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PENSOFT

First record of the Woodland Blue Worm *Octolasion cyaneum* (Savigny, 1826) (Lumbricina, Lumbricidae) in the Colombian Andes

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Abstract

In South America, the European epi-endogeic lumbricid *Octolasion cyaneum* (Savigny, 1826) is known from Argentina, Chile, Brazil, Uruguay, and Ecuador. Here, we report this earthworm from Colombia for the first time. We found it in areas undergoing ecologic restoration in the Neusa Forest Reservoir, which is located in the department of Cundinamarca. Predominant vegetation in sampled areas is composed of *Holcus lanatus*, *Hypochaeris radicata*, and *Anthoxanthum odorathum*.

Key words

Oligochaeta; invasive species; grassland; Neotropical montane forest; restoration ecology.

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Introduction

The lumbricid genus *Octolasion* Örley, 1885 is currently composed of 4 species and 1 subspecies (Pop et al. 2008). It is believed that *Octolasion* species are native to central Europe, where some authors have traced their geographical origin (Terhivuo and Saura 2006, Pop and Pop 2006, Pop et al. 2008, Kuu and Ivask 2013, Shekhovtsov et al. 2014). Earthworms belonging to this genus are entirely endogenic (Domínguez et al. 2015, Pérez-Losada et al. 2015). *Octolasion cyaneum* (Savigny, 1826) is one of the most widespread lumbricids, found on all the continents, as well as Iceland, New Zealand, and the Azores (Reynolds 1977, Blakemore 2002, Brown et al. 2006, González et al. 2006, Terhivuo and Saura 2006, Christoffersen 2011). This species is highly invasive and very successful in the colonization of new areas; it can even outcompete native earthworm species (Kuu and Ivask 2013). Factors related to the success of its invasiveness include strict parthenogenic reproduction, anthropochorous dispersion, high tolerance to extreme soil and climatic conditions, and preference for transformed landscapes, especially man-made grasslands (Brown et al. 2006, Hendrix 2006, Hendrix et al. 2006, Pop and Pop 2006, Tiunov et al. 2006, Kuu and Ivask 2013, Salvio et al. 2016). *Octolasion cyaneum* (Savigny, 1826) is present in five out of the ten countries of South America: Argentina, Chile, Brazil, Uruguay, and Ecuador (Christoffersen 2011). In 1976 the first record of a species of *Octolasion* was reported in Colombia: *O. lacteum lacteum* (Örley, 1881) by Fajardo and Prince (1976). Here, we record for the first time the presence of *O. cyaneum* in Colombian Andes.

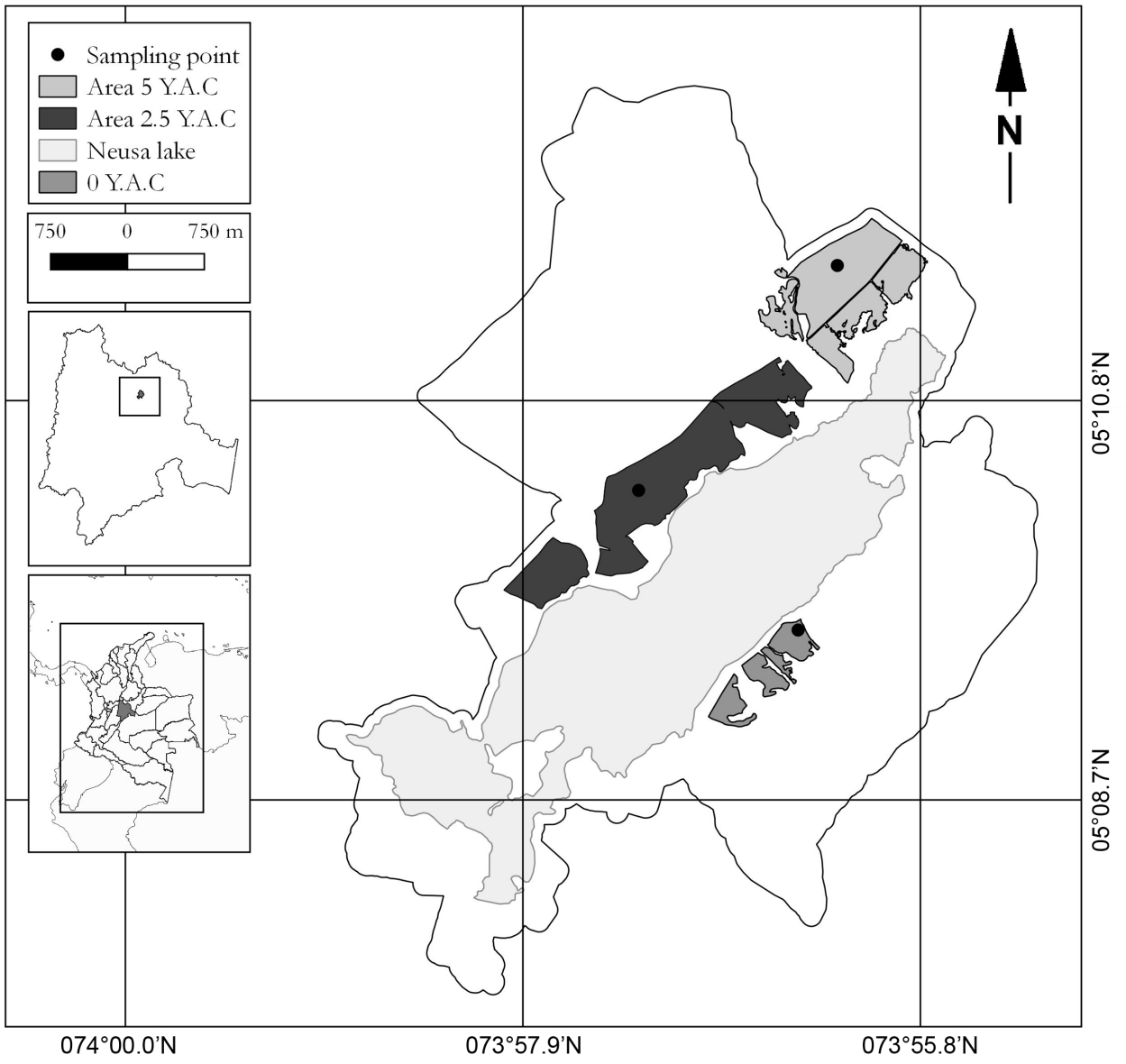

Figure 1. Distribution of *Octolasion cyaneum* in Colombia, Cundinamarca, Tausa-Cogua, Neusa Reservoir Forest Park, showing areas with different year after cut (YAC).

Methods

The sampling was conducted at the Neusa Reservoir Forest Park (NRFP), Cundinamarca department, located at 3100 m altitude, on the eastern Cordillera of Colombia. The average annual t = 10.5 °C, rainfall regime is bimodal with an average of 1025 mm/year. Soils are classified by their textural class as silty clay loam. NRFP, is located in the municipalities of Cogua and Tausa (Cundinamarca, Colombia). An artificial water lake reservoir was constructed in 1950, for which the native forest was removed, then replaced with a plantation of *Pinus patula* Schiede ex Schltdl. & Cham around the lake to control soil erosion (Kotschwar 1980). Park authorities began to remove these plantations in 2009 in order to start a restoration program. Samples were collected in three areas, each with different time elapsing since cutting down *P. patula* plantations, namely 0, 2.5 and 5 years after cut (YAC) (Fig. 1). Samplings were made following the Tropical Soil Biology and Fertility (TSBF) method (Anderson and Ingram 1993).

We followed the convention of using Arabic numerals for segments and intersegmental furrows (the external boundary between adjacent segments). For instance, *Clitellum 29–34, 35* indicates the Clitellum extends from body surface of segments 29–34 and sometimes to 35; spermatheca 3 pairs in 9–11 indicates 1 pair of spermathecae inside each of segments 9, 10, and 11; and spermathecal pores 2 pairs in 9/10/11 indicates 1 pair of spermathecal pores open onto the body surface between segments 9 and 10, 10 and 11. Setal formula is expressed as the distance between the setae, and is usually measured on segments 10 and/or 30, as an estimate of the space between the A, B, C, and D meridians of the earthworm body (see Reynolds 1977, 2017, Chang 2016). We

expressed this as groupings (AB>BC>CD), intersetal intervals are expressed in diminished (*ab>bc>cd*).

We sent some specimens to earthworm specialist Dr Alexander Feijoo (UTP) who confirmed the identification. All the specimens were fixed in 5% formaldehyde and then preserved in 80% ethanol. Collected specimens were deposited at the National Collection of Earthworms in the Technological University of Pereira (CNLT-UTP).

Results

***Octolasion cyaneum* (Savigny, 1826)**

(For synonyms see Christoffersen 2011.)

New records. Colombia: Cundinamarca: Tausa: Neusa Reservoir Forest Park: Guanquica : (05°011′40.3″ N, 073°57′07.2″ W, WGS84, 3060 m above sea level) (Fig. 2), January 2015, Patricia Pinzon-Garcia, Esteban Tulande-M coll. (189 specimens, CNLT-UTP 0316-1). Colombia: Cundinamarca: Tausa: Neusa Reservoir Forest Park: Chapinero (05°10′25.1″ N, 073°57′ 09.6″ W, WGS84, 3050 m above sea level), Esteban Tulande-M coll. (6 specimens, CNLT-UTP 0316-2). Colombia: Cundinamarca: Tausa: Neusa Reservoir Forest Park: Laureles (05°09′30.2″ N, 073°56′ 24.2″ W, WGS84, 3100 m above sea level) Esteban Tulande-M coll. (1 specimen, CNLT-UTP 0316-3).

Altogether, 189 individuals of *O. cyaneum* were collected in an area where the pines had been cut down five years ago (05°011′40.3″ N, 073°57′07.2″ W, WGS84, 3060 m above sea level). Six individuals were collected from an area where the trees had been cut down 2½ years ago (05°10′25.1″ N, 073°57′09.6″ W, WGS84, 3050 m above sea level), and 5 individuals where pines had been cut down less than 1 year prior (05°09′30.2″ N, 073°56′24.2″ W, WGS84, 3100 m above sea level) (Fig. 1).

In the 5-year after cut area, we estimated a total of 36 individuals/m^2, in a total of 3.75m^3 of hand sorted soil. In this area, the dominating vegetation was composed mostly by exotic grass species, including *Holcus lanatus L.*, *Hypochaeris radicata L.*, *Anthoxanthum odorathum L.* and *Rumex acetosella L*. Berry bush *Rubus floribundus* Kunth, was also common. The litter layer was thin (< 10 cm) consisting mainly of grass leaves.

Diagnosis. *External*. The body is cylindrical and towards the posterior area it becomes octagonal. Length 30 mm. Diameter 4 mm, segment number 90–115, prostomium epilobic, first dorsal pore 9/11, 10/11 and 11/12 between setal lines *cd*. Clitellum 29–34, 35 (usually beige or yellowish), saddle-shaped with the ventral margins reaching down nearly to setal line *a*. Setae small, closely paired on the anterior portion, CD<AB<BC<AA<DD, and widely paired in the posterior portion, AB>BC>CD. The setae of 10, 18, 19, 20, and 21 frequently related to the white genital tumescences. Male pores paired on the 15th segment between setal lines *bc*. From segments 9–12 there

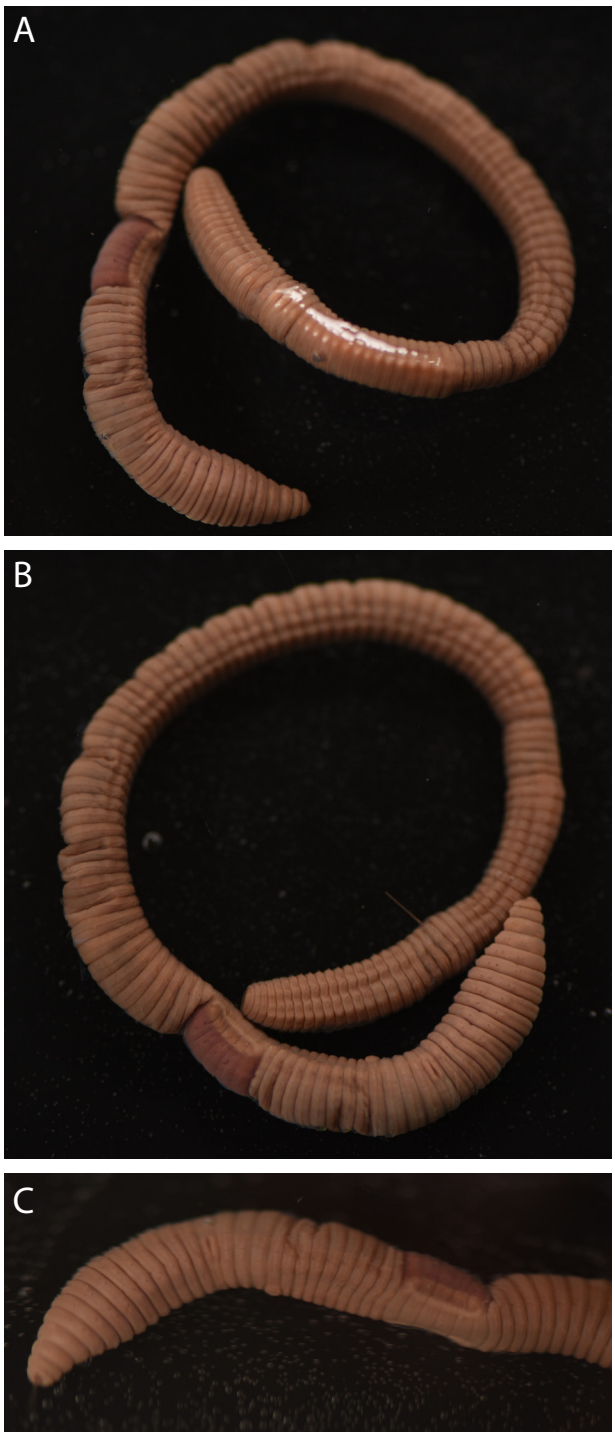

Figure 2. *Octolasion cyaneum* (CNLT-UTP 0316-1). General aspect (**A, B**) of an adult specimen and detail of its anterior region (**C**) in ventral views, from Neusa Reservoir Forest Park, Colombia, Cundinamarca Tausa. Photograpsh: Alexander Feijoo-M.

are 4 pairs of seminal vesicles. Two pairs 9/10/11 of spermathecal pore openings between *cd*. *Internal*. Anterior septa clearly seen 7/8–12, 13 slightly thickened. Four pairs of seminal vesicles in 9, 10, 11, and 12. Color of the individuals bluish-gray.

Octolasion cyaneum is very similar to *O. lacteum lacteum* from which it can be differentiated by the position of the clitellum (30–35) and the position of the tuberculata pubertatis (31–34) (Pavlíček et al. 2012, Reynolds 2017*)*. Another similar species found in Colombia is

Table 1. Differences between *Octolasion cyaneum* and *Dendrobaena octaedra*.

Character	*Octolasion cyaneum*	*Dendrobaena octaedra*
First dorsal pore	9/10, 10/11, 11/12	4/5, 5/6
Spermathecal pores	2 pairs 9/10/11 between setal lines *cd*	3 pairs in 9–11, in line with setal *d*
Male pores	Paired on segment 15, between setal lines *bc*	Paired on segment 15 across setal line *b*
Clitellum	29 –34, 35	27, 28, 29–33, 34
Genital tumescenses	17–20, 21	31–33, 34
Seminal vesicles	4 pairs in 9, 10, 11, 12	Paired in 3 segments 9, 11, 12
Anterior septa	7/8–12, 13 slightly thickened	Thin

Dendrobaena octaedra (Savigny, 1826), from which it can be differentiated by the differences given in Table 1.

Discussion

Given this new record of *O. cyaneum* in Colombia, it is possible that this species might also be present in Bolivia, Paraguay, Peru, and even Venezuela due to their proximity and the similarity of biomes.

Most individuals of *O. cyaneum* were collected in the areas where the trees had been cut down 5 years prior. This area congregate most anthropic disturbances, including a road with moderate to heavy traffic, occasional cattle, and proximity to crops, each of these being a potential dispersal mechanism for *O. cyaneum*.

According to Vera et al. (2007) the conversion of Andean forests into pastures produces important changes in the microstructure of the soil clay. Homeier et al. (2013) suggest that the appearance of grasslands after cutting down native Andean forests can be interpreted as the beginning of Andean ecosystems degradations. Considering the marked preference of *O. cyaneum* for pastures with ample anthropogenic intervention, the presence of the species in NRFP may negatively affect local native earthworm fauna, including *Glossodrilus palenke* (Righi, 1995) *Andiodrilus makaguaje* (Feijoo, 2008). It also might cause unwanted effects on soil structure and/or biochemical rates. In Amazonia, Chauvel et al. (1999) reported on the degradation of different areas by *Pontoscolex corethrurus* (Müller, 1857), another exotic earthworm species.

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Authors' Contributions

ETM collected the data, made some of the identifications, and wrote the manuscript; PPG reviewed and identified some of the material; AFM identified and confirmed part of the material, JIB made the maps and collected physical-chemical data.

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