

THE AFRO-ASIAN *MESOCYCLOPS ASPERICORNIS* (DADAY)  
(COPEPODA, CYCLOPIDAE) IN MEXICO:  
COMMENTS ON MORPHOLOGY AND DISTRIBUTION

BY

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ABSTRACT

The known distribution of *Mesocyclops aspericornis* in the Americas included the central and northern areas of South America and the insular Caribbean. It had not been collected before in continental North America. The analysis of samples collected in a pond in the state of Sinaloa, on the Pacific coast of Mexico, yielded female individuals of this species. The Mexican individuals tended to be smaller than the African females (1.14-1.20 mm vs 1.3-1.5 mm), but the morphology of the Mexican specimens is identical in most characters to that described or depicted in previous works. This is the first morphological study of this species aided with SEM; it includes detailed data on several microstructures, some of which undescribed previously. It also is the first report of its effective occurrence in Mexico. All previous records of this species in the Americas are related to the Atlantic coasts. This record, in the Mexican Pacific area, suggests that this supposedly introduced Afro-Asian species had an alternative route of dispersion from the Pacific coast. This is also the second documented record of an introduced freshwater copepod in Mexico.

RESUMEN

La distribución conocida de *Mesocyclops aspericornis* en el continente americano incluía las áreas sur y central de América del Sur y del Caribe insular. No había sido recolectada antes en América del Norte. El análisis de muestras recolectadas en un estanque en el estado de Sinaloa, costa pacífica de México, produjo la identificación de hembras de esta especie. Las hembras recolectadas en México tienden a ser de menor talla que las africanas (1.14-1.20 mm vs 1.3-1.5 mm); sin embargo, la morfología de los especímenes mexicanos es idéntica en prácticamente todos los caracteres a las descripciones previas. Este es, sin embargo, el primer estudio morfológico auxiliado por microscopía electrónica de barrido (MEB); incluye datos detallados sobre varias microestructuras, algunas previamente indescritas. Este es el primer registro efectivo de la presencia de esta especie en México;

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todos los registros anteriores estaban relacionados con las costas del Océano Atlántico. Este registro en el área del Pacífico Mexicano sugiere que esta especie Afro-asiática supuestamente introducida tuvo una vía alternativa de dispersión a partir de la costa del Pacífico Tropical Oriental. Este es, además, el segundo registro documentado de una especie de copépodo dulceacuícola introducida en México.

## INTRODUCTION

The freshwater cyclopoid copepod *Mesocyclops aspericornis* (Von Daday, 1906) is a widespread pantropical species known mainly from Asia (India, China, Birma (= Myanmar), the Philippines, Java, Sumatra) and Africa (Ethiopia, Ghana, Zaire (= Congo), Sudan, Nigeria) (Dussart & Defaye, 1985; Van de Velde, 1984). In America, this species has been recorded from various Neotropical areas, including the insular Caribbean (Martinica, Guadeloupe, Aruba, Curaçao, Puerto Rico, Haiti, Turks and Caicos Islands, Virgin Islands, Jamaica, among others) and South America (Brazil, Colombia, Venezuela, Argentina) (see Pesce, 1985; Reid, 1990; Reid & Saunders, 1986; Rocha & Botelho, 1998). The study of its distribution is a relevant issue, since this species has been tested successfully as a biological control of mosquito larvae in the neotropics (Suárez et al., 1984; Marten et al., 1994).

Despite its wide distribution in the tropical areas, this species had not been recorded from continental North America (Williamson & Reid, 2001), including Mexico and Central America. A previous record listed by Suárez-Morales & Reid (1998) from Aguascalientes, central Mexico, is considered invalid (see Dodson & Silva-Briano, 1996; Silva-Briano, pers. obs.). The occurrence of this species in Mexico was also outlined by Suárez-Morales & Gutiérrez-Aguirre (2001) in a project report. From samples collected in a small reservoir in the state of Sinaloa, on the Pacific coast of Mexico, the occurrence of *Mesocyclops aspericornis* is now effectively reported herein. The Mexican specimens were examined using both light microscopy and SEM in order to provide complementary morphological data for the species.

## MATERIALS AND METHODS

Zooplankton samples were collected in a small reservoir ("bordo") located near km 90 of the highway Culiacán-Los Mochis, in Sinaloa, Mexico (25°17'N 107°47'W). Samples were collected on 20 November 1985 by Alejandro Maeda-Martínez and Hortencia Obregón-Barboza with the aid of a scoop net with a mesh size of 0.05 mm. The specimens were sorted from the entire sample and identified using the descriptions and keys of Van de Velde (1984) and Hołyńska (2000).

Some individuals were processed for SEM analysis and the remaining ones were preserved in 70% ethanol. Morphological observations were made under a standard microscope and SEM analysis was performed using a Topcon electron microscope (10-16kV). Line illustrations were made using a camera lucida.

## RESULTS AND DISCUSSION

Only female specimens of *Mesocyclops aspericornis* were collected in Sinaloa (Silva-Briano, pers. obs.), which were part of an isolated population. Males of this species were not found in the samples. This is not uncommon, as males of this species are not found often (see Reid & Saunders, 1986) and morphological data are still limited.

### Morphology

Some of the main morphological characters of the Mexican female specimens of *M. aspericornis* are presented in figs. 1-6; these include both line drawings and SEM photographs. The morphology of the specimens from Mexico agrees in general with the descriptions of Kiefer (1981), Van de Velde (1984), and Hołyńska (2000), even in the structure and ornamentation of the mouthparts (figs. 2B-D, 3A-D) and swimming legs (figs. 3E, 4A-C). The South American specimens, except the Brazilian material, lack the pits on the lateral surfaces of the genital somite which were depicted by Kiefer (1981) for African specimens (Reid & Saunders, 1986). As stated by Hołyńska (2000) for Asian specimens, SEM analysis confirmed that in the Mexican individuals the entire ventral and dorsal surfaces of the genital somite are pitted (figs. 1A, D, F, 5D), not only the lateral margins as described by Kiefer (1981) and Pesce (1985). Therefore, the Brazilian, Mexican, and Asian specimens differ in this character from the (remaining) South American specimens. We report here the presence of a large pore surrounded by an other five pores on the surface posterior of the plate of the sixth leg; this was evident only through SEM observation (see fig. 6A). This character remained previously unnoticed, its taxonomic value has not yet been explored.

The Mexican material shows some differences with respect to the African and Asian specimens (Kiefer, 1981; Van de Velde, 1984; Hołyńska, 2000). The Mexican females tended to be smaller than the African ones (1.14-1.20 mm vs 1.3-1.5 mm). In our specimens, the pitted antennular segments are 1, 4, 5, and 7-16, versus the 1-6, 14-16 pattern described by Kiefer (1981). This character was not described by Van de Velde (1984) or Hołyńska (2000). The spine-bearing segments (fig. 2A) and the hyaline membrane on the last segment (fig. 5A) are identically built in the Mexican and in the African and Asian specimens (Van de Velde, 1984;

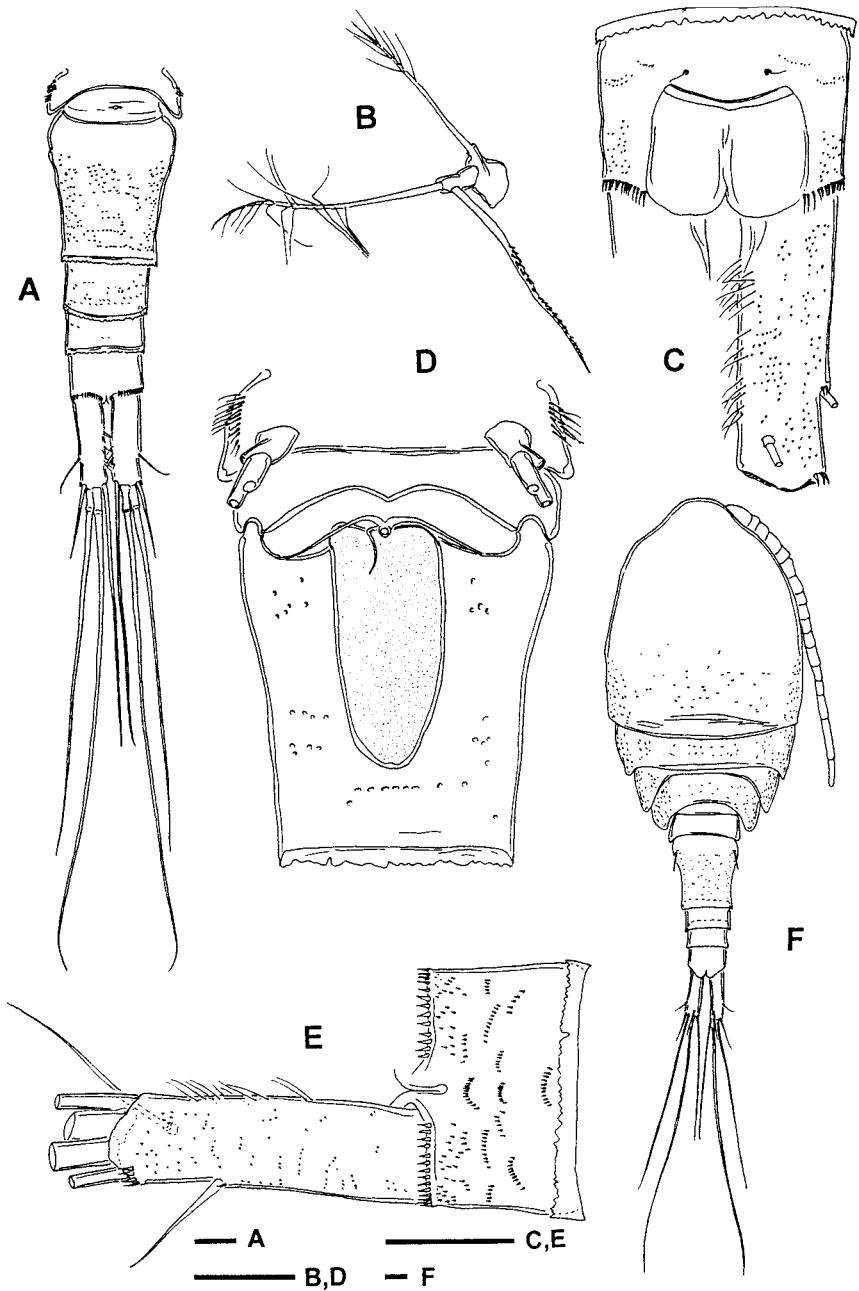


Fig. 1. *Mesocyclops aspericornis* (Daday, 1906), adult female from Sinaloa, Mexico. A, urosome and caudal rami, dorsal; B, fifth leg; C, anal somite and left caudal ramus, ventral; D, genital somite, ventral; E, anal somite and right caudal rami, dorsal; F, habitus, dorsal. All scale lines represent 50  $\mu\text{m}$ .

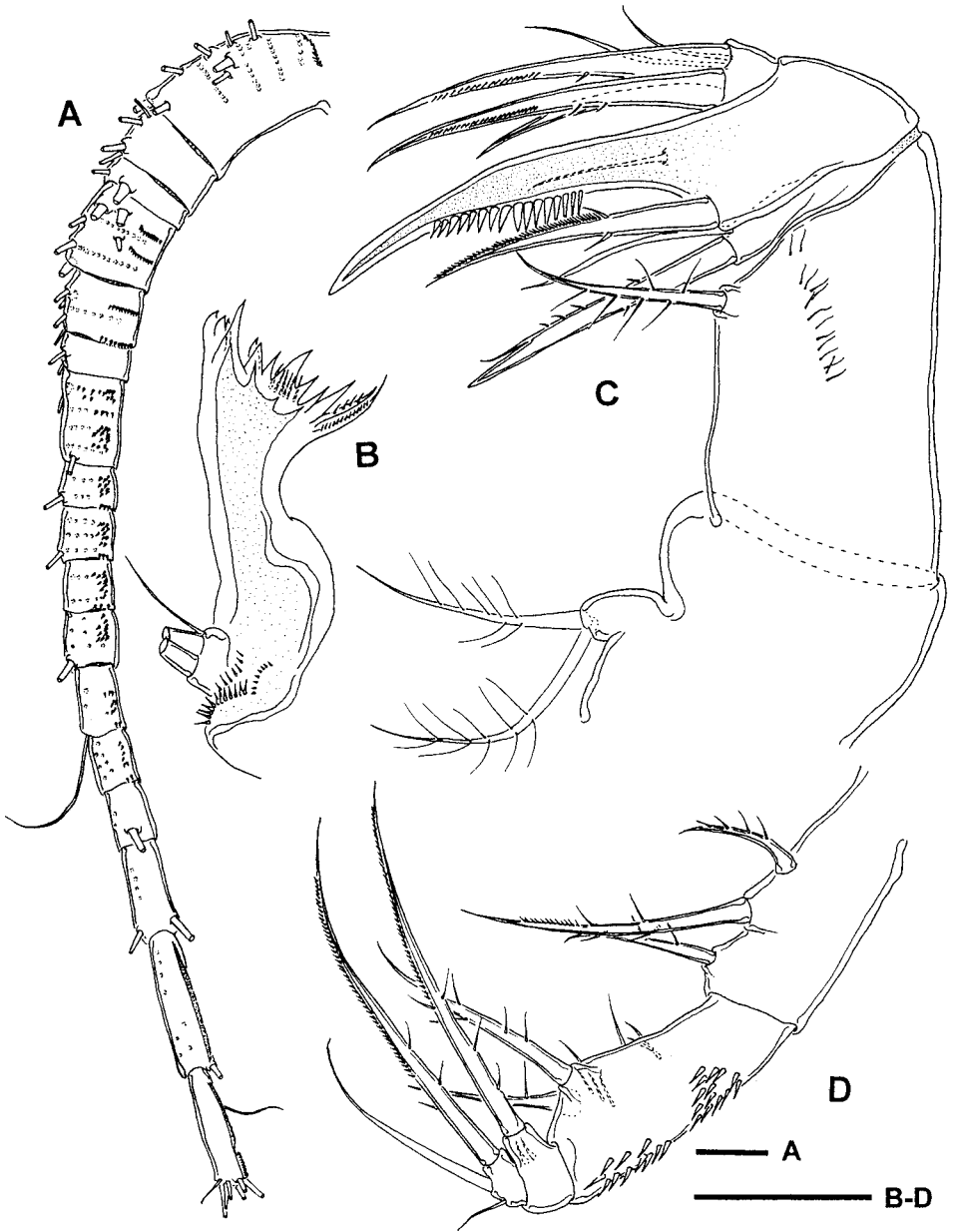


Fig. 2. *Mesocyclops aspericornis* (Daday, 1906), adult female from Sinaloa, Mexico. A, antennule; B, mandible with gnathal edge; C, maxilla; D, maxilliped. All scale lines represent 50  $\mu$ m.

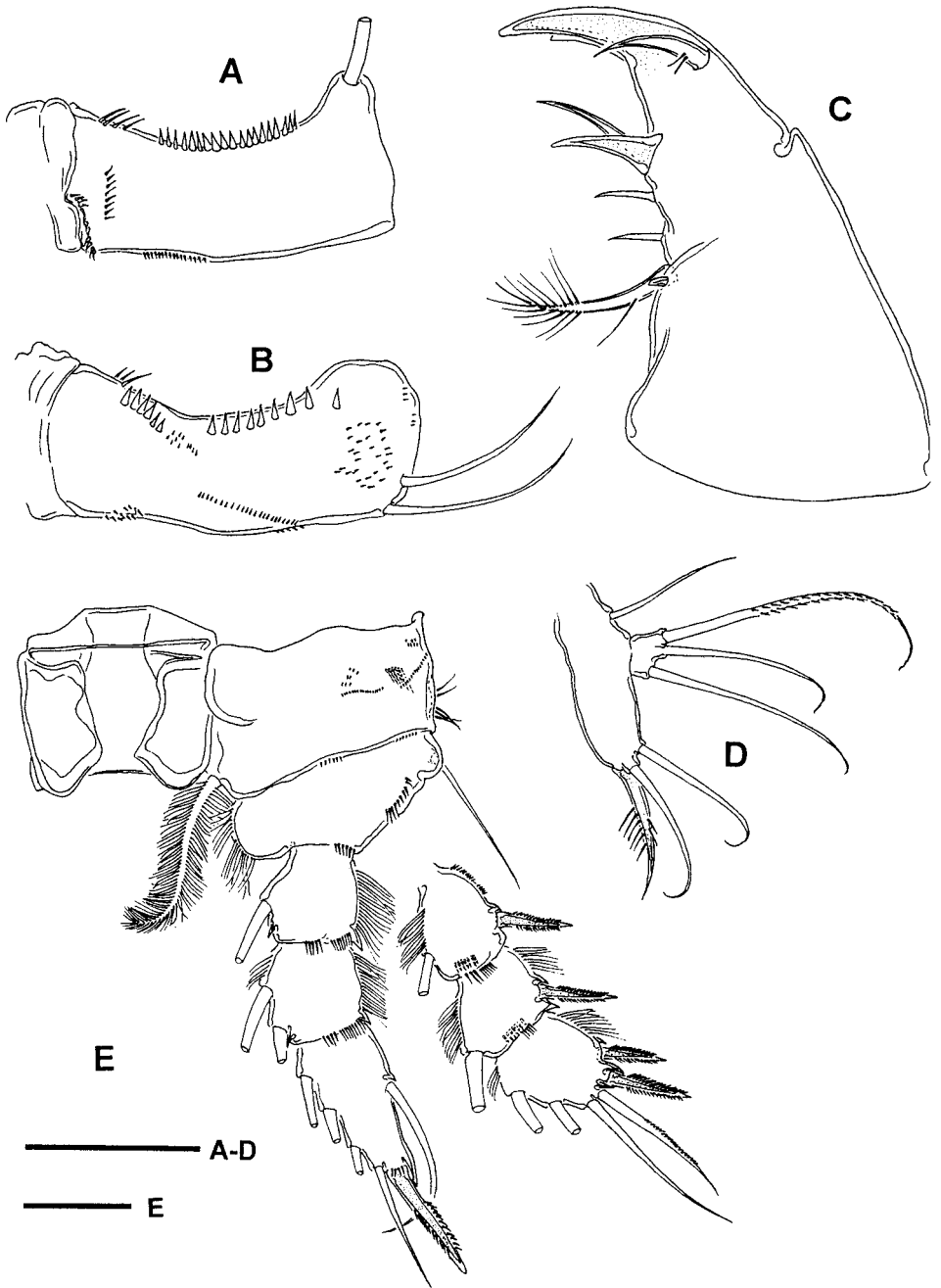


Fig. 3. *Mesocyclops aspericornis* (Daday, 1906), adult female from Sinaloa, Mexico. A, antennal basipodite, frontal; B, antennal basipodite, caudal; C, maxillule; D, maxillular palp; E, first leg, endopodite separated, frontal. All scale lines represent 50  $\mu\text{m}$ .

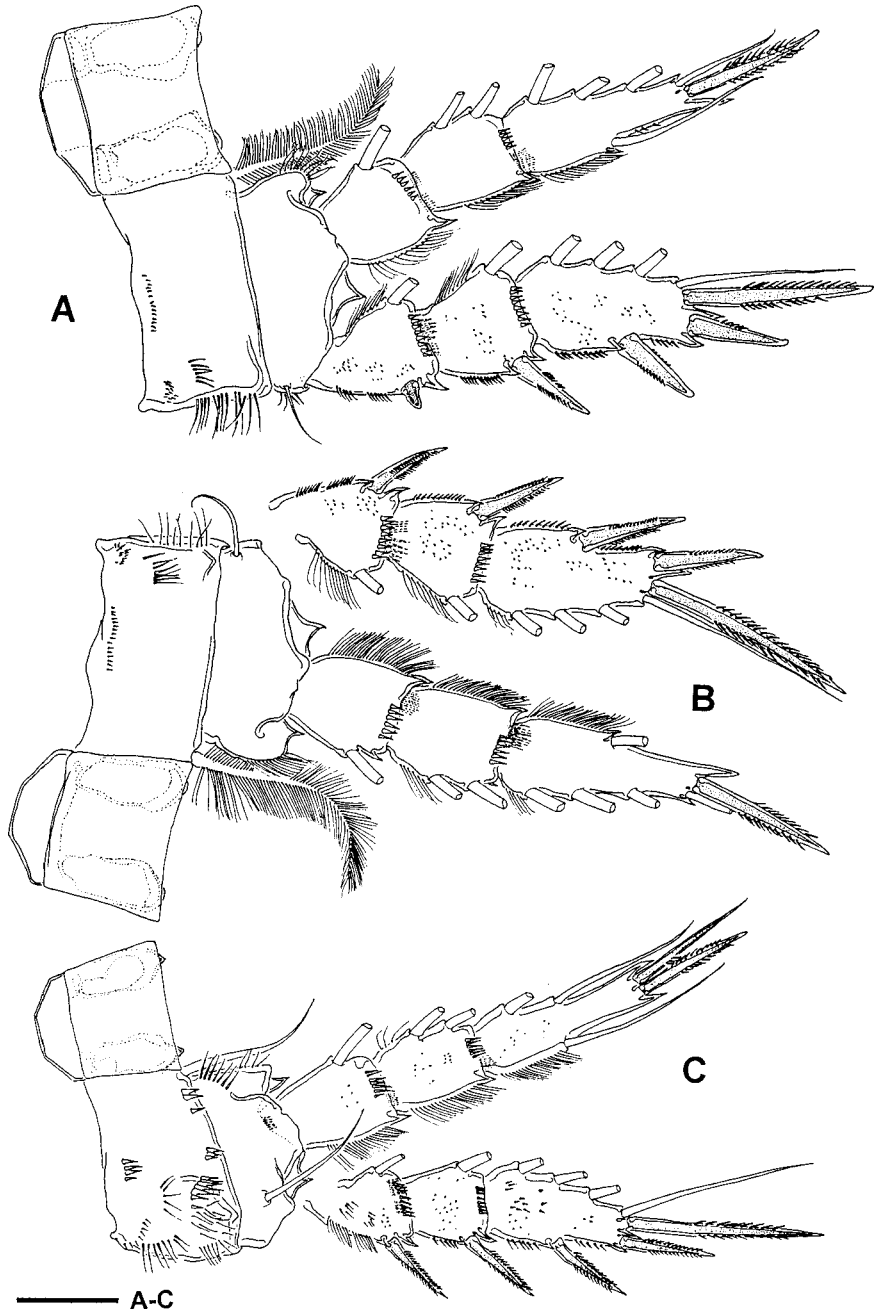


Fig. 4. *Mesocyclops aspericornis* (Daday, 1906), adult female from Sinaloa, Mexico. A, second leg, caudal; B, third leg, caudal; C, fourth leg, caudal. All scale lines represent 50  $\mu\text{m}$ .

TABLE I

Comparison of relevant taxonomic characters of Mexican specimens with published descriptions of African (Kieffer, 1981; Van de Velde, 1984) and Asian (Holyńska, 2000) specimens of *Mesocyclops aspericornis* (Daday)

	Specimens from Sinaloa, Mexico	Kieffer (1981) (Africa)	Van de Velde (1984) (Africa)	Holyńska (2000) (Asia)
Total length (mm)	1.2 ± 0.14	1.5	1.18-1.31	1.11-1.6
Antennule segments pitted	1, 4, 5, 7-16	1-6, 14-16	undescribed	undescribed
Antennule segments with spine	1, 4, 5, 7-13	undescribed	1, 4, 5, 7-13	1, 4, 5, 7-13
Ratio of antennular segments 16/17	1.67	1.25	1.4	undescribed
Antennule hyaline membrane	serrated, distal notch	serrated, distal notch	serrated, distal notch	serrated, distal notch
Length/width ratio of third endopod, leg 4	2.5-2.7	3.1	2.4-2.5	2.4-3.0
Ratio of length inner/outer spine, leg 4	1.15-1.2	1.13	1.23	1.1-1.5
Ratio of length apical spine/apical seta, leg 5	1	1	0.8	0.9
Ratio of length apical spine/proximal seta, leg 5	1.35	1	0.97	undescribed
Length/width ratio of furcal ramus	3.1-3.5	3-3.5	3.37-3.45	2.7-3.6
Mandible	3 groups of spines near palp insertion	3 groups of spines near palp insertion	3 groups of spines near palp insertion	3 groups of spines near palp insertion
Maxillar coxae	row of slender setae	undescribed	undescribed	row of slender setae
Maxilliped, syncoxa	oblique row of spinules	undescribed	undescribed	oblique row of spinules



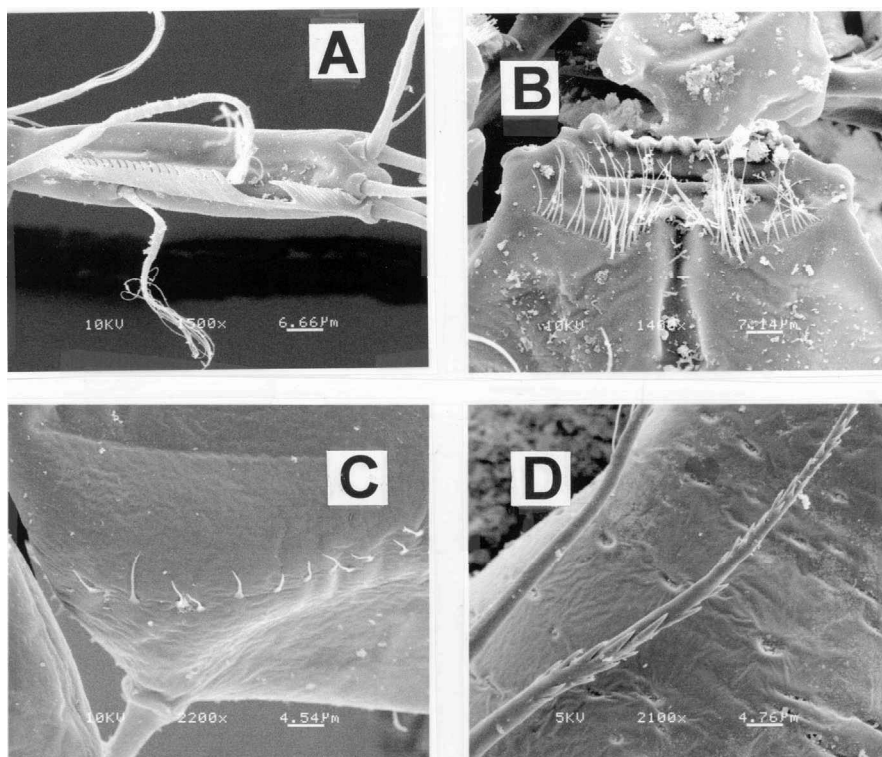


Fig. 5. *Mesocyclops aspericornis* (Daday, 1906), adult female from Sinaloa, Mexico. A, detail of hyaline membrane on last antennular segment; B, labrum, ventral; C, maxillar coxa, detail of ornamentation; D, fifth leg, detail of distal end of medial spine (SEM).

Holyńska, 2000). However, the antennular segment 16 tends to be relatively longer in the Mexican material (see table I). We found no relevant differences in the proportions of the structures of legs 4 and 5 (see table I) (fig. 4C). However, the proportional length of the terminal spine/proximal seta of the fifth leg (fig. 1B) is about 30% higher in the Mexican specimens.

There are similarities between these two groups of specimens in several minor details and proportions. The furcal length/width ratio values of the Mexican material (fig. 1C, E) fall well within the range described for the African and Asian material (see table I). The ornamentation of the mandibles, not described by Kiefer (1981) or Van de Velde (1984), was first depicted by Holyńska (2000) and includes three groups of spines near the insertion of the palp; this character is present in the Sinaloa specimens as well (fig. 2B). The same is true for the maxillae, which have a single row of slender setae on the coxal surface in both groups of specimens (table I) (figs. 2C, 5C). We observed the oblique row of minute spinules on the syncoxal surface of the maxilliped as reported by Holyńska (2000). As in the South

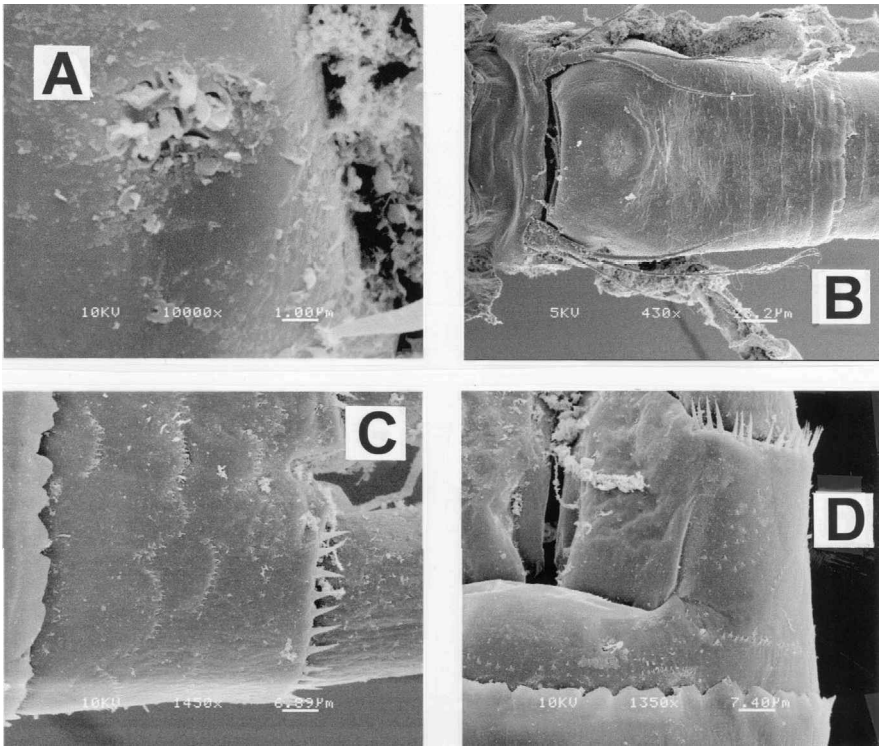


Fig. 6. *Mesocyclops aspericornis* (Daday, 1906), adult female from Sinaloa, Mexico. A, detail of pores on posterior surface of sixth leg plate; B, fifth pediger and genital somite, ventral; C, anal somite, ventral; D, anal somite, dorsal (SEM).

American specimens (see Reid & Saunders, 1986), the Mexican females possess several rows of small pits on the dorsal surface of the first antennular segment.

Reid & Saunders (1986) recommended the use of SEM in order to study some of the smallest cuticular structures of this species. It was clear that the use of SEM provided a more detailed overview of the micromorphology of this species; however, a similar analysis still has to be performed on the rarely found male specimens.

#### Distribution

The known latitudinal range of this species extends from the 33°N to 28°S, thus including various subtropical areas of the world. In the Americas, this species ranges roughly between 21°49'N (Caicos Islands) (Pesce, 1985) and 28°S (middle Paraná river, Argentina) (Dussart & Frutos, 1985). Hence, the northernmost limit of the known distributional range of this species in the Americas is expanded with this record, setting the northernmost limit of *Mesocyclops aspericornis* well beyond 25°N in Sinaloa, Mexico.

Most of the American records of *M. aspericornis* relate to the Atlantic coast (Caribbean islands, Venezuelan Caribbean, eastern coast of Brazil, Argentina). We considered this species to be an introduced form (Reid & Pinto-Coelho, 1994), clearly more related to the African-Asian species of *Mesocyclops* (see Van de Velde, 1984; Hołyńska, 2000). There are three morphological features shared by most African (67%) and Asian (87%) species of *Mesocyclops*: the absence of spines next to the insertion of the exopod on the antennal basipodite, the absence of a spine or seta on the inner basis in the first leg, and the wide lateral arms of the seminal receptacle, forming an anterior, deeply concave (or even V-shaped) margin (see Van de Velde, 1984; Hołyńska, 2000). These features are clearly present in *M. aspericornis*, too; hence, we speculate that it was originally an Old World form. This hypothesis is supported by two facts: (1) only 17% of the New World *Mesocyclops* bear these features; one of these (*M. ogunnus* Onabamiro, 1957) was recorded as an introduced species in Brazil (Reid & Pinto-Coelho, 1994). (2) The corresponding three features mentioned above are contrary to those of the American *Mesocyclops* (65%): presence of spines next to the exopodal insertion on the basis of the antenna, presence of a seta on the inner basis in the first leg, and the lateral parts of the seminal receptacle narrow, with anterior margin weakly concave or strongly convex (see Dussart, 1981; Suárez-Morales & Gutiérrez-Aguirre, 2001). Although we have no sound evidence to decide which feature is derived, it remains clear that these three characters can be useful to separate Old and New World *Mesocyclops*.

Therefore, considering its origin, distribution, and the previous records, we think that the introduction of *M. aspericornis* started somewhere along the Atlantic coast of America, from where this fugitive species (Reid & Saunders, 1986) dispersed in various directions. The unexpected record on the Mexican Pacific coast suggests both an alternative starting point for dispersal and a recent dispersal process, because (1) this large, conspicuous species has not been recorded previously in Mexico, neither in the southern nor in the central parts, which have been surveyed for several decades (Suárez-Morales et al., 1996; Suárez-Morales & Reid, 1998). (2) Sinaloa is a highly active area for aquaculture, an activity widely known as one of the main causes favouring the introduction of an exotic copepod fauna (Reid & Pinto-Coelho, 1994). Hence, this is considered to be the second record of an introduced species in Mexico after *Thermocyclops crassus* (Fischer, 1853) (cf. Gutiérrez-Aguirre & Suárez-Morales, 2000). Other introduced species such as the Afro-Asian *Mesocyclops ogunnus* (cf. Suárez-Morales et al., 1999) and *T. crassus* have been recorded along the Atlantic coast of the Americas.

## Ecology

*Mesocyclops aspericornis* has been collected from a wide variety of Neotropical freshwater environments. These include extreme habitats, from small containers of only a few liters to large lakes (see Reid & Saunders, 1986). Hence, the temporal cattle watering pond surveyed in Sinaloa, with its small volume (0.35 m deep) is, of course, within these limits. According to Reid & Saunders (1986), the species is an epibenthic form dwelling in the littoral zones. The discovery of a population of *M. aspericornis* in this clay bottom, shallow pond seems to support this statement.

## ACKNOWLEDGEMENTS

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