

Two new troglobitic species of the genus *Spelaeogammarus* da Silva Brum, 1975 (Amphipoda, Artesiidae) from Brazil

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Abstract

Recently, two new subterranean species of the genus *Spelaeogammarus* da Silva Brum, 1975 were found from two distinct regions in Brazil: Serra do Ramalho, Bahia, and Montes Claros, Minas Gerais, increasing the total number of known species in the genus to 10. Both species present all diagnostic characters of the genus, however *Spelaeogammarus* sp. nov. 2 has some unique distinctive characters such as the accessory flagellum 3-articulate and the antenna 2 flagellum 5-articulate, as well as *Spelaeogammarus* sp. nov. 1. that distinguishes by the antenna 2 flagellum 5-articulate and by the absence of plumose setae on apical margin of inner plate of maxilliped.

1. Introduction

The order Amphipoda stands out among Brazilian subterranean crustaceans, with species distributed across five distinct families. The genus *Spelaeogammarus* da Silva Brum, 1975, part of the family Artesiidae, is composed entirely of aquatic amphipods species exclusively adapted to subterranean environments (Bastos-Pereira & Ferreira, 2017; Bueno et al., 2022).

To date, eight species have been described within the genus. Seven are endemic to caves in Bahia: *Spelaeogammarus bahiensis* da Silva Brum, 1975 (type species), *S. spinilacertus* Koenemann & Holsinger, 2000, *S. trajanoae* Koenemann & Holsinger, 2000, *S. santanensis* Koenemann & Holsinger, 2000, *S. titan* Senna et al., 2014, *S. sanctus* Bastos-Pereira &

Ferreira, 2015, and *S. ginae* Bueno et al., 2022. Until 2017, the genus was believed to be exclusive to Bahia, but the discovery of *S. uai* Bastos-Pereira & Ferreira, 2017 in Minas Gerais expanded its known range (Figures 1 and 4).

Recent expeditions to western Bahia (Serra do Ramalho) and northern Minas Gerais (Montes Claros) have revealed two additional species of *Spelaeogammarus*. This study describes these new species, provides an updated identification key and morphological comparison table for the genus, and revises its diagnosis. Additionally, considerations on the habitat and conservation threats to the newly discovered species are discussed.

2. Materials and methods

Study Area

The species described were discovered in two distinct karst regions formed by limestone from the São Francisco Carbonate Supergroup, specifically the Bambuí Group. The Serra do Ramalho karst system (Bahia) (Figure 2) spans approximately 12,000 km², located between the Carinhanha and Corrente Rivers, tributaries of the São Francisco. It features karst landscapes with dolines, closed basins, limestone towers, and underground rivers, with recharge occurring through polygonal depressions and diffuse infiltration. The eastern margin is notable for striking cliffs and well-developed epikarst areas. The Montes Claros region (Minas Gerais) (Figure 3), also within the São Francisco River basin, has a tropical semi-arid climate with Cerrado vegetation, including deciduous and semideciduous forests. It ranges in altitude from 600 to 1,000 meters and is characterized by rugged terrain, prominent limestone outcrops, and diverse karst formations.

Field sampling and laboratory

Specimens were collected using a hand net and preserved in vials containing 70% ethanol. In the laboratory, they were measured and photographed using a ZEISS Axio Zoom V16 stereomicroscope with an Axio Cam 506 color camera. The analyzed specimens were stained with Bengal rose dye, dissected, and mounted on slides with Hoyer's medium. Drawings were created based on the holotype, with final illustrations produced using GIMP software (v. 2.10) and a Wacom Cintiq drawing pad (Montesanto 2015, 2016). One paratype of *Spelaeogammarus* sp. nov. 2 was dissected and photographed under an SEM. Additional material was deposited in the Collection of Subterranean Invertebrates at the Federal University of Lavras (ISLA/UFLA).

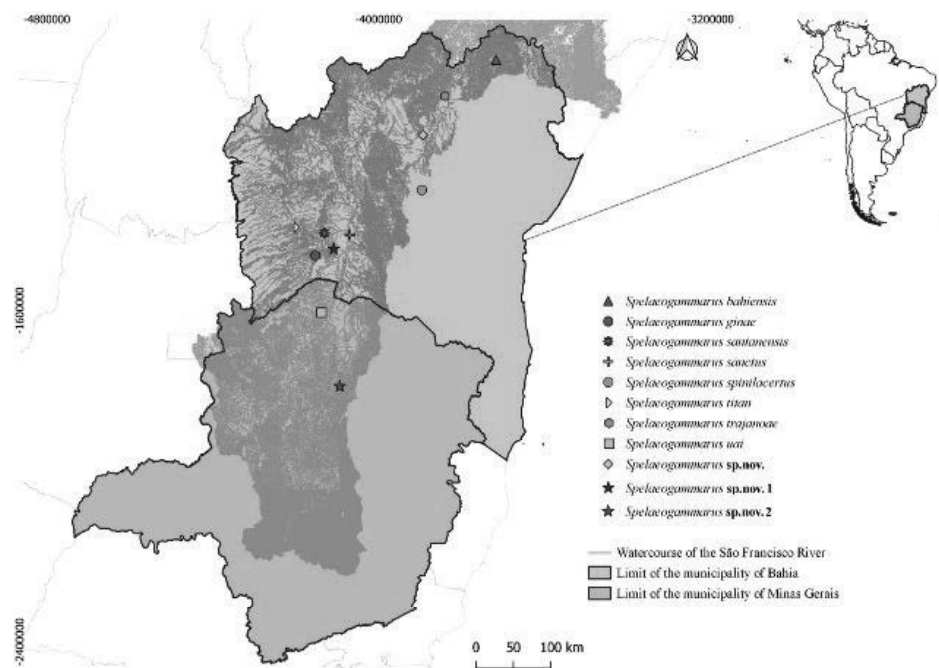


Figure 1: Map showing the distribution of *Spelaegammarus* species in Brazil.

3. Results

Spelaegammarus sp. nov. 1 (Figure 2) is characterized by the flagellum of the antenna 1 with 10 articles; accessory flagellum 4-articulate; maxilla 1 outer lobe apical margin with 7 simple robust setae; maxilliped inner plate apical margin without plumose setae; gnathopod 1 basis anterior margin with 2 small setae, posterior margin bearing 2 long setae; gnathopod 2 posterior margin with 3 long setae; uropod 3 outer ramus bearing 7 dorsal bifid setae; telson with 1 apical and 3 subapical stout setae.

Spelaegammarus sp. nov. 2 (Figure 3) is distinguished by the ac-

cessory flagellum 3-articulate and by the absence of bifid setae on outer ramus of uropod 3. It is also characterized by the antenna 1 flagellum with 11 articles; the antenna 2 flagellum 5-articulate; maxilla 1 outer lobe apical margin with 6 simple robust setae and 1 plumose setae; maxilliped inner plate apical margin with 3 plumose setae; gnathopod 1 basis anterior margin with 4 small setae, posterior margin with 4 simple long setae; gnathopod 2 posterior margin with 6 long setae; telson with 1 apical and 2 subapical stout setae.

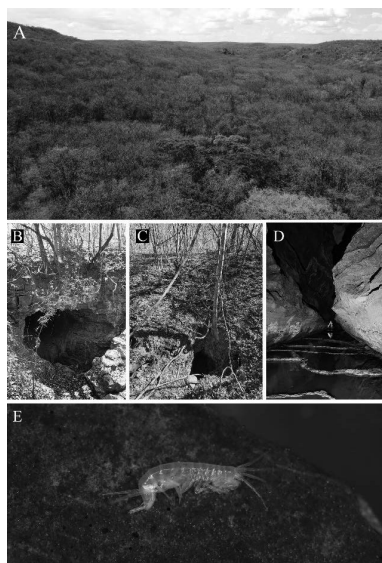


Figure 2: A) Overview of the external karst area of Serra do Ramalho, Bahia; B, C) cave entrance of *Spelaegammarus* sp. nov. 1; D) Inner section of the cave; E) *Spelaegammarus* sp. nov. 1 living specimens.

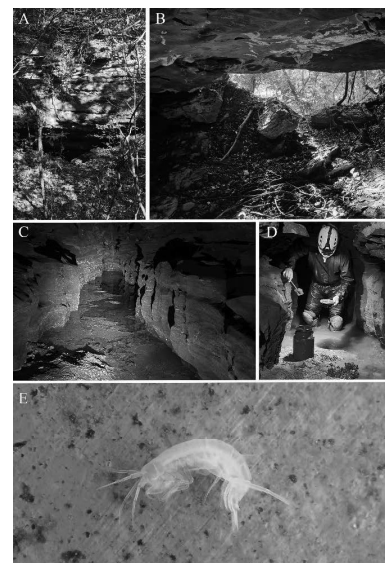


Figure 3: A, B) Cave's entrance of *Spelaegammarus* sp. nov. 2; C) Inner section of the cave, showing the ponds where specimens were found; D) collection of specimens using a hand net; E) *Spelaegammarus* sp. nov. 2 living specimens.

4. Discussion

Spelaeogammarus **sp. nov. 1** share morphological similarity with *S. spinilacertus*, *S. bahiensis* and *Spelaeogammarus* **sp. nov. 2**. These species share common features such as the number of articles in the accessory flagellum of antenna 1, number of setae on the apical margin of the outer plate of maxilla 1, absence of plumose setae on the apical margin on the inner plate of maxilliped and number of setae on coxa 6.

Spelaeogammarus **sp. nov. 2** is similar to *S. spinilacertus*, *S. bahiensis* and *Spelaeogammarus* **sp. nov.** by the 4-articulate accessory flagellum. It resembles *S. santanensis*, *S. bahiensis*, *S. uai* and *S. sanctus* by 7 multi-cuspidate stout setae on the outer plate of maxilla 1. Resembles *S. bahiensis* and *Spelaeogammarus* **sp. nov.** by the absence of plumose setae on the inner plate of maxilliped. It resembles *S. spinilacertus*, *S. trajanoae* and *Spelaeogammarus* **sp. nov.** by 1 stout setae on coxa 6. Finally, by 1 apical + 3 subapical stout setae per lobe on telson it bears a resemblance to *S. uai* and *S. titan*.

Spelaeogammarus **sp. nov. 2** resembles *S. sanctus* by 1 apical + 2 subapical stout setae per lobe on telson. By the number of plumose setae on the apical margin of the inner plate of maxilliped it resembles *S. uai* and *S. ginae*. With 4 small setae on anterior margin of gnathopod 1 basis it resembles *S. ginae* and *S. santanensis*. Finally, it resembles *Spelaeogammarus* **sp. nov.**, *S. spinilacertus* and *S. trajanoae* by 1 stout seta on coxa 6.

Although *Spelaeogammarus* **sp. nov. 2** shares similarities with *Spelaeogammarus* **sp. nov. 1**, such as 5-articulate antenna 2 flagellum and 1 stout seta on coxa 6, it is characterized by being the first species of the genus that presents a 3-articulate accessory flagellum and by the absence of bifid setae on the dorsal margin of the uropod 3 outer ramus.

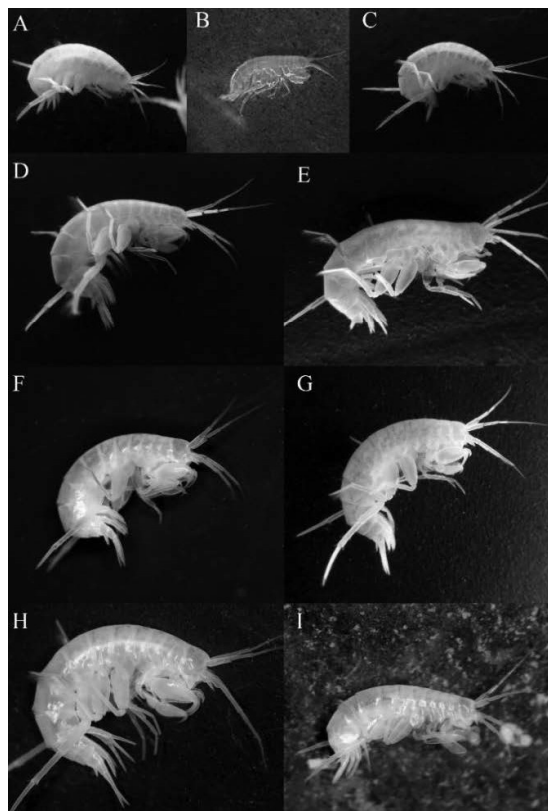


Figure 3: A,B) Cave's entrance of *Spelaeogammarus* **sp. nov. 2**; C) Inner section of the cave, showing the ponds where specimens were found; D) collection of specimens using a hand net; E) *Spelaeogammarus* **sp. nov.** 2 living specimens.

5. Conclusion

The increasing number of new described species within the genus *Spelaeogammarus* highlights the vast diversity that remains unexplored. With the recent discovery of a second species from Minas Gerais, the potential for expanding the known distribution of this genus has become increasingly evident.

The state of Bahia, in particular, stands out for its exceptional subterranean biodiversity, as reflected in the number of species described from the region. Within the Serra do Ramalho karst system, two major hotspots of subterranean biodiversity have been identified: ACCS and the Pedro Cassiano Cave (Ferreira et al., 2023; Vaz et al., 2024), which

are located in close proximity

The discovery of these two new species significantly enhances our understanding of the genus' distribution and underscores the importance of further exploratory efforts. Notably, the discovery of new species associated with the São Francisco River Basin suggests that their distribution may be closely linked to the basin's boundaries. Ongoing research in these karstic regions is likely to reveal additional species and provide deeper insights into the ecological dynamics of subterranean environments, emphasizing the urgent need for conservation initiatives to protect these unique ecosystems.

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References

- Bastos-Pereira R, Ferreira RL. 2015. A new species of *Spelaeogammarus* (Amphipoda: Bogidielloidea: Artesiidae) with an identification key for the genus. *Zootaxa*, 4021: 418–432.
- Bastos-Pereira R, Ferreira RL. 2017. *Spelaeogammarus uai* (Bogidielloidea: Artesiidae): a new troglitic amphipod from Brazil. *Zootaxa*, 4231: 38–50.
- Bueno AAP et al. 2022. A new species of the troglitic genus *Spelaeogammarus* da Silva Brum, 1975 (Amphipoda: Artesiidae) from a cave in the Brazilian semi-arid region, with new records of its congener, *Spelaeogammarus spinilacertus* Koenemann and Holsinger, 2000. *Nauplius*, 30. <https://doi.org/10.1590/2358-2936e2022020>
- da Silva Brum IN. 1975. *Spelaeogammarus bahiensis* g. n. sp. n. de anfípodo cavernícola do Brasil (Amphipoda-Bogidiellidae). *Atlas da Sociedade de Biologia do Rio de Janeiro*, 17: 125–128.
- Koenemann S, Holsinger JR. 2000. Revision of the subterranean amphipod genus *Spelaeogammarus* (Bogidiellidae) from Brazil, including descriptions of three new species and considerations of their phylogeny and biogeography. *Proceedings of the Biological Society of Washington* 113: 104–123.
- Senna AR, Andrade LF, Castelo-Branco LP, Ferreira RL. 2014. *Spelaeogammarus titan*, a new troglitic amphipod from Brazil (Amphipoda: Bogidielloidea: Artesiidae). *Zootaxa* 3887: 55–67.
- Montesanto G. 2015. A fast GNU method to draw accurate scientific illustrations for taxonomy. *Zookeys* 515: 191–206. <https://www.doi.org/10.3897/zookeys.515.9459>
- Montesanto G. 2016. Drawing setae: a GNU way for digital scientific illustrations. *Nauplius*, 24: 1–6. <https://www.doi.org/10.1590/2358-2936e2016017>
- Vaz GAS, Souza-Silva M, Ferreira AHSR, Ferreira RL. 2024. Exploring the factors shaping the invertebrate Community and habitat selection in a new Hotspot of Subterranean Biodiversity in South America. *Acta Oecologica*. <https://doi.org/10.1016/j.actao.2024.104043>