



## A new record and redescription of *Schizopera* (*Schizopera*) *knabeni* (Copepoda: Harpacticoida: Miraciidae) from north-western Mexico

### Un registro nuevo y redescrición completa de *Schizopera* (*Schizopera*) *knabeni* (Copepoda: Harpacticoida: Miraciidae) del noroeste de México

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**Abstract.** Specimens of *Schizopera* Sars, 1905 were found during sampling in 2 brackish systems in central and southern Sinaloa (north-western Mexico). The specimens turned out to belong to *Schizopera* (*Schizopera*) *knabeni* Lang, 1965 which was originally described from Monterey Bay (the type locality) and is known from Cocodrie (Louisiana). Amendments to Lang's (1965) original description and Fiers and Rutledge's (1990) partial redescription are given.

Key words: Copepoda, Harpacticoida, *Schizopera*, north-western Mexico, taxonomy.

**Resumen.** Durante una serie de muestreos se hallaron ejemplares del género *Schizopera* Sars, 1905 en 2 sistemas salobres en el centro y sur de Sinaloa (México). El material recolectado resultó ser *Schizopera* (*Schizopera*) *knabeni* Lang, 1965, una especie de copépodo harpacticoida originalmente descrita de material recolectado en la Bahía de Monterey (localidad tipo) y hallada también en Cocodrie (Louisiana, EUA). Se proporcionan enmiendas a la descripción original de Lang (1965) y a la redescrición parcial de Fiers y Rutledge (1990).

Palabras clave: Copepoda, Harpacticoida, *Schizopera*, noroeste de México, taxonomía.

#### Introduction

Since its erection, the genus *Schizopera* has been the subject of discussions of its phylogenetic relationships (Lang, 1948, 1965; Apostolov, 1982; Mielke, 1992). Lang (1965) was of the opinion that this genus was monophyletic on the basis of a number of character states (see below). In 1976 Wells and Rao (1976) suggested that at least 1 of the species that had been described (*Sch.* [*Sch.*] *anomala* Coull, 1971) could be regarded as a minor departure from the *Schizopera* plan and suggested that the group composed of *Sch. arenicola* Chappuis and Serban, 1953 (= *Schizoperopsis* (*Schizoperopsis*) *arenicola* (Chappuis and Serban, 1953)), *Sch. gauldi* Chappuis and Rouch, 1961 (= *Schizoperopsis* (*Psammoschizoperopsis*) *gauldi* (Chappuis and Rouch, 1961)) and *Sch. varnensis* Apostolov, 1967 (= *Sch.* (*Sch.*) *varnensis* (Apostolov, 1967)) could represent an advanced evolutionary trend within the genus. Since then, the genus *Schizopera* has undergone various changes, the most important being the reallocation of some species to the genus *Eoschizopera* Wells and Rao,

1976 and the subdivision of the genera *Schizopera* and *Eoschizopera* by Apostolov (1982), and the creation of the genus *Schizoperopsis* Apostolov, 1982 with 2 subgenera. Several authors (Mielke, 1992, 1995, Ax, 1987) rejected Wells and Rao's (1976) and Apostolov's (1982) views because these groups probably represent paraphyla based on symplesiomorphies. In contrast, Boxshall and Halsey (2004) adopted Wells and Rao's (1967) and Apostolov's (1982) schemes.

Lang (1965) did not describe or illustrate most of the mouth parts of *Sch.* (*Sch.*) *knabeni* from Monterey Bay. Later, Fiers and Rutledge (1990) presented some amendments to Lang's (1965) original description based on material collected in Louisiana, but they did not describe all the mouth parts. The present paper offers a complete redescription based on material collected in 2 brackish systems in northwestern Mexico.

#### Material and methods

Sediment samples for meiofaunal analyses were taken during a number of sampling campaigns in 2 brackish

systems in central and southern Sinaloa state (Ensenada del Pabellón lagoon and El Verde estuary) during the early 1990s (see Gómez Noguera and Hendrickx, 1997) and during 2005. Sediment samples were sieved through 500 µm and 40 µm sieves and benthic copepods were separated from the rest of the meiofauna with a stereomicroscope at 40X magnification. Specimens were stored in 70% ethanol. Observations and drawings at a magnification of 1000X were made from whole and dissected specimens mounted in lactophenol with a Leica compound microscope equipped with phase contrast and a drawing tube. The type material was deposited in the Copepoda collection of the Instituto de Ciencias del Mar y Limnología, Mazatlán Marine Station. The terminology proposed by Huys and Boxshall (1991) for the general description was adopted. Abbreviations used in the text and tables are: CIII, third copepodite; CIV, fourth copepodite; CV, fifth copepodite; P1-P6, first to sixth swimming legs; Exp, exopod; Enp, endopod; P1 (P2-P4) Exp (Enp) 1 (2, 3) denotes the proximal (middle, distal) exopodal (endopodal) segment of P1, P2, P3 or P4.

## Redescription

Order: Harpacticoida Sars

Family: Miraciidae Dana, 1846

Subfamily: Diosaccinae Sars, 1906

Genus: *Schizopera* Sars, 1905

Subgenus: *Schizopera* Sars, 1905

*Schizopera* (*Schizopera*) *knabeni* Lang, 1965 (Figs. 1-8)

*Female*. Body fusiform, tapering posteriorly (Fig. 1A). Total length ranging from 520 to 534 µm from tip of rostrum to posterior margin of caudal rami. Rostrum (Fig. 3A) distinct, somewhat elongated, triangular, with 1 setule on each side laterally. Cephalothorax with surface sensilla and plain hyaline frill. Dorsal and ventral surface of prosomites and first urosomite, genital double-somite and fourth urosomite with spinular pattern as figured (Figs. 1A, B; 2A). P2-P4-bearing somites with plain caudal frill; P5-bearing somite, genital double-somite, and fourth urosomite with finely serrated frill. Genital double-somite fused dorsally (Fig. 1A) and ventrally (Fig. 2A), with lateral trace of division between second and third urosomites (Fig. 1B); ventral surface plain except for transverse rows of minute spinules close to P6, the latter represented by 1 outer, short, plumose seta and 1 inner, long, slender element (Fig. 2A). Fifth urosomite with dorsal and ventral spinular pattern as figured (Fig. 1A, B; 2A), with finely serrated frill; dorsally with posterior frill bulging medially. Anal somite ornamented as figured (Fig. 1A, B; 2A); anal operculum with fringing spinules, and with

long ventrolateral spinules close to articulation with caudal rami, the latter tapering posteriorly, about 1.3 times as long as wide, with 6 elements as shown (Fig. 2B, C, D).

Antennule (Fig. 3A) 8-segmented; surface of segments smooth; second segment about 1.5 times as long as wide. Armature formula as follows: 1-(1), 2-(9), 3-(5), 4-(3+ae), 5-(2), 6-(2), 7-(5), 8-(5+acrothek). Acrothek consists of 2 setae basally fused to an aesthetasc.

Antenna (Fig. 3B) with allobasis armed with 1 abexopodal seta and ornamented with short rows of spinules along inner and outer margin proximally and at base of exopod. Exopod two-segmented; first segment with 1 seta, second segment with 2 setae and ornamented with spinules distally. Endopodal segment with longitudinal row of long spinules along inner margin, with 2 strong spines and 1 slender seta laterally and 7 distal elements (2 outermost elements fused basally).

Mandible (Fig. 4A). Gnathobasis with dentate pars incisiva, some spinules, and 1 seta. Coxa-basis with spinules as figured and 3 plumose setae distally. Endopod 1-segmented, with 2 setae laterally and 5 elements distally. Exopod consisting of a small segment with 2 setae, 1 of them small.

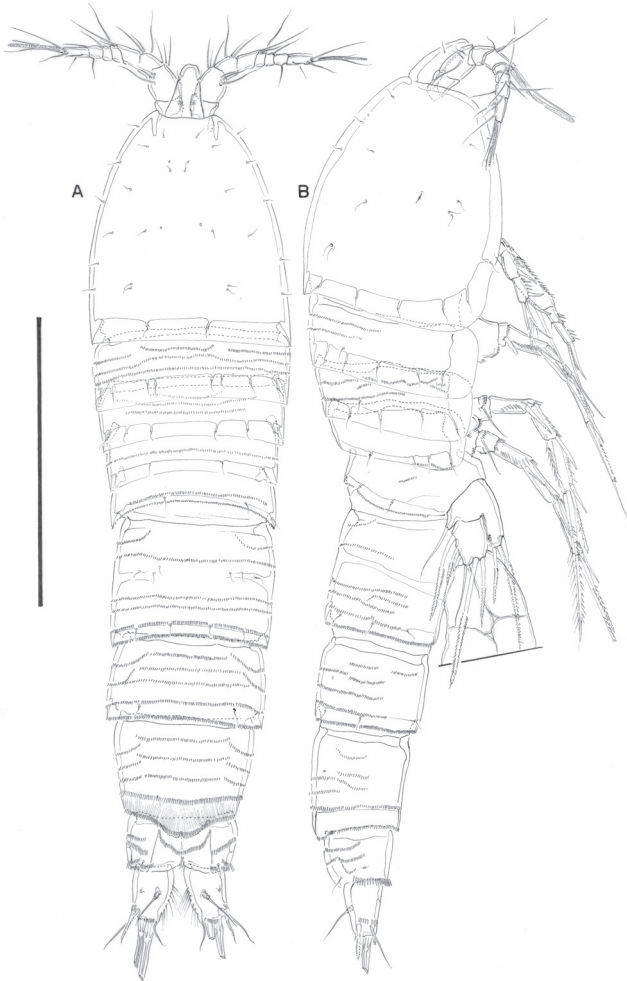
Maxillule (Fig. 4B). Praecoxal arthrite with 6 strong spines and 1 seta distally, 2 pinnate lateral elements, and 2 surface setae. Coxa with 2 setae. Basis with 7 elements. Endopod 1-segmented with 3 setae. Exopod minute, fused to basis, with 2 setae.

Maxilla (Fig. 4C). Syncoxa with 3 endites; proximal endite minute with 2 setae; middle and distal endites well developed, with 2 and 3 setae respectively. Basis with 1 claw, 1 strong and 2 slender elements. Endopod 2-segmented; first segment with 2, second segment with 4 setae.

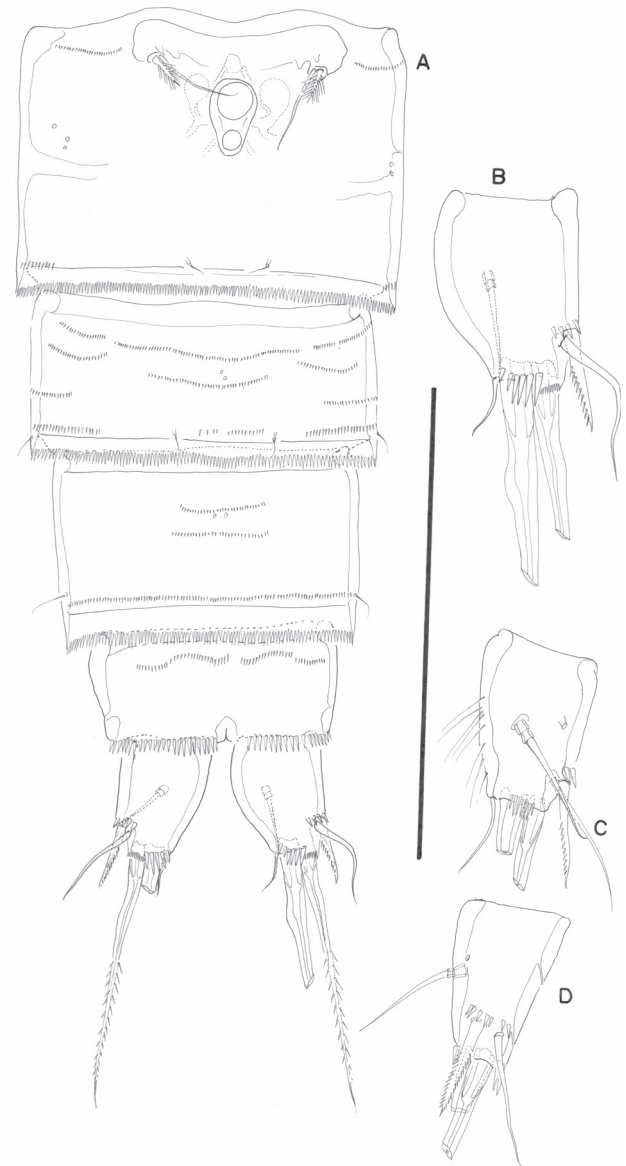
Maxilliped (Fig. 4D). Basis with spinules and armed with 1 subdistal and 2 apical pinnate setae. First endopodal segment with spinules along inner margin and with 2 setae; second segment with strong claw and 2 accompanying setae (1 of them very small).

P1 (Fig. 5A). Coxa with transverse spinular rows as figured. Basis with spinules at base of inner and outer spines and between rami. Exopod 3-segmented, smaller than first endopodal segment; third exopodal segment with 4 elements. Endopod 3-segmented; first segment about 6 times as long as wide, longer than second and third segments combined, with 1 strong element subdistally; second segment without armature; third segment with 1 inner slender, small seta, 1 geniculate seta, and 1 spine.

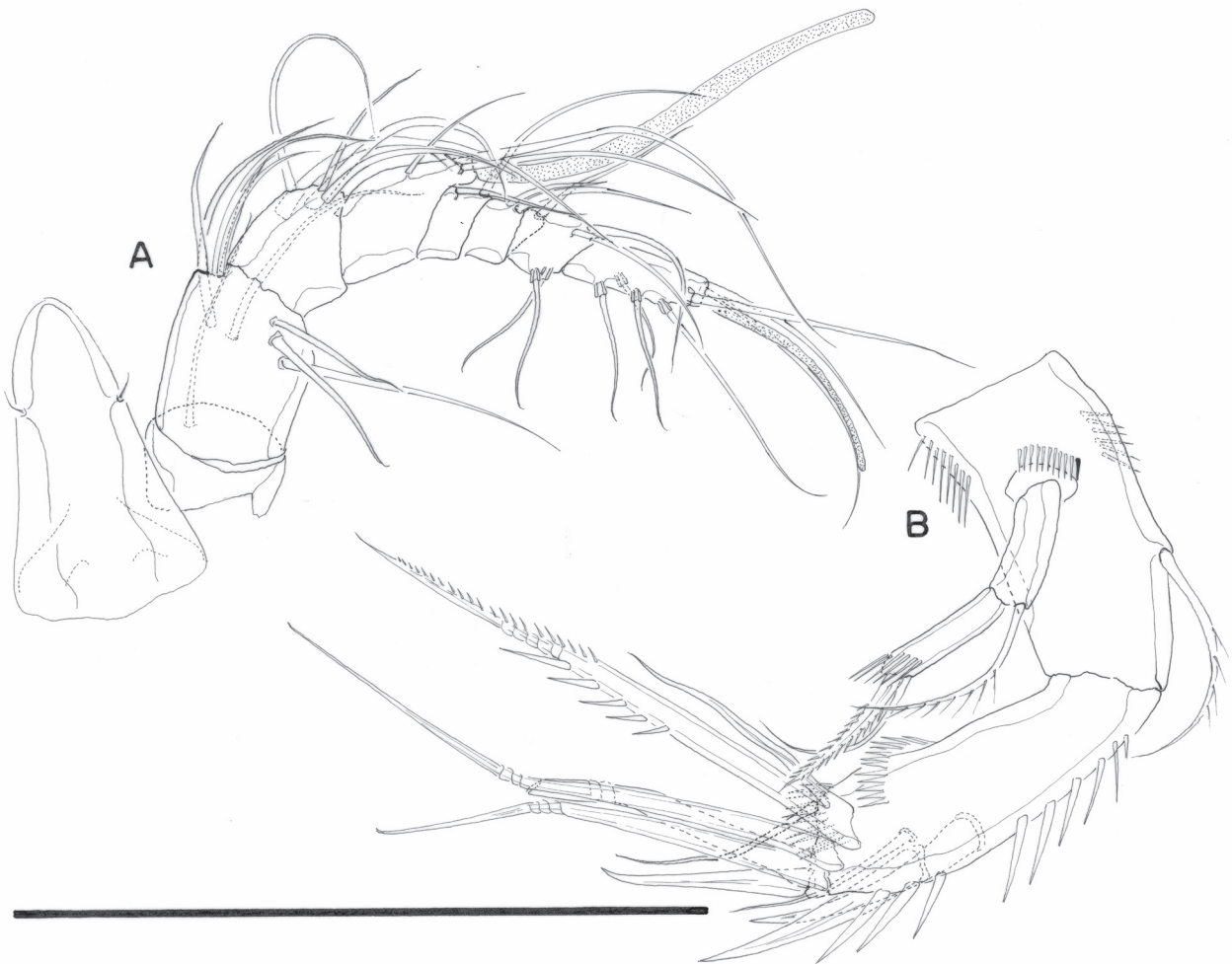
P2 (Fig. 5B). Coxa furnished with short spinular rows as figured. Basis with spinules at base of outer spine and at base of endopod. Rami 3-segmented. Exopod slightly shorter than endopod; Exp1 and 3 without, Exp2 with inner seta; Exp3 with 4 elements. First endopodal segment without, second



**Figure 1.** *Schizopera (Schizopera) knabeni* Lang, female. A, habitus, dorsal; B, habitus, lateral, showing only a portion of the egg sac. Scale bar: 200  $\mu$ m.



**Figure 2.** *Schizopera (Schizopera) knabeni* Lang, female. A, urosome, ventral (P5 bearing-somite omitted); B, caudal ramus, ventral; C, caudal ramus, dorsal; D, caudal ramus, lateral. Scale bar: A, 160  $\mu$ m; B-D, 109  $\mu$ m.



**Figure 3.** *Schizopera (Schizopera) knabeni* Lang, female. A, rostrum and antennule; B, antenna. Scale bar: A, 100  $\mu\text{m}$ ; B, 70  $\mu\text{m}$ .



**Figure 4.** *Schizopera (Schizopera) knabeni* Lang, female. A, mandible; B, maxillule; C, maxilla; D, maxilliped; E, P5. Scale bar: A-D, 70  $\mu$ m; E, 100  $\mu$ m.



**Figure 5.** *Schizopera (Schizopera) knabeni* Lang, female. A, P1; B, P2. Scale bar: 100  $\mu$ m.

and third segments with 1 inner seta (inner seta of Enp3 very strong); Enp3 with 4 setae in all.

P3 (Fig. 6A). Coxa with short spinular rows as figured. Basis with spinules at base of outer spine and at base of endopod. Rami 3-segmented. Exopod slightly longer than endopod; Exp1 and 3 without, Exp2 with inner seta; Exp3 with 4 elements. Endopodal segment with 1 inner seta (inner seta of Enp3 very strong); Enp3 with 4 setae in all.

P4 (Fig. 6B). Coxa and basis as in P3. Exopod as in P3; visibly longer than endopod. Endopod as in P3 except for lack of inner seta on P4Enp3.

Armature formula as follows:

	Exp	Enp
P1	I-0;I-0;II,2,0	0-1;0-0;I11
P2	I-0;I-1;II,2,0	0-0;0-1;I,2,12
P3	I-0;I-1;II,2,0	0-1;0-1;I,2,1
P4	I-0;I-1;II,2,0	0-1;0-1;I,20

P5 (Fig. 4E). Rami distinct. Baseoendopodal lobe with 2 inner and 2 distal setae. Exopod reaching beyond baseoendopod, with 6 setae.

*Male.* Habitus (not shown) as in female, except for genital double-somite (see Fig. 7A). Total body length ranging from 518 to 528  $\mu\text{m}$  from tip of rostrum to posterior margin of caudal rami. Anal somite and caudal rami as in female (Fig. 7A).

Antennule (Fig. 7B) haplocer; 8-segmented; third segment narrow; fourth segment swollen; with aesthetasc on fourth and seventh segments.

Mouth parts (not illustrated) as in female.

P1 as in female, except for dimorphic inner process of basis (Fig. 8A).

Coxa, basis, and exopod of P2 (not shown) as in female.

Endopod 2-segmented (Fig. 8B); proximal segment with slender spinules on inner and outer margin; distal segment with outer apophysis, with 4 elements in all.

Coxa, basis, and endopod of P3 (not shown) as in female. Exopod 3-segmented; first and second segment as in female; third segment with hyaline subdistal spine (Fig. 8C).

P4 (not illustrated) as in female.

Both P5 fused medially. Baseoendopodal lobe with 2 strong, pinnate spines. Exopod reaching beyond baseoendopodal lobe, with 5 elements as figured.

P6 (Fig. 7A) represented by asymmetrical smooth plates, without armature.

*Variability.* One female had a 7-segmented antennule, third and fourth segments being partially fused.

## Taxonomic summary

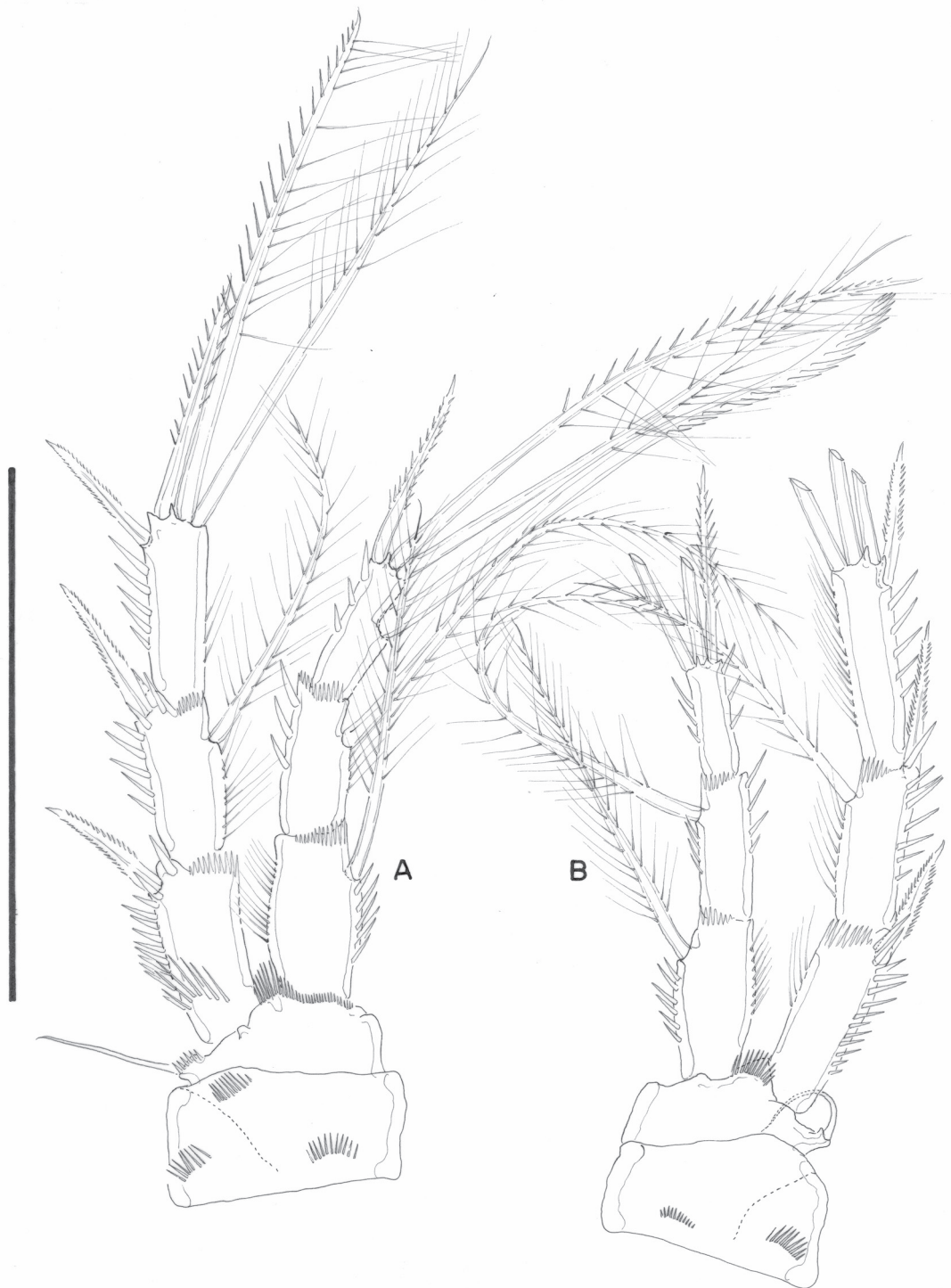
*Material examined.* Five dissected females (EMUCOP-080405-03, EMUCOP-030192-70, EMUCOP-030192-71, EMUCOP-300392-59, EMUCOP-300392-60) and 6 dissected males (EMUCOP-090205-05, EMUCOP-010591-61, EMUCOP-230691-49, EMUCOP-300392-57, EMUCOP-300392-58, EMUCOP-300491-51), 1 (EMUCOP-090205-06), 10 (EMUCOP-300392-63) and 18 females (EMUCOP-300392-72), and 12 (EMUCOP-300392-76), 1 (EMUCOP-080405-04), and 19 males (EMUCOP-300392-64) preserved in alcohol. Collected: 30 April, 1 May, and 23 June 1991; 3 January and 30 March 1992 (Ensenada del Pabellón lagoon (stn. 2, 6, 7, 9, 12 [for more information regarding environmental variables see Gómez Noguera and Hendrickx (1997)]), coll. S. Gómez; 8 April and 9 February 2005 (El Verde Estuary (stn. 7 and 2, Gómez, unpubl data), dissolved oxygen content from 2.6 to 4.9  $\text{ml l}^{-1}$ , biochemical oxygen demand from 0.3 to 2.2  $\text{ml l}^{-1}$ , sand, clay, and silt content in the sediment from 5.7% to 26.1%, from 24.2% to 51.2%, and from 32.8% to 80.5% respectively, salinity from 20‰ to 21 ‰, bottom-water temperature from 21.5 °C to 24.8 °C, sediment deposition from 0.0007  $\text{kg m}^{-2} \text{day}^{-1}$  to 0.9  $\text{kg m}^{-2} \text{day}^{-1}$ , coll. F. E. Vargas-Arriaga, F. N. Morales-Serna, and S. Gómez).

*Additional material available.* 39 females, 23 males, 4 CI, 15 CII, 13 CIII, 12 CIV, 15 CV collected on 30 April and 23 June 1991 and 3 January and 30 March 1992 (Ensenada del Pabellón lagoon (stn. 2, 4, 6, 7, 9, 10, 12 [for more information regarding environmental variables see Gómez Noguera and Hendrickx 1997]), 9 February and 8 April 2005 (El Verde Estuary (stn. 1, 2, 6, 7, Gómez, unpubl data), dissolved oxygen content from 2.4 to 3.7  $\text{ml l}^{-1}$ , BOD from 0.5 to 0.8  $\text{ml l}^{-1}$ , sand, clay, and silt content of the sediment from 3.4% to 9.4%, from 45.3% to 64.4%, and from 32.2% to 45.3% respectively, salinity from 20‰ to 21 ‰, bottom-water temperature from 20.8 °C to 25 °C, sediment deposition from 0.0003  $\text{kg m}^{-2} \text{day}^{-1}$  to 0.001  $\text{kg m}^{-2} \text{day}^{-1}$

*Distribution.* Monterey Bay, Elkhorn Slough (type locality) (Lang, 1965), Cocodrie (Louisiana) (Fiers and Rutledge, 1990); Mexico: Ensenada del Pabellón lagoon (24°19'–24°35'N, 107°28'–107°45'W) and El Verde estuary (23°25'30"N 106°33'30"W) (Sinaloa State) (present study).

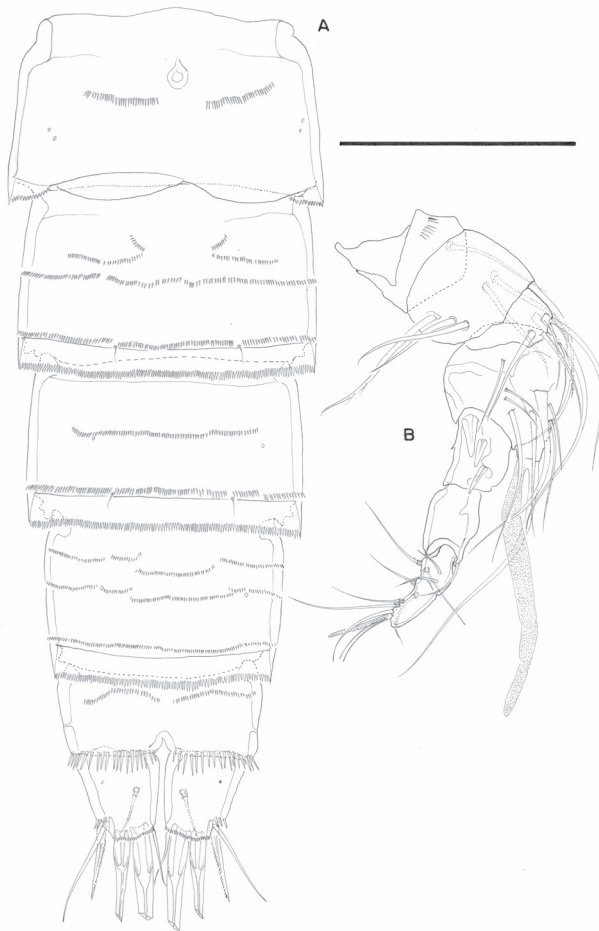
## Remarks

Since its creation to accommodate *Sch. longicauda* Sars, 1905 (= *Sch. (Sch.) longicauda* Sars, 1905), the genus *Schizopera* has been the subject of discussions regarding its phylogenetic relationships (Lang, 1948, 1965; Apostolov, 1982; Mielke, 1992). In Lang's (1948) monograph, 38

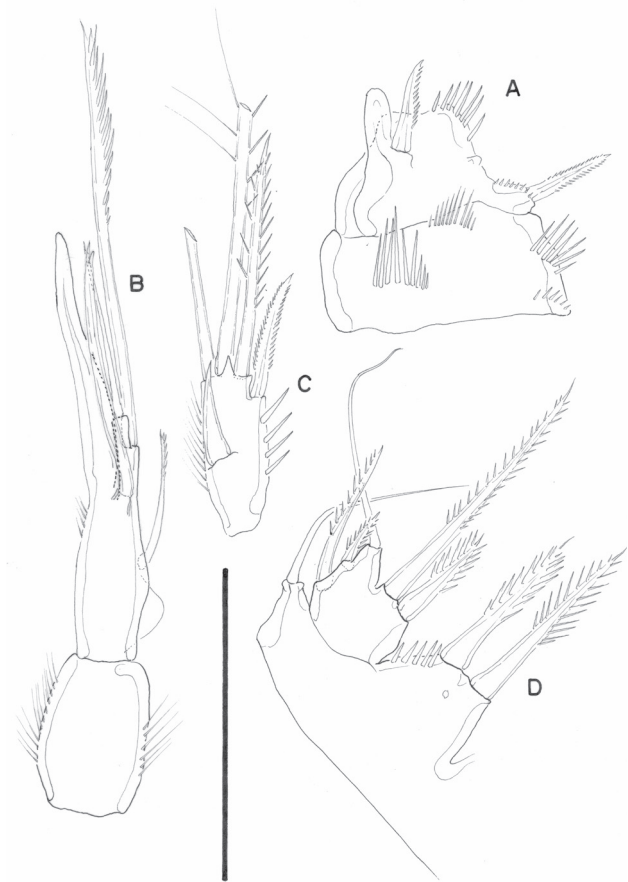


**Figure 6.** *Schizopera (Schizopera) knabeni* Lang, female. A, P3; B, P4. Scale bar: 100  $\mu\text{m}$ .





**Figure 7.** *Schizopera (Schizopera) knabeni* Lang, male. A, urosome, ventral (P5 bearing-somite omitted); B, antennule. Scale bar: A, 71  $\mu$ m; B, 50  $\mu$ m.



**Figure 8.** *Schizopera (Schizopera) knabeni* Lang, male. A, basis of P1; B, P2Enp; C, P3Exp3; D, P5. Scale bar: 50  $\mu$ m.

species were included in the genus *Schizopera*. In Lang (1965), after reallocation of the species at that time described, the number of species belonging to *Schizopera* increased to 42 (Lang, 1965, :324-326). Lang (1965) was of the opinion that this genus was monophyletic on the basis of *a*), the presence of a modified hyaline spine on the inner edge of the third exopodal segment of the male P3 (the “universal” presence of this hyaline spine within the genus and related genera was later confirmed by Wells and Rao (1976), even for the species for which this information was not available); *b*), the uniform transformation of the inner spine of the basis of the first leg in the males; *c*), the conformity of the female genital area; *d*), the loss of the proximal outer spine on the terminal exopodal segment of P1-P4, and *e*), the antenna with allobasis and 2-segmented exopod. By 1976, 5 species had been reported that departed from the *Schizopera* antennal plan. Wells and Rao (1976) were of the opinion that 1 of those species, *Sch. (Sch.) anomala*, could be regarded as a minor departure from the *Schizopera* plan, because it had an allobasis but a 1-segmented exopod. They suggested that the group of species composed of *Sch. (Sch.) arenicola*, *Sch. (Ps.) gauldi* and *Sch. (Sch.) varnensis*, which have a 2-segmented P4Enp, and the species with a 2-segmented P1Enp could represent an “advanced evolutionary trend” within the genus. On the other hand, following Wells and Rao (1976), the more primitive antenna (with basis and a 2- or 3-segmented exopod), and setation of P2-P4 of some other species could not be explained with such a simple model and erected *Eoschizopera* Wells and Rao, 1976 to include *Sch. crassispinata* Chappuis, 1954 (= *E. (Praeoschizopera) crassispinata* (Chappuis, 1954)), *Sch. gligici* Petkovski, 1957 (= *E. (P.) gligici* (Petkovski, 1957)), *Sch. indica* Rao and Ganapati, 1969 (= *E. (P.) indica* (Rao and Ganapati, 1969)), *Sch. sylvensis* Mielke, 1973 (= *E. (E.) sylvensis* (Mielke, 1973)), *E. (E.) reducta* Wells and Rao, 1976 and *Sch. marlieri* Rouch and Chappuis, 1960 (= *E. (P.) marlieri* (Rouch and Chappuis, 1960)), the latter considered as *incertae sedis* because the state of its antenna was in doubt. At that time, several genera had been erected and were supposed to be related to some extent to the *Schizopera*-group (*Psammotopa* Pennak, 1942, *Actopsyllus* Wells, 1967, *Protopsammotopa* Geddes, 1968, *Balucopsylla* Rao, 1972, *Helmutkunzia* Wells and Rao, 1976, *Paraschizopera* Wells, 1981, and questionably *Goffinella* Wilson, 1932 and *Schizoperoides* Por, 1968).

In an attempt to clarify the identity of the species belonging to the groups related to *Schizopera*, Apostolov (1982) created 2 subgenera of the genus *Schizopera* (characterized primarily by an antenna with allobasis and a 2-segmented antennal exopod): *Schizopera* (*Schizopera*) and *Schizopera* (*Neoschizopera*) Apostolov,

1982 on the basis of the structure of the P1Enp (3- and 2-segmented in *Sch. (Sch.)* and *Sch. (N.)* respectively). Additionally, Apostolov (1982) divided the species of the genus *Eoschizopera* into 2 subgenera: *Eoschizopera* (*Eoschizopera*) Wells and Rao, 1976 (*E. (E.) sylvensis*) and *Praeoschizopera* Apostolov, 1982 (*E. (P.) indica*, *E. (P.) crassispinata*, *E. (P.) marlieri* and *E. (P.) gligici*), mainly based on the structure of P1Enp (3-segmented in *E. (E.)* and 2-segmented in *E. (P.)*), antennal exopod (3- and 2-segmented in *E. (E.)* and *E. (P.)* respectively), and chaetotaxy of the female P5Exp (with 5 and 6 setae in *E. (E.)* and *E. (P.)* respectively). Apostolov (1982) also erected the genus *Schizoperopsis* Apostolov, 1982 (characterized primarily by a 2-segmented P4Enp), with 2 subgenera: *Schizoperopsis* (*Schizoperopsis*) Apostolov, 1982 and *Schizoperopsis* (*Psammoschizoperopsis*) Apostolov, 1982 on the basis of the presence of a 2-segmented endopod of P1 and P4.

According to Mielke (1992, 1995) and Ax (1987), the erection of the genera *Eoschizopera* and *Schizoperopsis*, and of all the subgenera created by Apostolov (1982), should be refused on the basis that they probably represent paraphyla based on symplesiomorphies, while Mielke's group B (1992: 90) (*Eoschizopera*, *Schizopera*, and *Schizoperopsis*) should be interpreted as a monophylum because the hyaline spine on the male P3Exp3 is restricted to this group and can be equated with the genus *Schizopera*. However, the division by Apostolov (1982) is at least of diagnostic value, and some authors (Boxshall and Halsey, 2004) have adopted Wells and Rao's (1967) and Apostolov's (1982) schemes.

The Mexican material resembles the original description of *Sch. (Sch.) knabeni* in the shape and relative length of the segments of the antennule, armature complement of the endopod and exopod of the antenna, armature formula and relative length of the rami and setae of P1-P5, and shape of the caudal frill of urosomites (minutely serrate). In fact, the only differences observed between the Mexican specimens and Lang's (1965) description were *a*), the setation of the maxillary exopod (with 1 small seta only in Lang's (1965: 331) description, with 2 long setae in the Mexican specimens), and *b*), the relative length of the dimorphic hyaline spine of the male P3 third exopodal segment (not reaching the tip of the supporting segment in Lang's (1965) description, reaching the tip of the third exopodal segment in the Mexican material). Unfortunately, Lang (1965) omitted the illustrations and written description of the other mouth parts because they agreed “almost exactly with those” of *Sch. (Sch.) californica* Lang, 1965. If this is the case, then *a*), the armature complement of the mandibular exopod (with 1 small seta in Lang's (1965) illustration, with 2 setae in the Mexican material); *b*),

the relative length of the lateral setae on the mandibular endopod (1 of them small in Lang's (1965) illustration, but of about the same length in the Mexican material); *c*), the apical armature complement of the mandibular endopod (with 4 setae in Lang's (1965) illustration, with 5 setae in the Mexican specimens; this can be a misinterpretation though); *d*), the armature complement of the maxillulary basis (with 5 setae only in Lang's (1965) illustration, with 7 setae in the Mexican specimens); *e*), the armature complement of the maxillulary endopod (with 2 short setae in Lang's (1965) illustration, with 3 setae (1 of them smaller) in the Mexican specimens); *f*), armature complement of maxillary endopod (1-segmented and armed with 4 setae in Lang's (1965) illustration, 2-segmented and armed with 6 setae in all in the Mexican specimens), and *g*), armature complement of the basis and second endopodal segment of the maxilliped (basis with 2 setae and second endopodal segment with 1 accompanying seta in Lang's (1965) illustration, basis with 3 setae and second endopodal segment with 2 accompanying setae in the Mexican material) are also different. Of course, this required careful inspection of Lang's (1965) material. One of us (SG) had the opportunity to examine Lang's material of *Sch. (Sch.) knabeni*. The material was deposited in the collection of the Swedish Museum of Natural History under the catalogue number SMNH-Type-2203 syntype(s). In the label appears the following: *Schizopera knabeni* Lang, 1965; USA, Monterey Bay, Elkhorn Slough; Mud, amongst cast away *Enteromorpha*; Leg. K. Lang 17 Sep 1960. In the vial there was only 1 male somewhat damaged and with the prosome and urosome separated. Since this was the only specimen in the vial we refrained from dissecting it and the observations were made from the whole specimen. Regarding the differences above, we confirmed the presence of 2 long setae on the maxillulary exopod in Lang's material, as in the Mexican specimens. Also, the relative length of the dimorphic hyaline spine in Lang's material is the same as in the Mexican specimens. Regarding the mouth parts whose descriptions were omitted by Lang (1965) (see above), it was confirmed that the armature complement of the mandibular exopod, the relative length of the lateral setae on the mandibular endopod, the apical armature complement of the mandibular endopod, as well as the armature complements of the maxillulary basis and endopod, of the maxillary endopod and of the basis and second endopodal segment of the maxilliped of the Mexican and Lang's material are the same. Also, Lang's material has short transversal spinular rows on free prosomites and urosomites and the spinular pattern is similar to that of the Mexican specimens and to that showed by Fiers and Rutledge (1990).

Fiers and Rutledge (1990) gave a partial redescription/

amendment of the species based on specimens collected in Cocodrie (Louisiana). These amendments (except for the presence of seta I in the caudal rami of Fiers and Rutledge's (1990: 107, Fig. 1b, f)) agree well with the description by Lang (1965) and the description herein presented for the Mexican material. Fiers and Rutledge (1990) mentioned the following differences between their material from Louisiana and Lang's (1965) description: *a*), the dorsal spinular ornamentation of the prosomites and urosomites: upon careful inspection of Lang's type material, the presence of short transverse spinular rows on free prosomites and urosomites was verified; *b*), the spinular ornamentation of the ventral surface of second and third abdominal somites: such spinular ornamentation is also present in Lang's type material; *c*), the presence of hyaline frills in the cephalothorax, prosomites and urosomites (except for the anal somite): on this regard, the hyaline frill of cephalothorax of Lang's type material is definitely plain, while the hyaline frill of free prosomites and urosomites is finely serrated. Dr. Guilherme Lotufo (U. S. Army Engineer Research and Development Center) kindly sent to us some cultured specimens of *Sch. (Sch.) knabeni*. The original stock of this material comes from Cocodrie (Louisiana), the same locality where Fiers and Rutledge (1990) found the specimens upon which they based their redescription. Upon careful examination of the specimens sent to us by Dr. Lotufo, we concluded that the cephalothorax of the specimens from Louisiana possesses a plain hyaline frill as in Lang's type material and as in the Mexican specimens; *d*), the shape of the inner spines of the female P5 baseoendopod: unfortunately there is only 1 male in the vial containing Lang's type material. However, the shape of the spines of the female P5 baseoendopod observed for the material from Louisiana and Mexico is the same, thus being probable that the more slender shape of these elements in Lang's (1965) description is simply a slip of the pen; *e*), the presence of an aesthetasc on the last male and female antennular segment: in this regard Fiers and Rutledge (1990) noted that Lang (1965) omitted this aesthetasc in both *Sch. (Sch.) knabeni* and *Sch. (Sch.) californica* Lang, 1965, and suggested that the presence of such aesthetasc could be a common feature for the genus. Unfortunately, Lang's type material of the species is badly damaged and the presence of such aesthetasc could not be verified; *f*), the shape of the dimorphic inner spinule and the inner projection of the basis of the male P1: both the dimorphic spinule and the inner projection of the basis of the male P1 of Lang's type material are identical to those observed by Fiers and Rutledge (1990) in specimens from Louisiana and to those observed in the Mexican specimens, and *g*), presence of the male P6: the male P6 showed by Fiers and Rutledge's (1990) is identical to that observed in

Lang's type material and in the Mexican specimens.

More evident are the following differences between Lang's (1965) description and the Mexican specimens, and Fiers and Rutledge's (1990) material: *a*), the different shape of the frill of the fifth urosomite (overlapping the anal segment almost entirely in Fiers and Rutledge's (1990) illustration, barely overlapping the proximal half of the anal segment in Lang's (1965) illustration and in the Mexican specimens), and *b*), the armature complement of the caudal rami (with 7 setae in Fiers and Rutledge's (1990) specimens (seta I present), with 6 setae only in Lang's (1965) and in the Mexican material (seta I absent). The condition of the frill of the fifth urosomite as shown in Fiers and Rutledge (1990) is the result of the intrusion of the anal somite into the fifth urosomite, therefore being identical to that of *Sch. (Sch.) knabeni* as described by Lang (1965) and in the present paper. On the other hand, and after careful inspection of the material sent to us by Dr. Lotufo, it is clear that the seta I of the caudal rami as shown in Fiers and Rutledge's (1990: 107, Fig. 1b, f) is in fact 1 of several spinules normally present at the base of seta II. All the evidence above supports the presence of *Sch. (Sch.) knabeni* in California, south-eastern Gulf of California (Mexico) and Louisiana (Gulf of Mexico, U.S.A.).

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#### Literature cited

- Ax, P. 1987. The phylogenetic system. The systematization of organisms on the basis of their phylogenesis. John Wiley, Chichester. 340 p.
- Apostolov, A. 1982. Genres et sous-genres nouveaux de la famille Diosaccidae Sars et Cylindropsyllidae Sars, Lang (Copepoda, Harpacticoida). Acta Zoologica Bulgarica 19:37-42.
- Boxshall, G. A. and S. H. Halsey. 2004. An introduction to copepod diversity, 1-2. The Ray Society, London. 966 p.
- Fiers, F. and Ph. Rutledge. 1990. Harpacticoid copepods associated with *Spartina alterniflora* culms from the marshes of Cocodrie, Louisiana (Crustacea, Copepoda). Bulletin del'Institut Royal des Sciences Naturelles de Belgique 60:105-125.
- Gómez Noguera, S. E. and M. Hendrickx. 1997. Distribution and abundance of meiofauna in a subtropical coastal lagoon in the South-eastern Gulf of California, Mexico. Marine Pollution Bulletin 34:582-587.
- Huys, R. and G. A. Boxshall. 1991. Copepod evolution. The Ray Society, London. 468 pp.
- Lang, K. 1948. Monographie der Harpacticiden. Håkan Ohlsson, Lund, Sweden, Vols. 1,2. 1682 p.
- Lang, K. 1965. Copepoda Harpacticoida from the Californian Pacific coast. Kungliga Svenska Vetenskapsakademiens Handlingar Fjärde Serien, 10:1-560.
- Mielke, W. 1992. Description of some benthic Copepoda from Chile and a discussion on the relationships of *Paraschizopera* and *Schizopera* (Diosaccidae). Microfauna Marina 7:79-100.
- Mielke, W. 1995. Species of the taxon *Schizopera* (Copepoda) from the Pacific coast of Costa Rica. Microfauna Marina 10:89-116.
- Wells, J. B. J. and G. C. Rao. 1976. The relationship of the genus *Schizopera* Sars within the family Diosaccidae (Copepoda: Harpacticoida). Zoological Journal of the Linnean Society 58:79-90.