Zoosyst. Evol. 100 (4) 2024, 1569–1584 | DOI 10.3897/zse.100.133632

The southernmost record for a symphylan: *Hanseniella guerreroi* sp. nov. (Myriapoda, Scutigerellidae), an inhabitant of the Tierra del Fuego archipelago

Andrés O. Porta[1,2,3], Antonio Parra-Gómez[4], Dante Poy[1], Gaston Kreps[5,6], Roy Mackenzie[7,8], Guillermo Martínez Pastur[9], Leonardo D. Fernández[10]

1 *División Aracnología, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" – CONICET, Av. Ángel Gallardo 470 C1405DJR, Buenos Aires, Argentina*
2 *Departamento de Biodiversidad y Biología Experimental, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Autónoma de, Buenos Aires, Argentina*
3 *Departamento de Ciencias Exactas, Universidad Nacional del Oeste, Belgrano 369 C1718, San Antonio de Padua, Buenos Aires, Argentina*
4 *Facultad de Ciencias, Universidad Austral de Chile, Av. Rector Eduardo Morales Miranda 23, Valdivia, Chile*
5 *Departamento de Ciencias de la Atmósfera y de los Océanos, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Argentina*
6 *Alfred-Wegener-Institut Helmholtz-Zentrum für Meeres - und Polarforschung, Bremerhaven, Germany*
7 *Centro Universitario Cabo de Hornos, Universidad de Magallanes, Puerto Williams Cape Horn International Center CHIC, Puerto Williams 6350000, Chile*
8 *Millennium Institute Biodiversity of Antarctic and Subantarctic Ecosystems (BASE), Las Palmeras, 3425, Santiago 7800003, Chile*
9 *Centro Austral de Investigaciones Científicas (CADIC) – CONICET, Houssay 200, 9410, Ushuaia, Tierra del Fuego, Argentina*
10 *Núcleo de Investigación en Sustentabilidad Agroambiental (NISUA), Facultad de Medicina Veterinaria y Agronomía, Universidad de Las Américas, Manuel Montt 948, Providencia, Santiago, Chile*

https://zoobank.org/669C7F58-9475-4F49-85E8-1B1715135246

Corresponding author: Leonardo D. Fernández (limnoleo@gmail.com)

Academic editor: Martin Husemann ♦ **Received** 1 August 2024 ♦ **Accepted** 15 October 2024 ♦ **Published** 14 November 2024

Abstract

A new species of Symphyla, *Hanseniella guerreroi* **sp. nov.**, is described from specimens collected during expeditions to the Tierra del Fuego archipelago, including Isla Grande de Tierra del Fuego and Isla de los Estados in Argentina, as well as Isla Navarino in Chile. To the best of our knowledge, this new species represents the southernmost record for a myriapod of the class Symphyla. The morphological affinities of this species with other *Hanseniella* species from Gondwanan landmasses are discussed, highlighting its potential for studying the impact of the last Quaternary glaciation on soil arthropods in the far south of the continent. This discovery provides important insights into the biogeographic and evolutionary history of soil arthropods in these remote and climatically challenging regions. *H. guerreroi* **sp. nov.** is an exemplary species adapted to the harsh environmental conditions of subantarctic ecosystems and contributes significantly to our understanding of biodiversity and ecological dynamics in such challenging habitats.

Key Words

Dientes de Navarino, garden centipede, Myriapoda, Navarino Island, *Nothofagus* forests, soil-dwelling arthropod, symphylans, Patagonia, Tierra del Fuego

Introduction

Symphylans, or garden centipedes, are small, soil-dwelling arthropods that belong to the subphylum Myriapoda and the class Symphyla (Minelli and Golovatch 2001). There are only two families within this class: Scutigerellidae and Scolopendrellidae (Jin et al. 2023). These myriapods inhabit organic soils on all continents except Antarctica (Szucsich and Scheller 2011). They have slender and fragile bodies, 5–8 mm long, which allows them to easily move through soil pores where they feed on detritus (Minelli and Golovatch 2001). Some species, particularly within the genera *Scutigerella* and *Hanseniella*, can become agricultural pests by feeding on seeds and plant roots, causing significant damage to crops (Boyle 1981; Murray and Smith 1983).

Argentina and Chile, two neighboring countries in southern South America, are known for their outstanding biodiversity and high rates of endemism of plants, animals, and microbes (Villagrán and Hinojosa 1997; Lamoreux and Lacher 2010; Fernández et al. 2015; Schiaffino et al. 2016; Campello-Nunes et al. 2022; Pérez-Schultheiss et al. 2024). Despite their remarkable diverse ecosystems, these countries have surprisingly low symphylan diversity. In Argentina, only 10 species have been recorded, three of which belong to the family Scutigerellidae and the genus *Hanseniella*, i.e., *Hanseniella angulosa*, *H. chilensis*, and *H. unguiculata* (Scheller 1992). In contrast, only one species, *H. chilensis*, has been recorded in Chile (Vega-Román et al. 2012; Parra-Gómez et al. 2024).

The symphylan diversity of Argentina and Chile is probably much higher than currently known but remains underestimated because no major sampling effort has ever been made to study them. Argentina and Chile have historically lacked Symphyla specialists (Attems 1897; Scheller 1992; Parra-Gómez et al. 2024). Furthermore, the diversity of these and other myriapods has been poorly studied in most of their territories, including remote areas such as the Tierra del Fuego archipelago in the southernmost tip of South America (Minelli and Golovatch 2001; Parra-Gómez and Fernández 2022).

The first records of symphylans in Argentina and Chile were documented by Attems in 1897. Attems (1902) reported the presence of *S. immaculata* in the Argentinean localities of Lapataia and Ushuaia on Isla Grande de Tierra del Fuego, which is divided between Argentina and Chile. He also extended his report to Navarino Island, one of the southernmost Chilean islands of the Tierra del Fuego archipelago. However, Scheller (1998) later questioned Attems' identification, arguing that *S. immaculata* is native to the northern hemisphere. Scheller contended that it is highly unlikely that this species would have established stable populations on these islands given their challenging climatic conditions. This issue, along with the remote origin of the specimens, has led to the suggestion that the symphylans identified by Attems may have belonged to another, perhaps undescribed, species adapted to thrive on the climatically harsh islands of the Tierra del Fuego archipelago (Scheller 1992; Parra-Gómez et al. 2024).

More than a century after Attems' pioneering study, we undertook field expeditions to investigate the arthropod biodiversity of the Tierra del Fuego archipelago. On this archipelago we found a new symphylan species of the genus *Hanseniella* that may correspond to the taxon originally observed by Attems in 1897. To our knowledge, this new species represents the southernmost record for a myriapod of the class Symphyla. Here we describe this species and discuss the similarities between this new species found in the remote, southern islands of Argentina and Chile and other species of the genus *Hanseniella*. We also highlight its significance for studying the effects of the Last Glacial Maximum on the soil mesofauna of extreme southern South America.

Materials and methods

The specimens were collected on Argentinean and Chilean islands of the Tierra del Fuego archipelago (for details see subsection Type material) during three field expeditions conducted by the Museo Argentino de Ciencias Naturales "Bernardino Rivadivia" (**MACN**), the Centro Austral de Investigaciones Científicas (**CADIC**), Argentina and the Universidad de Las Américas (**UDLA**), Chile.

Specimens from the Argentine expeditions were cleared with lactic acid for observation in an open chamber or mounted on slides with Hoyer's medium and examined and measured using an Olympus CH-2 or Wild Heerbrugg M11 compound microscope with phase contrast. For scanning electron microscopy (SEM), specimens were dehydrated through a series of ethanol solutions of increasing concentration in absolute hexamethyldisilazane (Porta and Tricarico 2018) and then air dried, mounted on individual stubs using copper adhesive tape, sputter-coated with gold-palladium, and examined using an FEI XL 30 TMP scanning electron microscope with varying working distance and voltage (15–22 kV).

Specimens collected from Isla Navarino, Chile, were mounted on concave glycerol-filled slides and examined using an N-200M microscope. Two specimens were mounted on copper adhesive tape and dehydrated using a Hitachi HCP-2 critical point dryer. They were then coated with gold and palladium on a Leica EM ACE200 and imaged with a Zeiss EVO M10 SEM at 20 kV. All specimens from both countries are preserved in 80% ethanol.

Descriptions and terminology follow Scheller's descriptions (e.g., Scheller 1961, 1971, 2002, 2007); for some structures, terminology follows Snodgrass (1952) and Domínguez Camacho (2009). Measurements and ratios given here are those of the holotype, followed by the range of other specimens in the type series in parentheses (e.g., 2.1 (2–2.3) vs. (2–) 2.1 (–2.3) in Scheller's notation). The material examined for this study is deposited in the following collections: the Myriapodological Collection of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires (**MACN-My**), the Invertebrate Collection of the Museo Nacional de la Plata (**MLP-Ar**), the Arthropod Collection of the

Centro Austral de Investigaciones Científicas (**CADIC**), Argentina, and the Museo Nacional de Historia Natural (**MNHNC**), Santiago, Chile.

Taxonomy

Scutigelleridae Bagnall, 1913
Hanseniella Bagnall, 1913

Hanseniella guerreroi Porta, Parra-Gómez & Fernández, sp. nov.

https://zoobank.org/2C92A070-37E8-4017-B9F5-530BD35544B3

Figs 2–10

Type material. ***Holotype***, male (MACN-My 69), from Argentina: Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Tierra del Fuego, Departamento de Ushuaia, Río Irigoyen, 54.62540; -066.70184 (+/-200 m), elev. 230 m, 20–24 Oct. Berlese funnel and hand collected, A. Porta leg., cleared, preserved in ethanol; • same data, 6 paratypes, 4 males and 2 females (MACN-My 70 to 75), cleared, preserved in ethanol; • 10 paratypes, 7 males and 3 females (MACN-My 76 to 85), cleared, preserved in ethanol; • 1 tube with 4 paratypes (MLP-Ar 20497), not cleared, preserved in ethanol; • 1 tube with 4 paratypes (CADIC-My 01), not cleared, preserved in ethanol; • same data, 3 paratypes (MACN-My 86 to 88), mounted for SEM; • Argentina: Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Isla Grande de Tierra del Fuego, Departamento de Ushuaia, El Martial, 54.790648, -068.391642 (+/- 100 m); elev. 550 MASL. (+/- 50 m); Berlese funnels, A. Porta leg; • 1 paratype, male (MACN-My 89), mounted on slide; • same data, 1 tube with 2 paratypes (MACN-My 90), cleared, preserved in ethanol; Argentina: Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Isla Grande de Tierra del Fuego: Departamento de Ushuaia: Bahía Buen Suceso, 54.79349, -065.26397; (+/- 20 m); elev. 12 MASL.; Berlese funnels and hand collecting; A. Porta leg., • 1 paratype male (MACN-My 91), cleared, preserved in ethanol; • same data, 1 paratype (MACN-My 96), mounted for SEM; Argentina: Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Departamento de Ushuaia: Isla de los Estados: Puerto Hoppner; 54.78344, -064.41387 (+/- 200 m); elev. 20 MASL; Berlese funnels and hand collecting, A. Porta leg., • 3 paratypes, 1 male and 2 females (MACN-My 97 to 99), cleared, preserved in ethanol; same data; • same data, 2 paratypes (MACN-My 100 to 101), mounted for SEM; Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Departamento de Ushuaia: Isla de los Estados: Puerto Parry; 54.81319, -064.37043 (+/- 50 m); elev. 70 MASL; Berlese funnels and hand collecting, A. Porta leg., • 3 paratypes, 2 females and 1 male (MACN-My 104 to 106), mounted; • 3 paratypes, 2 females and 1 male (MACN-My 107 to 109), cleared, preserved in ethanol; • 5 paratypes in 1 vial (MACN-My 110), not cleared, preserved in ethanol; Argentina: Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Departamento de Ushuaia: Isla de los Estados: Puerto Cook, 54.77711, -064.05438 (+/- 30 m); elev. 40 MASL. (+/-20 m); Berlese funnels and hand collecting, A. Porta leg., • 1 paratype (MACN-My 111), not cleared, preserved in ethanol; Argentina: Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur: Departamento de Ushuaia: Isla de los Estados: Puerto de San Juan de Salvamento, 54.753367, -63.889186 (+/- 50 m); elev. 15 MASL; • 2 paratypes, 2 males (MACN-My 112 to 113), cleared, preserved in ethanol; • 4 paratypes in 1 vial (MACN-My 114), not cleared, preserved in ethanol. Chile: Región de Magallanes y de la Antártica Chilena, Provincia de la Antártica Chilena, Isla Navarino, -54.9917, -67.6022, 23 March 2023; hand collecting, under the bark of a dead *Nothofagus pumilio* tree trunk, L. Fernández leg.,• 3 paratypes, 2 females (MNHNC8446 to 8447), mounted for SEM; • 1 paratype, 1 female (MNHNC8448), preserved in ethanol.

Etymology. The specific name is a patronymic in honor of Federico Guerrero, captain of the boat "Ocean Tramp," in recognition of her fundamental contribution to the organization, logistics, and success of the MACN-CADIC 2014 expedition to Península Mitre and Isla de los Estados.

Diagnosis. *H. audax* Clark & Greenslade, 1996 differs from *H. guerreroi* sp. nov. by a greater length (8.7 mm), longer setae on the tergites, both claws of 12 pairs of similar size, and by the morphology of the cerci; *H. conveniens* Clark & Greenslade, 1996 differs by the chaetotaxy and morphology of the cerci; *H. insequens* Clark & Greenslade, 1996 differs by the dorsum of the head with fine pubescence; *H. madecassa* Aubry & Masson, 1953 differs by the chaetotaxy of the first tergite and the apical antennomere with only 2 spined organs; *H. mutila*, Adam & Burtel, 1956 differs by the central rod of the head well-marked behind the ovoid knob, where it is produced forward into 2 lateral branches, claws of leg 12 being of similar size, and by the distribution of the outgrowths (microsetae) in the tergites; *H. nivea* (Scopoli, 1763) differs by the shape of the central rod of the head, the chaetotaxy of the first tergite, and by the relative size of the claws of the 12th leg pair; *H. pluvialis* Clark & Greenslade, 1996 differs by the claws of leg 12 of similar size and the tergal setae being more elongated and of different size; *H. proxima* Adam & Burtel, 1956 differs by the central rod of the head well marked behind the ovoid knob, where it is produced forward into 2 lateral branches and 2 branches delimiting an indistinct posterior area, leg 12 with an elongated anterior seta, and by the first tergite with 2+2 setae; *H. pyrethrata* Clark & Greenslade, 1996, by the cuticle on the posterior part of tergites glabrous and the apical antennomere with only one terminal spined organ; *H. vulgata* Adam & Burtel, 1956 differs by the central rod of the head well-marked before the ovoid knob and behind this where it is produced into 2 branches which delimit a posterior area, the presence of additional setae on the styli (particularly in leg 12), and by the different chaetotaxy on the cerci.

Description. Length of body (Fig. 1) without antennae and cerci 3.4 (3.1–5.4) mm.

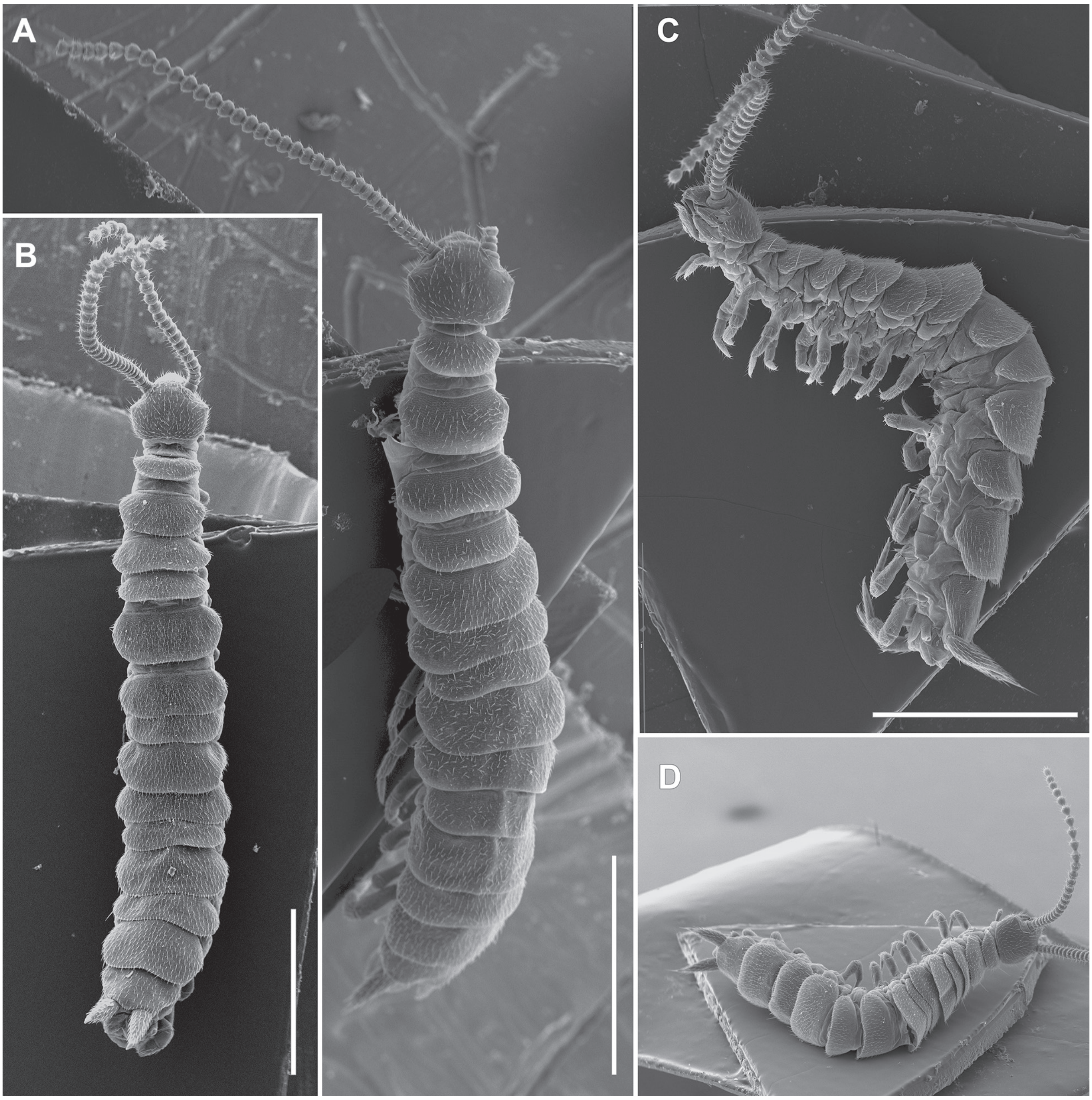

Figure 1. A. *Hanseniella guerreroi* sp. nov., habitus dorsal, paratype (MACN-My 86); **B.** Paratype (MACN-My 96); **C.** Paratype (MACN-My 97), lateral view; **D.** Same, dorsolateral view. Scale bars: 1000 µm (**A–C**).

Head (Fig. 2). Head short, 1.38 (1.05–1.44) broader than long, frontal margin convex with a prominent lateral angle at point of articulation of mandible (Fig. 2A), posterior margin concave with rounded posterolateral angles. Central rod posteriorly ovoid (Fig. 2A, *cr*), 0.24 (0.19–0.36) the length of the head, other parts of the rod and its branches lacking. Dorsal surface of head (Fig. 2A–C) covered with straight, very thin setae of lengths not significantly different. 3+3 distinct large setae near the antennal base. Longest seta of lateral head angles 0.9 (0.8–0.9) of the length of the diameter of the first antennomere and 3.5× longer than shortest setae. Each anterior plate (*m*) of the second maxillae (Fig. 2D) with 3 proximal setae, external side almost straight. External-distal corner of these plates with 5 sets of sensilla with a typical chandelier shape (Fig. 2D, arrow) decreasing in size proximally in addition to 2 elongated setae inserted on conic protuberances, the most posterodistal one with a contiguous small tooth; second-maxillary proximal arms (*pa*) not much wider than anterior plate. Each of the three terminal protuberances (*tp*) (Domínguez Camacho 2009) distal to transversal groove of the second maxilla (*tg*) with a characteristic set composed of 2–4 setae inserted on cylindrical cuticular protuberances plus 1 large distal sensillum, which is contiguous to a small tooth. First maxillary palp (Fig. 2D; *ml* and *p*, 2F) large, conical, and pointed. Head cuticle glabrous (Fig. 2B). Tömösvary organ circular (Fig. 2E, *To*) 30–44 µm wide. Both maxillae bearing several setae on surface.

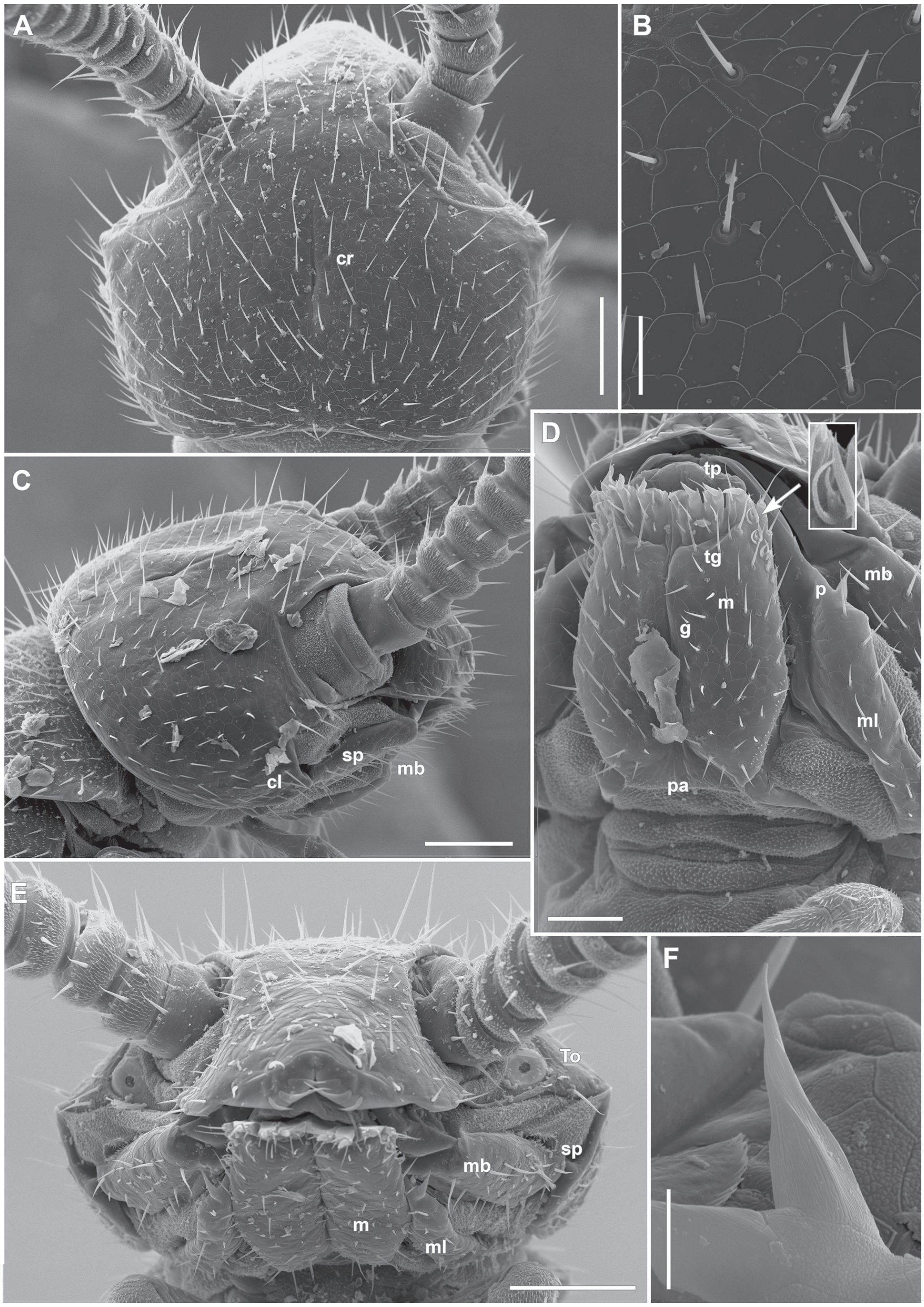

Figure 2. *Hanseniella guerreroi* sp. nov. **A.** Paratype (MACN-My 86), head, dorsal view; **B.** Head dorsal, detail of the cuticle, **C.** Paratype (MACN-My 96), head, lateral view; **D.** Paratype (MACN-My 96), head, ventral view; **E.** Paratype (MACN-My 96), head, anterior view; **F.** Paratype (MACN-My 96), left palp of the first maxillae. Abbreviations: *cl*, cephalic lobe; *cr*, central rod; *g*, median groove of the second maxillae; *m*, anterior plates of the second maxillae; *mb*, mandibular base; *ml*, first maxillae; *p*, first maxillary palp; *pa*, second-maxillary proximal arms; *tg*, transversal ridge of the second maxillae; *tp*, terminal protuberances at this anterior part of the second maxilallae; *sp*, spiracle; *To*, Tömösvary organ. Scale bars: 100 µm (**A, C, E**); 20 µm (**B**); 50 µm (**D**); 10 µm (**F**).

Antennae (Fig. 3). Antennae with (21–38) antennomeres; length (0.37–0.6) of length of body. Distal antennomeres much thinner than proximal antennomeres, diameter of distal antennomere (0.55–0.64) of that of first. First antennomere (Fig. 3A, B) 1.5 (1.4–1.82) × as wide as long with a single apical whorl of 5–6 setae: 2–3 thick-based dorsal setae and 2 inner setae and 0–1 ventral setae. Longest dorsal seta, 0.33 (0.38–0.48) × the diameter of antennomere. Second antennomere (Fig. 3A) 2.16 (1.61–2.6) × as wide as long with 9–10 setae: 6 (5) thick-based setae

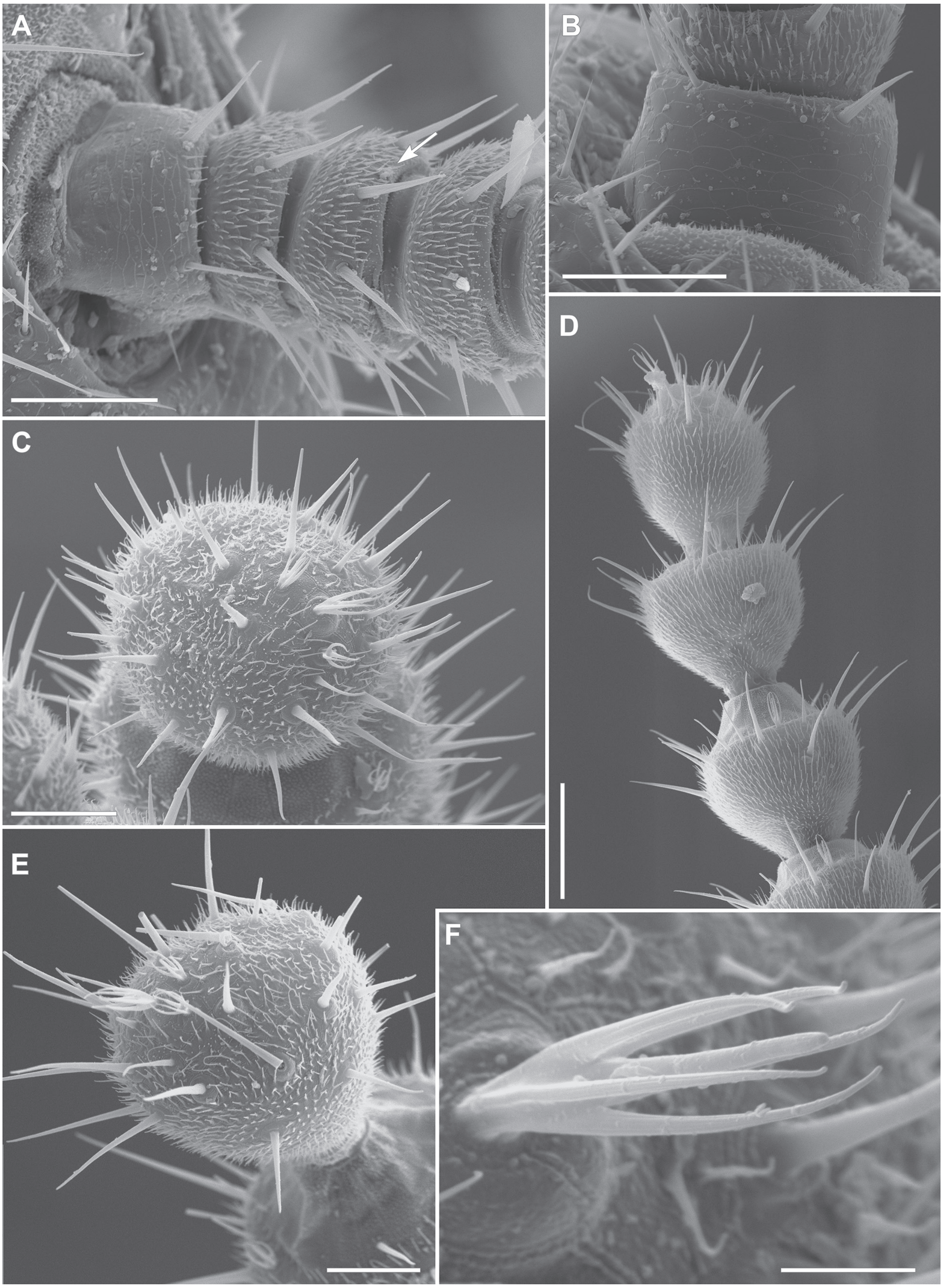

Figure 3. *Hanseniella guerreroi* sp. nov., antenna. **A.** Paratype (MACN-My 96), first four antenal segments, dorsal view; **B.** First antennal segment, dorsal view; **C.** Apical antennal segment, apical view; **D.** Three distal antennal segments, dorsoexternal view; **E.** Apical antennal segment, apical view; **F.** Long-spined apical organ antennal segment. Scale bars: 50 µm (**A, B, D**); 25 µm (**C, E**); 5 µm (**F**).

and 4 thin setae. Third antennomere (Fig. 3A) 1.77 (1.41–1.9) × as wide as long with 8 (6–10) setae; longest seta is dorsal, 0.46 (0.44–0.52) of diameter of antennomere. Small trifid spined organ begins on outer part of the tergal side of the third or fourth antennomere (Fig. 3A, arrow). Second medial whorl of setae begins with 1 seta on inner side of antennomere 4–5 and is complete in antennomere 10 (12–15). Tenth antennomere 1.3 (1.05–1.57) wider than long with 10–20 setae: 8–15 of about the same length, 5–6 very short and thin setae. The antennomere next to the

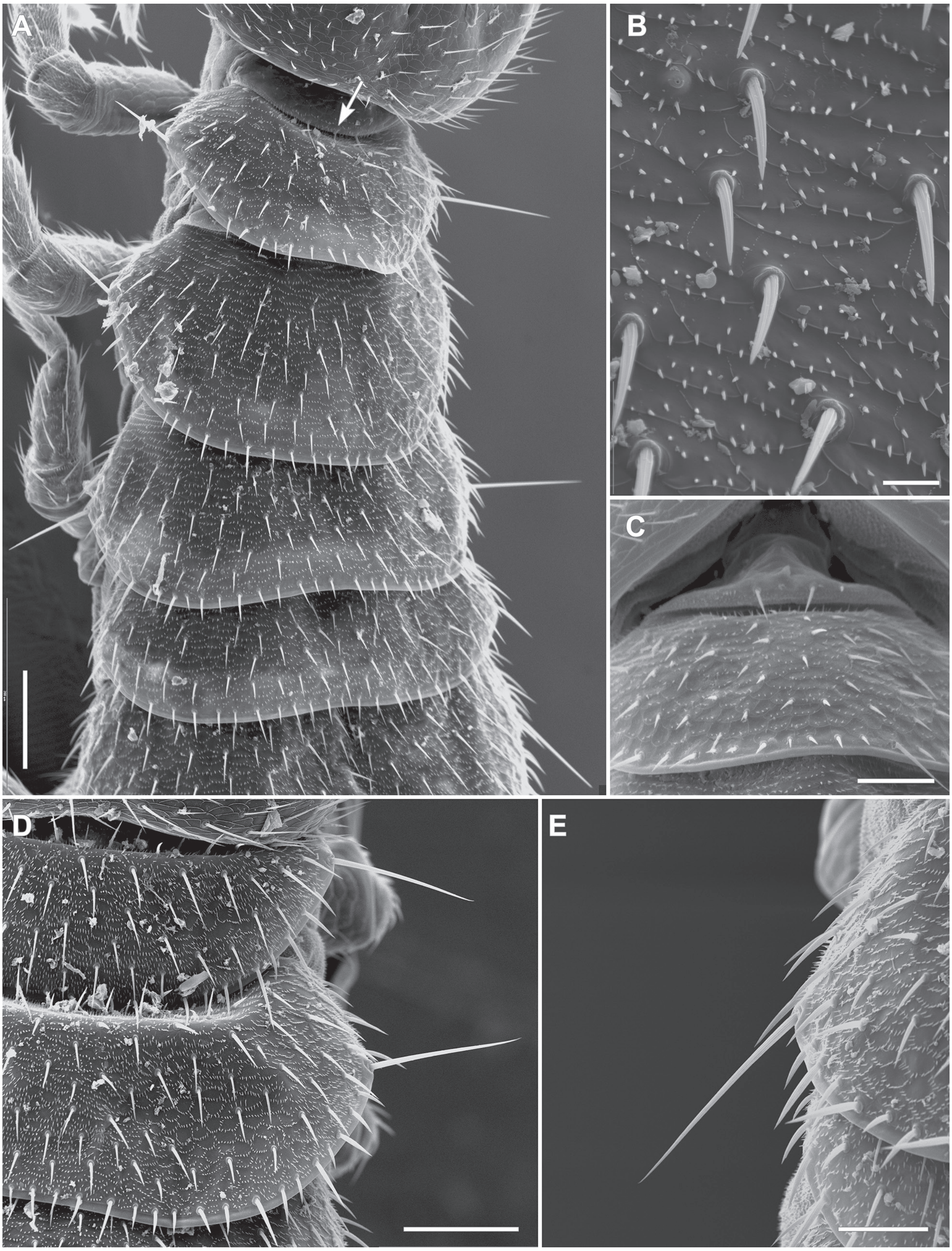

Figure 4. *Hanseniella guerreroi* sp. nov. **A.** Paratype (MACN-My 100), first to sixth terguite; **B.** Detail of the terguite cuticle; **C.** Paratype (MACN-My 87), first segment; **D.** Paratype (MACN-My 87), detail of the macrochaetae of the second and third terguites; **E.** Fourth terguite. Scale bars: 100 µm (**A, D**); 10 µm (**B**); 50 µm (**C, E**).

apical one (Fig. 3D) 1.13 (1.09–1.38) × as long as wide. An additional third whorl never completes, but traces occur from ventral side of 6–12 antennomeres below the apical whorl. Apical antennomere (Fig. 3C–F) 1.1 (1.31–1.5) × as long as wide with 24–28 setae, 2 small spined organs, and one large spined organ. The latter (Fig. 3F) 0.3 (0.21–0.31) of length of antennomere and consisting of a central straight rod surrounded by 5 (4) somewhat curved bracts. First antennomere glabrous with scaly cuticular pattern; distal antennomeres from the second with a sparce, evenly distributed pubescence; apical surface of distal antennomere (Fig. 3C, E) with fine pubescence.

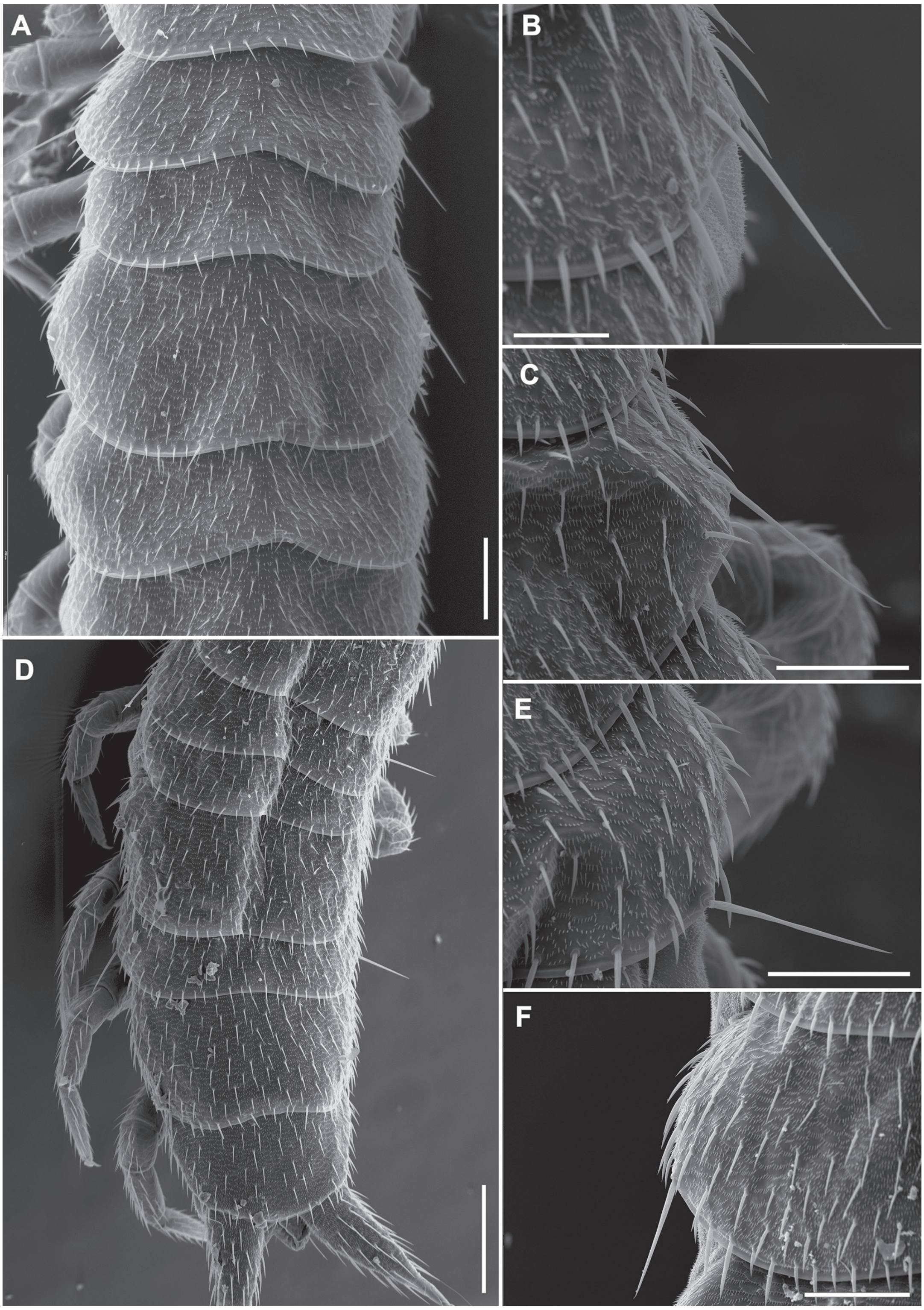

Figure 5. *Hanseniella guerreroi* sp. nov. **A.** Paratype (MACN-My 109), fifth to eighth terguites; **B.** Same, detail of the macrochaeta of the fifth terguite; **C.** Same, detail of the macrochaeta of the ninth terguite; **D.** Paratype (MACN-My 109), tenth to fifteenth terguites; **E.** Paratype (MACN-My 96), detail of the macrochaeta of the tenth terguite; **F.** Same, detail of the macrochaeta of the thirteenth terguite. Scale bars: 100 µm (**A, C, E, F**); 200 µm (**D**); 50 µm (**B**).

Tergites (Figs 1, 4, 5). First tergite (Fig. 4A, C) rudimentary, with 2 distinct lanceolate setae and 0–2 small setae (Fig. 4A, arrow). Second tergite complete (Fig. 4A, C), 2.52 (2.13–2.6) × as broad as long: posterior margin straight in the middle; anterolateral angles distinct with macrochaetae directed outwards and slightly forwards. These macrochaetae are 1.72 (1.25–1.9) of diameter of first antennomere, 21 (16–29) posteromarginal setae; longest posteromarginal seta, 0.5 (0.39–0.57) of the length of anterolateral macrochaetae. Inner setae of tergite short,

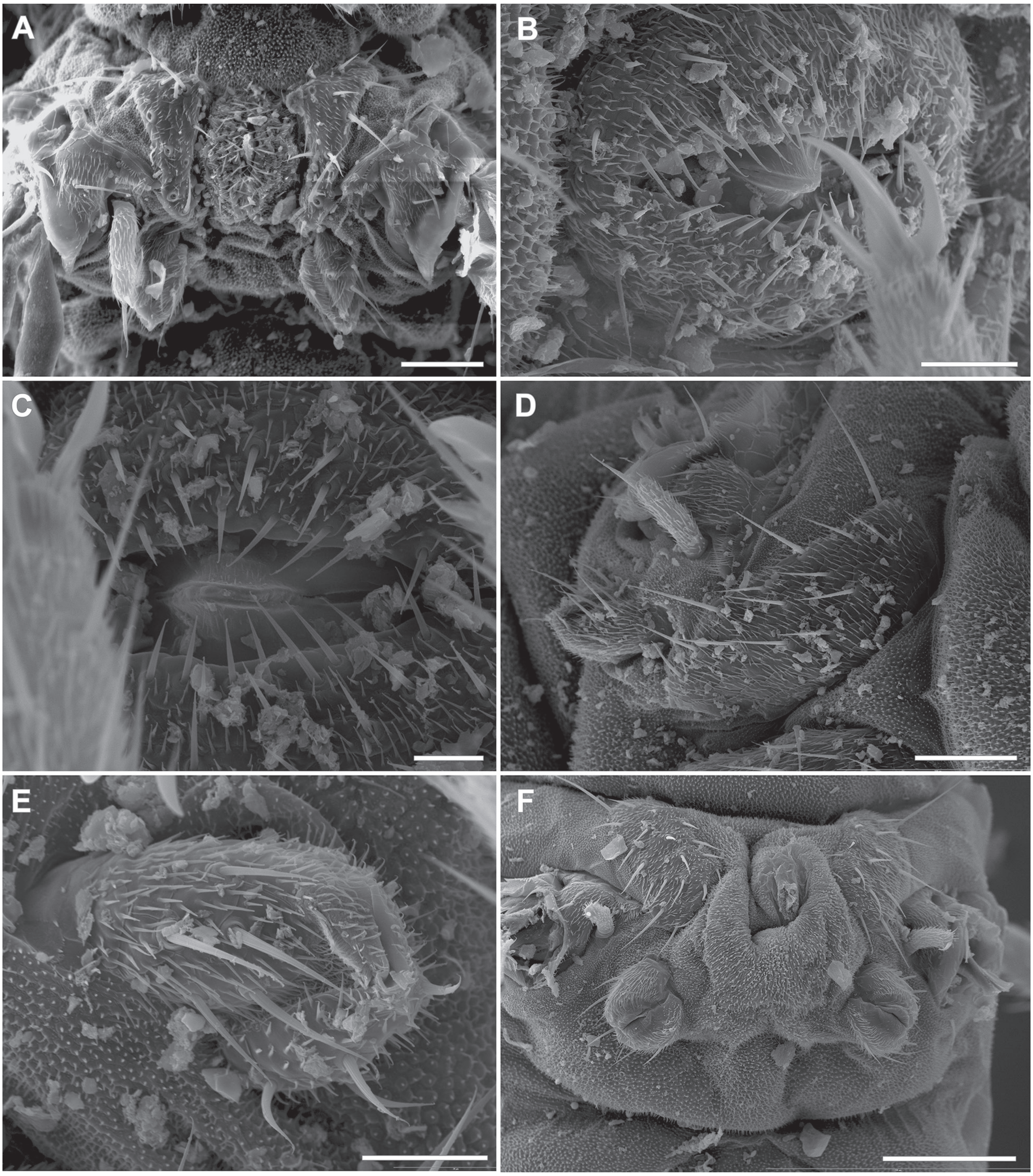

Figure 6. *Hanseniella guerreroi* sp. nov. **A.** Male paratype (MACN-My 88), fourth segment, ventral; **B.** Male paratype (MACN-My 98), detail of the genital opening; **C.** Same, different view; **D.** Same, fourth leg segment, coxal sac and stylus; **E.** Same, detail of the right coxal sac; **F.** Paratype female (MACN-My 99), fourth leg segment. Scale bars: 50 µm (**A, D**); 20 µm (**B, E**); 10 µm (**C**); 100 µm (**F**).

subequal in length, lanceolate, similar to posteromarginal setae. Pubescence short, reaching posterior margin, mostly in short transverse bows (Fig. 4B), reaching up the antero-posterior margins, posterior margin glabrous. Third tergite (Fig. 4A) 2.46 (2–2.85) × as broad as long with straight posterior margin; anterolateral macrochaetae (Fig. 4D) as on preceding tergite, 1.6 (1.31–1.6) of diameter of first antennomere; 30 (22–37) marginal setae between macrochaetae. Posteromarginal setae and pubescence similar to second tergite; longest posteromarginal setae, 0.56 (0.4–0.58) of the length of anterolateral macrochaetae. Fourth tergite (Figs 4A, 5A) much broader than preceding one, 2.81 (2.63–3.68) × as broad as long, posteriorly somewhat emarginate; with anterolateral macrochaetae directed outwards and backwards (Fig. 3E), 1.65 (1.07–1.81) of diameter of first antennomere; 31 (28–34) marginal setae between macrochaetae; inner setae as on third tergite. Tergite fifth to thirteen (Figs 1A, B, 5A, D) emarginated, pubescence as

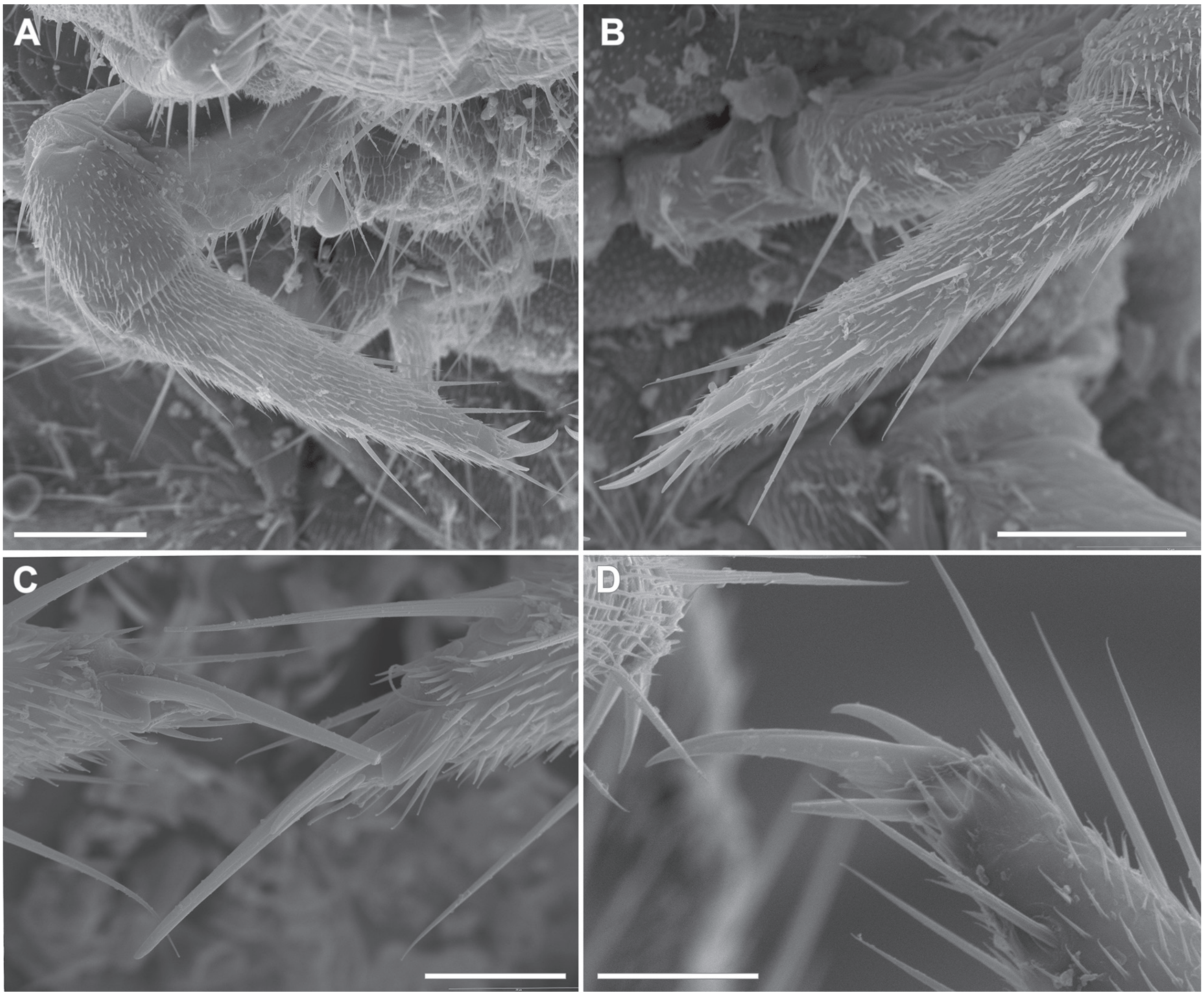

Figure 7. *Hanseniella guerreroi* sp. nov. **A.** Paratype (MACN-My 97), right leg 1; **B.** Left leg 1, tarsus; **C.** Same, detail of the claws, ventral view; **D.** Paratype (MACN-My 99), claws of left leg 1, anterolateral view. Scale bars: 50 µm (**A, B**); 20 µm (**C, D**).

on anterior tergites. Fifth tergite with posterior concavity less pronounced than the preceding one and significantly narrower than the fourth and the sixth (Fig. 1A, B). Penultimate tergite (Fig. 5D) with broad and shallow emargination; setae lanceolate, as on anterior tergites; pubescence as on anterior tergites. Last tergite (Figs 5D, 9B) with a convex posterior margin well projected behind tergal margin bearing 4 recognizable setae, pubescence reaching posterior margin. In addition to macrosetae on tergites 2, 3, and 4, lateral macrochaetae present on tergites 6 (Fig. 5B), 7, 9 (Fig. 5C), 10 (Fig. 5D, E), 12 (absent in populations of State Island), and 13 (Fig. 5D, F).

Ventral surface. Mainly covered by microsetae born from small knobs, last segment surface with longer pubescence born at the posterior end of scale-like cuticular structures. Male genital segment (Fig. 6A–D) with sternal plates with 9–13 setae, 2 of which are 2 (1.45–2.1) × longer than the rest. Female genital segment (Fig. 6F) with sternal plate with 13–18 setae, 2 or 3 of which are longer than the rest, 1.65–2.7 longer than the other setae.

Coxal sacs. Typical for the genus, fully developed at bases of legs 3–9, usually bearing 7–10 setae (Fig. 6E).

Male organs. Genital opening (Fig. 6A–C) valves with 7–10 setae on each of the internal borders and 7 (4–13) setae, which are subequal in length to those of the border.

Legs (Figs 7, 8). Tarsus of first pair of legs (Fig. 7A, B) 3.85 (3.38–4.53) × as long as wide, strongly tapering distally. Longest dorsal row with 5 (4–6) setae, longest ventral row with 4 (4–5) setae; distal setae longer than proximal ones; the longest one most distally on dorsal side, 0.9 (0.81–1.19) × as long as greatest diameter of tarsus. Anterior claw acuminates (Fig. 7C, D), almost straight, its length 0.21 (0.19–0.29) of the length of tarsus and 1.93 (1.7–2.5) × as long as posterior claw. Posterior claw basally suddenly thicker (Fig. 7D); frontal seta lanceolate and subequal in length to posterior claw. Pubescence short but distinct; trochanter with 13–23 setae subequal in length, the longest seta 2× longer than the shortest; coxa with (2–4) setae. Tarsus of 12th leg pair (Fig. 8A–F) 5.5 (4.3–5.6) × as long as wide, slowly tapering distally. Setae (Fig. 8B) arranged in rows lengthways, longest dorsal row with 6 (5–7) setae, longest ventral one with 7 (5–7) setae. Dorsal setae longer,

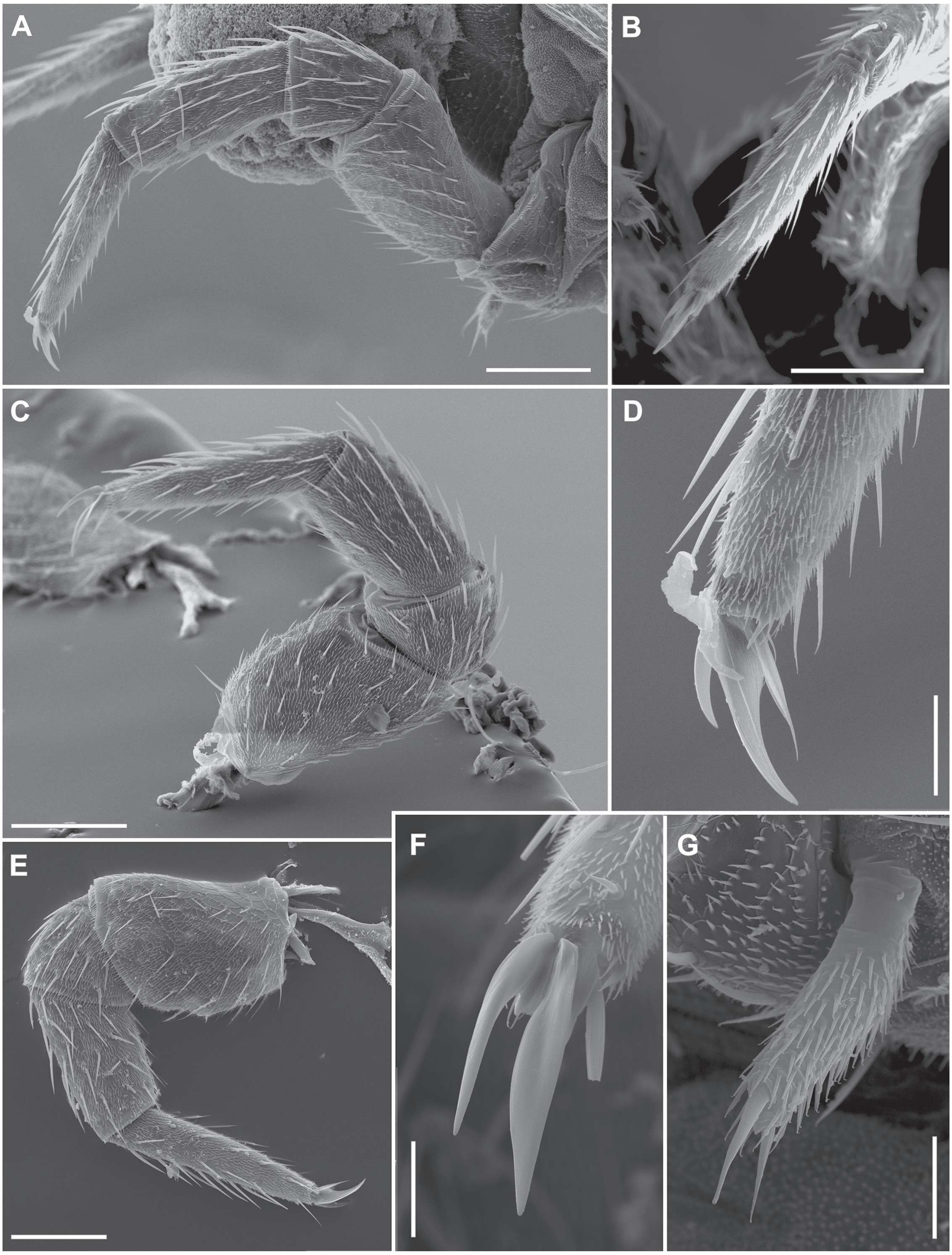

Figure 8. *Hanseniella guerreroi* sp. nov., leg 12. **A.** Paratype (MACN-My 97), right leg 12; **B.** Paratype (MACN-My 88), right leg 12, dorsal view of the tarsus; **C.** Paratype (MACN-My 99), left leg 12; **D.** Paratype (MACN-My 97), right leg 12, detail of the claws; **E.** Paratype (MACN-My 99), right leg 12, dorsal view of the tarsus; **F.** Paratype (MACN-My 96), right leg 12, frontal view of the claws; **G.** Paratype (MACN-My 96), stylus associated with the right leg 12. Scale bars: 100 µm (**A, C, E**); 25 µm (**D, F**); 20 µm (**G**).

longest of these 0.85 (0.61–0.95) of greatest diameter of tarsus. Anterior claw slender, somewhat curved, 0.14 (0.18–0.29) of the length of tarsus; length of posterior claw 0.52 (0.63–0.84) of the length of anterior claw, basally suddenly thicker; frontal seta (Fig. 8D) lanceolate and longer than posterior claw, with an aristate tip. Tibia (Fig. 8A, C, E) 2.23 (1.9–2.71) × as long as wide, its length 0.75 (0.72–0.83) of the length of tarsus; longest row of dorsal side with 5 (4–6) setae, the one on ventral side with 4 (2–5) setae; length of setae decreasing in length proximally but inconsiderably; posterior side with few, 6 (4–7), setae. Femur very short with 5 (2–5) rows of 2–5 setae on dorsal and anterior sides; 0–1 ventral and 0–1 posterior seta. Trochanter with 22–35 thin subequal setae on dorsal and anterior sides only. Pubescence on tarsus, tibia, and femur short but distinct, sparser in the posterior facies of femur and tibia.

Styli. 3.2 (2.5–3.8) longer than wide, with 2 terminal setae, the larger 2.14 (1.71–2.33) longer than the shorter. On 12 leg well developed, elongated, 3.3 (2.91–4) × longer than wide, their length 1.42 (1.1–1.5) of the width of tarsus and densely covered with a short pubescence, basally glabrous; with 2 apical setae, the longer 1.5 (1.4–2.66) longer than the other, and 0.53 (0.33–0.57) the length of the stylus (Fig. 8G).

Sense calicles. Typical for the genus (Domínguez Camacho 2009) (Fig. 9F).

Cerci (Fig. 9A–E). Conical, proportionately short, 0.12 (0.75–0.12) of the length of body and 3.1 (2.75–4.5) × as long as wide. They have a moderate number of somewhat arched setae, the most distal ones longer than proximal ones; longest distal setae 0.43 (0.37–0.63) of greatest diameter of cercus. Longest dorsal row with 7 (6–9) setae (Fig. 9C), ventral 8 (5–9) (Fig. 9E), longest inner row with 8 (4–9), outer (Fig. 9A), with 9 (5–10) setae. The proximal 0.81 (0.7–0.84) of the tergal side covered with dense pubescence, as in tergites, mainly in short transverse bows following posterior borders of scale-like cuticular structures. Apical end glabrous. 2 apical setae (Fig. 9C, D) of different lengths, the longer one being (0.19–0.29) × the length of the cerci and (1.8–2.75) × the length of shorter seta.

Distribution. We found this species on three islands of the Tierra del Fuego archipelago, which is divided between Argentina and Chile. On the Argentinean side, we found it in the south of the Isla Grande de Tierra del Fuego and in the Isla de Los Estados. On the Chilean side, we found it on the Isla Navarino, one of the southernmost islands of the archipelago. This species seems to be common in the Argentinean islands explored, but less common in Navarino.

Remarks. *H. guerreroi* inhabits the *Nothofagus* forests of the Argentine and Chilean parts of the Tierra del Fuego archipelago (Fig. 10). This species could correspond to the previous records attributed to *S. immaculata* by Attems (1897) from Navarino and Ushuaia, and most probably also from Lapataia.

Affinities. Twelve species of the genus *Hanseniella* have macrochaetae on tergites 2, 3, 4, 6, 7, 9, 10, and 13, putatively on 12, but not on 5, 8, 11, and 14 (Soesbergen 2019): *H. audax* Clark & Greenslade, 1996; *H. conveniens* Clark & Greenslade, 1996; *H. insequens* Clark & Greenslade, 1996; *H. madecassa* Aubry & Masson, 1953; *H. mutila*, Adam & Burtel, 1956; *H. nivea* (Scopoli, 1763); *H. pluvialis* Clark & Greenslade, 1996; *H. proxima* Adam & Burtel, 1956; *H. pyrethrata* Clark & Greenslade, 1996; and *H. vulgata* Adam & Burtel, 1956.

Discussion

In this study, we have described a new species of Symphyla, *H. guerreroi* sp. nov. We have recorded this species on islands of the Tierra del Fuego archipelago, which is divided between Argentina and Chile. On the Argentine side, we found it in the south of Isla Grande de Tierra del Fuego and Isla de Los Estados. On the Chilean side, we found it on Navarino Island, one of the southernmost islands of the archipelago. To our knowledge, *H. guerreroi* sp. nov. represents the southernmost record ever reported for a myriapod of the class Symphyla.

The new species, *H. guerreroi* sp. nov., shows interesting relationships with its congeners; nine of the eleven species that share a similar macrochaetotaxy are distributed on other Gondwanan landmasses, such as Tasmania (six species) and New Zealand (three species). It is well known that many of the endemic taxa from the southern end of the South American continent are phylogenetically more closely related to other taxa from other Gondwanan regions than to the rest of South America (e.g., Giribet and Edgecombe 2006; Giribet and Boyer 2010; Harvey 1996a, 1996b; Swenson et al. 2001; Sanmartín and Ronquist 2004). Further research on the phylogenetic relationships among *Hanseniella* species may reveal interesting relationships among species distributed in Tasmania, New Zealand, Argentina, Chile, and other countries located in areas related to the supercontinent Gondwana.

Symphyla are a diverse and abundant taxon in tropical and temperate climates (Scheller 1992; Minelli and Golovatch 2001; Parra-Gómez and Fernández 2022). However, the Tierra del Fuego archipelago has a subpolar oceanic climate. This suboptimal climate is a challenge for most South American taxa, including myriapods (Parra-Gómez and Fernández 2022). This is because many modern taxa exhibit tropical or temperate niche conservatism, i.e., evolutionary constraints to adapt to extremely hot or cold climates (Wiens et al. 2010; Fernández et al. 2016). The few modern representatives that are able to colonize suboptimal climates are usually taxa that have evolved recent evolutionary novelties that allow them to thrive, for example, in cooler climates (Wiens et al. 2010; Fernández et al. 2022). Except for "Isla de Los Estados", we found *H. guerreroi* sp. nov. at islands that were partially covered by the Patagonian Ice Sheet during the Last Glacial Maximum (LGM) (Davies et al. 2020). Therefore, *H. guerreroi* sp. nov. could be a glacial relict that survived the LGM in a glacial refuge or in ice-free areas east of the Tierra del Fuego archipelago (e.g., at the southeastern end of Isla Grande de Tierra del Fuego or in the Islas de los Estados). In this refuge, *H. guerreroi* sp. nov. probably evolved in isolation from other *Hanseniella* populations and adapted to the climatic conditions that prevail in the Tierra del Fuego archipelago today. Probably, at the end of the LGM, some of its representatives were passively dispersed to the west of Isla Grande de Tierra del Fuego and Isla Navarino, where they established stable populations. A recent analysis of the population genetic structure

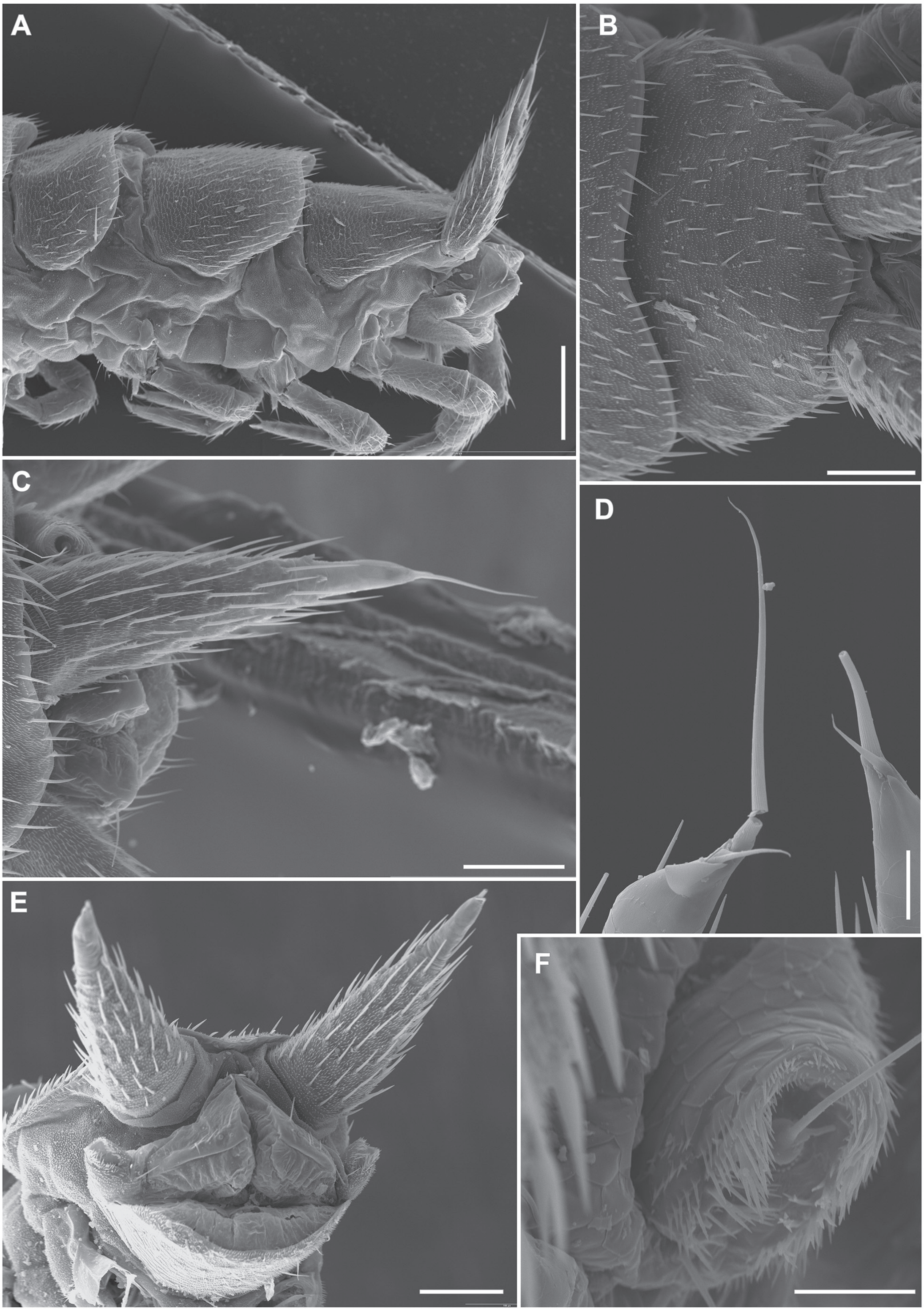

Figure 9. *Hanseniella guerreroi* sp. nov., cerci. **A.** Paratype (MACN-My 97), last trunk segments and left cercus, lateral view; **B.** Paratype (MACN-My 96), fifteenth terguite; **C.** Paratype (MACN-My 88), right cercus, dorsal view; **D.** Paratype (MACN-My 99), apical setae of the left cercus, ventral side; **E.** Paratype (MACN-My 97), posterior view of the trunk showing anus and ventral side of the cerci; **F.** Paratype (MACN-My 96), right sensory calicle. Scale bars: 200 µm (**A**); 100 µm (**B, C, E**); 25 µm (**D, F**).

of a microalga suggests that haplotypes from the western side of Isla Grande de Tierra del Fuego originated from a relict population that survived the LGM on the eastern side of the Tierra del Fuego archipelago (Fernández et al. 2017). Therefore, the populations of *H. guerreroi* sp. nov. from the western and southern regions of the Tierra del Fuego archipelago probably also originated from the eastern side of the archipelago. If this hypothesis is

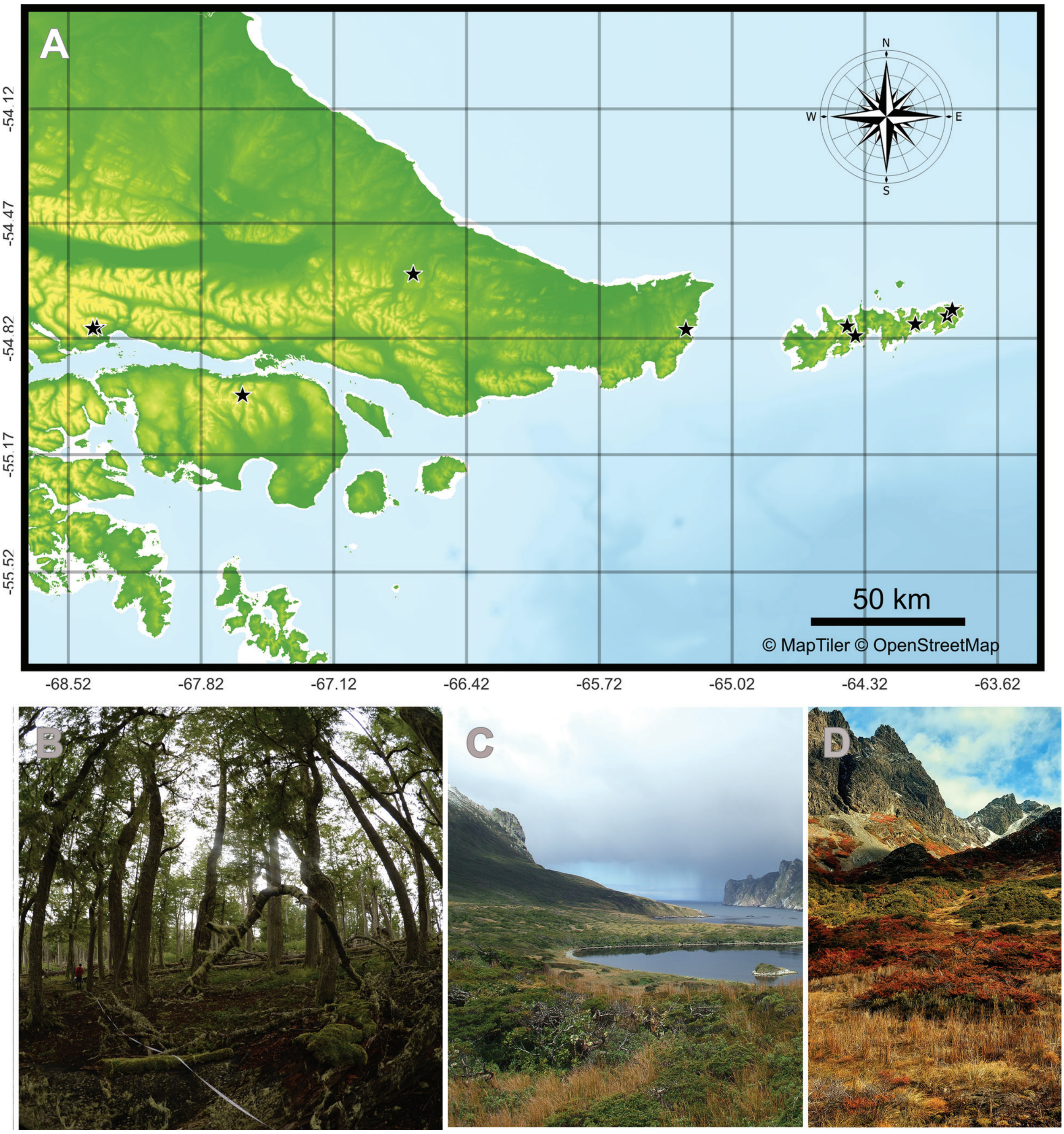

Figure 10. A. Collecting localities of *Hanseniella guerreroi* sp. nov.; **B.** Type locality, Río Irigoyen, Isla Grande de Tierra del Fuego, forest environment dominated by *N. pumilio* (Poepp. & Endl.) Krasser 1896 (Fagales: Nothofagaceae); **C.** Puerto Cook, Isla de los Estados, Argentina, panoramic view; **D.** Navarino Island, Chile (in the background is the Dientes de Navarino mountain range), panoramic view.

correct, the populations in the west and south of the archipelago should consist of a few recent haplotypes, while the populations in the east of the archipelago should have more and older haplotypes.

H. guerreroi sp. nov. may be an exception to the tropical and temperate niche conservatism, and so it is an excellent model organism to study the role of the LGM on the diversity and distribution of arthropods of the southern tip of South America. For instance, it might be useful for testing phylogeographical hypotheses on myriapods and other arthropods. In fact, phylogeographical studies regarding Argentine and Chilean arthropods are very scarce and do not consider taxa from the southern tip of the continent (e.g., Rosseti and Remis 2012; Zúñiga-Reinoso et al. 2016; Ceccarelli et al. 2017; Alfaro et al. 2018; Campos-Soto et al. 2020; Sosa-Pivatto et al. 2020; López-López et al. 2021). Moreover, studying the relations between *H. guerreroi* sp. nov. and a putatively new *Hanseniella* species in the Malvinas Islands (Pugh 2013) could help understand the origins and links of the Malvinas Islands fauna, as it has been discussed that the fauna from these islands has a close relationship with the rest of the austral Gondwanic South America fauna (Ringuelet 1955).

Acknowledgements

We wish to thank, particularly, the Argentine Navy personnel in Puerto Parry and Bahía Buen Suceso stations for their fundamental assistance during the collecting trips. Dr. Miguel Domínguez Camacho, Dr. Luis Pereira (MLP), and Bibl. Roberto Uguet (INTA-Castelar) for providing bibliographic materials. Field work in Argentina was supported by Foncyt grant PICT-2015-0283 to Martín J. Ramírez. Finally, both expeditions in Argentina were possible only because of the constant support of Federico Guerrero and Laura Smith of "Quijote Expeditions." L.D. Fernández and the expedition to Isla Navarino, located in the southern part of the Tierra del Fuego Archipelago, Chile, were funded by the ANID FONDECYT 1220605 project. R. Mackenzie thanks the support of the ANID/BASAL FB210018 y ANID – Millennium Science Initiative Program – ICN2021_002. L.D. Fernández and Roy Mackenzie thank Javier Estay (Wild Navarino Tourism Agency) and the "Watamericonsu" research team for their support during the fieldwork on Navarino Island, Chile. A.O. Porta thanks Ivan Fiorini de Magalhaes (MACN-Conicet) for his support during the collecting trip on Staten Island, Argentina. Valuable edits that helped improve this study were provided by Miguel Domínguez Camacho and Christopher James Dourte. Special thanks go to Martin Husemann, the subject editor, for his valuable assistance with this manuscript.

References

Adam MO, Burtel J (1956) A contribution to the study of the New Zealand Symphyla. Records of the Canterbury Museum 7(2): 61–88.

Alfaro MI, Muñoz-Ramírez, CP, Zúñiga-Reinoso, A, Trewick SA, Méndez MA (2018) Phylogeography of the Chilean red cricket *Cratomelus armatus* (Orthoptera, Anostostomatidae) reveals high cryptic diversity in central Chile. Biological Journal of the Linnean Society 123(4): 712–727. https://doi.org/10.1093/biolinnean/bly019

Attems CG (1897) Myriopoden. In Ergebnisse der Hamburger Magalhaensischen Sammelreise 1892/93. Friederichsen L & Co, Hamburg, 1–8.

Attems CG (1902) Myriopodes. Résultats du voyage du S.Y.Belgica en 1897–1898–1899 sous le commandement de A. de Gerlache de Gomery. Rapports Scientifiques, 3–5.

Aubry MJ, Masson C (1953) Contribution à la faune endogée de Madagascar. Symphyles. Mémoires de l'Institut Scientifique de Madagascar Série A 8: 43–66.

Bagnall RS (1913) On the classification of the order Symphyla. Journal of the Linnean Society of London, Zoology 32(216): 195–199. https://doi.org/10.1111/j.1096-3642.1913.tb01775.x

Boyle H (1981) Symphyla control in young plant cane. The Cane Growers' Quarterly Bulletin 44: 115–116.

Campello-Nunes PH, Woelfl S, da Silva-Neto ID, Paiva T da S, Fernández LD (2022) Checklist, diversity and biogeography of ciliates (Ciliophora) from Chile. European Journal of Protistology 84: 125892. https://doi.org/10.1016/j.ejop.2022.125892

Campos-Soto R, Díaz-Campusano G, Rives-Blanchard N, Cianferoni F, Torres-Pérez F (2020) Biogeographic origin and phylogenetic relationships of *Mepraia* (Hemiptera, Reduviidae) on islands of northern Chile. PLoS ONE 15(6): e0234056. https://doi.org/10.1371/journal.pone.0234056

Ceccarelli FS, Pizarro-Araya J, Ojanguren-Affilastro AA (2017) Phylogeography and population structure of two *Brachistosternus* species (Scorpiones, Bothriuridae) from the Chilean coastal desert – the perils of coastal living. Biological Journal of the Linnean Society 120(1): 75–89. https://doi.org/10.1111/bij.12877

Clark S, Greenslade P (1996) Review of Tasmanian *Hanseniella* Bagnall (Symphyla, Scutigerellidae). Invertebrate Taxonomy 10(1): 189–212. https://doi.org/10.1071/IT9960189

Davies BJ, Darvill CM, Lovell H, Bendle JM, Dowdeswell JA, Fabel D, García J-L, Geiger A, Glasser NF, Gheorghiu DM, Harrison S, Hein AS, Kaplan MR, Martin JRV, Mendelova M, Palmer A, Pelto M, Rodés Á, Sagredo EA, Smedley RK, Smellie JL, Thorndycraft VR (2020) The evolution of the Patagonian Ice Sheet from 35 ka to the present day (PATICE). Earth-Science Reviews 204: 103152. https://doi.org/10.1016/j.earscirev.2020.103152

Domínguez Camacho M (2009) Phylogeny of the Symphyla. Doctoral Thesis: Department of Biology, Chemistry and Pharmacy. Freie Universität Berlin. https://d-nb.info/1027814468/34 [Accessed 10 Feb 2020]

Fernández LD, Lara E, Mitchell EA (2015) Checklist, diversity and distribution of testate amoebae in Chile. European Journal of Protistology 51(5): 409–424. https://doi.org/10.1016/j.ejop.2015.07.001

Fernández LD, Fournier B, Rivera R, Lara E, Mitchell EAD, Hernández CE (2016) Water-energy balance, past ecological perturbations and evolutionary constraints shape the latitudinal diversity gradient of soil testate amoebae in south-western South America. Global Ecology and Biogeography 25: 1216–1227. https://doi.org/10.1111/geb.12478

Fernández LD, Hernández CE, Schiaffino MR, Izaguirre I, Lara E (2017) Geographical distance and local environmental conditions drive the genetic population structure of a freshwater microalga (Bathycoccaceae, Chlorophyta) in Patagonian lakes. FEMS Microbiology Ecology 93(10): fix125. https://doi.org/10.1093/femsec/fix125

Fernández LD, Seppey CVW, Singer D, Fournier B, Tatti D, Mitchell EAD, Lara E (2022) Niche conservatism drives the elevational diversity gradient in major groups of free-living soil unicellular eukaryotes. Microbial Ecology 83(2): 459–469. https://doi.org/10.1007/s00248-021-01771-2

Giribet G, Boyer S (2010) 'Moa's Ark' or 'Goodbye Gondwana': is the origin of New Zealand's terrestrial invertebrate fauna ancient, recent, or both? Invertebrate Systematics 24(1): 1–8. https://doi.org/10.1071/IS10009

Giribet G, Edgecombe GD (2006) The importance of looking at small-scale patterns when inferring Gondwanan biogeography: a case study of the centipede *Paralamyctes* (Chilopoda, Lithobiomorpha, Henicopidae). Biological Journal of the Linnean Society 89(1): 65–78. https://doi.org/10.1111/j.1095-8312.2006.00658.x

Harvey MS (1996a) Small arachnids and their value in Gondwanan biogeographic studies. In: Hopper SD (Eds) Gondwanan Heritage: Past, Present and Future of Western Australian Biota. Surrey Beatty & Sons: Chipping Norton, 155–162.

Harvey MS (1996b) The biogeography of Gondwanan pseudoscorpions (Arachnida). Revue suisse de Zoologie hors série 1, 255–264.

Jin Y-L, Nunes Godeiro N, Bu Y (2023) Description of the first species of Scutigerella (Symphyla, Scutigerellidae) from China, with mitogenomic and genetic divergence analysis. ZooKeys 1157: 145–161. https://doi.org/10.3897/zookeys.1157.99686

Lamoreux JF, Lacher Jr TE (2010) Mammalian endemism, range size and conservation status in the southern temperate zone. Diversity and Distributions 16: 922–931. https://doi.org/10.1111/j.1472-4642.2010.00697.x

López-López A, Acosta V, Rataj L, Galián J (2021) Evolution and diversification of the Southern Chilean genus *Ceroglossus* (Coleoptera, Carabidae) during the Pleistocene glaciations. Systematic Entomology 46(4): 856–869. https://doi.org/10.1111/syen.12494

Minelli A, Golovatch SI (2001) Myriapods. In: Levin SA (Ed.) Encyclopedia of Biodiversity. Academic Press, Amsterdam, 291–303. https://doi.org/10.1016/B0-12-226865-2/00204-2

Murray DAH, Smith D (1983) Effect of Symphyla, *Hanseniella* sp., on establishment of pineapples in south-east Queensland. Queensland Journal of Agricultural Science 40: 121–123.

Parra-Gómez A, Fernández LD (2022) Filling gaps in the diversity and biogeography of Chilean millipedes (Myriapoda, Diplopoda). Arthropod Systematics & Phylogeny 80: 561–573. https://doi.org/10.3897/asp.80.e86810

Parra-Gómez A, Pérez-Schultheiss J, Fernández LD (2024) Redescription of the enigmatic myriapod *Hanseniella chilensis* (Hansen, 1903) (Symphyla, Scutigerellidae) based on scanning electron microscope images of Chilean specimens. ZooKeys 1198: 1–15. https://doi.org/10.3897/zookeys.1198.119723

Porta A, Tricarico F (2018) Secado de muestras de ácaros de suelo para SEM usando hexamethyldisilazane (HDMS) Memorias del V congreso argentino de Microscopia SAMIC 2018. http://samic2018.congresos.unc.edu.ar/ [last accessed 29 May 2019]

Pugh PJA (2013) Why are there so few “far southern” myriapods? Journal of Natural History 47(43–44): 2769–2784. https://doi.org/10.1080/00222933.2013.791890

Ringuelet RA (1955) Ubicación zoogeográfica de las Islas Malvinas (in spanish). Editor Olivieri y Domínguez, 46 pp.

Rosetti N, Remis MI (2012) Spatial genetic structure and mitochondrial DNA phylogeography of Argentinean populations of the grasshopper *Dichroplus elongatus*. PLoS ONE 7(7): e40807. https://doi.org/10.1371/journal.pone.0040807

Sanmartín I, Ronquist F (2004) Southern hemisphere biogeography inferred by event-based models: Plant versus animal patterns. Systematic Biology 53(2): 278–298. https://doi.org/10.1080/10635150490423430

Scheller U (1961) A review of the Australian Symphyla (Myriapoda). Australian Journal of Zoology 9(1): 140–172. https://doi.org/10.1071/ZO9610140

Scheller U (1971) Symphyla from Ceylon and Peninsular India. Entomologica Scandinavica, Supplementum 1: 98–187.

Scheller U (1992) A study of Neotropical Symphyla (Myriapoda): List of species, keys to genera and description of two new Amazonian species. Amazoniana 12(2): 169–180.

Scheller, U (1998) Symphyla. In: Morrone JJ Coscaron S (Eds.). Biodiversidad de artrópodos argentinos: una perspectiva biotaxonómica, Volumen 1. Ediciones SUR, La Plata, 488–490.

Scheller U (2002) A new species of *Hanseniella* Bagnall (Myriapoda, Symphyla) found in a hothouse. Zoosystematics and Evolution 78(2): 269–273. https://doi.org/10.1002/mmnz.20020780206

Scheller U (2007) New records of Pauropoda and Symphyla (Myriapoda) from Brazil with descriptions of new species in *Allopauropus*, *Hanseniella* and *Ribautiella* from the northern Pantanal wetland and from Mato Grosso of Brazil. Amazoniana 19(3/4): 63–75.

Schiaffino MR, Lara E, Fernández LD, Balagué V, Singer D, Seppey CC, Massana R, Izaguirre I (2016) Microbial eukaryote communities exhibit robust biogeographical patterns along a gradient of Patagonian and Antarctic lakes. Environmental Microbiology 18(12): 5249–5264. https://doi.org/10.1111/1462-2920.13566

Schultheiss-Pérez J, Fernández LD, Bezerra Ribeiro F (2024) Two new genera of coastal Talitridae (Amphipoda: Senticaudata) from Chile, with the first record of Platorchestia Bousfield, 1982 in the southeastern Pacific coast. Zootaxa 5477(2): 195–218. https://doi.org/10.11646/ZOOTAXA.5477.2.5

Scopoli JA (1763) Entomologia carniolica exhibens insecta Carnioliae indigena et distributa in ordines, genera, species, varietates. Methodo Linnaeana. Vindobonae [=Vienna]: J. Trattner, xxxvi + 420 pp. https://doi.org/10.5962/bhl.title.119976

Snodgrass RE (1952) A textbook of arthropod anatomy. Cornell University Press, Ithaca, New York.

Soesbergen M (2019) *Hanseniella lanceolata* sp.n. (Myriapoda, Symphyla) found in a European hothouse. Arthropoda Selecta 28(1): 27–36. https://doi.org/10.15298/arthsel. 28.1.04

Sosa-Pivatto M, Camps GA, Baranzelli MC, Espíndola A, Sérsic AN, Cosacov A (2020) Connection, isolation and reconnection: Quaternary climatic oscillations and the Andes shaped the phylogeographical patterns of the Patagonian bee *Centris cineraria* (Apidae). Biological Journal of the Linnean Society 131(2): 396–416, https://doi.org/10.1093/biolinnean/blaa116

Swenson U, Hill R., Mcloughlin S (2001) Biogeography of *Nothofagus* supports the sequence of Gondwana break-up. Taxon 50(4): 1025–1041. https://doi.org/10.2307/1224719

Szucsich N, Scheller U. (2011) Symphyla. In: Minelli A (Ed.) Treatise on Zoology - Anatomy, Taxonomy, Biology. The Myriapoda, Volume 1. Brill, Leiden, The Netherlands, 445–466. https://doi.org/10.1163/9789004188266

Vega-Román E, Ruiz VH, Soto R, Díaz G (2012) Notas sobre el conocimiento de Symphyla de Chile. Dugesiana 19(1): 21–22.

Villagrán C, Hinojosa LF (1997) Historia de los bosques del sur de Sudamérica, II: análisis fitogeográfico. Revista Chilena de Historia Natural 70: 241–267.

Wiens JJ, Ackerly DD, Allen AP, Anacker BL, Buckley LB, Cor-nell HV, Damschen EI, Jonathan Davies T, Grytnes JA, HarrisonSP, Hawkins BA, Holt RD, McCain CM, Stephens PR (2010) Niche conservatism as an emerging principle in ecology and conservation biology. Ecology Letters 13: 1310–1324. https://doi.org/10.1111/j.1461-0248.2010.01515.x

Zúñiga-Reinoso A, Jerez V, Avaria-Llautureo J, Hernández CE (2016) Consequences of the last glacial maximum on *Nyctelia confusa* (Coleoptera, Tenebrionidae) in Patagonia. Biological Journal of the Linnean Society 117(4): 705–715. https://doi.org/10.1111/bij.12700