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New species of *Pseudonannolene* Silvestri, 1895 from Brazilian limestone caves with comments on the potential distribution of the genus in South America (Spirostreptida: Pseudonannolenidae)

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Abstract

Ten new species of *Pseudonannolene* Silvestri, 1895 are described from Brazilian limestone caves. The species are separated by the morphology of their gonopods and the processes of the first pair of legs of males. A pictorial identification key for the cave-dwelling species from Brazil is provided, besides comments on the distribution of the genus with a potential distribution map of *Pseudonannolene* and *Epinannolene* in South and Central America.

Key words: *Pseudonannolene*, Cave, Brazil, Conservation, Neotropics, Potential distribution

Introduction

The family Pseudonannolenidae was described by Silvestri in 1895, through samples of species *Pseudonannolene typica* Silvestri, 1895, found in Candelaria, Misiones, Argentina, and *Pseudonannolene bovei* Silvestri, 1895, from Giabibbirri, Misiones, Argentina (Silvestri 1895). The main features described were a longitudinal division of the promentum of the gnathochilarium, an elongated and cylindrical body shape, presence of 10 to 11 rows of pectinate lamellae on the mandibles, fourth corporal ring apodous and ozopores starting on the fifth ring (Silvestri 1895). The family has around 50 described species (Shear 2011), distributed in three subfamilies (Mauriès 1987; Hoffman & Florez 1995; Shelley 2003): Pseudonannoleninae Silvestri, 1895, comprising the genera *Pseudonannolene*, *Epinannolene* and *Typhlonannolene* (the validation of this genus is still under discussion); Physiostreptinae Silvestri, 1903, with the genera *Phallortus*, *Physiosreptus* and *Holopodostreptus*; and Cambalomminae Mauriès, 1974, with the single genus *Cambalomma*.

The three subfamilies are mainly separated by the morphology of the gnathochilarium. In Pseudonannoleninae the lamellae linguales are totally separated by the promentum (Brölemann 1903; Chamberlin 1923; Hoffman & Florez 1995) in Cambalomminae, they are separated only by a prolongation of the mentum (Loomis 1941); and in Physiostreptinae, the lamellae are fully connected, without a separation (Hoffman & Florez 1995).

In Brazil, the genus *Pseudonannolene* comprises the richest within the family, being frequently found in caves (Iniesta & Ferreira 2013a). Species are also found in different habitats, such as forests, monocultures, gardens and near houses (Schubart 1944).

Identification of *Pseudonannolene* is based mainly on a longitudinal bipartition of the promentum (a feature that formerly defined the family) and gonopod morphology (Mauriès 1987; Iniesta & Ferreira 2013a).

The first species described in Brazil was *P. longicornis* Porat, 1888, found in São Paulo state. The species was originally described as belonging to the genus *Alloporus* (Spirostreptidae), later being relocated to the genus *Pseudonannolene* (Brölemann 1909). In caves, the first Brazilian species described was *P. strinatii* Mauriès, 1974, found in the Gruta das Areias cave, São Paulo state (Mauriès 1974). Other species were subsequently described, mainly by Fontanetti (1996a; 1996b) and Iniesta & Ferreira (2013b, 2013c).

In this work, ten new species of *Pseudonannolene* Silvestri, 1895 are described from Brazilian limestone

in iron ore caves from the Amazon region (Pará) and *P. ambuatinga* Iniesta & Ferreira, 2013, from limestone caves of the municipality of Pains (Minas Gerais) (Iniesta & Ferreira 2013a; Iniesta & Ferreira 2013b). The habitats of these species are preserved only due to their presence. Accordingly, a single troglobitic species can protect a whole system, and this is why new inventories have to be urgently conducted. Thus, species of *Pseudonannolene* are revealing themselves as good tools for cave conservation, at least in Brazil.

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Bibliographic references

- Adis, J., Foddai, D., Golovatch, S.I., Hoffman, R.L., Minelli, A., de Moraes, J.W., Pereira, L.A., Scheller, U., Schileyko, A.A. & Wurmli, M. (2002) Myriapoda at “Reserva Ducke”, Central Amazonia/Brazil. *Amazoniana*, 17, 15–25.
- Berns, M.W. (1968) The development of the copulatory organs (gonopods) of a spirobolid millipede. *Journal of Morphology*, 126, 447–462.
- Brölemann, H.W. (1902) Myriapodes du Musée de Sao Paulo. *Revista do Museu Paulista*, 5, 35–237.
- Brölemann, H.W. (1903) Myriapodes recueillis à l'isla de Cocos par M. le Professeur P. Biolley. *Annales de la Société Entomologique de France*, 72, 128–143.
- Brölemann, H.W. (1909) *Catálogos da Fauna Brasileira*. Museu Paulista, São Paulo, Brasil, 236 pp.
- Carl, J. (1913) Diplopodenstudien II. Eine neue Physiostreptiden-Gattung. *Zoologischer Anzeiger*, 62, 212–216.
- Chamberlin, R.V. (1922) Notes on West Indian millipeds. *Proceedings U. S. National Museum*, 61(10), 1–19.
<http://dx.doi.org/10.5479/si.00963801.61-2431.1>
- Chamberlin, R.V. (1923) Results of the Bryannt Walker Expeditions of the University of Michigan to Colombia, 1913, and British Guiana, 1914. *Occ. Pap. Mus. Univ. Mich.*, 133, 1–143.
- Chamberlin, R.V. (1952) Further records and descriptions of American millipeds. *Great Basin Naturalist*, 12, 13–34.
- Fontanetti, C.S. (1996a) Description of three cave diplopods of *Pseudonannolene* Silvestri (Diplopoda, Pseudonannolenida, Pseudonannolenidae). *Revista Brasileira de Zoologia*, 13 (2), 427–433.
- Fontanetti, C.S. (1996b) Description of a new species and the karyotype of the cavernicolous millipede *Pseudonannolene* Silvestri and the karyotype of *Pseudonannolene Strinatti* Mauriès (Diplopoda, Pseudonannolenida, Pseudonannolenidae). *Revista Brasileira de Zoologia*, 13 (2), 419–426.
<http://dx.doi.org/10.1590/S0101-81751996000200012>
- Fontanetti, C.S. (2002) Taxonomic Importance of the Prefemoral Process of the first Pair of Legs in Males of the Genus *Pseudonannolene* (Diplopoda, Spirostreptida). *Folia biologica (Kraków)*, 50, 199–202.
- Golovatch, S.I., Hoffman, R.L., Adis, J., Vohland, K. & Mármol, A. (1997) On the identity of further two millipede species (Diplopoda) from environs of Manaus, Central Amazonia, Brazil. *Amazoniana*, 16, 301–309.
- Hoffman, R.L. & Florez, E. (1995) The millipede genus *Phallorthis* revalidated: another facet of a taxonomic enigma (Spirostreptida: Pseudonannolenidae). *Myriapodologica*, 3, 115–126.
- Hoffman, R.L. (1984) A new species of *Epinannolene* from the Amazon Basin, Brazil (Spirostreptida: Pseudonannolenidae). *Myriapodologica*, 1 (13), 91–94.
- Iniesta, L.F.M. & Ferreira, R.L. (2013a) The first troglobitic *Pseudonannolene* from Brazilian iron ore caves (Spirostreptida: Pseudonannolenidae). *Zootaxa*, 3669 (1), 85–95.
<http://dx.doi.org/10.11646/zootaxa.3669.1.9>
- Iniesta, L.F.M. & Ferreira, R.L. (2013b) Two new species of *Pseudonannolene* Silvestri, 1895 from Brazilian limestone caves (Spirostreptida: Pseudonannolenidae): syntopy of a trogliphilic and a troglobiotic species. *Zootaxa*, 3702 (4), 357–369.
<http://dx.doi.org/10.11646/zootaxa.3702.4.3>
- Iniesta, L.F.M. & Ferreira, R.L. (2013c) Two new species of *Pseudonannolene* Silvestri, 1895 from Brazilian iron ore caves

- (Spirostreptida: Pseudonannolenidae). *Zootaxa*, 3716 (1), 75–80.
<http://dx.doi.org/10.11646/zootaxa.3716.1.6>
- Loomis, H. F. (1941) New genera and species of millipeds from the southern peninsula of Haiti. *Journal of the Washington Academy of Sciences*, 31 (5), 187–195.
- Loomis, H.F. (1968) *A checklist of the millipeds of Mexico and Central America*. Bulletin of the U.S. National Museum 266, 137 pp.
- Mauriès, J.P. (1974) Un cambalide cavernicole du Brésil, *Pseudonannolene strinatii* n. sp. (Myriapoda, Diplopoda). *Revue Suisse de Zoologie*, 81 (2), 545–550.
- Mauriès, J.P. (1987) Cambalides nouveaux et peu connus d'Asie, d'Amérique et d'Océanie. II. Pseudonannolenidae, Choctellidae (Myriapoda, Diplopoda). *Bull. Mus. natn. Hist. nat. Paris*, 9, 169–199.
- Miley, H.H. (1927) Development of the male gonopods and life history studies of a polydesmid millipede. *The Ohio Journal of Science*, 27 (1), 25–43.
- Mwabvu, T., Lamb, J., Slotow, R., Hamer, M. & Barraclough, D. (2013) Is millipede taxonomy based on gonopod morphology too inclusive? Observations on genetic variation and cryptic speciation in *Bicoxidens flavicollis* (Diplopoda: Spirostreptida: Spirostreptidae). *African Invertebrates*, 54 (2), 349–356.
<http://dx.doi.org/10.5733/afin.054.0203>
- Phillips, S.J., Anderson, R.P. & Schapire, R.E. (2006) Maximum entropy modeling of species geographic distributions. *Ecological Modelling*, 190, 231–259.
<http://dx.doi.org/10.1016/j.ecolmodel.2005.03.026>
- Schubart, O. (1944) Os Diplopodos de Pirassununga. *Acta zool. Lilloana*, 2 (2), 321–440.
- Shear, W. (2011) Class Diplopoda de Blainville in Gervais, 1844. In: Zhang, Z.-Q. (Ed.) *Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness*. *Zootaxa*, 3148, 159–164.
- Shelley, R.M. (2003) A revised, annotated, family-level classification of the Diplopoda. *Arthropoda Selecta*, 11 (3), 187–207.
- Sierwald, P., Jeekel, C.A.W., Hoffman, R.L., Shelley, R.M., Kiser, S.B. & Golovatch, S.I. (2006) Nomenclator Generum Diplopodorum, Version 2. A complete listing of all genus-group names in the class Diplopoda from 1758 through 1999. On-line publication: This Excel file is available to download. Available from: http://www.fieldmuseum.org/research_collections/zoology/zoo_sites/millipeet/pdfsFullarticles/MILLGEN.xls (accessed 31 March 2014)
- Silvestri, F. (1895) *Chilopodi e diplopodi raccolti dal Capitano G. Bove e dal Prof. L. Balzan nell'America Meridionale*. Annali del Museo Civico di Storia Naturale di Genova, 34, 839 pp.
- Silvestri, F. (1902) Viaggio del Dr. A. Borelli nel Matto Grosso. *Boll. Musei. Zool. Anat. Comp. R. Univ. Torino*, 17 (432), 1–25.
- Trajano, E., Golovatch, S.I., Geoffroy, J.J., Pinto-da-rocha, R. & Fontanetti, C.S. (2000) Synopsis of brazilian cave-dwelling millipedes (Diplopoda). *Papéis Avulsos de Zoologia*, 18, 259–287.
- White, W.B. & Culver, D.C. (2012) *Encyclopedia of caves*. Elsevier Academic Press, Oxford, San diego, 966 pp.
- Zampaulo, R.A. (2010) *Diversidade de invertebrados cavernícolas na Província Espeleológica de Arcos, Pains e Doresópolis (MG): subsídios para a determinação de áreas prioritárias para conservação*. Dissertação (Mestrado em Ecologia Aplicada) - Universidade Federal de Lavras, Lavras, 190 pp.