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RESEARCH ARTICLE

Expanding the knowledge of Brazilian Gastrotrich biodiversity: Freshwater Paucitubulatina (Gastrotricha: Chaetonotida) from Northeastern Brazil

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ABSTRACT. Knowledge of neotropical freshwater gastrotrichs, especially in Brazil, has gained momentum in the past decades, with new species being discovered yearly, accumulating in the last 30 years more than 10% of known species worldwide. Nevertheless, there is still much to accomplish in the field, with large geographical gaps to be filled, especially in continental countries such as Brazil. In the present study, we report the partial results of an expedition that, for the first time, sampled the inland waters of Alagoas, Bahía, and Pernambuco states, Northeast Region, Brazil, and found ten species belonging to five genera of Chaetonotidae. We report the first occurrence in Brazil of *Chaetonotus majestuosus* Grosso & Drahg, 1984, originally described from Argentina, and the second record in Brazil of *Chaetonotus dadayi* Schwank, 1990, originally found in Paraguay, and the first occurrence beyond 'terra typica' of *Heterolepidodermella jureiense* Kisielewski, 1991, originally discovered in Southeastern Brazil. Furthermore, we report members of species in conformity to species originally described in European countries *Chaetonotus* cf. *persetosus* Zelinka, 1889, and *Chaetonotus* cf. *oculifer* Kisielewski, 1981, although further investigations are needed to confirm the occurrence of such widespread lineages. Finally, we list three putative undescribed species related to *Lepidochaetus* aff. *zelinkai* (Grünspan, 1908), *Chaetonotus* aff. *hoanicus* Schwank, 1990 and *Chaetonotus* aff. *acanthocephalus* Valkanov, 1937. This new survey increases the list of northeast Brazilian freshwater gastrotrichs to 13 species.

KEYWORDS. Caatinga, Chaetonotidae, freshwater, meiofauna, regional survey, taxonomy.

INTRODUCTION

Freshwater environments host a significant proportion of globally described species, and knowledge of their diversity and distribution in each ecoregion is essential for preservation and conservation (Dudgeon et al. 2006). Yet, despite these ecosystems facing greater declines in biodiversity than their terrestrial counterparts (Gibert and Deharveng 2002, Sala et al. 2000), there are still gaps in knowledge to be filled, mainly in high-diversity and low-taxonomic infrastructure countries (Grieneisen et al. 2014). Even within a country, taxonomic efforts can be unevenly distributed geographically among macroscopic organisms (Oliveira et al. 2016, 2017, Teixido et al. 2020) and even more in the microinvertebrate fauna that composes the meiofauna (Garraffoni et al. 2024). These microinvertebrates, in turn, suffer from biases toward macroscopic and charismatic animals (Mammola et al. 2023), and information on the diversity and ecology of these tiny animals is fragmentary, notwithstanding the crucial role of meiobenthos in diverse ecological functions (Majdi et al. 2024).

The Brazilian Caatinga is a seasonally dry tropical forest, but during the rainy season, the landscape turns lush green (Brasil 2017, Fernandes 2003). This biome, despite being located in the Brazilian semiarid region, features a diversity of aquatic ecosystems, such as temporary rivers, which leave semi-permanent puddles during periods of drought that serve as important refuges for the maintenance of local diversity (Zanella 2014); human-made weirs and reservoirs on the roadsides in rural and urban areas for

retaining water (Barbosa et al. 2012); and large permanent rivers, such as the São Francisco River. Research on these freshwater ecosystems has surveyed vertebrate macrofauna (Cardoso et al. 2012), entomofauna (e.g., Rocha et al. 2012), and malacofauna (e.g., Leal et al. 2021), besides microscopic cladocerans and copepods (Crustacea; e.g., Diniz et al. 2013 Simões et al. 2008), and rotifers in ecological studies (e.g., Arruda et al. 2017, Eskinazi-Sant'Anna et al. 2013). However, Gastrotricha Metschnikoff, 1865, is the subject of a single paper, recording the occurrence of two rare semiplanktonic species (Minowa and Garraffoni 2022).

Gastrotricha is a clade of approximately 900 species of microscopic metazoans measuring ca. 300–500 μm, ubiquitous member of meiofaunal community in marine interstices and freshwater epibenthos and periphyton (Balsamo et al. 2014, 2019, Balsamo and Todaro 2002, Garraffoni et al. 2024, Kieneke and Schmidt-Rhaesa 2015). The clade is subdivided into two main orders: Macrodasyida Remane, 1925, and Chaetonotida Remane, 1925—the latter consisting of suborders Multitubulatina d'Hondt, 1971, and Paucitubulatina d'Hondt, 1971; but see Kieneke et al. (2007, 2008) Leasi and Todaro (2008), Rothe et al. (2011) and Zrzavý (2003). Paucitubulatinian are easily recognizable from their vermiform larger (mostly marine) macrodasidian cousins by their smaller and fusiform (i.e., bowling pin-shaped) bauplan, bearing a single pair of adhesive tubes on a bifurcated caudal end referred to as a furca (Balsamo et al. 2014). The vast majority of Paucitubulatina species belong to the highly diverse taxon Chaetonotidae Gosse, 1864, accounting for over 80% of its representatives. The classification of Chaetonotidae is mainly based on external morphology and ultrastructure, leaving morphometric measurements of the body such as total length, width of the head and trunk, posterior furca and pharynx shape, and the arrangement and shape of the scales and spines, as well as some cuticular ornamentations, as the only tools for species determination (Kånneby 2011, Kolicka et al. 2020). Additionally, there is little information available on intraspecific variation in several species (Amato and Weiss 1982).

In the Brazilian freshwater environments, the studies by Kisielewski (Kisielewski, 1987, 1991) were the main (and for years, the only) references on gastrotrich biodiversity and distribution in the country (Araújo et al. 2024a). They presented several new records of species already known from Europe, expanding their distribution considerably, but also provided descriptions of numerous new endemic species of Paucitubulatina, within the families Chaetonotidae, Dasydytidae Daday, 1905 and Neogosseidae Remane, 1927. Besides sporadic contributions by Todaro and Rocha (2004, 2005), Garraffoni et al. (2010) initiated a new phase in the study of this fauna with the participation of national scholars and international fellows, and according to Araújo et al. (2024a) research gained momentum with the description of several new species and the discovery of new records of psammitic (e.g., Garraffoni et al. 2017, 2019) and peryphytic fauna (Minowa and Garraffoni 2020, 2022) and in the past 30 years, more than 10% of known species worldwide have been reported in Brazil, several of them being endemic, currently adding up to 88 species across 29 genera, with 57 freshwater species listed in the Taxonomic Catalog of the Brazilian Fauna (Catálogo Taxonômico da Fauna do Brasil, Portuguese acronym CTFB). Nevertheless, our knowledge of Brazilian and neotropic gastrotrich fauna still lags compared to other well-investigated countries in Europe and the Palearctic region, where the traditional centers of research are located (Araújo et al. 2024a, Balsamo et al. 2019, Garraffoni et al. 2024, Garraffoni and Balsamo 2017). The same phenomenon of unequal sampling efforts seen globally (Grieneisen et al. 2014), with greater species richness where researchers are present, arises within the Brazilian territory: the region with the greatest biodiversity is also the country's most developed region, with 38 species in southeastern Brazil, while sparse records are found in the north (19 species) and center-west (10 species) due to the work of a single researcher (Kisielewski 1991), and no formal records in the southern region (Garraffoni et al. 2024).

Herein, we describe the preliminary results of an ongoing project that gathered morphological data of freshwater Paucitubulatina, sampled in the Brazilian northeastern region, across the states of Alagoas (AL), Bahía (BA), and Pernambuco (PE). Each species was thoroughly recorded under a light microscope equipped with differential interference contrast lenses and a scanning electron microscope to register new morphological data that was inaccessible at the time of the original descriptions.

MATERIAL AND METHODS

Freshwater samples with floating aquatic vegetation were collected from artificial weirs on the roadside in rural and urban areas and several parts of the São Francisco River of the northeast region of Brazil (Fig. 1), in 07–16 December 2022, in the following localities: PT06: Casa Nova municipality, next to Nilo Coelho pumping station, in unidentified algae goop (9°22'15.71"S, 40°48'17.15"W); PT07: Abaré (8°43'15"S, 39°06'54"W); PT08: Chorrochó municipalities in small (5m²)

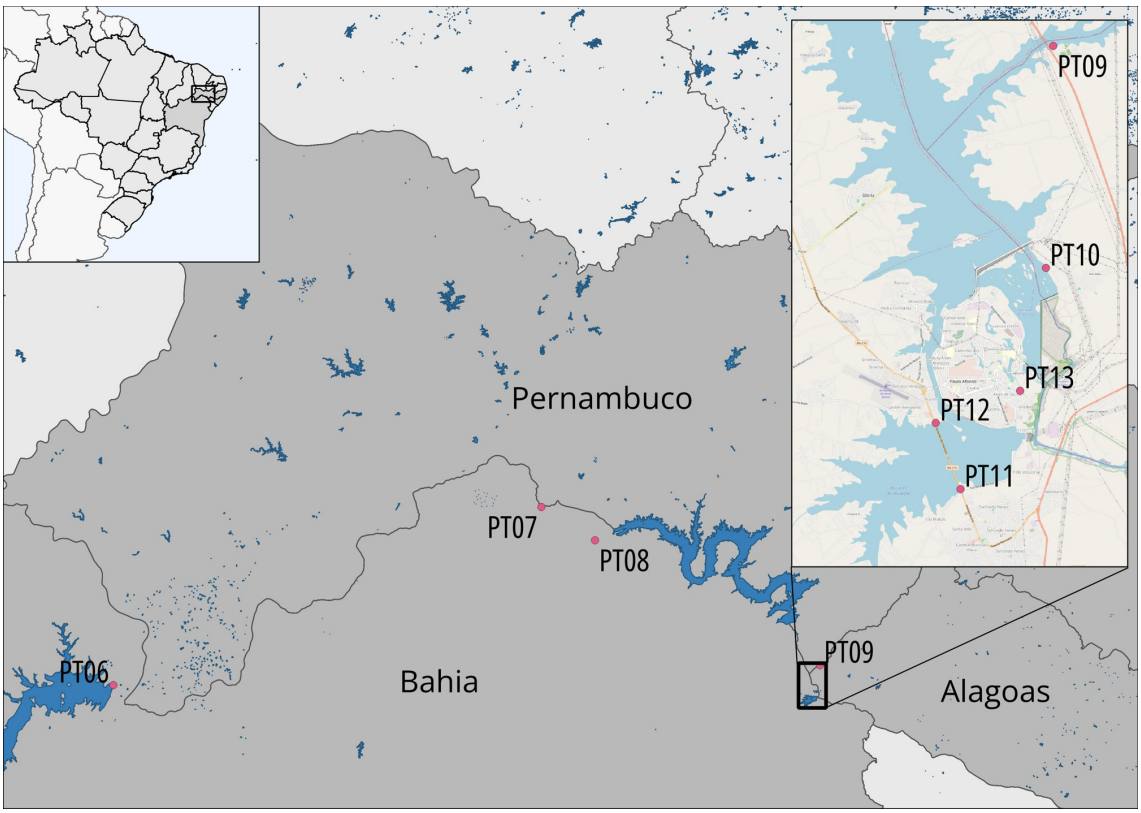

Figure 1. Sampling sites: PT06) Casa Nova (9°22'15.71"S, 40°48'17.15"W); PT07) Abaré (8°43'15"S, 39°06'54"W); PT08) Chorrochó (8°50'13.91"S, 39°1'44.07"W); PT09) Delmiro Gouveia (9°17'52.62"S, 38°11'57.89"W); PT10) Delmiro Gouveia (9°21'53.54"S, 38°12'5.69"W); PT11–13) Paulo Afonso (9°25'54.07"S, 38°13'38.58"W; 9°24'42.04"S, 38°14'5.71"W; 9°24'7.29"S, 38°12'33.82"W).

roadside artificial weir covered with Salvinia natans and Eichhornia crassipes (8°50'13.91"S, 39°1'44.07"W); PT09: Delmiro Gouveia (9°17'52.62"S, 38°11'57.89"W); PT10: Delmiro Gouveia (Lago Moxotó; 9°21'53.54"S, 38°12'5.69"W); PT11–13: Paulo Afonso in surroundings of São Francisco river, with mostly clear shore, with patches of Eichhornia crassipes where the samples were taken (9°25'54.07"S, 38°13'38.58"W; 9°24'42.04"S, 38°14'5.71"W; 9°24'7.29"S, 38°12'.33.82"W). Subsamples were immediately screened in Petri dishes under a Zeiss Stemi 2000 stereomicroscope for animals, which were isolated using mechanical pipettes for molecular purposes, anesthetized in 2% $MgCl_2$, and fixed in 4% paraformaldehyde (pH 7.4 at 4 °C) and stored in cryotubes grouped by morphotypes. Later, in the Laboratory of Evolution of Meiofaunal Organisms (Campinas, São Paulo, Brazil), each specimen was rinsed thoroughly in phosphate buffer saline (PBS) pH 7.4 at 4 °C, mounted individually on slides and digitally documented under a Zeiss Axio Imager M2 light microscope equipped with differential interference contrast lenses and AxioCam MRC5 digital video camera. The images and measurements were taken with the software ZEN lite 2.5 2018. Photomicrographs of each species are made available at the Museu de Diversidade Biológica (MD-Bio/Unicamp) under accession numbers ZUEC-PIC 933-1086.

For Scanning Electron Microscopy (SEM), animals were recovered from the light microscope slide by slowly adding PBS to lift the coverslip and move it aside, and each animal was placed inside small tube-shaped metal containers with both ends closed by two copper transmission electron microscopy grids (1500 mesh, hole size 9 µm), and dehydrated in an increasing ethanol series (10 minutes in each step), critical point dried and mounted on a round coverslip coated with a thin layer of TempFix wax. The coverslip was attached to a SEM stub and specimens were coated with palladium-gold. Observation and documentation were done with the VEGA3-Tescan Scanning Electron Microscope at the

German Centre for Marine Biodiversity Research (Wilhelmshaven, Hamburg, Germany).

The morphology and morphometric features of gastrotrichs were analyzed according to Kisielewski (1991) and Kolicka et al. (2016) and identification was performed based on Balsamo et al. (2019) and Garraffoni and Araújo (2020) identification keys.

Abbreviations: (AL) Adhesive tube Length, (CL) Caudal appendages Length, (DC) number of Dorsal scale Columns, (DR) number of Dorsal scale Rows, (DSL) Dorsal Spine Length, (FL) Furca Length, (MD) Mouth Diameter, (PhL) Pharynx Length, (SCA) number of Segments on Caudal Appendages, (SGI 1-4) Spine Group, (TL) Total Length, (TSl) Trunk Scale length, (TSp) Trunk Spines length, (TSw) Trunk Scale width, (VB) number of Ventral Bars below pharynx, (VC) number of Ventral scale Columns, (VR) number of Ventral Scale Rows, (VSL) Ventral Spine Length, (VTSl) Ventral Terminal Scales length, (VTSw) Ventral Terminal Scales width.

RESULTS

In total, 114 specimens from ten species of five genera of Chaetonotidae are reported in the present work. Four species of *Chaetonotus* and one species of *Heterolepidoderma* fit the original description. Two species of *Chaetonotus* have the majority of diagnostic features matching to known species descriptions, but some key features are missing, and are indicated as conformity ("cf." between generic and specific epithets), according to Bengtson (1988). Representatives of *Lepidochaetus* and two morphotypes of *Chaetonotus* have morphological specificities that indicate the potential of being undescribed species, and they are presented as affinities ("aff." between generic and specific epithets) to the morphologically closest species. One species of each *Polymerurus* and *Lepidodermella* were found but the lack of proper images make it impossible to determine its taxonomic identity beyond genus level, remaining as "sp.". The algae goop collected at Casa Nova (PT06) hosted most of the species found in the present study with totaling four species of *Chaetonotus*, plus *Polymerurus* sp., *Lepidodermella* sp. and *Heterolepidoderma jureiense*. Similarly, the floating vegetation of most of the sampling sites of the large water body of São Francisco River (PT09–11) hosted most of the species found in the present study. The artificial weirs (PT07–08), smaller and semi-permanent in nature hosted *Lepidodermella* sp., *Lepidochaetus* aff. *zelinkai*, *Heterolepidoderma jureiense*, *Chaetonotus* cf. *persetosus* and *Chaetonotus magestuosus*.

TAXONOMY

Phylum Gastrotricha Metschnikoff, 1865

Order Chaetonotida Remane, 1925 sensu Rao and Clausen (1970)

Suborder Paucitubulatina d'Hondt, 1971

Chaetonotidae Gosse, 1864 sensu Garraffoni et al. (2017)

Chaetonotinae Kisielewski, 1991

Chaetonotus Ehrenberg, 1830

Chaetonotus dadayi Schwank, 1990

Figs 2A, 5E–F

Locality: PT06, 09, 10 (Fig. 1).

Examined Material: 3 specimens TL 88–155 µm; FL 8–9 µm; AL 23–24 µm; PhL 34–43 µm; MD 6–11 µm; DR 27–28; TSl 6–12 µm; TSw 3 µm; TSp 28–48 µm; DC 7; DSL 18–27 µm.

Remarks: Short, stompy, tempin-shaped habitus. Head clearly five-lobed with a trapezoid cephalion, small dorsolateral epipleura, and ventrolateral hypopleura. Small transversal hypostomium posteriorly adjacent to the mouth. Mouth subterminal, cylindrical wide pharynx with large pharyngo-intestinal junction. Cephalic ciliature consists of dorsolateral pairs of ciliary tufts inserted between the cephalion and epipleura, a lateral tuft inserted between epipleura and hypopleura, with no particularly longer cilia. Head and neck with the same width and trunk widens posteriorly. Posterior end bears a short V-shaped furca with thin adhesive tubes, distally subtly swollen. No sensory bristles were seen. The dorsal surface is covered by hemielliptical scales posteriorly concave with a long single-barbed spine and anterior double-edge. Dorsal scales increase in size from the anterior to the middle body region and subsequently decrease toward the rear. Ventrolateral scales with similar shape increase in size along the body. Interciliary area delimited by two ciliary bands converging anteriorly, covered by rounded and unilobed scales with increasing length along the body. Four rounded scales at the ventral furca, and a pair of single-lobed oval scales medial to the furca. Present specimens fit the original description within the range of morphological variance and morphometric measurements from subsequent reports found in the literature.

Distribution: Paraguay (Daday 1905), French Guiana (d'Hondt et al. 2006), Brazil: Jundiaí (SP) (Guidetti et al. 2021), Paulínia (São Paulo: SP), Santo André (SP), Diamantina (Minas Gerais: MG) (Salgado et al. 2022), Casa Nova (BA), and Delmiro Gouveia (AL) (present study).

Chaetonotus majestuosus Grosso & Drahg, 1984

Fig. 2B

Locality: PT06, 07, 09 (Fig. 1).

Examined Material: 9 specimens. TL 88–181 μm; FL 8–26 μm; AL 14–29 μm; PhL 22–55 μm; MD 6–16 μm; DR 24–38; TSl 5–12 μm; TSw 3–9 μm; TSp 6–48 μm; DC 7; DSL 14–27 μm; VTSl 11–20 μm; VTSw 3–9 μm.

Remarks: Long, slender, fusiform habitus. Head clearly five-lobed with a large round cephalion, large dorsolateral oval epipleura with edges free and highly raised, and small ventrolateral sub-triangular hypopleura. Trapezoid hypostomium posteriorly adjacent to the mouth, with a pair of rod-like cuticular reinforcements. Mouth subterminal, straight and cylindrical pharynx, and narrow pharyngo-intestinal junction. Cephalic ciliature consists of dorsolateral pairs of ciliary tufts inserted between cephalion and epipleura, lateral tuft inserted between epipleura and hypopleura, with no particularly longer cilia. Head delimited from trunk by subtle neck constriction. Posterior end bears a short furca with thin adhesive tubes curved inward. No sensory bristles were seen. The dorsal surface is covered by 7 columns of 24 intercalated sub-pentagonal scales with a long single-barbed spine. Dorsal head and neck scales are smaller and progressively enlarging toward the trunk. Interciliary area delimited by two ciliary bands adjoining each other posteriorly to the hypostomium, covered by 6 alternated columns of longer spined scales, and the furcal branch is armed with two pairs of slender scales with extremely thin and long simple spines. Present specimens fit the original description within the range of morphological variance and morphometric measurements.

Distribution: Argentina (Grosso and Drahg 1986), Brazil: Casa Nova, Abaré (BA), and Delmiro Gouveia (AL; present study).

Chaetonotus aff. *acanthocephalus* Valkanov, 1937

Fig. 1F

Locality: PT 09, 10 (Fig. 1).

Examined Material: 6 specimens. TL 107–120 μm; FL 20–22 μm; AL 17–18 μm; PhL 30–32 μm; MD 6–10 μm; DR 23; TSl 4–5 μm; TSw 7–8 μm; TSp 11–16 μm; DC 5; DSL 19–23 μm.

Remarks: Small, compact fusiform habitus. Head three-lobed with very small conical shaped cephalion, and large lateral epipleura and hypopleura, hypostomium unseen. Mouth subterminal, cylindrical pharynx with narrow pharyngo-intestinal junction. Cephalic ciliature consists of one sub-oral tuft of tactile cilia and locomotory ciliar tufts are discreet. Head followed by subtle neck constriction with almost the same width, and trunk slightly wider. Posterior end bears a very short V-shaped furca with long thick adhesive tubes, no sensory bristles were seen. The dorsal surface is covered by 5 intercalated columns with several simple spined scales with various shapes and sizes. A set of five long anteriormost keeled scales on the head, with conspicuous spiny process posteriorly adjacent to the cephalion. Followed by several simple spined scales smaller on head and neck than the trunk. Two pairs of dorsolateral scales with longer scales strongly curved posteriorly on the mid-neck. Two pairs of lateral scales with very long and stronger spines on the posterior end of the trunk. Interciliary cuticles were unobservable. The specimens share the general morphology with *Chaetonotus acanthocephalus* with the presence of the set of anteriormost keeled cephalic dorsal scales, and sparse strong simple-spined scales with various shapes and sizes along the longitudinal axis. However, they differ in the presence of smooth scales on the dorsal head and neck region, and presence of spined scales on ventral pharyngeal region, and longer and thinner spines on the ventrolateral row.

Distribution: Brazil: Delmiro Gouveia (AL; present study).

Chaetonotus aff. *hoanicus* Schwank, 1990

Figs 2E, 4A–C

Locality: PT06, 09 (Fig. 1).

Examined Material: 19 specimens TL 103–194 μm; FL 5–16 μm; AL 12–32 μm; PhL 34–66 μm; MD 7–15 μm; DR 20–26; TSl 2–6 μm; TSw 2–5 μm; TSp 2–16 μm; DC 10–13 μm; DSL 9–24 μm; VC 4–5; VTSl 11–18 μm; VTSw 5–10 μm; VR 25–29; VSL 5–18 μm.

Remarks: Slender, fusiform habitus. Head clearly five-lobed, with strong arrow-head shaped cephalion with thin wrinkled posterior edge, large dorsolateral elliptical epipleura and lateral hypopleura, small transversal rod-shaped hypostomium posteriorly adjacent to the mouth. Mouth terminal, cylindrical pharynx with small pharyngo-intestinal junction. Cephalic ciliature consists of dorsolateral pairs of ciliary tufts inserted between cephalion and epipleura and ventrolateral one between epipleura and hypopleura, with one longer cilium. Head followed by subtle neck constriction and trunk widens posteriorly. Posterior end bears a short V-shaped furcal base with strong adhesive tubes narrower distally. Anterior sensory bristles on the neck are inserted on specialized smooth scales and posterior on the furca base inserted on specialized double-keeled scales. The dorsal surface is covered by 14 columns of pentalobed scales posteriorly concave with a

long single-barbed spine. On the head scales are smaller and anteriorly circular progressively enlarging toward the neck and trunk and elliptical in shape. Ventral interciliary area covered by 5 columns of elliptical keeled scales. Furca base is completely covered with small triangular scales with diverse morphology, some smooth, some spined with a long base resembling a keel with a spiny process. The specimens share the general morphology with *Chaenotus hoanicus*, in dorsal head and trunk scale shapes, with smaller rounded scales on the head and larger pentalobed on trunk, each bearing a long single barbed spine. Both species feature a dorsal posteriormost set of smaller scales with short simple spines on the furcal base. However, they differ in the number of dorsal columns, with *C. hoanicus* featuring a larger number of cephalic dorsal scales. On the dorsal furcal base, the present species feature two pairs of larger, stronger single-barbed spines, one larger one laterally to adhesive tube insertion, and smaller medial one with straight spines.

Distribution: Brazil: Casa Nova (BA), and Delmiro Gouveia (AL; present study).

Chaetonotus cf. *oculifer* Kisielewski, 1981

Fig. 2C

Locality: PT09, 10 (Fig. 1).

Examined Material: 4 specimens TL 109–133 µm; FL 10–11 µm; AL 14–17 µm; PhL 28–43 µm; MD 8–11 µm; DR 28–33; TSl 7 µm; TSw 5 µm; TSp 13 µm; DC 9; DSL 13 µm; VTSl 8 µm; VTSw 3 µm.

Remarks: Small, compact fusiform habitus. Head five-lobed with rectangular cephalion and dorsolateral epipleura, and ventrolateral hypopleura, hypostomium unseen. Mouth subterminal, cylindrical pharynx with narrow pharyngo-intestinal junction. Cephalic ciliature consists of dorsolateral pairs of ciliary tufts inserted between cephalion and epipleura, with no particularly longer cilia. Head followed by subtle neck constriction, and trunk slightly wider. Posterior end bears a short U-shaped furca with short thick adhesive tubes. No sensory bristles were seen. The dorsal surface is covered by nine intercalated columns of 28 simple short-spined scales. Scales on the head and neck are smaller than dorsal trunks, as well as each spine. Interciliary area cuticle is naked, with two parallel columns of smaller ventrolateral scales adjacent to ciliary bands. Ventral surface of the furcal branch is medially armed with one pair of keeled scales, while there is a pair of scales with stronger spines dorsolaterally to each adhesive tube. The general morphology of the specimens fits the original description, however the precise shape of the dorsal dorsal scales was hardly determinable.

Distribution: France (Grilli et al., 2008), Poland (Kisielewski 1981, 1986), Canada (Schwank 1990), Great Britain (Martin 1990), Russia (Tretjakova 1989), Sweden (Kånneby 2013; Kånneby et al. 2009), Brazil: Iguape (SP) (Kisielewski 1991) and Delmiro Gouveia (AL;) present study).

Chaetonotus cf. *persetosus* Zelinka, 1889

Figs 2D, 4D

Locality: PT06, 08 (Fig. 1).

Examined Material: 6 specimens. TL 94–158 µm; FL 5–14 µm; AL 16–35 µm; PhL 27–60 µm; MD 6–10 µm; DR 20–32; TSl 7–12 µm; TSw 4–12 µm; TSp 20–27 µm; DC 7–12 µm; DSL 8–10 µm; VC 8; VTSl 7 µm; VTSw 3 µm; VR 20–29; VSL 10–11 µm.

Remarks: Long, slender fusiform habitus. Head five-lobed with large cephalion and dorsolateral epipleura, hypostomium unseen. Mouth subterminal, cylindrical pharynx with subtle posterior bulb and narrow pharyngo-intestinal junction. Cephalic ciliature consists of ciliary tufts inserted between cephalion and pleurae. Head followed by distinct and long neck constriction and trunk wider. Posterior end bears a short U-shaped furca with thin and long adhesive tubes. Posterior sensory bristles inserted on specialized dorsal double-keeled scales anteriorly to furcal base. The dorsal body surface is covered by 7 intercalated columns of 20 spined arrow-head-shaped trilobed scales, with a concave posterior edge. Each spine is ornate with a denticle at ¾ of its total length from the base. Scales on head and neck are smaller than dorsal trunk scales. Ventrolateral row of scales along the ciliary band with a long simple spine with blade-like lamellae on the inner edge. The ventral furcal branch is armed with one pair of slender keeled scales. The general morphology of the specimens fits the original description, however the precise shape of the ventral cuticular ornamentation was indeterminable.

Distribution: Bulgaria (Valkanov 1937), Denmark (Grilli et al. 2010), France (d'Hondt 1971), Germany (Schwank 1990), Great Britain (Martin 1981), Italy (Balsamo 1983), Poland (Kisielewski and Kisielewska 1986), Romania (Rudescu 1967), Russia (Preobrajenskaja 1926), Japan (Saito 1937), Korea (Lee and Chang 2000); Sweden (Kånneby 2011), Brazil: Iguape (SP) (Kisielewski 1991) and Casa Nova, Chorrochó (BA) (present study).

Heterolepidoderma Remane, 1927
Heterolepidoderma jureiense Kisielewski, 1991

Figs 3A–E, 5A–D

Locality: PT06-09, 11 (Fig. 1).

Examined Material: 37 specimens TL 93–190 µm; FL 5–15 µm; AL 14–26 µm; PhL 27–56 µm; MD 5–13 µm; DR

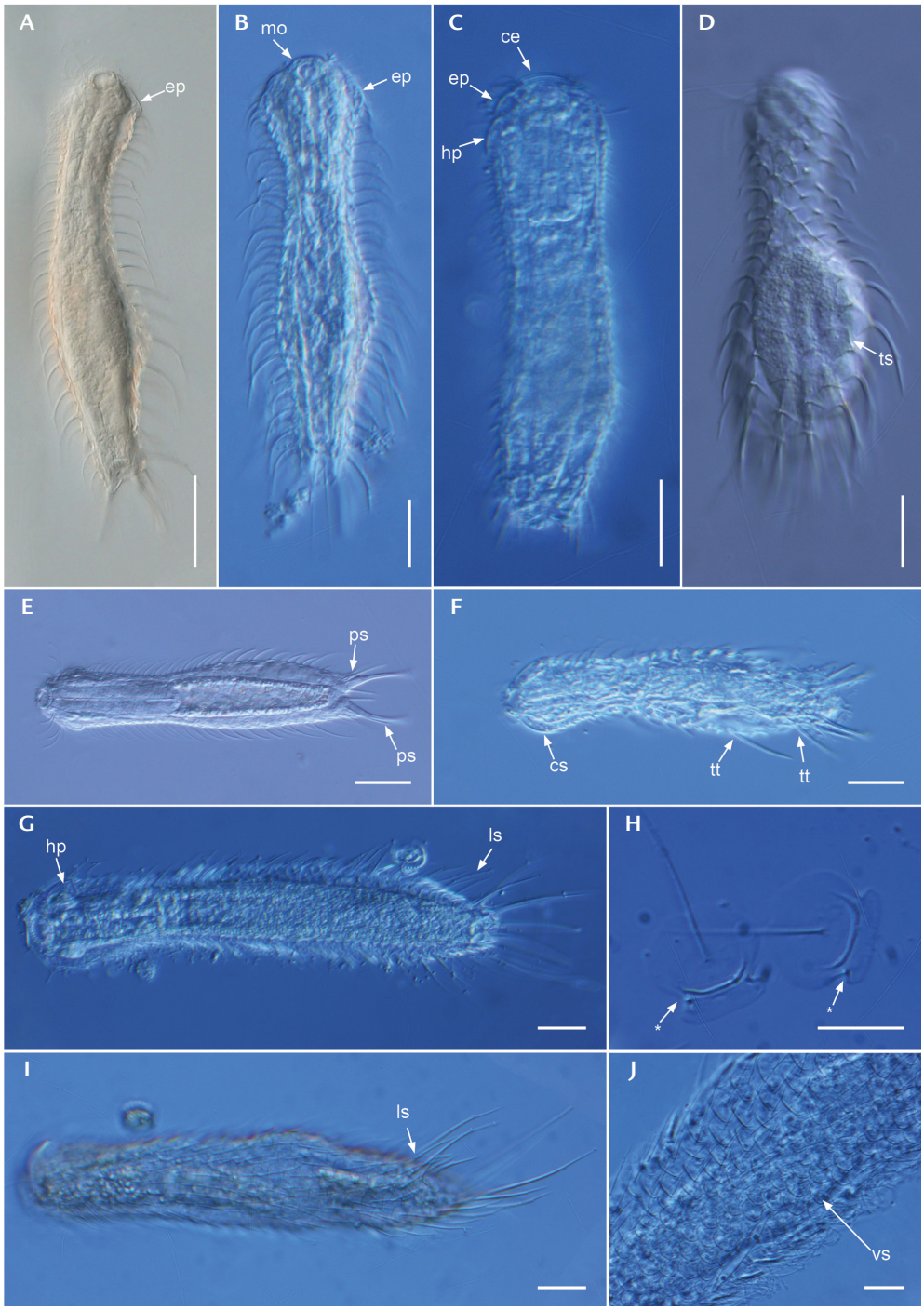

Figure 2. Light microscopic images of: (A) *Chaetonotus dadayi*; (B) *C. majestosus*; (C) *C.* cf. *oculifer*; (D) *C.* cf. *persetosus*; (E) *C.* aff. *hoanicus*; (F) *C.* aff. *acanthocephalus*; (G–J) *Lepidochaetus* aff. *zelinkai*: (G) ventral view; (H) close-up of scallop-shell shaped scales, asterisk: dorsal scale's anterior indentation; (I) lateral view; (J) close-up of ventral cuticular ornamentation. Scale bars: A–G, I = 20 µm; H, J = 10 µm. (ce) Cephalion, (cs) cephalic special scales, (ep) epipleurae, (hp) hypopleurae, (ls) *Lepidochaetus*-specific patch of posterior spines, (mo) mouth, (ps) parafurcal scales, (ts) trilobed scales, (tt) trunk thick spines, (vs) ventral scales.

25–50; TSl 5–12 µm; TSw 2–5 µm; DC 15–31; VC 5; VTSl 5–17 µm; VTSw 2–6 µm; VR 15.

Remarks: Slender, elongated fusiform habitus. Head five-lobed with large trapezoidal cephalion, covering dorsal and partially ventrolateral head, small oval lateral epipleura and elliptical ventrolateral hypopleura, small trapezoidal hypostomium posteriorly adjacent to the mouth. Mouth terminal, wide and short cylindrical pharynx with posterior bulb, and large pharyngo-intestinal junction. Cephalic ciliature consists of dorsolateral tufts inserted between cephalion and epipleura, and ventrolateral tufts inserted in intersection point between cephalion, epipleura and hypopleura, with no particularly longer cilia. Head followed by subtle neck constriction and trunk widens posteriorly. Posterior end bears a short U-shaped furca with a thin long adhesive tube. Anterior dorsal sensory bristle on neck inserted directly on the cuticle and posterior sensory bristles emerge from specialized double-keeled scales. The dorsal surface is covered by narrow keeled scales with a spiny process that exceeds the posterior concave edge of the scale. Dorsal scales are clearly obliquely arranged along the head and neck, and parallel along almost the whole trunk and oblique at the trunk end. One column of ventrolateral scales along the ventral ciliary bands bears a thin lamella. Ventral ciliation consists of two longitudinal bands wider anteriorly, adjoining each other posteriorly to the hypostomium. Interciliary area covered by narrow elliptical keeled scales with spiny process as long as keel insertion base on the scale, except for the naked ventral pharyngeal region. Furcal branch is armed with one pair of wider keeled scales. Present specimens fit the original description within the range of morphological variance and morphometric measurements.

Distribution: Brazil: Rio Verde (SP) (Kisielewski 1991), and Casa Nova, Abaré, Chorrochó, Paulo Afonso (BA), Delmiro Gouveia (AL) (present study).

Lepidochaetus Kisielewski, 1991

Lepidochaetus aff. *zelinkai* (Grünspan, 1908)

Fig. 2G–J

Locality: PT09, 10 (Fig. 1).

Examined Material: 6 specimens TL 125–271 µm; FL 9–17 µm; AL 25–64 µm; PhL 30–61 µm; MD 8–14 µm; DR 19–37; TSl 4–14 µm; TSw 4–11 µm; TSp 11–27 µm; DC 7–11; DSL 6–17 µm.

Remarks: Long and slender body, with three-lobed head followed by subtle neck constriction. Anterior dorsal head completely covered by very large cephalion and conspicuous dorsolateral epipleura and ventrolateral hypopleura. The dorsal trunk is covered by overlapping dorsal scales with a transversal rod shaped sub-rectangular anterior edge, followed by a distinct constriction, and rounded posterior portion with medial v-shaped indentation ("scallop shell-shaped"), bearing a thin long simple spine. Dorsal posterior trunk with scales progressively increasing in length, and three pairs of lateral scales at the posterior trunk, with long, thick, straight, and finely barbed spines, overshooting the furcal branches. The ventral interciliary area is covered by oval scales from hypostomium to posterior end, which is covered by larger scales with longer spines. The specimens feature the characteristic cuticular ornamentation of members of the genus *Lepidochaetus*, with spines of dorsal posterior trunk scales progressively increasing in length, with special proximity to *Lepidochaetus zelinkai* (Grüspan, 1908), but the presence of morphological specificities such as the presence of a one-of-a-kind "scallop shell-shaped" scale the potential of being an undescribed species, but due to the lack of sufficient material to support a taxonomic act, they are presented as affinities.

Distribution: Brazil: Delmiro Gouveia (AL) (present study)

Lepidodermella Blake, 1933

Lepidodermella sp.

Fig. 3F

Localities: PT6-11 (Fig. 1).

Examined Material: 23 specimens. TL 97–165 µm; FL 6–13 µm; AL 9–23 µm; PhL 24–45 µm; MD 5–10 µm; DR 25–31; TSl 4–9 µm; TSw 5–9 µm; DC 7–11; VC 5; VB 15; VR 10.

Remarks: Small rounded body, with weakly five-lobed head followed by subtle neck constriction, posterior trunk subtly wider than head. Small and transversally elliptic cephalion with small pleura tangent laterally, square small hypostomium with two anterior hooks. Dorsal surface covered by smooth scales with anterior double-edged margin. Dorsal head scales longitudinally elliptic, with obtuse angle posteriorly. Dorsal neck scales are rectangular followed by longer sub-rectangular dorsal trunk scales. Ventral ciliation in two separate longitudinal bands. Interciliary area is covered by 20 transverse cuticular plates below the pharynx and anterior intestine, followed by five columns of smooth rounded quadrangular scales. The specimens feature the characteristic cuticular ornamentation, with smooth spineless keelless scales covering whole dorsal and ventral body, but the genus has extremely tenuous diagnostic characters of species determination, and cannot be putatively related to any known species, remaining as "sp.".

Distribution: Brazil: Paulo Afonso, Casa Nova, Abaré, Chorrochó (BA), Delmiro Gouveia (AL) (present study).

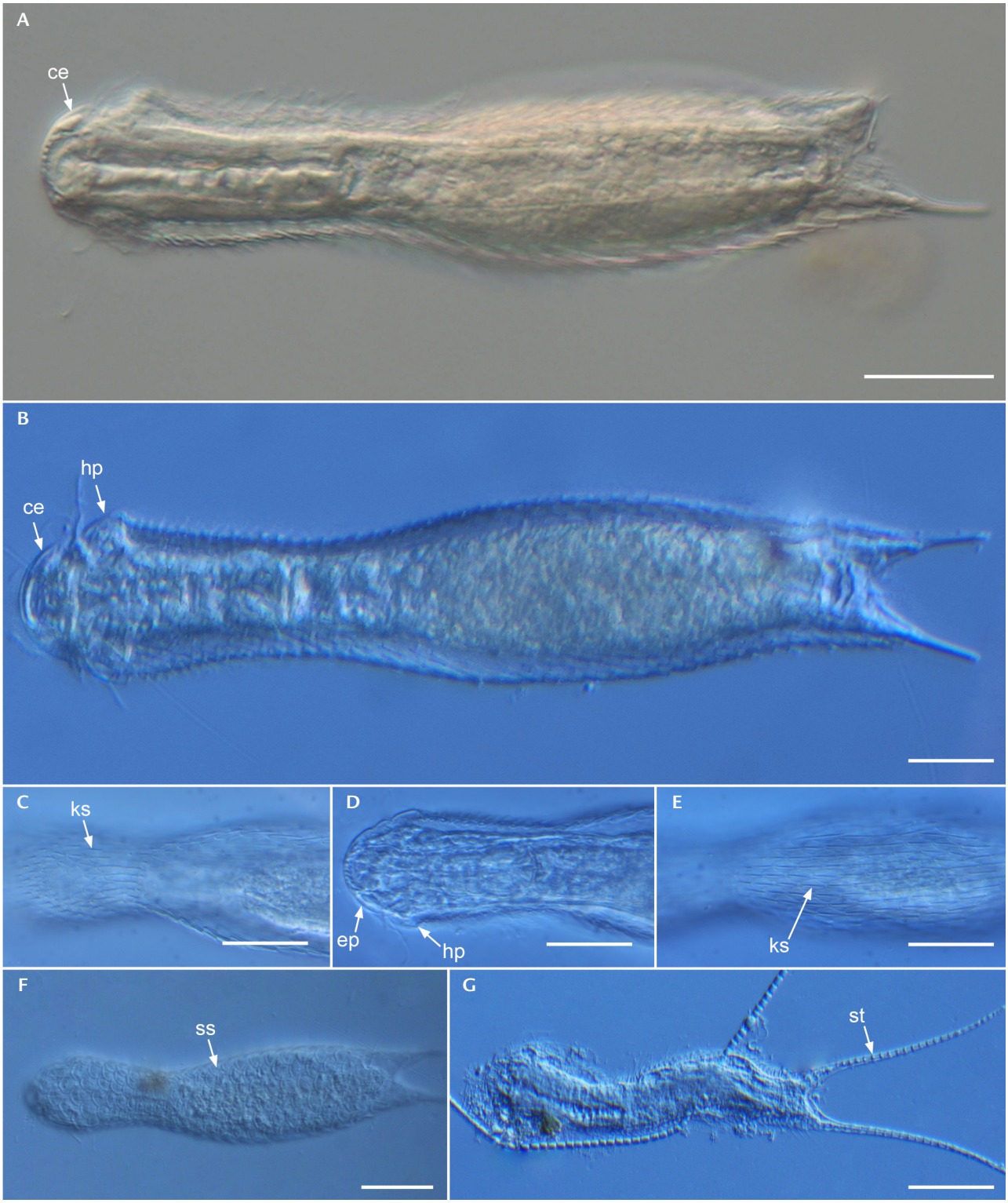

Figure 3. Light microscopic images of: (A–E) *Heterolepidoderma jureiense*; (F) *Lepidodermella* sp.; G) *Polymerurus* sp. Scale bars: 20 µm. (ce) Cephalion, (ep) epipleurae, (hp) hypopleurae, (ks) keeled scales, (ss) smooth scales, (st) segmented tube.

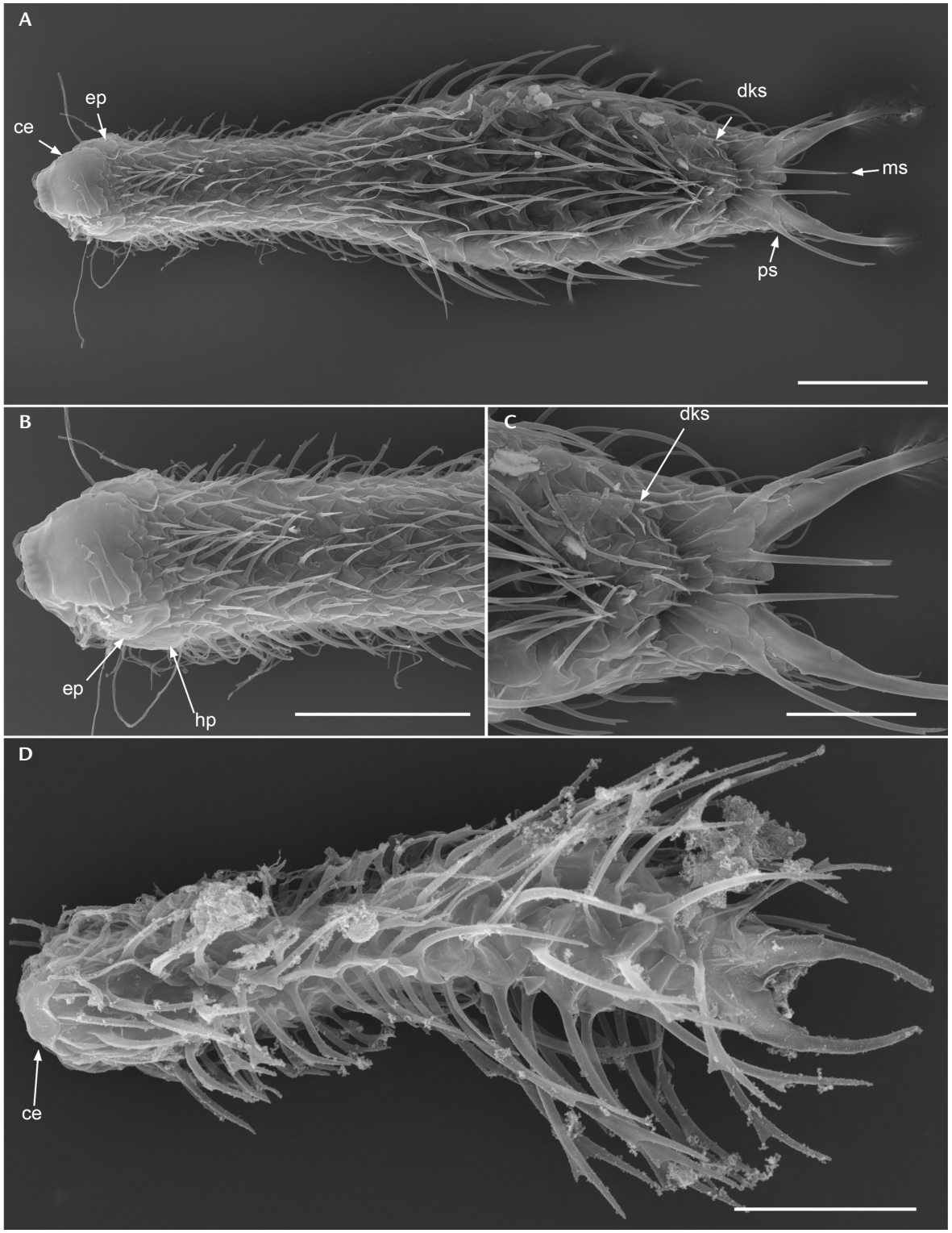

Figure 4. Scanning electron micrographs of: (A–C) *Chaetonotus* aff. *hoanicus*; (D) *Chaetonotus* cf. *persetosus*. Scale bars: 20 µm. (ce) Cephalion, (dks) double keeled scales, (ep) epipleurae, (hp) hypopleurae, (ms) medial scales, (ps) parafurcal scales.

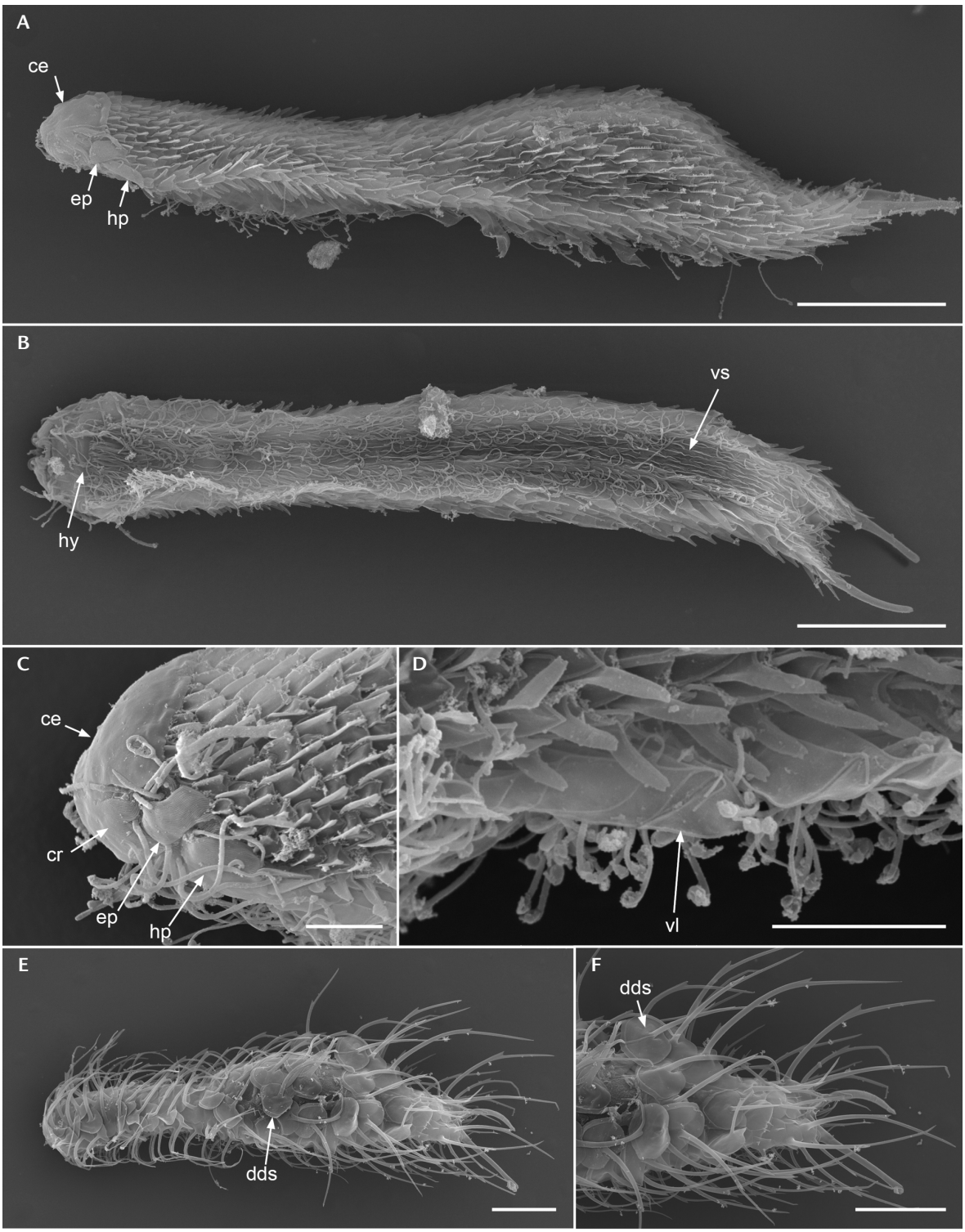

Figure 5. Scanning electron micrographs of: (A–D) *Heterolepidoderma jureiense*; (E, F) *Chaetonotus dadayi*. Scale bars: A, B, E, F = 20 µm; C, D = 5 µm. (ce) Cephalion, (cr) cephalion ridges, (dds) dorsal double-edged scale, (ep) epipleurae, (hp) hypopleurae, (hy) hypostomium, (vl) ventral lamellae scale, (vs) ventral scales.

Polymerurus Remane, 1926

Polymerurus sp.

Fig. 2G

Locality: PT06 (Fig. 1).

Examined Material: 1 specimen (sub-adult). TL 284,5 µm; FL 10,3 µm; AL 110 µm; PhL 68 µm; MD 15 µm; DR 50; TSl 3 µm; TSw 3 µm; TSp 16 µm; DSL 14,3 µm; CL 110; SCA. 26.

Remarks: Elongated body with three-lobed head. Cephalion well developed and large transverse concave bar-shaped hypostomium. Long furca with ornamented adhesive tubes divided into 26 segments. Dorsal and ventral body surface covered by simple spined small scales, with similar shape across the body. Ventral ciliation in two longitudinal bands connected posteriorly to the hypostomium by transverse ciliary band. The single specimen features the distinctive adhesive tubes of the genus *Polymerurus*, extremely long and adorned with smooth scales, giving the aspect of segments, but for being a single juvenile specimen, it is impossible to determine further putatively related to a known species nor feature distinctive features to indicate to be an undescribed species.

Distribution: Brazil: Casa Nova (BA; present study).

DISCUSSION

Our study explored the diversity of gastrotrichs in the northeastern region of Brazil, expanding the known distribution of five species and uncovering three potentially undescribed species. These findings increase the species richness of the phylum in the region sixfold and positions the northeast as the third most diverse region in Brazil for gastrotrichs.

Consequences of the historical bias of studies of gastrotrichs and meiofauna in general being carried out in the northern hemisphere (Garraffoni et al. 2021, 2024, Garraffoni and Balsamo 2017) "European species", or species originally described there, have continental or even global distributions, as for the last 150 years several northern countries have been explored (Garraffoni and Balsamo 2017). In contrast, the Neotropics suffer from scarce and scattered sampling, leading to the rediscovery of species known from Europe or new species labeled as endemic to each South American country. Brazil, in particular, is known for its diverse fauna of endemic and rare species, such as *Cephalionotus kisielewskii* Garraffoni et al., 2017, *Undula paraensis* Kisielewski, 1991, *Arenotus strixinoi* Kisielewski, 1987 and *Ornamentula paraensis* Kisielewski, 1991 and *Ornamentula miyazakii* Minowa & Garraffoni, 2021 (Garraffoni et al. 2017, Kisielewski 1991, 1997, Minowa and Garraffoni 2021). But it also hosts cosmopolitan species as *Lepidodermella squamata* (Dujardin, 1841) (see Garraffoni and Balsamo 2017), *Polymerurus nodicaudus* (Voigt, 1901) (but see Magpali et al. 2021), and *Heterolepidoderma majus* Remane, 1927 (see Garraffoni and Melchior 2015), originally described in Europe. The identification of *Chaetonotus majestuosus* Grosso & Drahg, 1984 from Argentina expanding its range around the southern continent, as was the case with other such as *Chaetonotus dadayi* Schwank, 1990 from Paraguay and *Heterolepidoderma famaillense* Grosso & Drahg, 1991 from Argentina discovered in São Paulo and Minas Gerais (Garraffoni and Melchior 2015, Salgado et al. 2022), highlights the potential for cross-continental species distribution within South America. Likewise, as future expeditions in neighboring countries uncover the diversity of gastrotrichs, they will certainly find "Brazilian" species.

Our findings indicate that, despite the differences between sampling sites—ranging from shallow ponds and small artificial and temporary weirs to the São Francisco reservoir—the species diversity was relatively uniform, with similar species and genera present. This suggests that small ecosystems in the Caatinga can support rich biodiversity comparable to that of larger water bodies (see Boix et al. 2012, Davies et al. 2008). Although further ecological and experimental investigations are needed, it appears that after the drought season, when these small ecosystems dry out, meiofaunal invertebrates can rapidly reclaim the habitat during the rainy season. They achieve this through dispersal mechanisms such as water flow, wind, or other animals (Mogle et al. 2018, Ptatscheck et al. 2018a, 2018b), coupled with the ability to parthenogenetically produce resting eggs, which can effectively establish populations, as all individuals are capable of producing offspring (Araújo et al. 2024b, Balsamo et al. 2008, Brunson 1949, 1963, Hummon 1984a, 1984b, 1986, Kearney 2005, Ricci and Balsamo 2000, Strayer et al. 2010).

Despite significant progress in recent years, Brazilian research on gastrotrichs still has considerable gaps. It is crucial to continue expanding our knowledge of these small and often overlooked, yet fascinating micrometazoans. Further research should focus on understanding the ecological interactions within these communities, the specific environmental factors driving their distribution, and the role of dispersal mechanisms in shaping their biogeography.

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