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MORPHOLOGICAL COMPARISON OF *MESOCYCLOPS ARAUCANUS* CAMPOS ET AL., 1974, AND *M. LONGISETUS* THIÉBAUD, 1912, AND FIRST DESCRIPTION OF THEIR MALES

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ABSTRACT

Originally described by Löffler in 1962 as a variety of *Mesocyclops longisetus*, *M. araucanus* was found to have autapomorphies of its own to deserve specific rank. For a long time the identification of these two species were mixed up. Here, *M. araucanus* female is redescribed and the male described for the first time. A comparison is made with *M. longisetus*, whose male is also described for the first time. Detailed comparison between these two species shows that the following traits on specimens of both sexes can be used to separate the species: length/width ratio of caudal rami, ratio of terminal caudal setae, and length/width ratio of last segment of endopod of leg 4. Additional diagnostic characters for each sex are given. The geographic distributions of these two species do not overlap.

Key words: Copepoda, Cyclopoida, *Mesocyclops*, South America, morphology

INTRODUCTION

The taxon described by Löffler (1962) as *Mesocyclops longisetus* var. *araucanus* was first considered a subspecies by Campos et al. (1974) and later by Dussart & Defaye (1985), and Dussart (1987). Menu-Marque (1994) indicated that it showed enough autapomorphies to justify its elevation to specific rank, but mistakenly preserved the original authorship and date. This species was misnamed in many occasions, and confused with *M. longisetus* (Thiébaud, 1914), mainly in Chile (Menu-Marque, 1994). Thus a detailed and illustrated comparison between both species is needed. The female of *M. araucanus* is here redescribed and the male described for the first time upon material from Argentina and Chile.

The descriptions of *M. longisetus* found in the literature (Thiébaud, 1914; Kiefer, 1929; Lowndes, 1934; Dussart, 1984; Reid & Reed, 1994) are all referred to females. We used the detailed description by Reid & Reed (1994) and material from Argentina and Uruguay to contrast its diagnostic characters with those of *M. araucanus* and describe the male of *M. longisetus* for the first time.

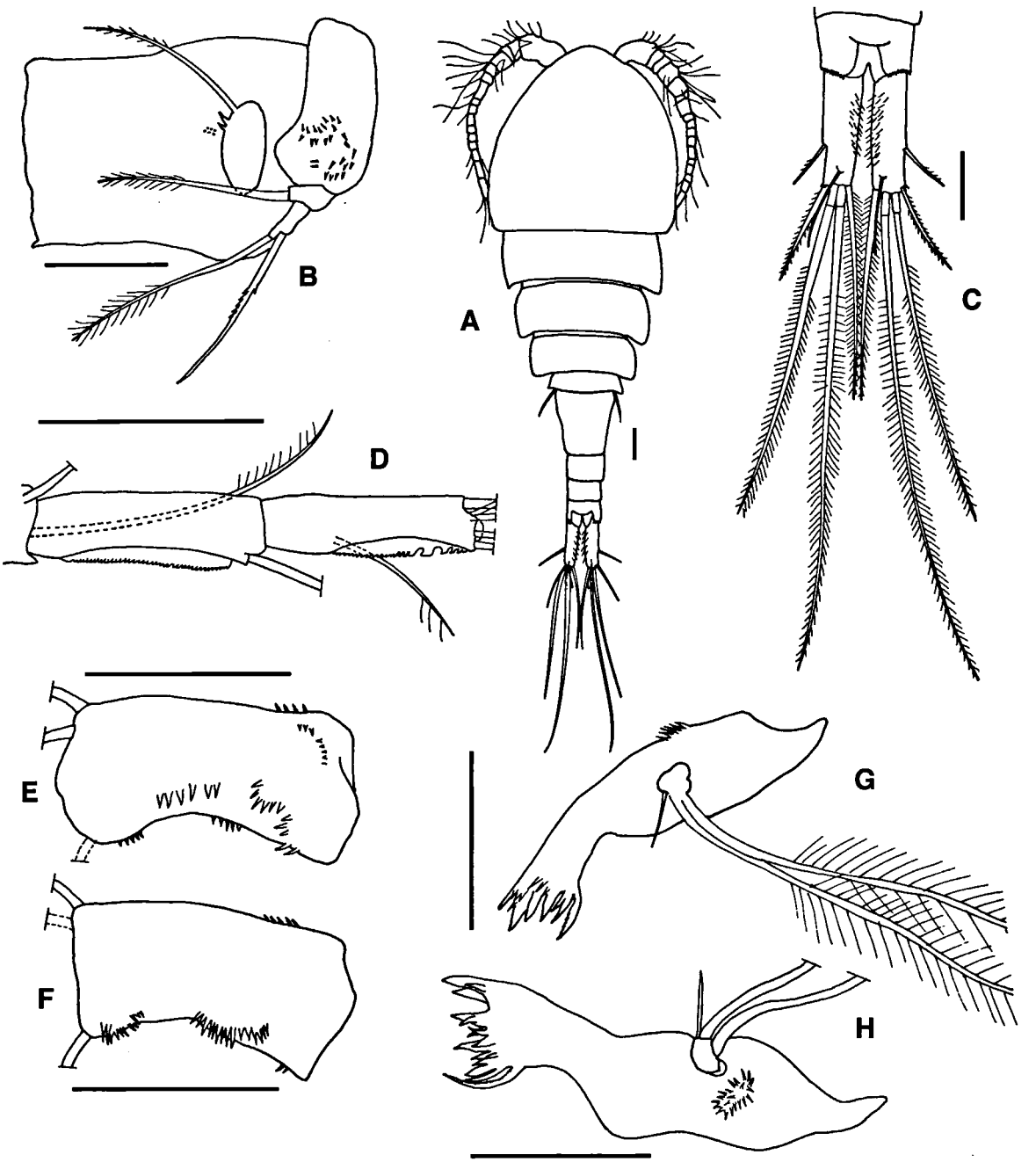

Fig. 1. *M. araucanus*, female. A, habitus, dorsal. B, pediger 5 and genital double-somite, lateral view. C, anal urosomite and caudal rami, dorsal view. D, antennule, segments 16 and 17. E, antenna, basal segment, caudal view. F, antenna, basal segment, frontal view. G, mandible, lateral view. H, mandible, ventral view (scale bars = 0.1 mm).

A comparison of the contrasting traits between the two species is made for both sexes.

MATERIALS AND METHODS

Argentinean specimens of *M. araucanus* were obtained from Laguna Esquel (42°53'S 71°04'W, 10-III-1984) and Lago Chultas (42°10'S 71°44'W, 30-III-1983 and 14-XII-1984), Chubut. Chilean specimens come from Lago Tarahuin (42°42'S 73°37'W, 7-I-2001), Lago Ranco (40°19'S 72°14'W, 18-XII-2000), Lago

Todos los Santos (41°08'S 72°24'W, 20-XII-2000), and Lago Llanquihue (44°12'S 72°32'W, 20-XII-2000). The last three are localities from which Löffler (1962) had obtained material. Specimens of *M. longisetus* came from Laguna El Tigre, Santa Fe (31°41'S 60°40'W, February 1988), Estanque Ciudad Universitaria, Horco Molle, Tucumán (26°47'S 65°20' W, 29-II-1976), charca La Aguadita, Tucumán (26°46'S 65° 09'W, 22-V-1974), Embalse Cabra Corral, Salta (25°18'S 65°24'W, 15-VIII-1977), Embalse Salto Grande, Entre Ríos (31°14'S 57°56'W, November, 1983), all in Argentina. Uruguayan specimens of *M. longisetus* were obtained from Arroyo Pereira (34°29'S 56°52'W, 30-I-2002). All specimens are formalin preserved.

Polyvinil lactophenol slides of dissections of *M. longisetus* and *M. araucanus* were deposited at Colección de Invertebrados, Museo Argentino de Ciencias Naturales Bernardino Rivadavia (MACN). Voucher whole specimens fixed and preserved in 10% formalin, belonging to both species, were deposited in the above mentioned museum and in the Zoological Museum Amsterdam (ZMA), University of Amsterdam.

Specimens were obtained with conical plankton nets of different mesh sizes and fixed in the field with formalin. Previous to observations, adult specimens were treated with lactic acid to clear nonchitinous tissues. Occasionally chlorazol black E was added to increase contrast. Measurements were done in a depression slide on organisms in a glycerine-5% formalin mixture. Drawings were made using a drawing tube attached to a Olympus BH2 microscope.

Abbreviations used in the text are: s = seta; sp = spine; ae = aesthetasc; ce = cylindrical element.

TAXONOMIC PART

Mesocyclops araucanus Campos, Bucarey & Arenas, 1974
Figs. 1, 2, 3A-F

MATERIAL. - Twelve females (MACN 34946) and 9 males (MACN 34947), 1 dissected male in 5 slides (MACN 34950), 2 dissected females in 2 slides (MACN 34995), 2 dissected males in 4 slides (MACN 34996), 6 females and 4 males (ZMA Co. 204.512), 8 females and 12 males (ZMA Co. 204.513), from Lago Chultas, Chubut, Argentina; 8 females (MACN 34994), 8 females and 6 males (ZMA Co. 204.516) from Laguna Esquel, Chubut, Argentina; 10 females and 2 males (MACN 34997), 6 females and 3 males (ZMA Co. 204.515) from Laguna Tarahuin, Chile; 2 males (MACN 34998) and 2 males (ZMA Co. 204.510) from Lago Ranco, Chile; 3 females and 1 male (MACN 34999) and 2 females (ZMA Co. 204.511) from Lago Llanquihue, Chile; 6 females and 3 males (MACN 35000) and 3 females and 3 males (ZMA Co. 204.514) from Lago Todos los Santos, Chile.

REDESCRIPTION OF THE FEMALE. - A small sized *Mesocyclops* (Fig. 1A), length ranging from 1.1 to 1.6 mm. Pediger 5 ornamented laterally with spinules, more numerous and stouter than the setules in *M. longisetus*. Genital double-somite with group of small circular pores posterior to leg 6 plate, arranged in two rows (Fig. 1B). Anal urosomite with row of spines on distal margin not only on ventral side but also ascending along the flanks (Fig. 1C). Caudal rami (Fig. 1C) 3.8 times longer than broad (range = 3.5-4.2); hairs on medial face of caudal rami ascending dorsally, more dense than in *M. longisetus*; two small spines at the base of each lateralmost terminal caudal setae. Setulation of caudal setae heteronomous, lengths as in Fig. 1C; longest caudal seta 4 times (3.7-4.37) length of caudal rami.

Antennule slightly shorter than in *M. longisetus*, but with the same armature formula: 8s, 4s, 2s, 6s, 4s, 1s + 1sp, 2s, 1s, 1s, 0, 1s, 1s + 1ae, 0, 1s, 2s, 2s +1ae, 7s + 1ae. Main structural difference consisting in the shape of the hyaline membrane of article 17 (Fig. 1D) which shows two big notches instead of one. This membrane does not extend over the entire length of the segment but just reaches the insertion place of the lateral seta. An arch of spinules is observed on the proximal third of the first segment (Fig. 3C), as in *M. longisetus*. All segments lack transversal rows of shallow pits, also common in *M. longisetus*.

Basipodite of the antenna with the same number of spine rows as in *M. longisetus*. Mandible (Figs. 1G and 1H) coxopodite with a group of strong spines proximal to the palp. Maxilliped (Fig. 2A) with the three curved rows of spines on article 2 stouter than in *M. longisetus*, and an additional patch of spines present on article 3; longest spine on the distal segment bearing a 'saw' of big teeth.

Leg 1 (Fig. 2B) with strong spine on distal inner expansion of basipodite, with stiff heteronomous setules, similar to those of *M. venezolanus* Dussart,

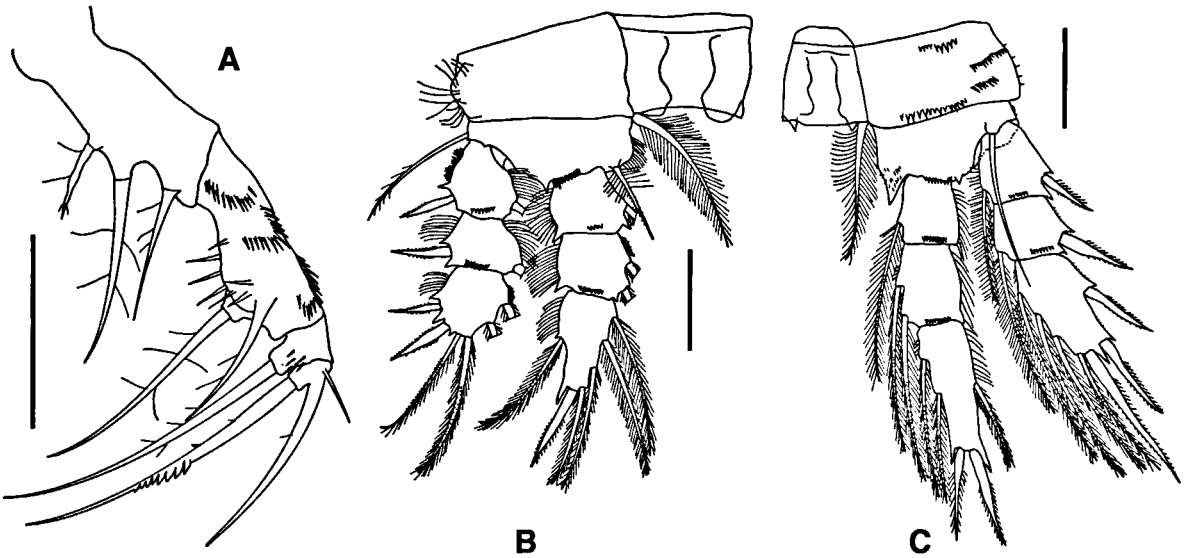

Fig. 2. *M. araucanus*, female. A, maxilliped. B, first leg. C, fourth leg (scale bars = 0.1 mm).

1987. Legs 2 and 3 fairly similar to those of *M. longisetus*. Leg 4 posterior surface of coxopodite (Fig. 2C) with similar spine pattern as in *M. longisetus*, but different size proportions; no hairs present on the posterior surface of exopodite segments; article 3 of endopodite more slender than in *M. longisetus*, length/width 3.5 (3.3-3.8), bases of its terminal spines separate, inner spine shorter and slimmer than external spine. Leg 5 (Fig. 1B) with spine proportionally longer than in *M. longisetus*. Leg 6 consists on an oval flap with two tiny spines and sparsely plumose seta, which barely reaches the end of the genital double-somite.

DESCRIPTION OF MALE. - Size range overlapping that of females: 0.95-1.2 mm (Fig. 3A). Only dimorphic traits are described. Caudal rami proportionally shorter than in female, length/width 3.27 (3.13-3.38). Lateral seta of caudal rami with several (up to four) small spines at its base on the ventral side (Fig. 3B). Antennule (Fig. 3C) with last two segments partially fused; armature formula: 8s + 3ae, 4s, 2s, 2s + 1ae, 2s, 2s, 2s, 2s, 1s +1sp +1ae, 2s, 2s, 2s, 2s + 1ae, 2s + 1ae, 1s +1ae + 1ce, 5s, 7s +1ae. Arch of spinules in first segment, similar to that of the female. Segment 15 with two short transversal rows of uneven spinules in its basal third (Fig. 3D) only visible after long storage in lactic acid. Two striated, plate-like structures on segment 15 and one on segment 14. Antenna similar to that of the female, except for the basalmost patch of spinules on the caudal side of the first segment which is missing. (Fig. 3E).

Fifth leg with seta of basal segment 1.2 times longer than terminal spine of distal segment. Leg 6 with ventral spine reaching 2/3 of urosomite 3, middle seta reaching urosomite 4, and very long dorsal seta extending halfway anal urosomite (Fig. 3F).

Mesocyclops longisetus Thiébaud, 1914
Figs. 3G-J

MATERIAL. - One female (MACN 34948), and 1 dissected male in 4 slides (MACN 34949), Estanque Ciudad Universitaria, Horco Molle, Tucumán, Argentina; 1 dissected female in 2 slides (MACN 35001) and 3 females (MACN 35002), from charca La Aguadita, Tucumán, Argentina; 1 female (MACN 35003) from Laguna El Tigre, Santa Fe, Argentina; 8 females (MACN 35004), 3 dissected females in 6 slides (MACN 35005) and 8 females (ZMA Co. 204.509) from Arroyo Pereira, Uruguay. Earlier dissected material from Embalse Cabra Corral, Salta, Argentina and Embalse Salto Grande, Entre Ríos, Argentina, which had been observed and drawn in detail was unfortunartely lost on account of improper mounting in glycerine non-permanent slides.

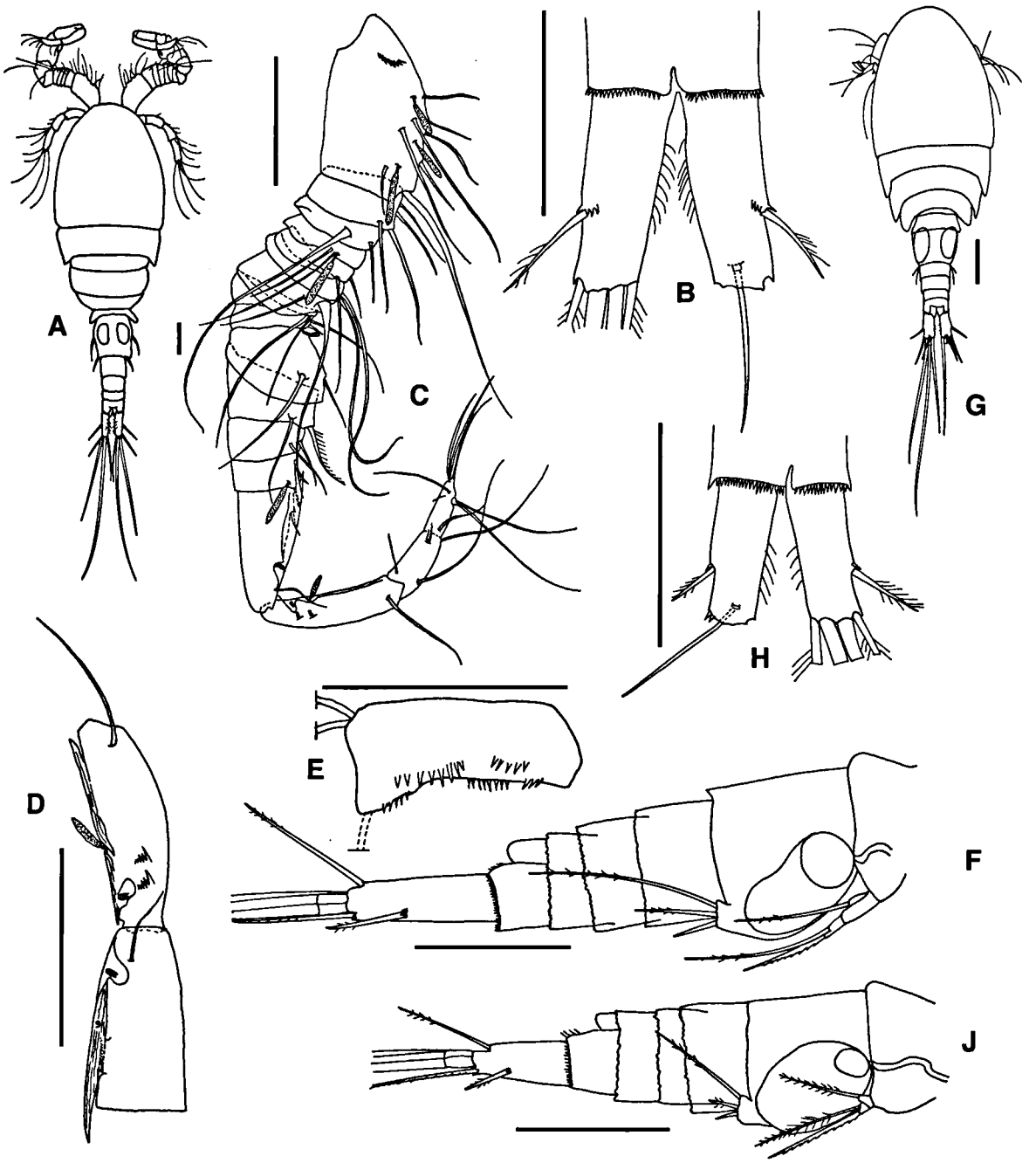

Fig. 3. *M. araucanus*, male. A, habitus, dorsal. B, caudal rami, ventral view. C, antennule. D, antennule, segments 14 and 15. E, antenna, basal segment, caudal view. F, urosome, lateral view. *M. longisetus*, male. G, habitus, dorsal. H, caudal rami, ventral view. J, urosome, lateral view (scale bars = 0.1 mm).

DESCRIPTION OF FEMALE. - Size range: 1.20-2.80 mm. All characters were found to be similar to the description of the same species found in Canada by Reid & Reed (1994) except for:

- Shape of patch of pores posterior to leg 6 very variable (V-shaped to oval); no South American material showed the circular pattern observed by Reid & Reed (1994).
- The patch of spinules distal to the palp in the mandible coxopodite is absent.

DESCRIPTION OF MALE. - Size range much small-

Table 1. Comparative data for females and males of *M. araucanus* and *M. longisetus*.

Female	*M. longisetus*	*M. araucanus*
Total length (mm)	1.20-2.80 (n=38)	1.02-1.60 (n=60)
Length/width of caudal rami	3.06 (2.80-3.27)	3.79 (3.50-4.20)
Row of spines on distal margin of anal urosomite	only on ventral side	also ascending dorsally
Hairs on medial face of caudal rami	along medial margin	extending also dorsally
Base of lateralmost terminal caudal seta	without spines	with two minute spines
Setulation of caudal setae	almost homonomous	heteronomous
Ratio of terminal caudal setae (inner to outer)	3.4 : 6.9 : 5.1 : 1	2.3 : 5.3 : 3.7 : 1
Hyaline membrane on last segment of antennule	with one big notch	with two deep notches
Longest spine on distal article of maxilliped	finely serrate	with 'saw' of big teeth
Spine on medial expansion of leg 1 basipodite	slender, finely denticulate	strong with stiff hairs (as in *M. venezolanus*)
Posterior surface of leg 4 exopodite segments	with hairs	without hairs
Length/width of leg 4 endopodite 3	2.52 (2.00-2.80)	3.48 (3.30-3.80)
Bases of terminal spines of leg 4 endopodite 3	together	separate
Outer terminal spine of leg 4 endopodite 3	as stout as inner spine	much stouter than inner spine
Male	***M. longisetus***	***M. araucanus***
Total length (mm)	0.70-0.97 (n=10)	0.80-1.20 (n=50)
Length/width of caudal rami	2.93 (2.84-3.06)	3.27 (3.13-3.38)
Base of lateral caudal seta	with one small spine	with several small spines (4)
Ratio of terminal caudal setae	3.4 : 5.7 : 4.4 : 1	2.4 : 5.4 : 3.7 : 1
Length/width of leg 4 endopodite 3	2.94 (2.75-3.05)	3.21 (3.14-3.46)
Seta of basal segment/ spine distal segment ratio of leg 5	0.8	1.2
Long seta of leg 6	not reaching end of urosomite 4	reaching halfway anal urosomite

er than female (0.70-0.97 mm). The male of *M. longisetus* (Fig. 3G) differs from the female not only in certain classic dimorphic features such as size, length/width ratio of caudal rami, ratios of terminal caudal setae (Table 1), structure of antennule and genital double-somite (see Reid & Reed, 1994), but also in certain characters that are used as diagnostic in the female. These are: the row of spines along the posterior margin of the anal urosomite extends dorsally in the male while it is strictly ventral in the females (Fig. 3H); tiny spines are present at the bases of the lateral and the lateralmost terminal caudal setae which are absent in the female (Fig. 3J). Basal segment ornamentation of antenna as in *M. araucanus*. Leg 5 with seta of basal segment 0.8 times shorter than terminal spine of distal segment. Leg 6 with almost subequal spine and middle seta not reaching the end of urosomite 3, and dorsal seta barely surpassing the distal border of urosomite 4 (Fig. 3J).

DISCUSSION

The main features which led to the confusion between the two studied species are the shape of the seminal receptacle and the relatively long

inner terminal caudal setae. Particularly, the shape of the seminal receptacle does not seem to be a good diagnostic trait. At least, when Dussart (1987) described the variety *M. longisetus* var. *curvatus* he reviewed the information on seminal receptacles and assigned the misdetermined *M. araucanus* (Thomasson, 1957) found in Lake Riñihue (Chile) to *M. longisetus*, which supports that this feature is of no use in separating certain species of South American *Mesocyclops*.

Detailed comparison between these two species (see Table 1) shows that the following characteristics on specimens of both sexes can be used to separate the species: length/width ratio of caudal rami, ratio of terminal caudal setae, and length/width ratio of last segment of endopod of leg 4. Additionally, females can be easily separated mainly by the serrulation of the hyaline membrane on distalmost segment of antennule, hair distribution on inner side of caudal rami, setulation of caudal setae, and disposition of terminal spines in the endopodite 3 of leg 4. On the other hand, though *M. longisetus* is more dimorphic in size than *M. araucanus*, their total length can be also used to separate males of both species. Seta of basal segment/spine distal segment ratio of leg 5, and the relative length of the seta of leg 6 are also useful discriminatory characteristics.

The distributions of these two species do not overlap. The southernmost locality for *M. longisetus* is at 35°42'S (Ringuelet, 1958). It extends northward along the American continent up to southern USA, with an exceptional record from 68°56'N (Reid & Reed, 1994) in Canada. *M. araucanus* is found in Patagonian lakes of Argentina and Chile. On the Argentinean side it has a confirmed distribution between 39°36'S and 44°19'S (Menu-Marque, 2000). On the Chilean side, it extends at least from 37°55'S to 51°35'S (Soto & Zúñiga, 1991).

No *Mesocyclops* are found in Tierra del Fuego. A mislocation of Lake Llanquihue by Reid (1985) has begun to propagate through the literature the probable presence of *M. araucanus* in this island (Sendacz, 1993).

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