Zootaxa 3694 (2): 185–195
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3694.2.8
http://zoobank.org/urn:lsid:zoobank.org:pub:59C9143D-FB0F-4129-AA38-F0A444C1E72D

First species of the family Bogidiellidae Hertzog, 1936 (Crustacea: Amphipoda) in Chilean groundwaters: *Patagongidiella wefkoi* n. sp.

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Abstract

The first Chilean species of Bogidiellid amphipod, *Patagongidiella wefkoi* **n. sp.**, is described from freshwater springs in the Osorno Province, Los Lagos Region. The new taxon is characterized principally by the structure of the hypertrophied facial robust seta present on the peduncle of male uropod 1, and the modified dimorphic setae on the exopod of male pleopod 2. The new species is described and illustrated and its morphological relationships with the other species of this group are discussed.

Key words: Bogidiellidae, *Patagongidiella wefkoi* **n. sp.**, groundwater amphipod, Osorno, Chile

Resumen

Se describe la primera especie chilena de anfípodo Bogidiéllido, *Patagongidiella wefkoi* **n. sp.**, de manantiales de agua dulce en la provincia de Osorno, Región de Los Lagos. El nuevo taxón se caracteriza principalmente por la estructura de la seta robusta facial hipertrofiada en el pedúnculo del urópodo 1 del macho y las setas modificadas dimórficas del exopodito del pleópodo 2 del macho. Se describe e ilustra completamente la especie y se discuten sus relaciones morfológicas con las especies previamente conocidas de este grupo.

Palabras clave: Bogidiellidae, *Patagongidiella wefkoi* **n. sp.**, anfípodo aguas subterráneas, Osorno, Chile

Introduction

The stygobiontic family Bogidiellidae is diverse in South American groundwaters (Koenemann & Holsinger 1999), especially in Argentina, where several genera and species have been described (Grosso 1988, Grosso & Claps 1984, 1985, Grosso & Fernández 1985, 1993, Grosso & Ringuelet 1979). In contrast, the presence of this family in Chile had not been confirmed yet, in spite of the remarkable advance in the knowledge of freshwater Senticaudatan amphipods attained in recent years (González 2003; Grosso & Peralta 2009; Pérez-Schultheiss 2013).

The first mention of a Bogidiellid amphipod in Chile was by Noodt (1965) which, with some reservations, attributed to the genus *Bogidiella* specimens collected at Río Choapa and near Illapel in the Region Coquimbo (Noodt 1965: 25). After this work nothing else has been published about this group in the country.

In this paper, I confirm the presence of the groundwater Senticaudatan family Bogidiellidae in Chile. The new species *Patagongidiella wefkoi* **n. sp.** is described from the outlet of small springs in the Middle Depression of Osorno Province, in the south of the country. The new taxon is illustrated and its morphological relationships with related species are discussed.

Accepted by Jim Lowry: 14 Jul. 2013; published: 2 Aug. 2013

Material and methods

The specimens were collected from the outlet of springs after stirring-up the bottom sediments and collecting all particles displaced by the current with a hand sieve. The material was sorted in the laboratory using a dissecting microscope and then preserved in 75% ethanol. Holotype, allotype and some paratypes were deposited in the Zoological Museum of the Universidad de Concepción, Concepción, Chile (MZUC); other specimens were deposited in the personal collection of the author (JPS). Appendages of dissected specimens were mounted on slides in pure glycerin and sealed with nail varnish. Drawings, terminology and body length of specimens were obtained following the methodologies described in Pérez-Schultheiss (2013). Systematic arrangement follows the new classification proposed by Lowry & Myers (2013).

Figures abbreviations. A1 and A2: antennula and antenna, La: labrum, Pa: paragnath, rM and lM: right and left mandibles, M1 and M2: maxillula and maxilla, Mp: maxilliped, Gn1 and Gn2: gnathopods 1 and 2, P3–P7: pereopods 3 to 7, U1–U3: uropods 1 to 3, U1v: uropod 1 ventral view, Pl1–Pl3: pleopods 1 to 3, Cx1–Cx7: coxae 1 to 7, C4–C6: coxal gill on coxae 4 to 6, O2–O3: oostegites on coxae 2 to 3, Sh: sternal humps (blisters), Ep: epimera, T: telson. Lower case letters (*e.g.*, a, b) before structure abbreviation denoting specimens different from principal unattributed specimen in each figure.

Systematics

Order Amphipoda Latreille, 1816

Suborder Senticaudata Lowry & Myers, 2013

Infraorder Bogidiellida Hertzog, 1936

Parvorder Bogidiellidira Hertzog, 1936

Superfamily Bogidielloidea Hertzog, 1936

Family Bogidiellidae Hertzog, 1936

Genus *Patagongidiella* Grosso & Fernández, 1993

Patagongidiella Grosso & Fernández, 1993: 340; Koenemann & Holsinger, 1999: 793

Diagnosis (amended from Koenemann & Holsinger 1999)**.** Peduncle of male uropod 1 with modified, hypertrophied facial robust seta. 2nd article of exopodite of male pleopod 2 with modified distolateral seta; sternal humps ("large mediosternal processes") on pereonites 2-5 or 4-6.

Species included. Two species, *Patagongidiella danieli* Grosso & Fernández, 1993 (type species); *Patagongidiella wefkoi* **n. sp.** (described herein).

Patagongidiella wefkoi n. sp.

(Figs 1–5)

Type specimens. *Holotype:* ***undissected female*** (MZUC Nº 39633) 4.45 mm, Ñadi Pichidamas, Puyehue, Osorno, Región de Los Lagos, 40°40'34.9''S, 72°50'54.37''W, 20-II-2011, Col. J. Pérez, Vertiente. *Allotype:* ***partially dissected male*** (MZUC Nº 39634) 4.45 mm, data as holotype except date: 2-IV-2010 dissected parts mounted in a slide. *Paratypes:* ***3 undissected females*** (JPS-226) 3.54–3.76 mm, same data as holotype. ***1 dissected female*** (JPS-228) 3.70 mm, same data as holotype, dissected parts mounted in two slides. ***1 undissected female*** (MZUC Nº 39635) 3.86 mm, same data as holotype except date: 21-III-2010. ***1 undissected female*** (MZUC Nº 39636) 3.13 mm, same data as holotype except date: 2-IV-2010. ***1 undissected male*** (MZUC Nº 39637) 3.11 mm, Pichidamas, Osorno, Región de Los Lagos, 40°44'S, 72°48'W, 11-X-2010, Col. J. Pérez & G. Ojeda, Vertiente vado.

Type locality. Ñadi Pichidamas (40°40'34.9''S, 72°50'54.37''W), Puyehue, Osorno, Middle depression of Los Lagos Region (Fig. 5). In a small spring draining to Quebrada Honda river, upper portion of the Damas basin.

Diagnosis. *Patagongidiella* with hypertrophied facial robust seta on peduncle of male uropod 1 provided with a convex blunt tip and with short setules subdistally on medioventral margin and on dorsomedial margin of cap. Modified seta directed laterodorsally on exopod of male pleopod 2. Sternal humps (blisters) present on pereonites 4-6.

Description. *Female:* Total length: 3.13–4.45 mm (mean: 3.73 mm). *Head*: eyes absent; *Antennula* (Fig. 1: A1): about 17% longer than antenna; relative length of peduncular segments 1–3 as 1:0.7:0.4; peduncle segments progressively shorter towards distal; flagellum longer than peduncle, 12-articulate, each article with distolateral slender setae and with single aesthetasc present on articles 5–8 and 10–11. Accessory flagellum 3-articulate, reaching third article of main flagellum. *Antenna* (Fig. 1: A2): shorter than antennula, attaining 85% of antennular length; gland cone slightly shorter than peduncular segment 3; peduncular segment 4 slightly longer than segment 5, ratio as 1:0.9; peduncle and flagellum provided with distal slender setae; flagellum 6-articulate, length ratio of articles as 1:0.68:0.65:0.53:0.48:0.25; all articles longer than wide (Fig. 1: A1 and A2). *Labrum* (Fig. 1: La): hexagonal, wide.

Right mandible (Fig. 1: rM): incisor 2-denticulate, main distal denticle with a medial cutting edge provided with two small cusps; lacinia mobilis 6-denticulate, hand-shaped; spine row reduced to single, wide cutting raker; molar strong, triturative; palp segments 1:2:3 length ratio as 1:2.37:1.62, segment 2 anterior margin swollen, segment 3 with two D-setae and two E-setae. *Left mandible* (Fig. 1: lM): incisor with six teeth separated in two discernible groups, two pappose rakers; lacinia mobilis 4-denticulate, proximal denticle subcuadrate. *Paragnaths* (Fig. 1: Pa): internal lobes barely discernible; outer lobes covered distally with short setules. *Maxillule* (Fig. 1: M1): palp 2-segmented, segment 2 longest with three distal setae; basal endite with 7 distal comb-like or bifurcate robust setae; coxal endite with three apical plumose setae. *Maxilla* (Fig. 1: M2): endites distally with rows of long simple setae, inner lobe with seven distal setae plus two and slightly larger subdistal setae on medial margin. *Maxilliped* (Fig. 1: Mp) basal endite with two short robust and four simple setae; ischial endite with three robust and six simple setae; palp developed, carpal segment longest, elongate and wide, with a cluster of long simple setae along anterior margin; propodus with a posterodistal comb row of closely-set blunt denticles.

Gnathopod 1 (Fig. 2: Gn1): coxa wider than long, with anteroventral angle slightly produced (Fig. 2: Cx1); basis with seven long setae on posterior margin; merus with patch of short spinules on posterior margin; carpus subtriangular, shorter than propodus, with posterior margin produced into well defined posterior lobe; posterodistal margin of lobe covered with patch of short spinules; propodus oblong ovoid, posterior margin slightly convex, palm margin oblique, about as long as posterior margin, straight, with marginal row of five short flagellate robust setae; palm angle with single robust seta similar to those lining palm margin. *Gnathopod 2* (Fig. 2: Gn2): longer and more slender than Gn1; coxa wider than long, with rounded anterior margin (Fig. 2: Cx2); basis with nine long setae on posterior margin; merus with one subdistal seta on posterior margin; carpus subtriangular elongated, but shorter than propodus, with three groups of long single setae and patch of short spinules on posterior margin; propodus oblong, palm oblique, about 2/5 length of posterior margin, straight, defined by two unequal flagellate robust setae, palm margin crenulate as in Gn1, with two flagellate robust setae.

Pereopods 3–4: subequal (Fig. 2: P3 and P4), not sexually dimorphic; coxa 3 slightly longer than wide, with anterior margin evenly rounded (Fig. 2: Cx3), coxa 4 subquadrate, with posterior margin not excavated (Fig. 2: Cx4); basis of both limbs swollen with strong setae along both margins. *Pereopod 5* (Fig. 3: P5): coxa wider than long, with broad, evenly rounded anteroventral lobe (Fig. 2: Cx5); basis suboval, posterodistal lobe wanting. *Pereopod 6* (Fig. 3: P6): longer than pereopod 5, basis suboval, merus longer than carpus; coxa with posteroventral lobe not so produced and more slender than in coxa 5 (Fig. 2: Cx6). *Pereopod 7* (Fig. 3: P7): longer but similar to pereopod 6, merus shorter than carpus; coxa triangular, wider than long (Fig. 2: Cx7).

Epimeral plates (Fig. 3: Ep): postero-ventral angle rectangular, with tip slightly produced, one very small seta on posteroventral margin of epimera 1–2. *Pleopods* (Fig. 3: Pl1 to Pl3): peduncle with two mediodistal coupling hooks, endopodite reduced, uniarticulate, reaching third article of exopodite in pleopod 1 and second article in pleopods 2 and 3; exopodite with 4 articles in pleopod 1 and 3 articles in pleopods 2 and 3. *Uropod 1* (Fig. 4: aU1v): peduncle with a proximo-ventrolateral (= facial) strong robust seta, rami slightly shorter than peduncle, exopodite slightly shorter than endopodite (Fig. 4: U1); *uropod 2* (Fig. 4: U2): shorter than uropod 1, rami longer than peduncle, exopodite slightly shorter than endopodite; *uropod 3* (Fig. 4: U3): longest, rami 2.5 times longer

than peduncle, endopodite uniarticulate, nearly as long as exopodite; endo and exopodite lined with short robust setae. *Telson* (Fig. 4: aT): subrectangular, longer than wide, distal margin slightly emarginated; with two distal, two subdistal and two dorsolateral robust setae. *Coxal gills* (Fig. 2: C4 to C6): on pereopods 4 to 6. *Sternal gills* absent. *Sternal humps (blisters)* (Fig. 3: Sh): present on sternites 4 to 6, sternites 3 and 7 strongly bulging but not forming a blister. *Oostegites* (Fig. 2: O2 and O3): present on coxae 2–5, narrow and devoid of setae.

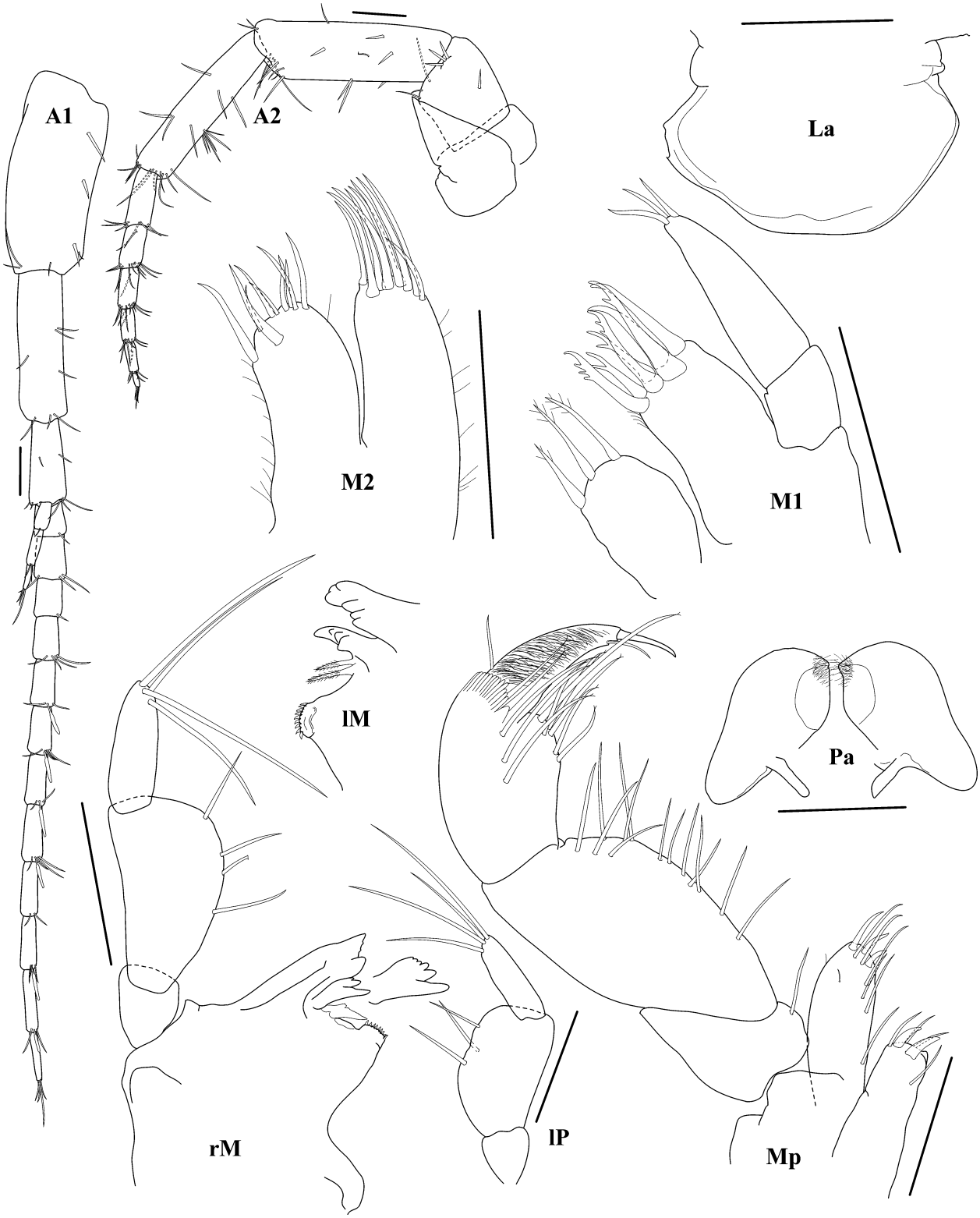

FIGURE 1. *Patagongidiella wefkoi* **n. sp.**, female paratype (MZUC N° 39635): antennae and mouthparts. Scale bar: 0.1 mm.

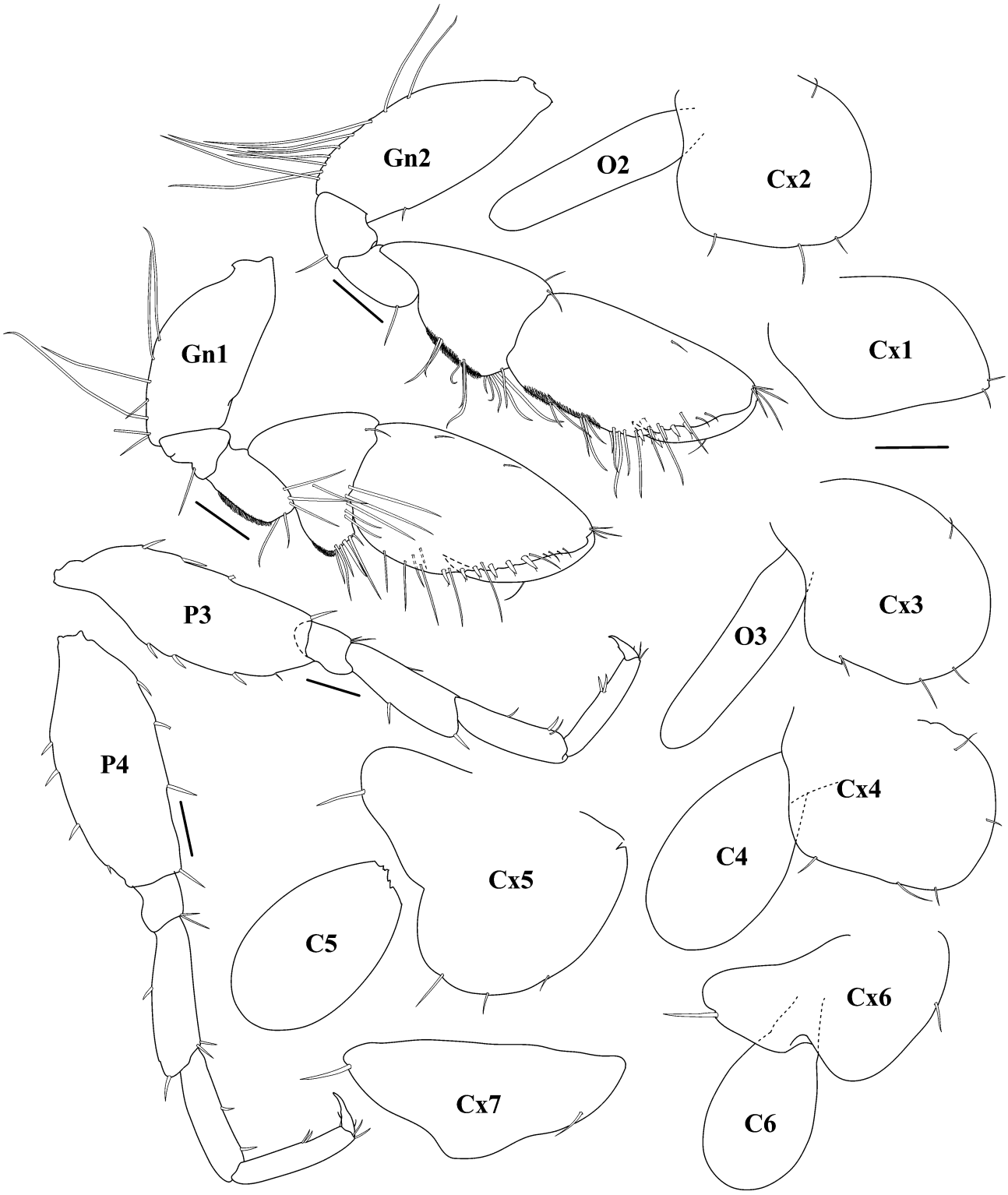

FIGURE 2. *Patagongidiella wefkoi* **n. sp.**, female paratype (MZUC N°37182): gnathopods, pereopods 3 and 4 and coxae. Scale bar: 0.1 mm.

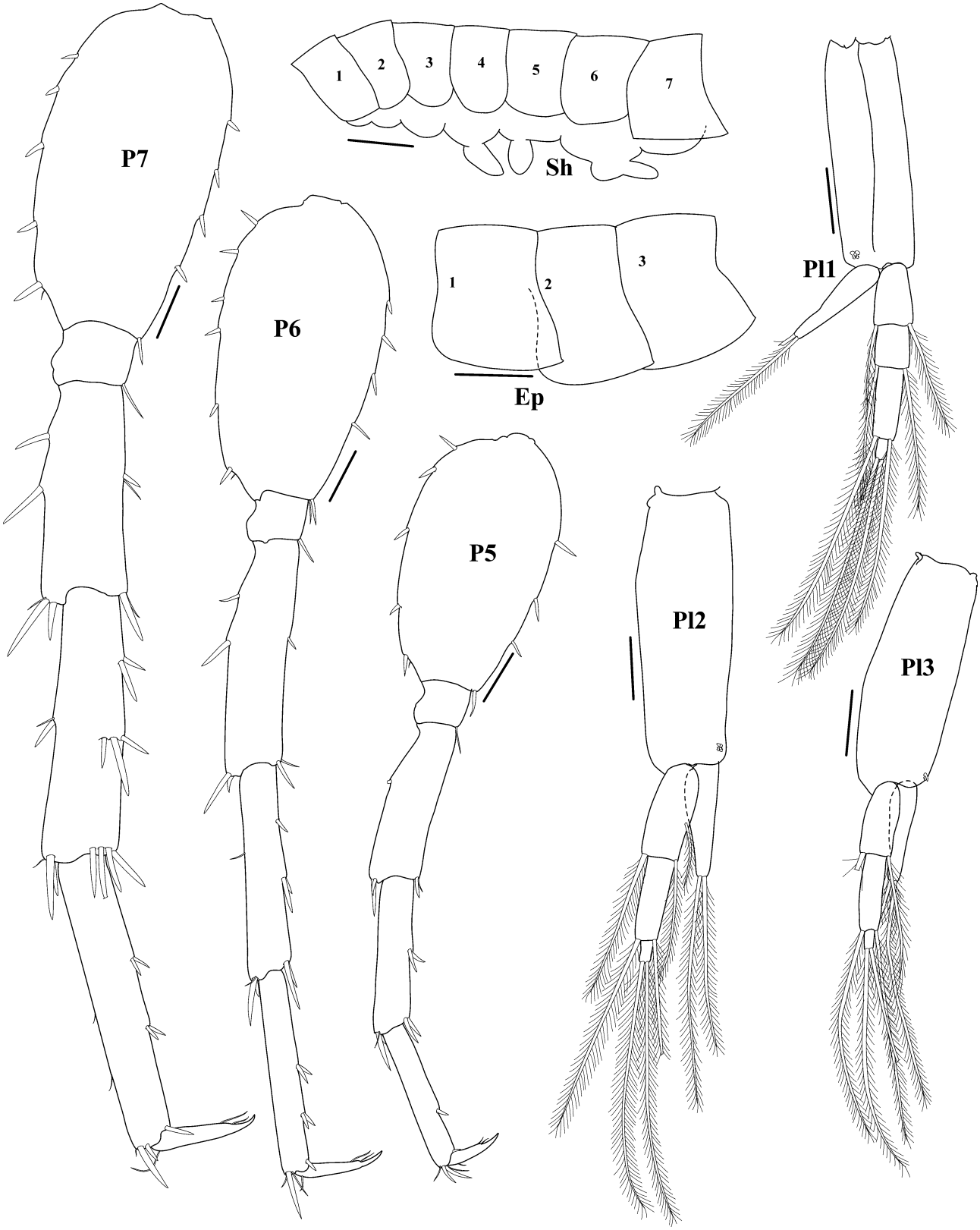

FIGURE 3. *Patagongidiella wefkoi* **n. sp.**, female paratype (MZUC N°39635): pereopods 5 to 7, sternal humps, epimera and pleopods. Scale bar: 0.1 mm.

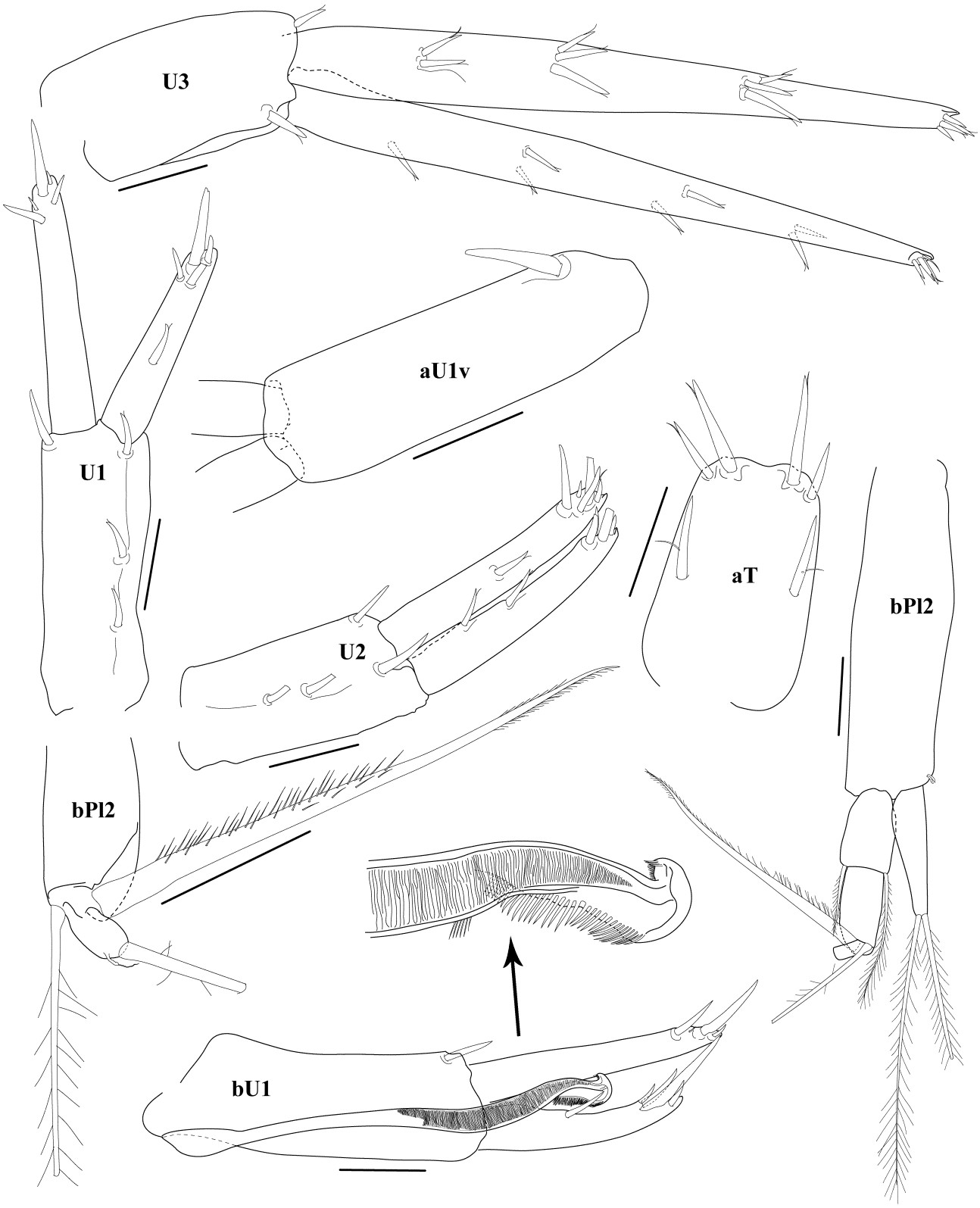

FIGURE 4. *Patagongidiella wefkoi* **n. sp.**, female paratype (MZUC N°39635): uropods. a, female paratype (MZUC N° 39636): uropod 1 and telson. b, male allotype (MZUC N° 39634): pleopod 2 and uropod 1. Scale bar: 0.1 mm.

Male: Total length: 3.11–4.45 mm (mean: 3.78 mm). As the female except for: *Pleopod 2* (Fig. 4: bPl2): exopodite with a special seta inserted laterally on second article, dorsolaterally directed and 1/3 longer than ramus itself; dorsal (lateral) margin and apex of seta lined with short setules; third article reduced and laterally directed, provided with an ordinary distal and a distolateral atrophied seta. *Uropod 1* (Fig. 4: bU1): facial seta on peduncle

hypertrophied and convoluted distally, running along lateral margin of peduncle until half of uropodal rami; distal half of lateral surface of seta finely striated, distalmost portion flattened and coiled, with inner-ventral margin lined with faint setules; apex recurved, blunt, provided with shorter setules as figured (Fig. 4: bU1, detail). One of the distal strong setae on exopod nearly as long as half ramus length.

Etymology. The new species is named for "wefko", that means "spring" or "fresh water" in Mapudungun, the language of the Mapuche, in allusion to the habitat where the studied specimens were found.

Ecological observations. *Patagongidiella wefkoi* **n. sp.** inhabits small running freshwater springs at 80–85 km from the sea and 120–150 m above sea level, in the Middle Depression of Osorno Province, Los Lagos Region, Chile. The animals were collected in highly impacted zones (agricultural and livestock rearing areas).

Accompanying *Patagongidiella wefkoi* **n. sp.** we found an undescribed species of protojanirid isopod, and occasionally the amphipod *Hyalella chiloensis* Gónzalez & Watling, 2001.

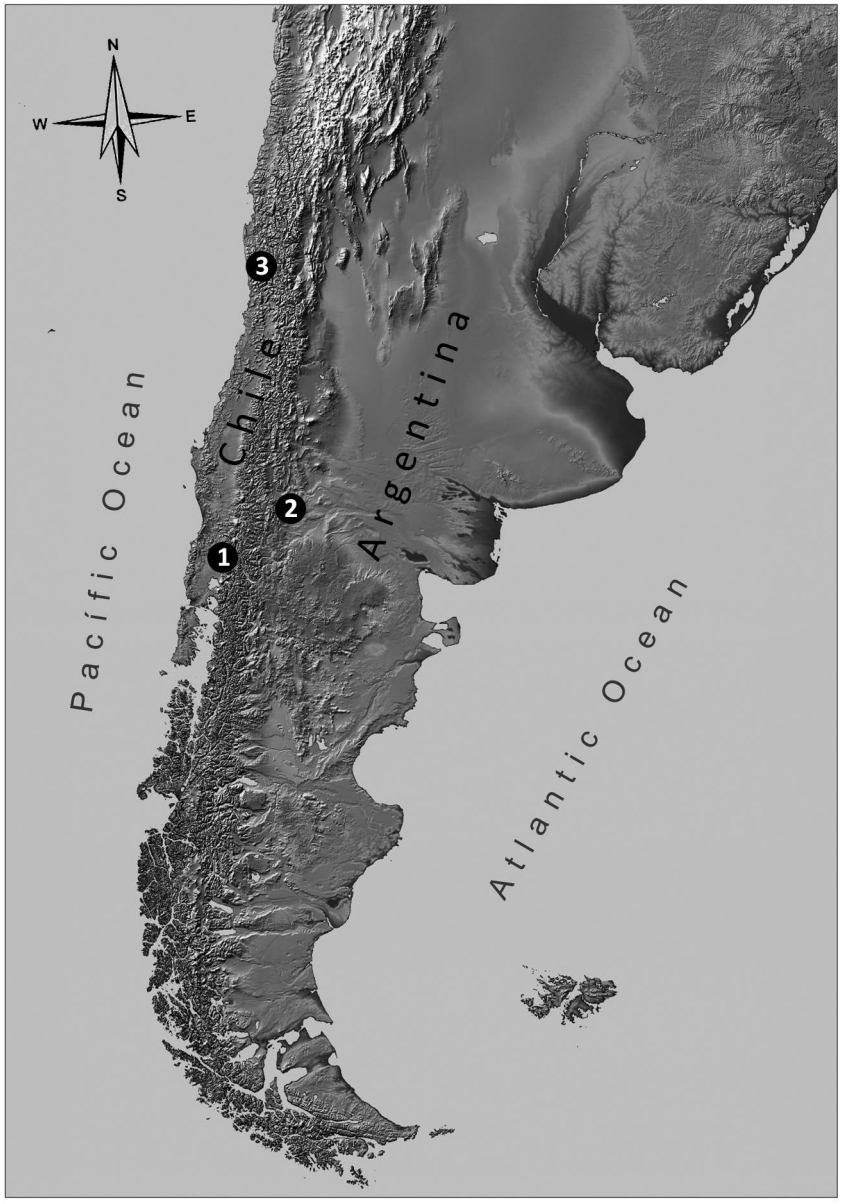

FIGURE 5. Distribution of the genus *Patagongidiella* and additional records of Bogidiellidae in Chile. 1. Osorno Province, type locality of *P. wefkoi* **n. sp.**; 2. Neuquén Province, type locality of *P. danieli* Grosso & Fernández, 1993 (Argentina); 3. Coquimbo Region, record of "*Bogidiella"* by Noodt (1965).

Discussion

The genus *Patagongidiella* Grosso & Fernández, 1993 originally embraced two species, *P. mauryi* Grosso & Fernández, 1993 and *P. danieli* Grosso & Fernández, 1993, both from the same cave system in Neuquén, Argentina (Grosso & Fernández 1993). *Patagongidiella danieli* was incompletely described and was considered to be nearly indistinguishable from *P. mauryi* except for the display of sexual dimorphism on pleopod 2 and uropod 1 (Grosso & Fernández 1993). However, Koenemann & Holsinger (1999) considered these characters to be sufficiently important as to allocate both species in different genera, and transferred *P. mauryi* to the new genus *Grossogidiella* Koenemann & Holsinger, 1999. Since the only species of *Patagongidiella* is incompletely described, here I compare *Patagongidiella wefkoi* **n. sp.** with *Grossogidiella mauryi* (Grosso & Fernández, 1993) for the general morphology, and with *Patagongidiella danieli* Grosso & Fernández, 1993 for the sexually dimorphic characters (Table 1).

TABLE 1. Comparison of *Patagongidiella wefkoi* **n. sp.**, with related species. Character states for *Patagongidiella danieli* assumed to be as in *Grossogidiella mauryi* except for pleopod 2 and uropod 1 (see discussion).

	Patagongidiella wefkoi **n. sp.**	*Patagongidiella danieli* Grosso & Fernández, 1993	*Grossogidiella mauryi* (Grosso & Fernández, 1993)
Flagellar articles of Antenna	12	16	16
Distal robust setae on maxillipedal basal endite	2	3	3
Setae on mandibular palp segment 3	2 E-setae/ 2 D-setae	3 E-setae/ 3 D-setae	3 E-setae/ 3 D-setae
Modified seta of male pleopod 2	inserted laterally and laterodorsally directed	Normally inserted, distally directed	Absent
Distal third of hypertrophied facial robust seta on peduncle of male uropod 1	Flattened and coiled, with only one type of setules	Not coiled, with anteriorly directed bifid spike and two types of ornamental setules	Absent
Telson distal margin	Slightly emarginated	Convex	Convex

The new species presents sternal humps developed only on the sternites 4 to 6 (versus 4–7 in the rest of species). However, the third and seventh sternites have a strongly bulging surface, suggesting a rudimental sternal hump.

Patagongidiella wefkoi **n. sp.** obviously differs from *Grossogidiella mauryi* in the display of sexually dimorphic pleopod 2 and uropod 1; other relevant differences between both taxa (that probably also hold for *Patagongidiella danieli*) include the 12-articulate flagellum of antenna 1 (versus flagellum 16-articulate in *G. mauryi*); the basal endite of the maxilliped bears two strong distal setae (versus three in *G. mauryi*); the mandibular palp has two E-setae and two D-setae (versus three E-setae and three D-setae); and the basis of pereopod 3–4 is slightly widened and the telson is distally emarginated (versus convex).

The structure of the male pleopod 2 and uropod 1 are diagnostic in the differentiation of both species of *Patagongidiella*. The special seta present on the second article of the exopodite of pleopod 2 is laterally inserted and laterodorsally directed in *P. wefkoi* **n. sp.**, in contrast to its normally inserted, distally directed position in *P. danieli*.

Moreover, the peduncular hypertrophied facial seta on male uropod 1 of both species differs in general structure and ornamentation. In *P. wefkoi* **n. sp.** the distal third of this seta is flattened and coiled, and is lined only with straight setules. In *P. danieli* the facial seta is not coiled and has an anteriorly directed bifid spike, whereas its ornamentation includes two types of setules arranged in two groups, one comprises smaller and more slender setules conforming a subdistal crown, whereas the setules of the second group are stronger and are associated to the spike.

The presence of *Patagongidiella* in southern Chile could give some clues on the origin of the genus. The Andean Cordillera represents an important barrier for the establishment of groundwater connections, because the impermeability of consolidated rock beds, high volcanism activity and gravity-driven divergent flows originating

from the high elevations (Gleeson & Manning 2008). All this factors could have contributed to the isolation of eastern and western populations of *Patagongidiella*, and in accord with the geologic history of the Southern Andean Cordillera this process could have begun shortly before the principal uplift of the mountain system, which is estimated to have occurred between 14 and 10 million years ago (Thomson *et al*. 2001; Adriasola *et al*. 2006).

Patagongidiella wefkoi **n. sp.** is the first bogidiellid described from Chile; however, it is highly probable that there are several additional species waiting to be discovered in the country, which certainly could provide better insights on the role of the Andean cordillera in the evolution of South American Bogidiellid fauna.

Acknowledgements

The author is very grateful to John Holsinger and specially to Damià Jaume for their valuable comments and advise on the manuscript. Thanks also to Gabriel Ojeda for his help during collecting in the springs of Pichidamas, to Constantino Mpodozis for his valuable comments and literature about the geologic history of southern Andean Cordillera, and to David Núñez, for the correct specific name for the new species. To Jorge Artigas and Elvira Solar, for responding to my request for deposit type material in the collection of the Zoological Museum of Universidad de Concepción. This is the publication N° 2 of the "Departamento de Sistemática Animal" of the Centro de Estudios en Biodiversidad (CEBCh).

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