

## First record of the genus *Cyclopina* (Copepoda: Cyclopoida), and fully illustrated redescription of *Cyclopina caissara* from northwestern Mexico

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**Resumen.** Especímenes del género *Cyclopina* Claus 1863 fueron colectados durante el desarrollo de un proyecto de investigación en el sistema Urías (sur de Sinaloa, México). Análisis preliminares indicaron gran semejanza entre estos especímenes de *Cyclopina* y *C. caissara* Lotufo 1994, y debido a la distribución conocida de esta última especie (registrada sólo en São Sebastião, Brasil, su localidad tipo), se pensó que era probable que los especímenes del sistema Urías representaran una nueva especie. Sin embargo, después de realizar análisis y comparaciones detalladas del material tipo de *C. caissara* y los especímenes mexicanos, no se observaron diferencias significativas que justificaran la descripción de una nueva especie. Este trabajo constituye el primer registro del género para sistemas costeros mexicanos, y el hallazgo de *C. caissara* en la boca del Golfo de California representa una extensión de su distribución desde Brasil hasta el Pacífico Oriental Subtropical. Se presentan también algunas correcciones a la descripción original de la especie.

Palabras clave: Copepoda, Cyclopoida, *Cyclopina*, México.

**Abstract.** Specimens of *Cyclopina* Claus 1863, were collected during a short term study in the Urías system (southern Sinaloa, NW Mexico). Preliminary observations indicated similarity with *C. caissara* Lotufo 1994, only known from São Sebastião, Brazil, its type locality. The newly found *Cyclopina* specimens were thought to belong to a new species. After thorough examination and comparison with type material of *C. caissara*, no significant differences were found as to justify the establishment of a new species. This is the first record of the genus from Mexican localities and the finding of *C. caissara* in the mouth of the Gulf of California represents a range extension of the species from Brazil to the sub-

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tropical eastern Pacific. Some amendments to the original description regarding the spinular ornamentation are given.

**Key words:** Copepoda, Cyclopoida, *Cyclopina*, Mexico.

## Introduction

In the original description of *Cyclopina caissara* Lotufo 1994 from Segredo Beach (São Sebastião, State of São Paulo, Brazil), the species is separated from all other congeners by a set of characters such as the number of antennular segments, armature formula of the antennary exopod, armature formula of the maxillular epipodite, shape of the setae on the maxillary exopod, number of segments of the maxillipedal endopod and armature formula of the second endopodal segment of maxilliped, length/width ratio of caudal ramus, ornamentation of the endopodal setae of P4, and armature formula of male P5 exopod. According to Lotufo (1994), *C. caissara*, *C. americana* Herbst 1982 (known from Beaufort, North Carolina, U. S. A.), and *C. esilis* Brian 1938 (known from Mallorca) are united by the synapomorphic reduced inner (not outer as in Lotufo 1994: 154) exopodal spine of female P5, being 6 and 2.5 times shorter than the outer spine both in males and females of *C. caissara*, and *C. americana* and *C. esilis*, respectively. Also, according to Lotufo (1994) *C. caissara* seems to be more closely related to *C. esilis* given the presence of two inner setae on the male P5 exopod. However, since these setae are also present in the male of *C. kieferi* Schäfer 1936 (the female P5 of *C. kieferi* lacks the reduced inner spine), it is here considered as a symplesiomorphy.

Three specimens of *Cyclopina* Claus 1863, were collected during a short term study on the effects of organic enrichment on the abundance and diversity of benthic copepods from a heavily polluted brackish system in southern Sinaloa, northwestern Mexico. These *Cyclopina* specimens fitted the description of *C. caissara* by Lotufo 1994, and given the known distribution of the latter (reported only from São Sebastião, Brazil, its type locality), the newly found *Cyclopina* specimens were thought to belong to a new species. After thorough examination and comparison of the paratypes (MZUSP 11.533, not 11492 as in Lotufo 1994: 154) and female holotype (MZUSP 11.491) of *C. caissara* (deposited in the Museu de Zoologia of the Universidade de São Paulo) with the Mexican representatives of the genus, no significant differences were found as to justify the establishment of a new species. This is the first record of the genus from Mexican localities and the finding of *C. caissara* in northwestern Mexico represents a range extension from São Sebastião (Brazil) to Mazatlán (Sinaloa, in northwestern Mexico). Considering the wide distribution of the species, we considered useful to present a full redescription of the species based on the Mexican specimens. Also, some amendments to the original description of the species regarding the spinular ornamentation are given.

## Methods

Quantitative triplicate sediment cores were taken for the analysis of abundance and diversity of benthic copepods from the Urías system (northwestern Mexico). Meiofauna samples were fixed with 10% formalin and sieved through 500 and 63  $\mu\text{m}$  sieves to separate macro- and meiofauna. Material retained in the 63  $\mu\text{m}$  sieve was preserved in 70% ethanol. Copepods were separated from the rest of the meiofauna using a stereomicroscope at 40X. Specimens were stored in 70% ethanol prior to further investigation. Observations and drawings were made at 1000X using a Leica microscope equipped with phase contrast and drawing tube.

In order to verify the presence of possible differences between the Brazilian *C. caissara* and the Mexican specimens, the paratypes (MZUSP 11.533, not 11492 as in Lotufo 1994: 154) and female holotype (MZUSP 11.491) were borrowed from the Museu de Zoologia of the Universidade de São Paulo, and one female paratype was dissected with permission of Dr. Gustavo Augusto S. de Melo (curator of the Crustacea collection, Museu de Zoologia, Universidade de São Paulo). The Mexican specimens of *C. caissara* are deposited in the collection of the Mazatlan Marine Station of the Institute of Marine Sciences and Limnology (National Autonomous University of Mexico). The terminology proposed by Huys & Boxshall (1991) for the general description was adopted. Abbreviations used in the text, figures and tables: P1-P6, first to sixth swimming leg; EXP, exopod; ENP, endopod.

## Results

Family Cyclopinidae Sars 1913  
Genus *Cyclopina* Claus 1863  
*Cyclopina caissara* Lotufo 1994  
(Figs 1-7)

*Material examined*: Three females preserved in alcohol (EMUCOP-170801-19, EMUCOP090301-182), and one dissected female (EMUCOP-170801-16).

*Known distribution*. Mexico. Urías system, Mazatlán, Sinaloa, northwestern Mexico (23°11'06"N; 106°25'06"W) (present study); Brazil. Segredo beach, São Sebastião, São Paulo (Lotufo 1994).

*Redescription of the female*. Body length including caudal rami ranging from 645 to 765  $\mu\text{m}$  (mean, 708.3  $\mu\text{m}$ ,  $n = 4$ ). Without lateral expansions of the cephalothorax covering the first pedigerous somite, the latter free (Fig. 1A). Surface of cephalothorax, pedigerous somites and urosomites, smooth dorsally and ventrally, except for dorsolateral transverse spinular row close to P6; dorsally with plain hyaline fringe (Fig. 1A); urosomites with semi-incised hyaline fringe laterally and ventrally (Figs 1C, 2B). Surface of anal somite smooth dorsally and ventrally. Genital

double-somite longer than wide (width measured at the widest proximal part) (Figs 1A, C, 2B). Seminal receptacle in anterior half as shown in figure 2B. Caudal rami (Figs 1A, B, 2A, B) cylindrical, about 1.5 times longer than wide; without ornamentation dorsally (Fig. 1B) and with spinules at base of seta III, IV and V ventrally (Fig. 2A, B); with six setae; seta I absent; seta II arising laterally in median third; seta III slightly shorter than seta VI, both plumose; seta IV about twice as long as seta III, plumose along both margins and with few rigid spinules proximally on outer margin; seta V longest, about 1.3 times longer than seta IV, with few rigid spinules proximally and plumose distally along both margins; seta VII plumose, monoarticulated at its base, arising dorsally from a distinct protuberance close to posterior margin of caudal rami (Figs. 1A, B, 2A, B).

Antennule (Fig. 3A) 12-segmented. Third and sixth segment longest, the former about twice as long as wide, the latter about three times longer than wide. Division between ninth and tenth segments subtle (arrowed in Fig. 3A). Setal complement as follows: I(3), II(5), III(8), IV(3), V(6), VI(6+ae), VII(1+ae), VIII(1), IX(1), X(2); XI (2+ae), XII(7+ae).

Antenna (Fig. 3B). Coxo-basis with small spinules proximally and subdistally, with exopodal seta and a single abexopodal seta. Endopod three-segmented; endopodal segments with row of spinules along inner margin, with one, five and seven setae, respectively.

Mandible (Fig. 4A) with robust gnathobasis. Biting edge with six teeth (three of them bicuspidate), two spinulose elements and one smooth seta. Basis large, ornamented with some spinules at base of exopod, armed with one seta subdistally close to endopod. Exopod four-segmented, with setal complement 1, 1, 1, 2; exopodal segments without ornamentation. Endopod two-segmented, first segment with three setae and ornamented with setules (fragile spinules?) along inner margin, second segment with six setae and without ornamentation.

Maxillule (Figs 4B, 5A, B, C) with short praecoxal arthrite armed with ten setae/spines (Figs 4B, 5A). Coxal endite with one seta, and two (one long, one minute) epipodal setae. With two basal endites, proximal one with three, distal one with two setae. Exopod (Figs 4B, C) with four, endopod (Figs 4B, 5B) with seven setae.

Maxilla (Figs 4C, 5D-J) six-segmented. Precoxa separated from coxa by remnant of ancestral separation on one side only. Precoxa with two endites; proximal one with three long setae and one small element (Figs 4C, 5J); distal endite with one seta (Fig. 4C). Coxa with two endites ornamented with spinules distally; proximal endite with three (Figs 4C, 5I), distal endite (Figs 4C, 5H) with four elements. Basis produced into strong serrate claw with accompanying seta arising from claw and one long seta arising proximally (Figs 4C, 5G). First and second endopodal segment with three and two elements, respectively (Figs 5F, E). Third endopodal segment with four setae (Fig. 5D).

Maxilliped (Figs 4D, 5K-N) seven-segmented. Separation between precoxa and coxa present on one side only as integumental fold. Precoxa with two, coxa with

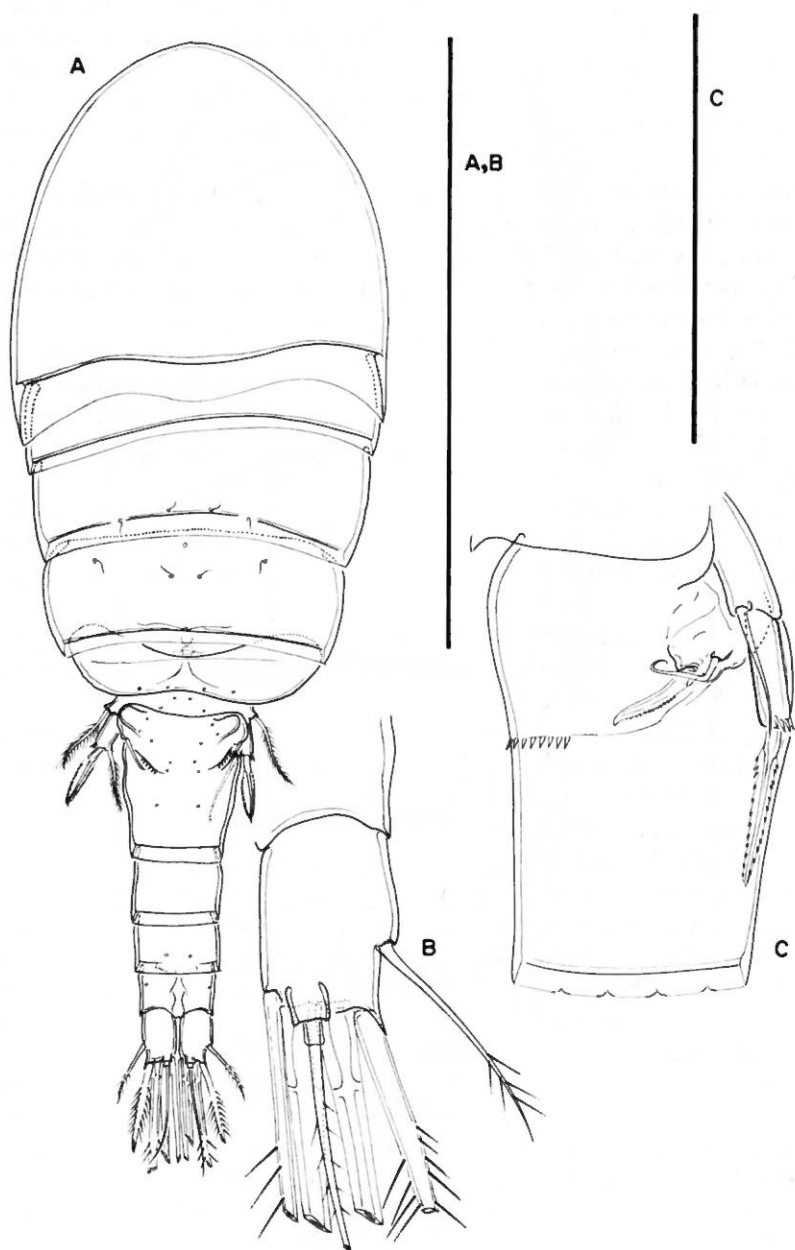


Fig. 1. *Cyclopina caissara* Lotufo 1994, female. A, habitus, dorsal; B, right caudal ramus, dorsal; C, genital double-somite, lateral. Scale bar: A, 400 $\mu$ m; B, 100 $\mu$ m; C, 100 $\mu$ m.

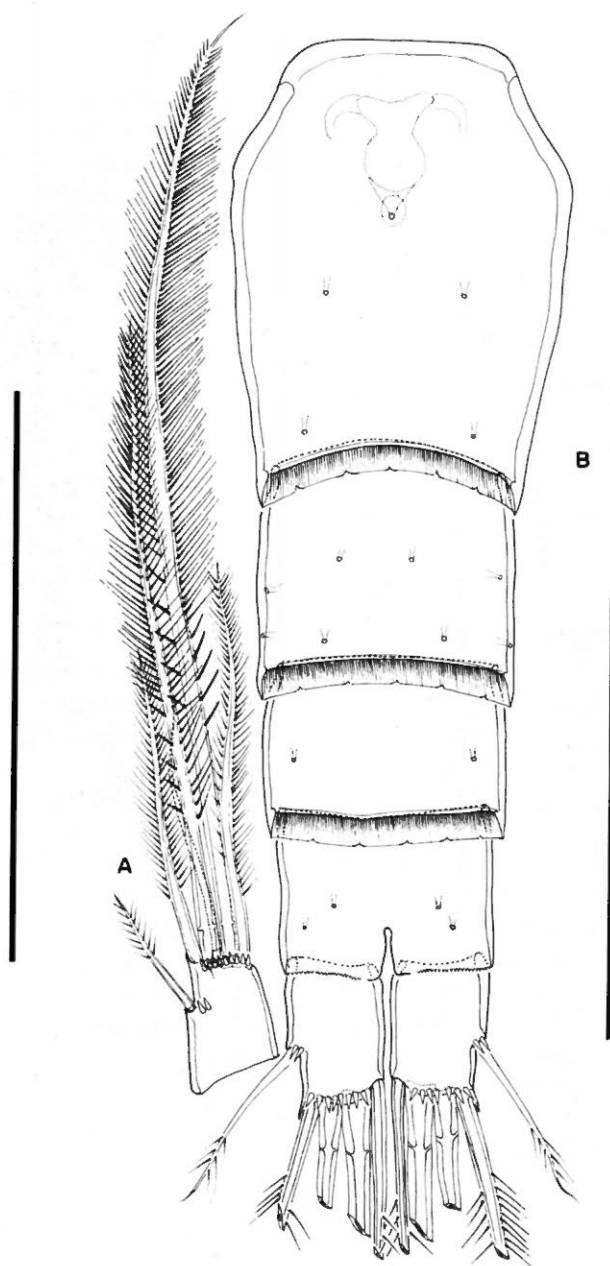


Fig. 2. *Cyclopina caissara* Lotufo 1994, female. A, right caudal ramus, ventral; B, urosome (P5-bearing somite omitted). Scale bar: A, 134 $\mu$ m; B, 100 $\mu$ m.

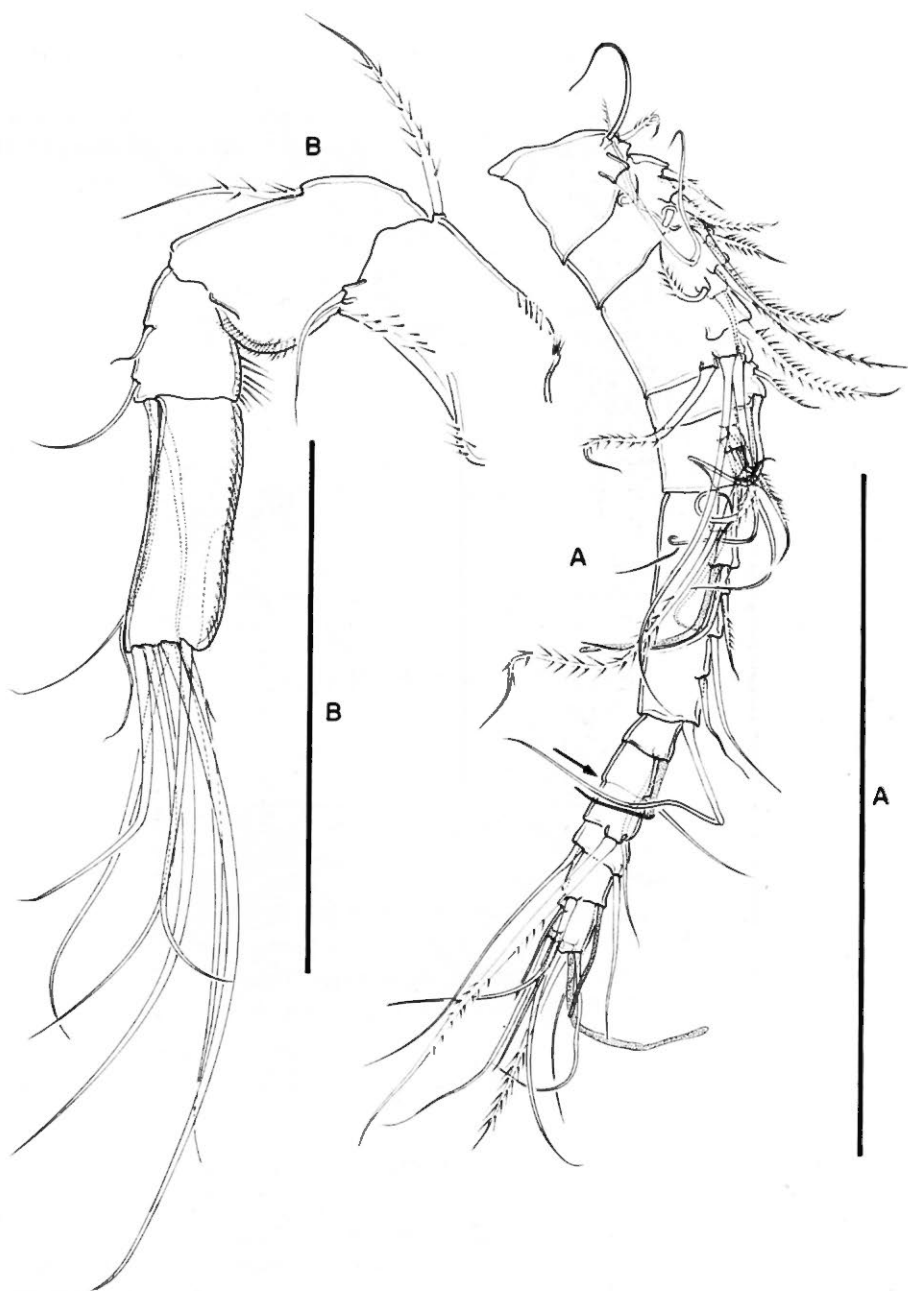


Fig. 3. *Cyclopina caissara* Lotufo 1994, female. A, antennule; B, antenna. Scale bar: A, 200 $\mu$ m; B, 100 $\mu$ m.



Fig. 4. *Cyclopina caissara* Lotufo 1994, female. A, mandible; B, maxillule; C, maxilla; D, maxilliped. Scale bar, 100 $\mu$ m.



one endite. Precoxal proximal endite (Fig. 4D) with one seta, distal endite (Figs. 4D, 5N) ornamented with set of minute spinules and two long and slender spinules, and armed with three elements. Coxal endite (Figs 4D, 5M) with some minute spinules and two long and slender spinules, armed with two elements. Basis (Figs 4D, 5L) with one endite bearing two setae, ornamented with small and long spinules along inner margin. Endopod (Figs 4D, 5K) four-segmented; first and second segment without armature, third segment with one seta, fourth segment with four elements.

P1-P4 (Figs. 6A-D, 7A-D) with distinct coxa and basis and three-segmented rami. Coxal seta of P1-P4 plumose. Inner basal spine of P1 serrate. Outer basal seta of P1-P4 plumose. Outer spines of exopodal segments of P1-P4 serrate and flagellate. Apical outer spine of P1 EXP 3 serrate along outer margin and plumose along inner margin, the same element of P2-P4 EXP 3 serrate on both margins. Apical inner seta of P1-P4 EXP 3 and all inner exopodal and endopodal setae plumose. Intercoxal sclerite of P1-P3 with transverse rows of minute spinules along caudal surface anteriorly (Fig. 7D) of P4 with coarser spinules on anterior and posterior surface (Fig. 7E). Armature formula as follows:

	Coax	Basis	EXP	ENP
P1	0-1	1-I	I-1;I-1;III,I,3	0-1;0-1;1,2,3
P2	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,2,3
P3	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,2,3
P4	0-1	1-0	I-1;I-1;II,I,4	0-1;0-2;1,2,2

P5 (Fig. 7C) with fused coxa and basis bearing one outer bipinnate seta distally, and ornamented with medial spinules along inner margin. Exopod one-segmented, ornamented with transverse row of medial spinules close to inner margin and distally close to insertion of apical setae; armed with one dwarfed inner spine, one bipinnate and one serrate seta, the latter about 6.5 times longer than inner dwarfed spine.

P6 (Fig. 1C) located laterally, with one serrate spine and one slender setae.

## Discussion

Although they are less abundant than harpacticoid copepods, cyclopinid copepods are common representatives of shallow water benthic communities. Despite their relative importance in benthic systems, the study of marine free living Cyclopoida has been often neglected due to the lack of specialists. *Cyclopina* is characterized by the presence of 12 to 10-segmented female antennule, whose 6<sup>th</sup>

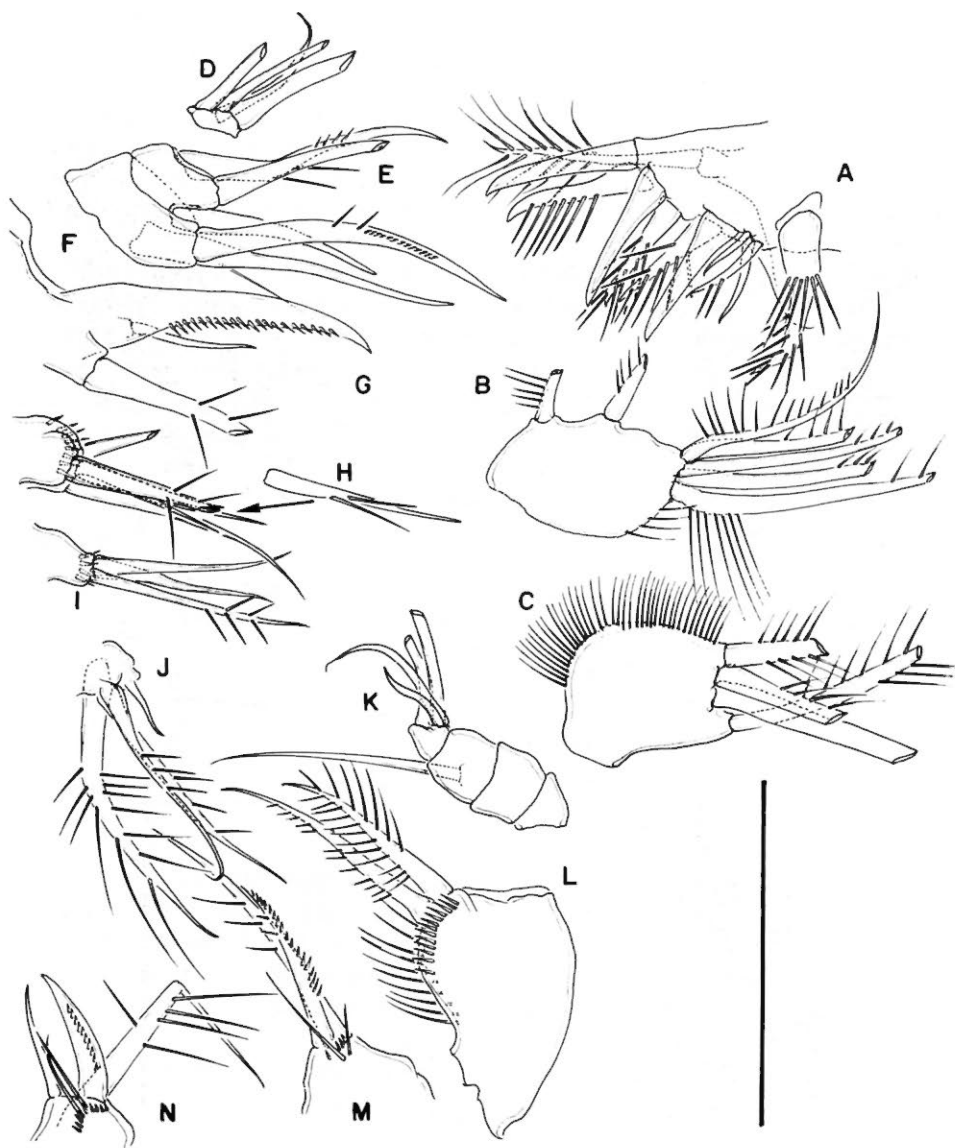


Fig. 5. *Cyclopina caissara* Lotufo 1994, female. A, distal part of praecoxal arthrite of maxillule; B, endopod of maxillule; C, exopod of maxillule; D, third endopodal segment of maxilla; E, second endopodal segment of maxilla; F, first endopodal segment of maxilla; G, basis of maxilla; H, distal endite of coxa of maxilla; I, proximal endite of coxa of maxilla; J, proximal endite of praecoxa of maxilla; K, endopod of maxilliped; L, basis of maxilliped; M, coxal endite of maxilliped; N, distal endite of praecoxa of maxilliped. Scale bar, 50  $\mu$ m.

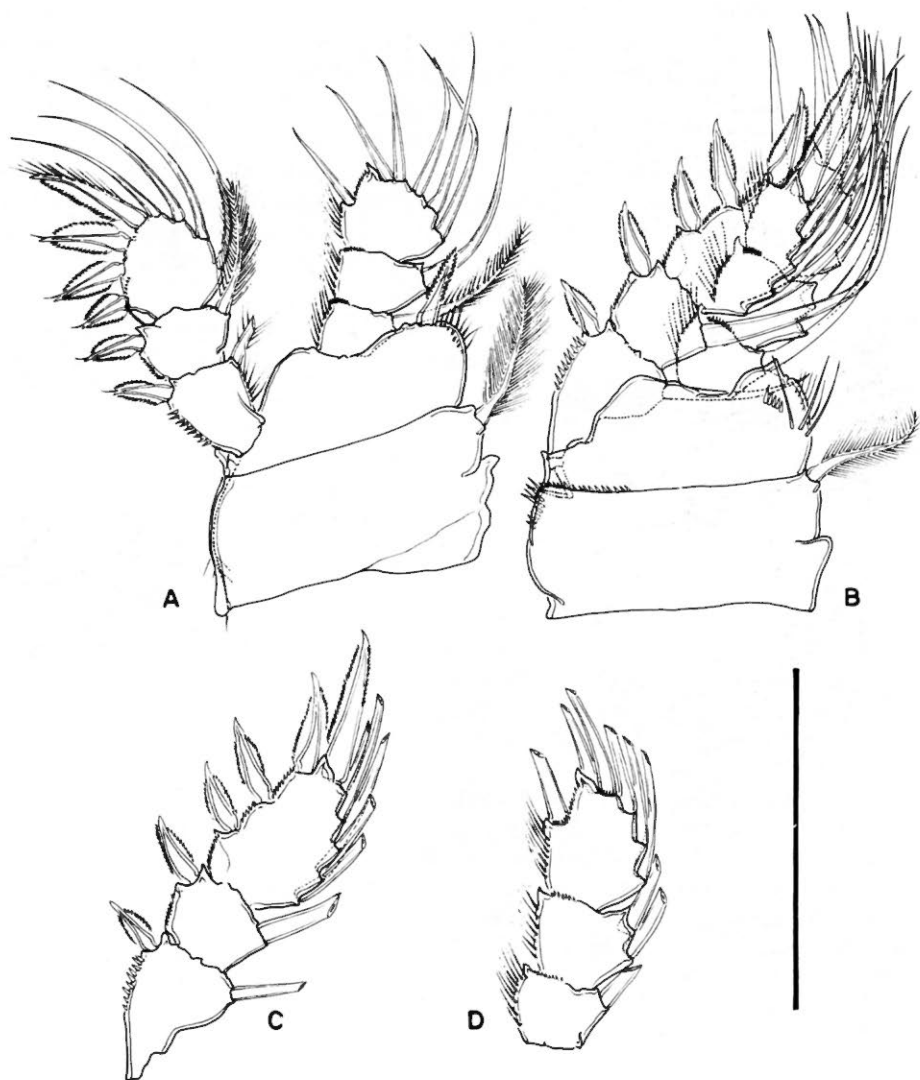


Fig. 6. *Cyclopina caissara* Lotufo 1994, female. A, P1; B, P2; C, P2 EXP; D, P2 ENP. Scale bar, 100 $\mu$ m.

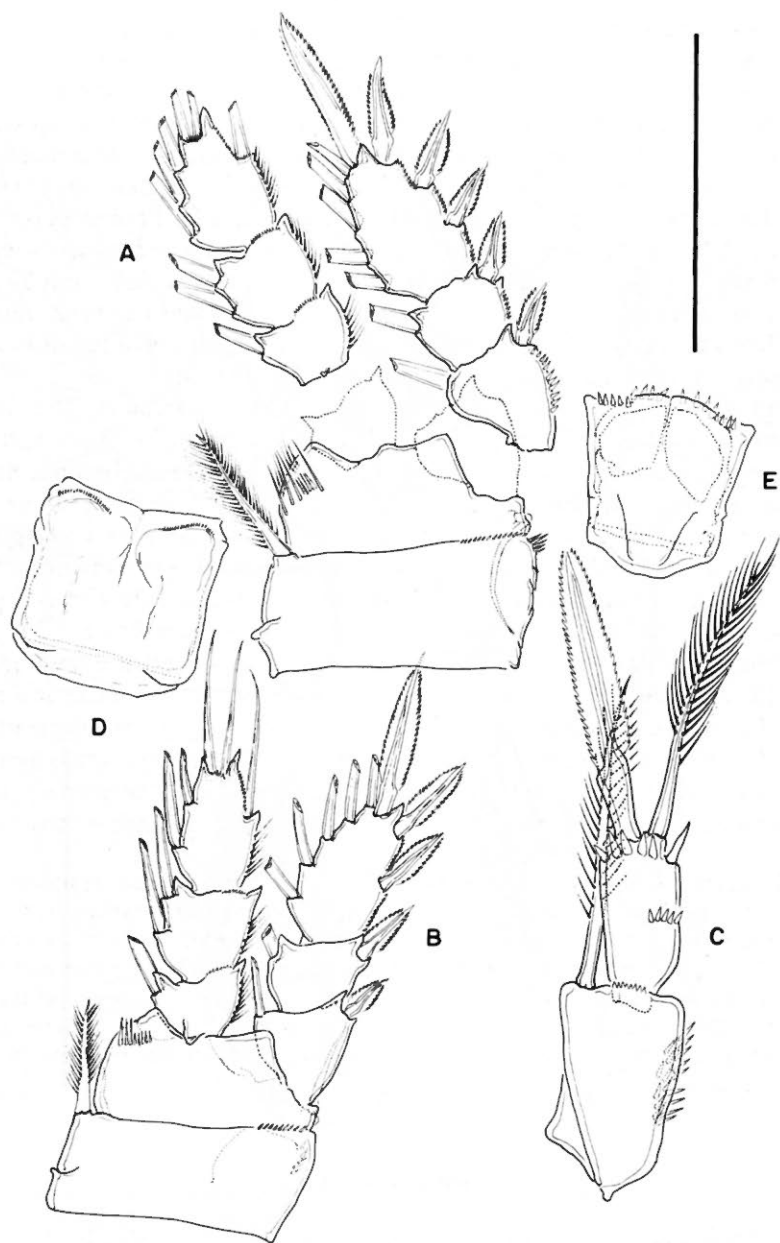


Fig. 7. *Cyclopina caissara* Lotufo 1994, female. A, P3; B, P4; C, P5; D, intercoxal sclerite of P2; E, intercoxal sclerite of P4. Scale bar: A-B, 100µm; C, 50µm; D-E, 71µm.

segment is typically the longest. This compound segment is homologous to the segments XV-XX of an hypothetical 28-segmented copepod antennule. This cluster originates through lack of division during copepodite development resulting in this truncated pattern (Grainger & Mohammed 1991). A second apomorphic character of *Cyclopina* is the presence of only three elements in the female P5, *i. e.* a terminal seta flanked by two spines. In addition, the outermost seta on the 4<sup>th</sup> mandibular exopodal segment displays a characteristic tuft of spinules terminally, and the caudal rami do not possess seta I. A trend towards a reduction of segments and armature of appendages can be recognized in the genus. Although 37 species have been recognized in *Cyclopina*, phylogenetic analyses have not been performed so far. Therefore our conclusions on the phylogenetic relationships of *C. caissara* and supposed related species must be considered preliminary.

The genus is here reported for the first time in Mexican waters. The find of *C. caissara* in the subtropical eastern Pacific is an unexpected discovery and constitutes a long-distance range extension of the species from São Sebastião, Brazil, to Mazatlán (northwestern Mexico). Even though the occurrence of the same species in the Atlantic and Pacific coasts of America seems to be common among benthic copepods (Gómez 2000, 2003), the means by which such relatively immobile organisms achieved their present distribution remain obscure. It has been suggested earlier that Western Atlantic species could have colonized the Eastern Pacific during the Early Tertiary (see Gómez 2003 and references cited therein). However, one would expect some degree of differentiation and therefore, some other means of passive dispersal should be taken into account, mainly passive transport in ballast water of ships (see Gómez 2003 and references cited therein). Such hypotheses are still speculative and extensive research is required on this subject to better understand the present distribution of relatively immobile marine metazoans.

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