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Is *Aporrectodea borellii* (Cognetti, 1904) (Oligochaeta. Lumbricidae) present in North America?

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Abstract
Recent phylogenomic analyses have clarified long standing taxonomic confusion within the *Aporrectodea trapezoides* complex. Historically treated as a junior synonym of *A. trapezoides*, *Aporrectodea borellii* (Cognetti de Martiis, 1904) is now recognized as a distinct species corresponding to Lineage I of Marchán *et al.* (2025). Specimens from the type locality of *A. trapezoides* belong to Lineage II, whereas topotypic material of *A. borellii* clusters within Lineage I and exhibits diagnostic morphological traits consistent with Cognetti's original description, most notably a clitellum terminating on segment 35. Because North American records of *A. trapezoides* frequently include specimens with clitellar termination on segment 35, many of these likely represent *A. borellii*. Historical treatments by Bouché (1972), Mršić (1991), and Csuzdi and Zicsi (2003) submerged *borellii* within *A. caliginosa* sensu lato, while Gates (1972) documented broad clitellar variability that contributed to decades of misidentification. Under the revised phylogenetic framework, re-examination of museum material across Canada and the United States is required to determine the true distribution of *A. borellii* in North America. This study synthesises historical taxonomy, morphological diagnosis, and recent molecular evidence to support the presence—and likely widespread misidentification—of *A. borellii* in North America. A substantial proportion of North American specimens currently labelled as *A. trapezoides* are expected to belong to *A. borellii*.

Keywords: *Aporrectodea borellii*, *Aporrectodea trapezoides*, Lumbricidae, earthworm taxonomy, clitellum morphology, phylogenomics, North America, species misidentification, Cognetti de Martiis, lineage I/lineage II

Introduction

Recent molecular work has fundamentally reshaped the taxonomy of the *Aporrectodea trapezoides* species complex. Historically, *Aporrectodea borellii* was regarded as a junior synonym of *A. trapezoides*. However, recent phylogenomic analyses demonstrate that *A. trapezoides* is not monophyletic, but instead comprises two distinct evolutionary lineages (Lineage I and Lineage II) representing separate species (Marchán *et al.* 2025) [26]. Because specimens from the type locality of *A. trapezoides*—the Montpellier Botanical Garden—belong to Lineage II, that lineage retains the name *A. trapezoides*. Lineage I is therefore resurrected as *A. borellii*, a conclusion supported by topotypic evidence (specimens collected near the type locality of *A. borellii* belong to Lineage I) and by morphological traits, notably the termination of the clitellum on segment 35 in Lineage I rather than segment 34 in *A. trapezoides*. Consequently, North American records of *A. trapezoides* with a clitellum ending on segment 35 likely represent *A. borellii* (Brown *et al.* 2026) [2].

The original description of *Helodrilus (Allolobophora) Borellii* n. sp. by Dr. Luigi Cognetti de Martiis (1904, pp. 2–3) [8] reads: "Clitello a cingolo, non tigonfio, esteso sui segmenti 25–35, poco sviluppati ventralmente. Tubercula pubertatis 31–½34, in forma di due facette longitudinali di tinta oscura." [Clitellum as a girdle, not swollen, extending over segments 25–35, slightly developed ventrally. Tubercula pubertatis on segments 31–½34, shaped as two longitudinal dark coloured facets.] Cognetti's description was based on a single adult specimen collected at Massiccio d'Astazou, a massif straddling the border between France and Spain in the central Pyrenees. The clitellum covering segments 25-35 is the significant diagnostic taxonomic character.

My early research (1969–1975) was strongly influenced by Bouché (1972) [3] and especially Gates (1972) [19]. Gates' treatment of *Aporrectodea trapezoides* (Dugès, 1828) [11] documented considerable variation in clitellar extent, as illustrated by the following series selected at random: "(xxv?)-xxxiv (1), xxv/n-xxxv (1), xxv/-n-xxx/n (2), (xxvi?)-xxxiv (1), with 17 additional specimens too poorly preserved to determine clitellar limits." Later (p. 31), Gates noted that variation in the genitalia of *A. trapezoides* was largely confined to parietal portions of the reproductive system, and that the clitellum may comprise 7–11 segments, beginning on any of segments xxv–xxviii and ending on any of xxxiv or xxxv.

Bouché (1972) [3] treated *Allolobophora borelli* [sic] as *Nicodrilus caliginosus* sensu lato (pp. 132, 335), with a saddle shaped clitellum on segments 27–34. This interpretation was followed by Mršić (1991, p. 321) [29] and Csuzdi and Zicsi (2003, p. 75) [9], who placed the taxon within *Aporrectodea (Aporrectodea) caliginosa caliginosa* (Savigny, 1826) [41]. After Gates (1972) [19], both Gates and I considered *Nicodrilus (Nicodrilus) caliginosus meridionalis* Bouché, 1972 (p. 334) to be a synonym of *A. trapezoides*, and *Nicodrilus (Nicodrilus) caliginosus caliginosus* (Savigny, 1826) [41] (Bouché, 1972, p. 326) [3] to be a synonym of *Aporrectodea turgida* (Eisen, 1873) [12], although many authors today consider *A. turgida* to be *A. caliginosa* (Savigny, 1826) [41] [Likewise, *Nicodrilus (Nicodrilus) caliginosus alternisetosus* (Bouché, 1972, p. 333) [3] was treated as a synonym of *Aporrectodea tuberculata* (Eisen, 1874) [13]. *A. subterrestris* (Laínez &

Jordana 1983) [24] is now considered a junior synonym of *A. borellii* (Marchán *et al.* (2025) [26].

Reynolds *et al.* (1974) [40] reported *Allolobophora* (now *Aporrectodea*) *trapezoides* with clitellar extent 27, 28–33, 34. They also cautioned that numerous references to *Helodrilus* or *Allolobophora caliginosa* subspecies, varieties, or forma *trapezoides* could not be reliably placed because of inadequate descriptions, and that many such specimens were certainly not *A. trapezoides* (*cf.* Gates 1972, p. 4) [19].

In Gates (1972) [19] and Reynolds (2018) [36], *Aporrectodea trapezoides* was recorded from all Canadian provinces except Newfoundland and Labrador and the three territories (Northwest, Nunavut, and Yukon), and from all American states except Alaska and the District of Columbia. Their reports include several thousands of specimens which are primarily deposited in The Canadian Museum of Nature (Gatineau, Quebec) and the New Brunswick Museum (Saint John). Fragoso (2001) [16] reported that *A. trapezoides* was absent from Mexico, but Juárez Ramón and Fragoso (2014) [17] later documented its presence.

Given Gates' (1972) [19] observation that the clitellum may occasionally extend from xxv to xxxv (25–35), it is possible that Gates and I regarded specimens with this clitellar range as anomalies, when in fact they may have represented *A. borellii*.

Discussion

1. Taxonomic History of *Aporrectodea borellii* and the *A. trapezoides* Complex

The taxonomic history of *Aporrectodea borellii* is intertwined with more than a century of confusion surrounding the *A. trapezoides–A. caliginosa* complex. Cognetti de Martiis (1904) described a single mature specimen of *Allolobophora borellii* from the central Pyrenees, noting a clitellum extending to segment 35 and distinctive tubercula pubertatis.

During the mid 20th century, the species was progressively submerged into *A. caliginosa* sensu lato. Bouché (1972) [3] placed *A. borelli* [sic] within *Nicodrilus caliginosus*, and subsequent regional monographs (Mršić 1991; Csuzdi and Zicsi 2003) [29, 9] followed this interpretation. Gates (1972, p. 31) [19], however, emphasized the extraordinary morphological variability of *A. trapezoides*, particularly in clitellar extent, which he documented as spanning segments xxv–xxxiv or occasionally xxv–xxxv. This variability contributed to the long-standing synonymy of *A. borellii* under *A. trapezoides*.

The advent of molecular phylogenetics fundamentally altered this view. Marchán *et al.* (2025) [26] demonstrated that *A. trapezoides* is composed of two non-monophyletic lineages. Lineage II corresponds to specimens from the type locality of *A. trapezoides* (Montpellier Botanical Garden) and retains that name. Lineage I, however, includes specimens from near the type locality of *A. borellii* and exhibits diagnostic morphological traits consistent with Cognetti's original description. Consequently, Lineage I was resurrected as *Aporrectodea borellii* (Table 1). Marchán *et al.* (2025) [26] based their support for the resurrection on studies reported by Ferández *et al.* (2012) [15] and De Sosa *et al.* (2017) [10]. Although Fernández *et al.* (2012) [15] and De Sosa *et al.* (2017) [10] did not recognize Lineage I as *A. borellii*, they provided the molecular groundwork.

Table 1: Summary of historical synonymies of *Aporrectodea borellii* and *Aporrectodea trapezoids*

Phylum **Annelida** de Lamarck, 1802[25]
Subphylum or Superclass **Clitellata** Michaelsen, 1919[28]
Class **Oligochaeta** Grube, 1850[20]
Order **Crassiclitellata** Jamieson, 1988[21]
Suborder **Lumbricina** Blainville, 1828[1]
Family **Lumbricidae** Rafinesque-Schmaltz, 1815[31]
Genus ***Aporrectodea*** Örley, 1885[30]

***Aporrectodea borellii* (Cognetti de Martiis, 1904) [8]**

1904 *Helodrilus (Allolobophora) Borellii* Cognetti de Martiis, Boll. Mus. Zool. Anat. Comp. R. Univ. Torino 19(476): 2.

1972 *Nicodrilus caliginosus* -Bouché, Inst. Natn. Rech. Agron., Paris, p. 132.

1983 *Nicodrilus subterrestris* Laínez and Jordana, Megadrilogica 4(4): 89.

1991 *Aporrectodea caliginosa caliginosa*-Mršić, Slovenska Akad. Znanosti Umetnosti, Opera 31: 321.

2003 *Aporrectodea caliginosa caliginosa*-Csuzdi & Zicsi, Pedozool. Hung. Budapest, p. 278 pp.

2012 *Aporrectodea trapezoides*-Fernández *et al.,* Mole. Phylogen. Evol. 64: 376 (Eurosiberian lineage/lineage I).

2025 *Aporrectodea borellii*-Marchán *et al.*, Zool. J. Linn. Soc. 203(3): zlaf002.

***Aporrectodea trapezoides* (Dugès, 1828) [11]**

1828 *Lumbricus trapezoides* Dugès, Ann. Sci. Nat. 15: 289.

1867 *Lumbricus novaehollandiae* Kinberg, Öfv. Vet. -Akad. Förh., Stockholm 23: 99.

1867 *Lumbricus capensis* Kinberg, Öfv. Vet. -Akad. Förh., Stockholm 23: 100.

1900 *Helodrilus (Allolobophora) caliginosus trapezoides*-Michaelsen, Das Tierre, p. 483.

1917 *Helodrilus (Helidrilus) mariensis* Stephenson, Rec. Indian Mus. 13: 414.

1923 *Allolobophora (Eophilia) marinensis*-Stephenson, The Fauna of British India, p. 504.

1931 *Allolobophora caliginosa trapezoides*-Chen, Cont. Biol. Lab. Sci. Soc. China (Zool.) 7: 168.

1938 *Dendrobaena samarigera* var. *graeca* Černosvitov, Zool. Anz. 123: 192.

1941 *Allolobophora caliginosa* f. *trapezoides*-Gates, Proc. California Acad. Sci. (4), 23: 452.

1947 *Allolobophora iowana* Evans, Ann. Mag Nat. Hist. (11), 14: 515.

1969 *Allolobophora longa* (part only?)-Reinecke and Ryke, Rev. Écol. Biol. Sol 6: 515.

1972 *Nicodrilus (Nicodrilus) caliginosus meridionalis*-Bouché, Inst. Natn. Rech. Agron., Paris, p. 334.

1975 *Aporrectodea trapezoides*-Reynolds, Megadrilogica 2(3): 3.

2012 Aporrectodea trapezoids-Fernadez *et al.*, Mole. Phylogen. Evol. 64: 376 (Mediterranean Lineage/lineage II)

2. Diagnosis of *Aporrectodea borellii* (Cognetti de Martiis, 1904) [8]

Adult size: Medium-sized lumbricid; length typically 60–110 mm (inferred from type description and Lineage I specimens).

Colour: Brownish to grey dorsally; ventral surface paler.

Clitellum: Saddle shaped, extending over segments 25–35; not swollen; slightly developed ventrally.
Tubercula pubertatis: On segments 31–½ 34, forming two longitudinal dark facets.
Setae: Lumbricine arrangement; setal spacing typical of *Aporrectodea, i.e.* closely paired.
Male pores: Paired, on segment 15; often slightly protuberant.
Spermathecal pores: Usually in 9/10 and 10/11 (Lineage I pattern).
Internal morphology: Gizzard in segment 6; calciferous glands in segments 10–12; nephridia holonephridial.
Genitalia: Parietal portions of reproductive system moderately developed; morphology consistent with Lineage I of Marchán *et al.* (2025) [26].

Diagnostic trait
Clitellum always terminating on segment 35 in mature specimens — the most reliable external character distinguishing *A. borellii* from *A. trapezoides* (Table 2).

Table 2: Differential diagnosis: *Aporrectodea borellii* vs *Aporrectodea trapezoides*

Character	***A. borellii (Lineage I)***	***A. trapezoides (Lineage II)***
Clitellum termination	*Segment 35*	*Segment 34*
Clitellar extent variability	*Narrow, stable (25-35)*	*Broad (25-28 to 34-35)*
Tubercula pubertatis	*31-½34, dark longitudinal facets*	*Typically, 31-33, less elongate*
Spermathecal pores	*Usually in 9/10 and 10/11*	*Minute, above C in 9/10 and 10/11*
Type locality	*Massiccio d'Astazou (Pyrenees)*	*Montpellier Botanical Gardens*
Moecular lineage	*Lineage I*	*Lineage II*
North American records	*Likely widespread, but misidentified*	*True A. trapezoifdes widespread*
	in part as A. trapezoids	

Key distinction
Clitellum ending on segment 35 = *Aporrectodea borellii*
Clitellum ending on segment 34 = *Aporrectodea trapezoides*

Distribution
Aporrectodea borellii appears native to the central Pyrenees (Andorra, France, Spain). Its presence elsewhere is likely the result of introductions, historically obscured by misidentification within the *A. trapezoides* complex.
Aporrectodea trapezoides: A native of Palearctis and a well documented peregrine species, it is now known from Europe, North America, South America, Africa and Australia (Reynolds, 2022) [38]. All collections of *A. trapezoides* records need reassessment because clitellar segment 35 is essential for *A. borellii*.

Conclusion
This revision has major implications for North American records. Gates (1972) [19], Reynolds *et al.* (1974) [40], and Reynolds (1977, 2018) [34, 36] reported *Aporrectodea trapezoides* widely across Canada and the United States, with clitellar ranges occasionally extending to segment 35. Under the new phylogenetic framework, such specimens likely represent *A. borellii*. Brown *et al.* (2026) [2] explicitly note that North American material with clitellar termination on segment 35 should be reassigned to *A. borellii*. Since there are so many specimens of *Aporrecodea trapezoides* in various museums and universities, primarily Canadian Museum of Nature, New Brunswick Museum and the Smithsonian, it will take considerable time and money to examine all these specimens to determine if *A. borellii* was misidentified as *A. trapezoides* and therefore present in North America. Reynolds (2022) [38] reported 33 terrestrial earthworm species in Canada, and Reynolds (2024) [39] added four more earthworm species. If *A. borellii* is found to be in Canada, it will be the 38th species. In the USA, Reynolds (2017, 2020) [35, 37] reported 191 species, recently, Carrera-Martínez *et al.* (2025) [4] reported seven new species bringing the total to 198 species. If *A. borelli* is found the new total will be 199. Several authors have reported collecting a number of species new to science so that the actual number will in the near future exceed 200. Mexico has approximately 130 species including *A. borelli* (Fragoso and Rojas, 2014) [17]. Given the frequency of clitellar termination on segment 35 in North American material, the presence of *A. borellii* in Canada, the United States, and Mexico is highly probable.

Declarations

- **Conflict of Interest**

The author declares no conflict of interest.

- **Funding Statement**

No external funding was received for this study.

Data Availability Statement
No new datasets were generated or analyzed during this review study.

Ethics Statement
This article does not involve human participants or animal experimentation.

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