by Ruben Dario, Nicaraguan author.

**Diagnosis.** *L.* 79–83 mm, *D.* 4–5 mm. *No.* segments: 132–146. Pigmentation blue alive, reddish-brown preserved. First dorsal pore in 11/12. Clitellum 13–20. ♀ 14 paired, in between *a*–*a*. Prostatic pores 17, 19. Spermathecal pores 7/8, 8/9, spermathecae with sac-shaped ampoule, and a duct which ectally bears several small diverticula almost encircling the duct. A large proventriculus in 5, gizzards in 6–7, last pair of hearts in 12, meronephridia 5 on each side. Penial setae are of two types, larger *L.* 1.2 mm, *D.* 0.01 mm, tip hooked, ornamentation scattered small teeth. Smaller *L.* 1.1, mm *D.* 0.015 mm, tip trihedral, true ornamentation lacking.

**External characters.** Holotype. Length 83 mm, diameter 5 mm, number of segments 132. The sole paratype 79 mm in length, 4 mm in diameter, number of segments: 146. Colour blue alive, reddish-brown preserved, more prominent on dorsum. Prostomium epilobous open with slight furrows running to segment 2. First dorsal pore in 11/12. Setae all ventral, setal arrangement after the clitellum aa:ab:bc:cd:dd=3.3:1:3.3:1:26.7. Clitellum circular extends over segments 13–20, on 13 slightly developed. Male field barbell-shaped, prostatic pores paired on 17, 19 in the setal line *a*. Male pores clearly visible on 18, in the seminal groves. Female pores paired on 14 in between setae *a*–*a* (Fig. 3A). Spermathecal pores paired in 7/8, 8/9 in the setal line *a*. Porophores absent.



**FIGURE 3.** *Eutrigger (Graffia) azul* n. sp. A. Ventral view of the clitellar region, B. Spermatheca, C&D. Photographs of the penial setae. *fp* = female pores, *pp* = prostatic pores, *mp* = male pores.

**Internal characters.** The first septum 4/5, septa 11/12–13/14 slightly thickened. A voluminous proventriculus in segment 5 and two oesophageal gizzards in 6 and 7. Three pairs of calciferous glands open separately in segments 15–17, their size slightly increasing backwards. Excretory system meroic, with 6 meronephridia on each side. Paired hearts are present in segments 10–12. Typhlosole small, lamellar, due to the bad preservation of the intestine its beginning can not be determined. There are two pairs of well detached lateral deflections, similar to intestinal caeca in 34, 35.

Testes are enclosed in large suboesophageal testis sacs in 10 and 11. Seminal vesicles lacking. Seminal duct is convoluted, its end widening and becoming muscular before discharging in segment 18. Two pairs of prostatic glands are present in 17 and 19, those in 17 are large and highly coiled, in 19 small. Each prostate is provided with a penial setal sack containing two different types of penial setae. The longer one is about 1.2 mm long and 0.01 mm wide with hooked tip. Ornamentation consists of small scattered teeth. The shorter one is almost smooth only several bumps can be seen just under the tip. Length about 1.1 mm diameter 0.015 mm tip trihedral (Fig. 3C–D). There are two pairs of spermathecae in segment 8 and 9. The ampoule is irregular sac-shaped and as long as the muscular duct. The duct ectally bears several bunches of diverticula accompanied by some singular ones almost encircling the duct (Fig. 3B).

**Remarks.** We have assigned *E. (G.) azul* sp. nov. to the subgenus *Graffia* due to the presence of penial setae. The new species, regarding the shape of spermathecae is similar to *E. (G.) picadoi* Michaelsen, 1912; however differs from it by presence of two different types of penial setae. *E. (G.) azul* sp. nov. possessing dimorph penial setae shows some affinity to *E. (G.) michaelsoniana* Csuzdi & Zicsi, 1991 as well but differs from it in the shape of spermathecae and in the morphology of penial setae.

*Eutrigaster (Graffia) nicaraoi* Csuzdi & Sherlock new species

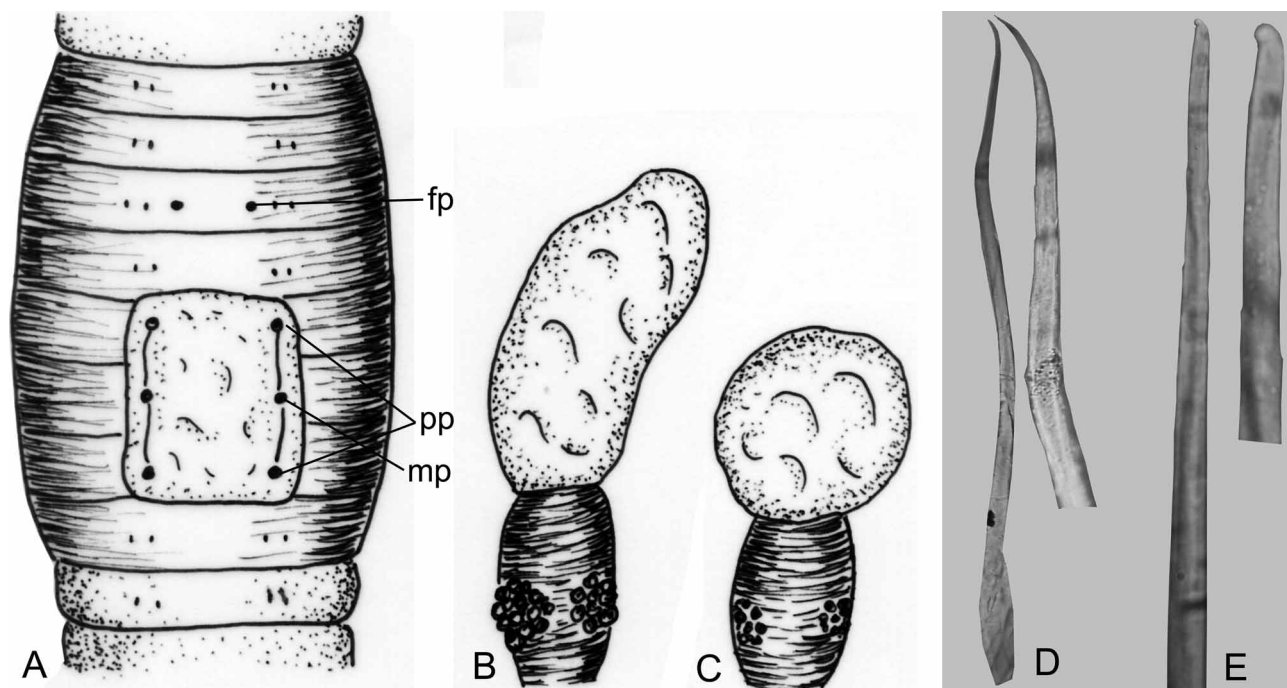
(Fig. 4)

**Material.** *Holotype.* HNHM AF/5475 Nicaragua, Dpto. Rió San Juan, Refugio Bartola (N 10°58.346', W 84°20.341') under log. Leg. O. Merkl, N. Bálint & T. Németh, 15–25.06.2007. *Other material.* HNHM AF/5476 1 praeadult, locality and date same as that of the Holotype.

**Etymology.** The specific epithet refers to Cacique Nicarao, an indigenous leader when the Spanish arrived.

**Diagnosis.** *L.* 80 mm, *D.* 5 mm. *No.* segments: 172. Pigmentation preserved reddish-brown. First dorsal pore in 12/13. Clitellum  $\frac{1}{2}$ 12–20. ♀ 14 paired, in between *a*–*a*. Prostatic pores 17, 19. Spermathecal pores 7/8, 8/9, spermathecae with elongated sac-shaped ampoule, and a duct which ectally bears several small diverticula almost encircling the duct. A prominent proventriculus in 5, gizzards in 6–7, last pair of hearts in 12, meronephridia 7–6 on each side. Penial setae are of two types, larger *L.* 0.75 mm *D.* 0.008 mm, tip slightly hooked, ornamentation weak serrations. Smaller *L.* 0.625 mm *D.* 0.01 mm, tip slightly spoon-shaped, ornamentation weak serrations.

**External characters.** *Holotype.* Length 80 mm, diameter 5 mm, number of segments 172. Colour reddish-brown preserved, more prominent on dorsum. Prostomium epilobous open with slight furrows running to segment 2. First dorsal pore in 12/13. Setae all ventral, setal arrangement after the clitellum *aa:ab:bc:cd:dd*=3.5:1:3.25:1:22.5. Clitellum circular extends over segments  $\frac{1}{2}$ 12–20, on 12 slightly developed. Male field oblong, prostatic pores paired on 17, 19 in the setal line *a*. Male pores clearly visible on 18, in the seminal groves. Female pores paired on 14 in between setae *a*–*a* (Fig. 4A). Spermathecal pores paired in 7/8, 8/9 in the setal line *a*. Porophores absent.



**FIGURE 4.** *Eutrigaster (Graffia) nicaraoi* n. sp. A. Ventral view of the clitellar region, B. Spermatheca, C&D. Photographs of the penial setae. *fp* = female pores, *pp* = prostatic pores, *mp* = male pores.

**Internal characters.** The first septum 4/5, septa 11/12–13/14 slightly thickened. A voluminous proventriculus in segment 5 and two oesophageal gizzards in 6 and 7. Three pairs of calciferous glands open separately in segment 15–17, the first pair somewhat smaller than the others. Excretory system meroic, with 7–8 meronephridia on each side. Paired hearts are present in segments 10–12. Typhlosole small, lamellar, begins in segment 27 and accompanied by a pair of auxiliary typhlosole until 34. The intestine is prominently bulging in 30–34 but due to being filled with debris definite caecum-like organ can not be seen. In the juvenile specimen examined slight caeca were paired in 33–34.

Testes are enclosed in large suboesophageal testis sacs in 10 and 11. Seminal vesicles lacking. Seminal duct is convoluted, its end widening and becoming muscular before discharging in segment 18. Two pairs of prostatic glands are present in 17 and 19 those in 17 are large and highly coiled, in 19 small. Each prostate is provided with

a penial setal sack containing two different types of penial setae. The longer one is about 0.75 mm long and 0.008 mm wide with slightly bent tip. Ornamentation consists of weak serrations. The shorter seta is 0.65 mm in length and 0.01 mm in diameter, its tip somewhat bent and slightly spoon-shaped, ornamentation weak serrations (Fig. 4D–E). There are two pairs of spermathecae in segment 8 and 9. The first pair is somewhat smaller than the second one. The ampoule is elongated sac-shaped and longer than the muscular duct. The duct ectally bears several bunches of diverticula almost encircling the duct (Fig. 4B–C).

**Remarks.** *E. (G.) nicaraoi* **sp. nov.** belongs to the subgenus *Graffia* due to the presence of penial setae. The new species, regarding the shape of spermathecae is similar to *E. (G.) picadoi* Michaelsen, 1912; however differs from it by presence of two different types of penial setae. It shows affinity to *E. (G.) azul* **sp. nov.** by possessing dimorph penial setae but differs from it in the structure of spermathecae and in the morphology of penial setae.

### *Eutrigaster (Graffia) sporadonephra sporadonephra* (Cognetti, 1905)

*Dichogaster sporadonephra* Cognetti, 1905b: 2, Cognetti 1905a: 43, Csuzdi & Zicsi 1991: 191.

*Eutrigaster (Graffia) sporadonephra*: Csuzdi 1995: 109, Csuzdi 1996: 360, Brown & Fragoso 2007: 66, Blakemore 2008: 184.

**Material.** BMNH 2010.34, 2010.34, 2010.36–37, 2010.40, 2010.43, 2010.74. Locality: **M** 6 ex. (micro/brom), HNHM AF/5473 2 ex. Locality: **RSJ**, 2 ex. (micro).

### Family Glossoscolecidae Michaelsen, 1900

#### *Diachaeta thomasi* Benham, 1886

*Diachaeta thomasi* (sic) Benham, 1886: 89.

*Diachaeta thomasi*: Michaelsen 1900: 424, Zicsi 1995a: 58, Blakemore 2008: 440.

**Material.** BMNH 2010.48–49. Locality: **M**, 2 ex. (mono).

#### *Glossodrilus nemoralis* (Cognetti, 1905)

*Glossoscolex nemoralis* Cognetti, 1905b: 6, Cognetti 1906: 247, Michaelsen 1918: 293.

*Andioscolex nemoralis*: Michaelsen 1927: 373.

*Glossodrilus nemoralis*: Righi 1995: 578, Zicsi 1995b: 101, Brown & Fragoso 2007: 51.

**Material.** BMNH 2010.44. Locality: **S**, 1 ex. (mono).

#### *Periscolex brachycystis* (Cognetti, 1905)

*Hesperoscolex brachycystis* Cognetti, 1905b: 4, Cognetti 1906: 157.

*Periscolex brachycystis*: Michaelsen 1918: 249, Zicsi 1992: 214, Brown & Fragoso 2007: 56.

**Material.** BMNH 2010. 61, 2010.126. Locality: **MAN**, 2 ex. (mono/micro), HNHM AF/5474 1 x. Locality: **RSJ**, 1 ex. (micro).

#### *Pontoscolex corethrurus* (Müller, 1857)

*Lumbricus corethrurus* Müller, 1857: 113.

*Pontoscolex corethrurus*: Beddard 1892: 127; Michaelsen 1900: 425, Cognetti 1906: 170, Michaelsen 1918: 234, Blakemore 2008: 444 (for complete synonymy).

**Material.** BMNH 2010.53, 2010.54–57. Locality: **EJ**, 18 ex. (mono/micro), BMNH 2010.58–59. Locality: **M**, 11 ex. (mono/micro), BMNH 2010.94–95. Locality: **C**, 1 ex. (mono), HNHM AF/5467. Locality: **RSJ**, 1 ex. (micro).

**Family Lumbricidae Rafinesque-Schmaltz, 1815*****Eisenia fetida* (Savigny, 1826)**

*Enterion fetidum* Savigny, 1826: 182.

*Eisenia foetida*: Michaelsen, 1900: 475.

*Eisenia fetida*: Blakemore 2008: 571 (for complete synonymy).

**Material.** BMNH 2010.100-109. Locality: **MO**, 12 ex. (micro).

**Family Megascolecidae Rosa, 1891*****Amyntas corticis* (Kinberg, 1867)**

*Perichaeta corticis* Kinberg, 1867: 102.

*Amyntas corticis*: Easton 1982: 726, Blakemore 2008: 271 (for complete synonymy).

**Material.** BMNH 2010.60. Locality: **EJ**, 1 ex. (mono).

***Amyntas gracilis* (Kinberg, 1869)**

*Nitocris gracilis* Kinberg, 1867: 102.

*Amyntas gracilis*: Sims & Easton 1972: 235, Blakemore 2008: 283 (for complete synonymy).

**Material.** BMNH 2010.76-78. Locality: **EJ**, 5 ex. (micro).

***Metaphire californica* (Kinberg, 1867)**

*Pheretima californica* Kinberg, 1867: 102.

*Metaphire californica*: Sims & Easton 1972: 238, Blakemore 2008: 342 (for complete synonymy).

**Material.** BMNH 2010.51-52, 2010.96-99, 2010.80-89. Locality: **EJ**, 14 ex. (micro/mono).

***Metaphire houlleti* (Perrier, 1872)**

*Perichaeta houlleti* Perrier, 1872: 99.

*Metaphire houlleti*: Sims & Easton 1972: 238, Blakemore 2008: 377 (for complete synonymy).

**Material.** BMNH 2010.71-72. **S**, 10 ex.(micro/mono)., **C**, 10 ex. (micro), **M**, 9 ex. (micro) , 2010.73, 2010.110-114

***Polypheretima elongata* (Perrier, 1872)**

*Perichaeta elongata* Perrier, 1872: 124.

*Polypheretima elongata*: Easton 1979: 53, Blakemore 2008: 427.

**Material.** BMNH 2010.45. Locality: **S**, 4 ex. (mono)



## Family Ocneroдрilidae Beddard, 1891

### *Nematogenia panamaensis* Eisen, 1900

*Ocneroдрilus* (*Nematogenia*) *lacuum* var. *panamaensis* Eisen, 1900: 127.

*Nematogenia panamaensis*: Michaelsen 1900: 376, Blakemore 2008: 145 (for complete synonymy).

**Material.** BMNH 2010.50, 2010.79. Locality: **EJ**, 2 ex. (mono/micro).

## Discussion

The present survey yielded 19 species from five different families and 11 different genera. Two of the *Eutrigaster* species are new to science. All species found but one (*Pontoscolex corethrurus*) are new records for Nicaragua and seven species are probably native.

Of the previously described native fauna, two species are of particular interest: *Eutrigaster* (*Eutrigaster*) *oraedivitis* Cognetti, 1904 and *Dichogaster* (*Diplothecodrilus*) *tristani* (Cognetti, 1907). Both species were described from Costa Rica and have not been reported at all or only once (*D. (Dt.) tristani* by its synonymous name *D. pithayana* by Michaelsen (1912)) since their original description. The re-emergence of *Eutrigaster* (*Eutrigaster*) *oraedivitis* is especially important because it is the type species of the somewhat controversial genus *Eutrigaster* (See James 2004). This species seems to be more frequent in Central America than the present data shows, which is proved by its record under the synonymous name *D. kepo* as well.

The species list produced here is just a fraction of the number of species to be found in Nicaragua. The expedition was limited: just two weeks were spent in the country and during this time the project was hampered by the inaccessibility of one of the planned sites and injury. This resulted in a number of sampling days being lost. A more comprehensive and systematic sampling trip across the country needs to take place to accurately get a picture of the extent and diversity of the earthworm fauna in Nicaragua.

For the South American continent as a whole though the picture is not so gloomy. Interest appears to be growing and consolidating. The first Latin American meeting of Earthworm Ecology and Taxonomy was held in Brazil in 2003. This was such a success that a second meeting was organised and held in Puerto Rico in 2005 and subsequently a third in Brazil in 2007. Also in 2007 George Brown and Carlos Fragoso edited a comprehensive book on the earthworm fauna of Latin America 'Minhocas na America Latina: Biodiversidade e Ecologia'. This interest has led to the establishment of taxonomy training workshops in the Americas and hopefully will lead to a more systematic and holistic approach to collecting earthworm data across Latin America.

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