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ARTICLE

Eastern range record of the semiaquatic freshwater earthworm *Glyphidrilus gangeticus* Gates, 1958 (Clitellata: Crassiclitellata: Almidae) from West Bengal, India, with a brief key to the Indian species of the genus

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Abstract: The semi-aquatic earthworm genus *Glyphidrilus* is poorly documented in West Bengal, India, with only one species previously recorded. To fill this distribution gap, we surveyed riverbanks of the Mahananda River (West Bengal) and Ganga River (Bihar). Earthworms were collected by hand sorting from wet soil and mud during low-water conditions in 2021 and 2024, preserved in 4% formalin, and identified using morphological characters under a stereomicroscope. We report the first record of *Glyphidrilus gangeticus* Gates, 1958 from West Bengal, extending its known range eastward from Uttar Pradesh and Bihar. Additionally, we provide a revised identification key to all seven Indian species of *Glyphidrilus* (*annandalei*, *elegans*, *fluviatilis*, *gangeticus*, *papillatus*, *spelaeotes*, and *tuberosus*) based on literature and newly examined material. This discovery increases the number of *Glyphidrilus* species known from West Bengal to two and highlights the need for further surveys of semi-aquatic habitats in the Gangetic plains. The improved key will aid future biodiversity assessments and conservation planning.

Keywords: Almidae, first record, freshwater biodiversity, Ganga River, identification key, Mahananda River, semiaquatic earthworms.

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Author contribution: MNH, JWR and CKM: conceptualization, investigation and writing – original draft. MNH, JWR, CKM and SG: data curation, monitoring and validation. MNH, JWR, CKM and SG: visualization. MNH, JWR, CKM, SG and HN: writing, reviewing and editing. All authors contributed to the article and approved the submitted version.

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INTRODUCTION

There are approximately 5,739 species and subspecies of megadrile earthworms worldwide (Marchán et al. 2022; Mısırlıoğlu et al. 2023; Reynolds & Wetzel 2025). At present, India has 457 species under 10 families – Almidae, Acanthodrilidae, Benhamiidae, Eudrilidae, Lumbricidae, Moniligastridae, Megascolecidae, Ocnerodrilidae, Octochaetidae, and Rhinodrilidae (Balakrishnan et al. 2024). India hosts 12.5% of the world's known earthworm species (Julka et al. 2009), with 71% of genera and 85% of species endemic (Julka & Paliwal 2005). *Glyphidrilus* (40 species-level taxa) is found in China, Cambodia, India, Indonesia, Laos, Myanmar, Sri Lanka, Singapore, and Thailand, but only one species, *G. stuhlmanni* Michaelsen, 1897, has been recorded from Africa (Chanabun et al. 2013). *Glyphidrilus* is mainly represented in the Gangetic plains and associated freshwater habitats. Classical works by Stephenson (1923) and Julka (1988) documented the presence of several species, including *G. gangeticus*, *G. tuberosus*, *G. fluviatilis*, *G. elegans*, *G. spelaeotes*, *G. papillatus*, and *G. annandalei*. These records highlight the genus as an important faunal component of Indian freshwater ecosystems. Recent surveys and taxonomic contributions (Narayanan et al. 2023) continue to confirm the occurrence of these species, while also emphasizing the need for detailed ecological and molecular studies to resolve species boundaries.

Despite these records, the earthworm fauna of West Bengal remains poorly explored for semi-aquatic *Glyphidrilus* species. Only *G. tuberosus* has been reported from the state (Ahmed et al. 2022), leaving a significant distributional gap for other species, including *G. gangeticus*, which is known from adjacent states (Uttar Pradesh and Bihar).

We hypothesize that *Glyphidrilus gangeticus* occurs in West Bengal due to the hydrological continuity of the Ganga River system, which may facilitate eastward dispersal along the Gangetic floodplains.

The present study was undertaken to: (1) survey selected riverbanks in West Bengal and Bihar for the presence of *Glyphidrilus* species; (2) confirm the identity of any newly collected material using morphological characters; (3) report the first record of *G. gangeticus* from West Bengal, if found; and (4) compile an improved identification key for all seven Indian *Glyphidrilus* species to aid future research.

Glyphidrilus species play important roles in sediment aeration and nutrient cycling and can serve as bioindicators of freshwater ecosystem health (Chanabun et al. 2013). Detailed ecological functions have been reviewed elsewhere and are not repeated here to avoid redundancy. Many regions of India remain unexplored for earthworms, and targeted surveys are needed to fill knowledge gaps. The present study addresses this need by providing a new state record and a practical identification tool.

MATERIALS AND METHODS

The study areas were the semiaquatic riverbanks of the lower Mahananda River in West Bengal and the Ganga River in Bihar (Figure 1).

The earthworms were collected in low-water conditions during the years 2021 and 2024 from the wet soil and mud by digging and sorting by hand from fallen tree trunks and leaf litter. The collected samples of earthworms were washed with water and preserved in 4% formalin overnight and then transferred to 70% alcohol for identification. Identification was done using a Leica EZ4HD stereomicroscope. The morphometric characters of the species were carefully recorded after preservation. Measurements were taken manually using a slide caliper, which allowed accurate determination of body length, width, and segmental details. This method ensured precision in documenting the diagnostic features essential for taxonomic study. The collected specimens were identified using Blakemore (2012), Gates (1972), Julka (1988), and Stephenson (1923). The specimens were deposited with the Zoological Survey of India, headquarters, Kolkata (ZSI), and additional specimens at the Gangetic Plains Regional Centre, Patna.

RESULTS

Genus *Glyphidrilus* Horst, 1889

Glyphidrilus Horst, 1889: 86. Type species: *Glyphidrilus weberi* Horst, 1889.
Bilimba Rosa, 1890: 386.
Annadrilus Horst, 1893: 44.
Glyphidrilus + Bilimba + Annadrilus - Beddard, 1895: 679, 686, 680.
Glyphidrilus Michaelsen, 1900: 459.
Glyphidrilus Michaelsen, 1909: 244.
Glyphidrilus Michaelsen, 1910: 99.
Glyphidrilus Michaelsen, 1918: 343.
Glyphidrilus Gates, 1972: 234.

Currently, 40 species of the *Glyphidrilus* genus have been reported from Asia (from the Indonesian islands

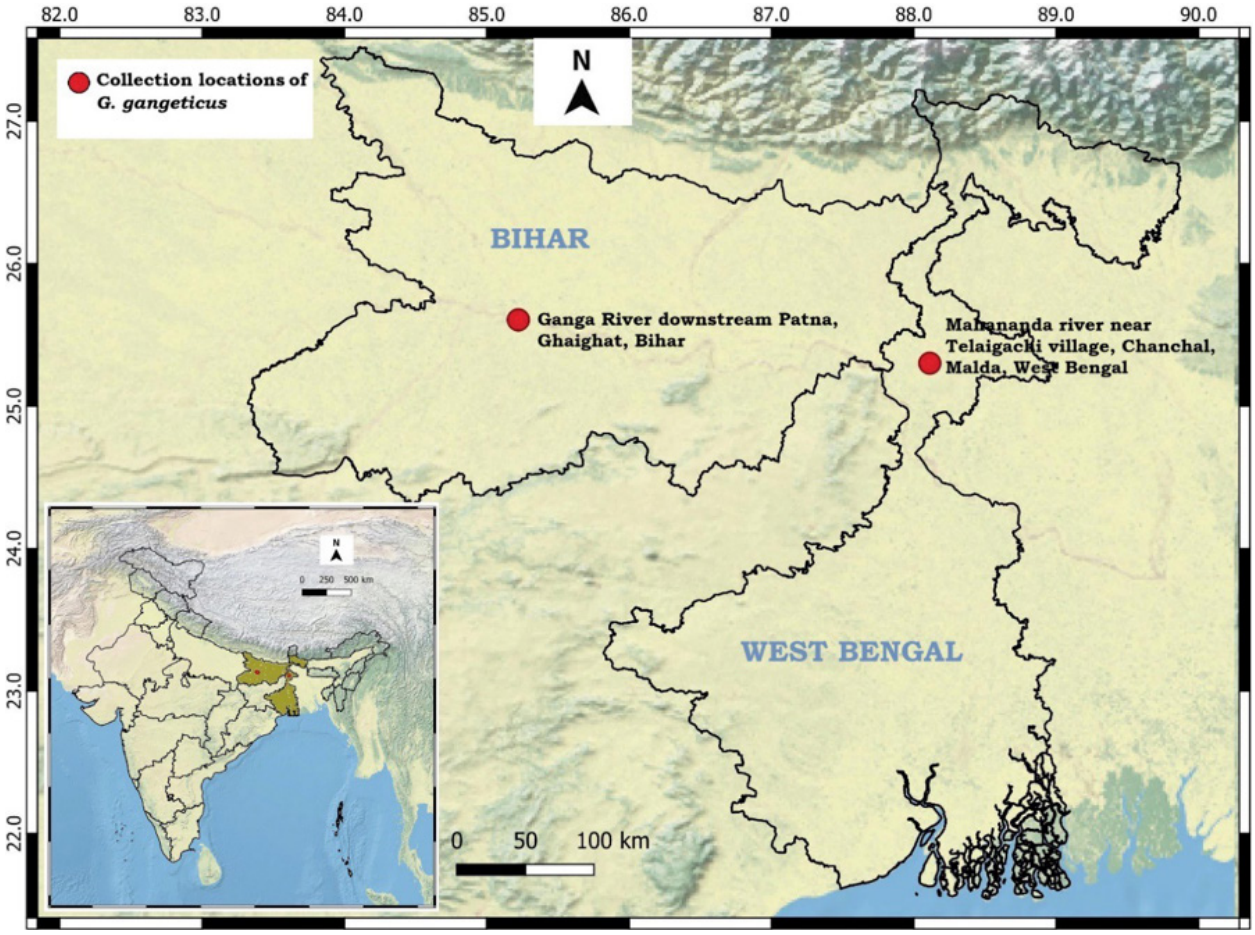

Figure 1. Study area of *Glyphidrilus gangeticus* Gates, 1958 in West Bengal and Bihar in India. (Map made by Q-GIS).

to the Malay Peninsula and Myanmar, extending to western India, to northern China and Africa (Gates 1951; Naidu 2005; Chanabun et al. 2013). Thus, a key for seven species of *Glyphidrilus* found in India is presented. These taxa are briefly characterized by their external features together with a short synonymy, based on the cited references.

1. ***Glyphidrilus gangeticus* Gates, 1958**

Glyphidrilus sp.? Michaelsen, 1909: 244.

Glyphidrilus papillatus Stephenson, 1920: 258–260.

Glyphidrilus papillatus (part) - Stephenson, 1923: 493.

Glyphidrilus sp. - Gates, 1947: 121.

Glyphidrilus papillatus Gates, 1948: 175–176.

Glyphidrilus papillatus Gates, 1951: 17.

Glyphidrilus gangeticus Gates, 1958: 58 Type missing (Reynolds & Wetzel, 2025).

Glyphidrilus gangeticus Narayanan et al., 2023: 114.

Type locality: Saharanpur, Uttar Pradesh State, India.

Material examined: (from Gates 1959; Stephenson 1920). India; West Bengal, Mahananda River near Telaigachi Village, Chanchal, Malda, 25.302° N, 88.111° E, 6 m; 26.xii.2021; M. Nurul Hasan leg.; 9 clitellate adults (0-0-9) ex. Reg. no. ZSI-An6247/1. Bihar State, Ganga River downstream Patna, Ghaighat, 25.606° N, 85.221° E, 64 m; 12.iv.2024, Gopal Sharma with Hasko Nesemann, 2 clitellate adults (0-0-2) ex. Reg. no. NDRC/IV/2024.

Brief description: Length 85–140 mm, diameter 3–5 mm. Number of segments 202–340. The prostomium is zygolobous. Clitellum, saddle, xiii, xvi, xvii–xxxiv. Wings xviii–xxiii. Spermathecal pores are not visible in 12/13–16/17 segments. One female pore on 14 near setal line B, about midway between 13/14 and the setal equator. Dorsal pores absent. The G. gangeticus morphological characters of the gizzard, heart, seminal vesicles (4 pairs), spermathecae (4 pairs), nephridia and dorsal blood vessels are provided in Image 1. Setae closely paired. Prostates absent. Typhlosole begins in xviii.

Distribution: India (Assam, Delhi, Uttarakhand, Uttar Pradesh, Bihar (Michaelsen 1909; Stephenson 1920;

Gates 1951; Naidu 2005; Chanabun et al. 2013), and West Bengal); Thailand (Nesemann et al. 2004, 2007).

2. ***Glyphidrilus tuberosus*** **Stephenson, 1916**

Glyphidrilus tuberosus, Stephenson, 1916: 349. Type: Zoological Survey of India, Calcutta, cat. no. 6517 (Reynolds & Wetzel 2025).

Glyphidrilus papillatus Gates, 1958: 59.

Glyphidrilus tuberosus Narayanan et al., 2023: 114.

Type locality. Kendrapara Canal near Cuttack, Odisha State, India.

Material examined: None.

Brief description: (from Gates 1958; Stephenson 1916). Length 60 mm, maximum diameter 3 mm. Number of segments 215–221. Size of the segments is smaller after the clitellar region. Colour is brown. Dorsal surface is concave in arrears of the clitellum xiv, xv, xvi–xxviii, xxix, xxx, ventral surface flat and concave occasionally. Wings xx–xxiv. The section of the body looks four-sided. Prostomium pro- or zygolobous. Setae are widely paired. Gizzard in vii. No calciferous glands.

Distribution: India (Bihar, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal (Stephenson 1923, Julka & Senapati 1987 and Mandal & Kumar 2018)); Bangladesh (Das & Reynolds 2003).

3. ***Glyphidrilus annandalei*** **Michaelsen, 1910**

Glyphidrilus annandalei Michaelsen, 1910: 101. Type: Zoologisches Museum Universität Hamburg cat. no. 3600! (Reynolds & Wetzel, 2025)

Glyphidrilus annandalei Cognetti, 1900: 502.

Glyphidrilus achencoili (laps.) - Michaelsen, 1913: 92.

Glyphidrilus annandalei - Stephenson, 1916: 349.

Glyphidrilus annandalei- Michaelsen, 1918: 344.

Glyphidrilus annandalei - Stephenson, 1921: 767.

Glyphidrilus fluciatilis + G. elegans + G. rarus + G. saffronensis - Rao, 1922: 53, 66.

Glyphidrilus annandalei - Stephenson, 1922: 387.

Glyphidrilus annandalei - Narayanan et al., 2023: 112.

Type locality: Quilon (Kollam), Kerala State, India.

Material examined: None.

Brief description: (from Michaelsen, 1910; Stephenson, 1916, 1921). Length 90–265 mm, diameter 2.5–11 mm. Number of segments 125–322. Colour dark grey, without any pigmentation; a slight pink colour is found on the clitellum. Four-sided section found in its subsequent half of the body. The dorsal side broader than the ventral side.

Distribution: Endemic to India (Karnataka, Kerala (Rao 1922; Chanabun et al. 2013; Narayanan et al. 2023), Madhya Pradesh, Tamil Nadu, Uttarakhand, Uttar Pradesh (Stephenson 1923)).

4. ***Glyphidrilus elegans*** **Rao, 1922**

Glyphidrilus elegans Rao, 1922; 62. Type locality: Mysore, India. Type: British Museum (Natural History)

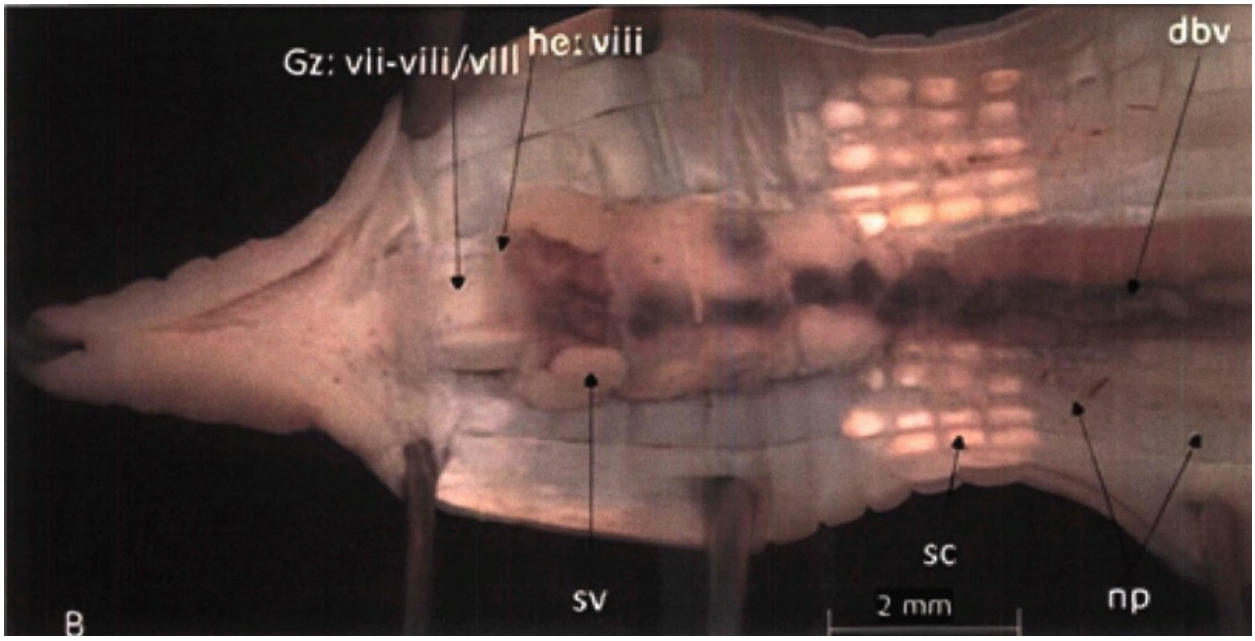

Image 1. ***Glyphidrilus gangeticus*** **Gates, 1958: B-gz—Gizzard | he—Heart | sv—Seminal vesicle | sc—Spermathecae | np—Nephridia | dbv—Dorsal blood vessels.**

1922:4:20:9! (Reynolds & Wetzel, 2025).

Glyphidrilus annandalei - Stephenson, 1923: 491.

Glyphidrilus annandalei Brinkhurst & Jamieson, 1971: 755.

Glyphidrilus elegans Chanabun et al., 2013: 27.

Glyphidrilus elegans - Narayanan et al., 2023: 113.

Type locality: Sandy islets in the Cauvery River in Dubari Forest at Fraserpett (=Kushalnagar), Karnataka State, India.

Material examined: None.

Brief description: (from Rao 1922; Stephenson 1923; Brinkhurst & Jamieson 1971). Length 139 mm. Body quadrangular in transverse section behind the clitellum, cylindrical in the anterior region. Total segments 248. Body tone light brown. Dorsal surface noticeably wider than the ventral surface at the posterior end. In the ventro-lateral region of the clitellum, setae are seen in 25–31.

Distribution: India (Karnataka, Tamil Nadu (Kathireswari et al. 2008), Rajasthan, Punjab, Haryana, and Gujarat (Dhiman & Battish 2006)); Bangladesh; Myanmar (Reynolds et al. 1995 as *G. e.* ssp. *paski* Stephenson, 1923); Thailand (Chanabun et al. 2013).

5. ***Glyphidrilus fluviatilis* Rao, 1922**

Glyphidrilus fluviatilis Rao, 1922: 53. Type: British Museum (Natural History) 1922:4:20:5! (Reynolds & Wetzel, 2025).

Glyphidrilus annandalei Stephenson, 1923: 481.

Glyphidrilus annandalei Brinkhurst & Jamieson, 1971: 755.

Glyphidrilus fluviatilis Chanabun et al., 2013: 27.

Glyphidrilus fluviatilis Narayanan et al., 2023: 113.

Type locality: Sandy banks of the Harangi River in Madapur, Telangana State, India.

Material examined: None.

Brief description: (from Rao 1922). Length 272 mm. Body quadrangular behind the clitellum, anterior half cylindrical. Number of segments 225.

Distribution: India (Karnataka); Thailand (Chanabun et al. 2013).

6. ***Glyphidrilus papillatus* (Rosa, 1890)**

Bilimba papillata Rosa, 1890: 386.

Bilimba papillatus - Beddard, 1895: 687.

Glyphidrilus papillatus Michaelsen, 1896: 196.

Glyphidrilus papillatus Michaelsen, 1900: 459.

Glyphidrilus papillatus Michaelsen, 1918: 344.

Glyphidrilus papillatus Stephenson, 1920: 58.

Type locality: Cobapo (Carin Mountains), Burma (Myanmar).

Material examined: None.

Brief description: (from Stephenson 1920). Body length 74–120 mm, maximum diameter 3–6 mm. Total number of segments 130–330. No pigmentation dorsally, colour greyish. Secondary annulation found after five segments of the anterior part. Posterior half flattened dorsally. Prostomium pro- or zygolobous. Dorsal pores absent. Clitellum, saddle xiii, xiv–xl. Wings begin in xvii–xix and end in xxiii–xxvii. Genital markings, unpaired and median in xi–xxi, paired and lateral to A in xii–xxx. Gizzard in viii. Intestinal origin in xv. Typhlosole, lamelliform beginning in xviii.

Distribution: India (Uttar Pradesh (Stephenson 1923)); Myanmar (Stephenson 1923).

7. ***Glyphidrilus spelaeotes* Stephenson, 1924**

Glyphidrilus spelaeotes Stephenson, 1924: 133. Type: Zoological Survey of India, Calcutta, cat. no. 1155–1156 (Reynolds & Wetzel, 2025).

Glyphidrilus papillatus (part.) Gates, 1958: 54.

Glyphidrilus papillatus Brinkhurst & Jamieson, 1971: 764.

Glyphidrilus spelaeotes Narayanan et al., 2023: 114.

Type locality: Siju Cave, Meghalaya State, India.

Material examined: None.

Brief description: (from Stephenson 1924; Brinkhurst & Jamieson 1971). Length 175 mm, diameter 2–3 mm, segment number 310. Pale or light brownish-grey colour, four-sided behind the wings. The wings are attached between the line of the dorsal and that of the ventral setal couples, and extend from xviii or xix to xxiv or xxv; they are bent downwards and inwards, and on segment xviii they are, if present, less prominent than in the rest of their extent.

Distribution: India: Assam, Meghalaya (Stephenson 1924).

DISCUSSION

Glyphidrilus are restricted to subtropical Africa and southern Asia (Magalhães et al. 2021). These semi-aquatic earthworms usually inhabit river banks, wetlands, and muddy substrates, where they play an important role in soil aeration and nutrient cycling. Their restricted distribution makes them ecologically significant indicators of freshwater-associated habitats. Many regions of India are still unexplored in terms of earthworm fauna. Extensive surveys have been conducted in some biodiversity-rich zones, but several river systems, wetlands, and floodplains remain poorly

Key to the Indian species of the genus *Glyphidrilus* Horst, 1889

1. Clitellum begins on segment 13 2
1'. Clitellum begins on segment 14 5

2. Clitellum on 13–34; wings on segments 17–25 ..... *G. gangeticus*
2'. Wings begin on segment 25 3

3. Wings extend beyond segment 32; wings on segments 25–36; clitellum beginning 13–18, ending 35–41; spermathecal pores in 13/14–16/17 ..... *G. annandalei*
3'. Wings end on or before segment 32 4

4. Wings on segments 25–31; clitellum on 13–35; spermathecal pores in 13/14–17/18 ..... *G. elegans*
4'. Wings on segments 25–32; clitellum on 13–33 (occasionally extends to 36 or 38); spermathecal pores in intersegmental furrows 7/8 and 8/9 ..... *G. fluviatilis*

5. Wings on segments 20–24 to 28; clitellum on 14–30; spermathecal pores in 14–15 ..... *G. tuberosus*
5'. Wings begin before segment 20 6

6. Wings on segments 18–25; clitellum on 14–30; spermathecal pores in 13/14–15/16 ..... *G. spelaeotes*
6'. Wings on segments 18–26; clitellum on 14–40; spermathecal pores in 14–17 ..... *G. papillatus*

studied. This gap in knowledge highlights the possibility of discovering new records or even undescribed species, especially in areas with unique hydrological conditions. From West Bengal, only *Glyphidrilus tuberosus* was known (Ahmed et al. 2022). This species was previously reported from the Ganga-Brahmaputra Basin and is characterized by its distinct gizzard position and genital markings. *Glyphidrilus* gangeticus is the first record of this species from this state. Earlier, this species was reported from Uttar Pradesh and Bihar along the Ganga River system, and its occurrence in West Bengal extends the known distribution range eastward. The finding demonstrates the connectivity of aquatic habitats across the Ganga floodplains and lack of systematic studies. This list summarizes all known species from India with details of their diagnostic characters, type localities, and ecological preferences. *Glyphidrilus gangeticus* is the second species from this state. Thus, the state now contributes two members of this semi-aquatic genus, enriching the faunal diversity of the region. There are seven species of the genus *Glyphidrilus* known from India. These include *G. tuberosus*, *G. gangeticus*, and five others described from various river basins across Uttar Pradesh, Bihar, Assam, and Meghalaya. Their distributions are often linked to major river systems such as the Ganga, Brahmaputra, and Barak. This discovery is significant as it not only adds to the state checklist but also provides baseline information for future biodiversity assessments and conservation planning of semi-aquatic habitats. The study emphasizes the need for a taxonomy combining morphology with molecular data. The local faunistic studies largely contribute to our knowledge of poorly known semi-aquatic species. Such studies are crucial in recognizing habitat-specific taxa, detecting biogeographical patterns, and informing conservation priorities in freshwater ecosystems.

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