

MEGADRILOGICA

Volume 29, Number 1, April 2025

ADVANCES TO THE TAXONOMIC KEY FOR THE FAMILY ACANTHODRILIDAE FOR EARTHWORMS IN INDIA

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ABSTRACT

The study presents a comprehensive revision of the taxonomic key for the family Acanthodrilidae for Indian earthworms. Taxonomic keys are essential tools for accurately identifying organisms, aiding in biodiversity studies, ecological assessments, and conservation efforts. The revision incorporates recent taxonomic advancements and reclassifications, particularly concerning genera previously classified under the family Octochaetidae. The updated key incorporates the most recent revisions in the systematic classification of earthworms found in India. This revised key has the potential to improve the precision and effectiveness of identifying different species, leading to a deeper comprehension of earthworm biodiversity in the region. This, in turn, would facilitate future research efforts and conservation initiatives.

Keywords: Biodiversity, Classification, Identification, Indian earthworms, Taxonomic advancements, Taxonomic key, Taxonomy.

भाववाचक संज्ञा

अध्ययन भारतीय केंचुओं के ऐकॅथोड्रिलिडे परिवार के लिए वर्गीकरण कुंजी का एक व्यापक संशोधन प्रस्तुत करता है। वर्गीकरण कुंजी जीवों की सटीक पहचान करने, जैव विविधता अध्ययन, पारिस्थितिक आकलन और संरक्षण प्रयासों में सहायता करने के लिए आवश्यक उपकरण हैं। संशोधन में हाल ही में वर्गीकरण संबंधी उन्नति और पुनर्वर्गीकरण शामिल हैं, विशेष रूप से ऑक्टाचैटिडे परिवार के तहत पहले वर्गीकृत किए गए जेनेरा के संबंध में। अद्यतन कुंजी भारत में पाए जाने वाले केंचुओं के व्यवस्थित वर्गीकरण में सबसे हाल के संशोधनों को शामिल करती है। इस संशोधित कुंजी में विभिन्न प्रजातियों की पहचान करने की सटीकता और प्रभावशीलता में सुधार करने की क्षमता है, जिससे क्षेत्र में केंचुआ जैव विविधता की गहन समझ हो सकेगी। यह बदले में, भविष्य के शोध प्रयासों और संरक्षण पहलों को सुविधाजनक बनाएगा।

संकेत शब्द: जैव विविधता, वर्गीकरण, पहचान, भारतीय केंचुआ, वर्गीकरण संबंधी उन्नति, वर्गीकरण कुंजी, वर्गीकरण।

* Published on the traditional territory of the Chonnonton (=Neutral), Anishinaabe, and Haudenosaunee peoples.

RÉSUMÉ

L'étude présente une révision complète de la clé taxonomique de la famille Acanthodrilidae pour les vers de terre indiens. Les clés taxonomiques sont des outils essentiels pour identifier avec précision les organismes, contribuant ainsi aux études de biodiversité, aux évaluations écologiques et aux efforts de conservation. La révision intègre les avancées taxonomiques et les reclassifications récentes, notamment concernant les genres précédemment classés dans la famille Octochaetidae. La clé mise à jour intègre les révisions les plus récentes de la classification systématique des vers de terre trouvés en Inde. Cette clé révisée a le potentiel d'améliorer la précision et l'efficacité de l'identification des différentes espèces, menant à une compréhension plus approfondie de la biodiversité des vers de terre dans la région. Cela faciliterait à les efforts de recherche et les initiatives de conservation à venir.

Mots-clé: Biodiversité, Classification, Identification, Vers de terre indiens, Progrès taxonomiques, Clé taxonomique, Taxonomie.

INTRODUCTION

Taxonomic keys serve as indispensable tools for scientists in determining unidentified organisms, typically employing a series of predetermined steps leading to a taxonomic name. Among these, the dichotomous key, with its binary decision-making process, reigns as the most favoured and effective method across various organisms. However, it's important to note that taxonomic keys, often tailored to specific groups of species or regional contexts, making them not universally applicable (Tiwari, 2022).

India boasts a rich diversity of earthworms, with a total of 469 species and subspecies across 9 families and 72 genera (Ahmad *et al.*, 2025; Naik *et al.*, 2024; Narayanan *et al.*, 2024a, 2024b, 2025a, 2025b; Tiwari *et al.*, 2024, 2025a, 2025b). This abundance is particularly noteworthy, considering that India occupies just 2% of the world's landmass, but hosts approximately 7.96% of the global earthworm population. This places India as the third most earthworm diversity-rich nation globally, with a large number of endemic species (Narayanan *et al.*, 2023; Tiwari *et al.*, 2020). The earthworm fauna of India are primarily characterized by native species, with a significant proportion, around 89.28%, belonging to three dominant families: Megascolecidae, Acanthodrilidae, and Moniligastridae (Narayanan *et al.*, 2023).

The classification of oligochaetes and clitellates at higher and lower levels has been a subject of ongoing debate and frequent revision. Earlier, *Dichogaster* was placed within the family Octochaetidae, but later reclassified into the subfamily Benhamiinae and elevated to the family Acanthodrilidae

by Csuzdi (1996). Subsequently, James and Gamiette (2016) elevated subfamily Benhamiinae to the family level and named it Benhamiidae. Recent updates in classification, as outlined by Brown *et al.* (2023) and Misirlioğlu *et al.* (2023), have led to further changes at both family and genus levels. Notably, the family Octochaetidae has been incorporated into Acanthodrilidae, except for two genera (*Barogaster* placed in Megascolecidae family and *Parryodrilus* in Ocnerodrilidae).

Acanthodrilidae Claus (1850) ranks as the second most species-rich earthworm family, including a notable 746 species and 48 subspecies across 68 genera globally (Misirlioğlu *et al.*, 2023). While in India, Acanthodrilidae emerges as the second most prominent family, consisting of 131 species or subspecies, comprising 28.45% of the total earthworm diversity (Narayanan *et al.*, 2023).

In the realm of Indian earthworm taxonomy, historical taxonomic keys were primarily provided by Stephenson (1923) and Gates (1972). Subsequently, Julka (1988) designed an extensive taxonomic key, specifically for the family Octochaetidae. Despite the documentation of numerous new genera and species within the family Octochaetidae in India, there has been a lack of revision to previous taxonomic keys. Moreover, the family Acanthodrilidae has subsequently reassigned many genera from the family Octochaetidae. Therefore, this study aims to update and revise the taxonomic keys for the family Acanthodrilidae to reflect these taxonomic changes and advancements.

The revised and updated key to the Acanthodrilidae of India is presented in **Table 1**.

Table I. Updated Key To The Genera of Indian Acanthodrilidae (Claus, 1850).

1. Oesophagus with a single gizzard	2
1'. Oesophagus with vestigial gizzard.....	<i>Microscolex</i> Rosa, 1887
1". Oesophagus with gizzards.....	19
2(1). Discrete calciferous glands present	3
2'(1). Discrete calciferous glands absent	16
3(2'). Stomate megameronephridia present at least in caudal segments; micromeronephridia astomate throughout the body.....	4
3'(2'). Megameronephridia absent; micromeronephridia stomate, at least in caudal segments.....	12
4(3). Megameronephridia exonephric	5
4'(3). Megameronephridia enteronephric	10
5(4). Calciferous glands intramural.....	6
5'(4). Calciferous glands extramural.....	8
6(5). Calciferous glands one pair, in xii	7
6'(5). Calciferous glands 2 pairs, in xi-xii	<i>Bahlia</i> Gates, 1945
7(6). Combined male and prostatic pores on xviii; typhlosole rudimentary.....	<i>Scolioscolides</i> Gates, 1937
7'(6). Male pores slightly posterior to prostatic pores on porophores or in fissures or invaginated into vestibula, on xvii, typhlosole well-developed	<i>Eutyphoeus</i> Michaelsen, 1900
8(5'). Calciferous glands one pair, single lobed, in xv.....	<i>Kotegeharia</i> Julka, 1988
8'(5'). Calciferous glands one pair, each gland bilobed, one lobe in xiv and the other in xv.....	<i>Senapatiella</i> Julka, Blanbchard & Chapuis-Lardy, 2004
8"(5'). Calciferous glands more than one pair	9
9(8"). Calciferous glands 3 pairs, in xiv-xvi; typhlosole rudimentary.....	<i>Priodochaeta</i> Gates, 1939
9'(8"). Calciferous glands 4 pairs, in x-xiii; typhlosole well-developed, ventrally bifid.....	<i>Calebielia</i> Gates, 1945
10(4'). Calciferous glands one pair, each gland bilobed, one lobe in xv and the other in xvi.....	11
10'(4'). Calciferous glands 4 pairs, in x -xiii	<i>Hoplochaetella</i> Michaelsen, 1900
11(10). Prostomium prolobic.....	<i>Herbettodrilus</i> Julka, Blanbchard & Chapuis-Lardy, 2004
11'(10). Prostomium tanylobic.....	<i>Karmiella</i> Julka, 1983
12(3'). Calciferous glands one pair	13
12'(3'). Calciferous glands 4 pairs	15
13(12). Typhlosole simple	<i>Octonochaeta</i> Julka, 1988
13'(12). Typhlosole ventrally bifid	14
14(13'). Calciferous glands asymmetrical, one gland in xv and the other in xvi; clitellum annular, xiii-xvi, xvii, xviii.....	<i>Octochaetona</i> Gates, 1962
14'(13'). Calciferous glands: symmetrical, each gland bilobed, one lobe in xv and the other in xvi; clitellum saddle shaped, extending xii-xix	<i>Chaetocotoides</i> Julka, 1988

15(12'). Calciferous glands in x-xiii; stomate micromeronephridia enteronephric in xv and posteriad segments.....	<i>Travoscolides</i> Gates, 1939
15'(12'). Calciferous glands in xiv-xvii, stomate micromeronephridia exonephric in caudal segments	<i>Priodoscolex</i> Gates, 1939
16(2'). Oesophagus with calciferous lamellae in viii-xi	<i>Ramiella</i> Stephenson, 1921
16'(2'). Oesophagus with calciferous lamellae posterior to xi	17
17(16'). Megameronephridia in caudal segments exonephric.....	18
17'(16'). Megameronephridia in caudal segments enteronephric	<i>Wahoscolex</i> Julka, 1988
18(17). Oesophagus enlarged and with calciferous lamellae, in xiv-xv	<i>Mallehulla</i> Julka & Rao, 1982
18'(17). Oesophagus enlarged and with calciferous lamellae in xvi, slightly extending to adjacent segments.....	23
19(1"). Calciferous glands anterior to xiv.....	20
19'(1"). Calciferous glands posterior to xiii.....	<i>Octochaetoides</i> Michaelsen, 1921
20(19). Intestinal roof with 'grid-like' thickening at the posterior end of typhlosole; combined male and prostatic pores on xviii.....	21
20'(19). Intestinal roof with equatorially separated supra-intestinal glands at the posterior end of typhlosole; male pores on xviii, prostatic pores on xvii and xix.....	<i>Eudichogaster</i> Michaelsen, 1902
21(19). Calciferous glands 3 pairs, in x-xii or xi-xiii	<i>Lenngaster</i> Gates, 1939
21'(19). Calciferous glands 4 pairs, in x-xiii	22
22(21'). Gizzards in v-vi; male pores on xviii, prostatic pores on xvii and xix, at the ends of seminal grooves	<i>Pellogaster</i> Gates, 1939
22'(21'). Gizzards in vi-vii, combined male and prostatic pores on xix, seminal grooves absent.....	<i>Rillogaster</i> Gates, 1939
23(18'). Tufted micromeronephridia present.....	<i>Shimodrilus</i> Julka, Blanbchard & Chapuis-Lardy, 2004
23'(18'). Tufted micromeronephridia absent.....	<i>Konkadrilus</i> Julka, 1988

CONCLUSION

This study presents a comprehensive update of the taxonomic key for the family Acanthodrilidae, with particular emphasis on earthworms found in India. The revised key accurately reflects the latest taxonomic advancements and reclassifications, particularly various genera previously categorized under the family Octochaetidae. The updated information could be quite valuable for researchers engaged in the study of the diversity of earthworm species found in India, specifically those which are classified under the family Acanthodrilidae, within the discipline of systematics and ecology. The study is intended to enhance the accuracy and efficiency of earthworm identification endeavours, ultimately contributing to a deeper understanding of the biodiversity of earthworms in India. The updated taxonomic key is expected to con-

tribute to future research undertakings and conservation, focused on preserving the rich diversity of Indian earthworms.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support provided by the Science and Engineering Research Board (SERB), Department of Science and Technology (DST), Government of India. We thank W.M. Reynolds of the Oligochaetology Laboratory for reviewing the manuscripts, her comments and suggestions. We also acknowledge Denis La France of the Institut national d'agriculture biologique, Cégep de Victoriaville, Québec for checking our Résumé and Mots-clé French translation.

DISCLOSURES

Authors' Contributions: NT conception, wrote the first draft, **JWR** publication funding, edited and reviewed the manuscript, and **SY** conception, supervision, provided review, editing, and final approval for publication.

Conflict of interest: The authors have no conflicts of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by the authors, and no AI was used in the preparation of this article.

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New website for the journal *Megadrillogica*:

<https://mjwetzels.inhs.illinois.edu/megadrillogica>

New website for *Nomenclatura Oligochaetologica* – A catalogue of names, descriptions, and type specimens of the Oligochaeta. *Editio Secunda*.

<https://nomenclatura-oligochaetologica.inhs.illinois.edu>

