JOURNAL OF CRUSTACEAN BIOLOGY, 23(1): 94–118, 2003

THREE NEW SPECIES OF *ENHYDROSOMA* AND A NEW RECORD OF *ENHYDROSOMA LACUNAE* (COPEPODA: HARPACTICOIDA: CLETODIDAE) FROM THE EASTERN TROPICAL PACIFIC

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ABSTRACT

A number of harpacticoid copepods were collected during two series of sampling campaigns in a coastal lagoon and in a brackish system in northern and southern Sinaloa (northwestern Mexico), respectively. Four enhydrosomid species were recognized. Three of them are new to science. *Enhydrosoma lacunae* is reported for the sixth time. This record extends the distribution of the species from the Caribbean Sea to the Eastern Tropical Pacific, and it is suggested that it is an invasive species borne in water ballast of ships. *Enhydrosoma parapropinquum* sp. nov. bears a strong resemblance to *E. propinquum*, but these species are different in shape of the caudal rami and female fifth leg. *Enhydrosoma casoae* sp. nov. and *E. solitarium* sp. nov. showed to be closely related to *E. vicinum*. These three species seem to be related by the structure and armature formula of the female fifth swimming leg. *Enhydrosoma casoae* sp. nov. and *Enhydrosoma solitarium* sp. nov. can be separated from each other by the ventral spinular ornamentation of urosome and spinular ornamentation of female P5 baseoendopod.

The study of meiofauna is a relatively new field for the Mexican scientific community. To the best of my knowledge only some papers about the ecology of meiofauna from the Mexican Pacific and Gulf of Mexico are available (e.g., Escobar *et al*., 1997; Escobar-Briones and Soto, 1997; Gómez-Noguera and Hendrickx, 1997).

A number of harpacticoid taxa were collected during two short-term studies about the effects of organic enrichment on the distribution and abundance of meiofauna in Ensenada del Pabellón lagoon (central Sinaloa, Mexico) and Urías estuary (a polluted system in Mazatlán, southern Sinaloa, Mexico). The present paper deals with the description of three new species of *Enhydrosoma* and a new record of *E. lacunae* Jakubisiak, 1933, from northwestern Mexico.

MATERIALS AND METHODS

Quantitative sediment cores were taken for the analysis of the distribution and abundance of meiofauna in Ensenada del Pabellón lagoon (central Sinaloa) and Urías estuary (southern Sinaloa) during 1991 and 2001, respectively. Sediment samples were taken directly from the sediment surface in intertidal areas in Ensenada de Pabellón lagoon using plastic corers with a sampling surface of 7.06 cm^2 (see also Gómez-Noguera and Hendrickx, 1997). Sediment samples from Urías estuary were taken using an Eckman box corer with a sampling area of 33 cm^2. In this case, sediment subsamples were taken with the same corers used during field work in Ensenada del Pabellón lagoon. The sediment cores taken in Ensenada del Pabellón were then divided vertically into separate sediment slices as follows: 0–3 cm, 3–6 cm, and 6–9 cm depth, and were fixed with 70% ethanol. Subsamples taken in Urías estuary were divided vertically as follows: 0–1 cm, 1–2 cm, 2–3 cm, 3–4 cm, and 4–5 cm depth, and were then fixed with 10% Formalin. Sediment samples were stained with Bengal Rose and sieved through 500 and 63 μm sieves to separate macro- and meiofauna. Harpacticoids were separated from the rest of the meiofauna using a stereomicroscope at a magnification of 40×. The specimens were then stored in 70% ethanol prior to further investigation. Observations and drawings were made from whole and dissected specimens mounted in glycerin, at 1,000× using a Leica compound microscope equipped with phase contrast and drawing tube. The type material has been deposited in the 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: P1–P6, first to sixth swimming leg; EXP, exopod; ENP, endopod.

RESULTS

Family Cletodidae T. Scott, 1905

Genus *Enhydrosoma* Boeck, 1872

Enhydrosoma parapropinquum sp. nov.
Figs. 1–9

Enhydrosoma sp. 3: Gómez, in press.

Type Locality.—Ensenada del Pabellón lagoon, Sinaloa, México (24°19′–24°35′N, 107°28′–107°45′W).

Other Localities.—Urías estuary (23°09′–23°13′N, 106°20′–106°25′W).

Type Material.—One female holotype (EMUCOP-010591-44) and one male allotype (EMUCOP-010591-43) preserved in alcohol; one male and four female paratypes (EMUCOP-010591-45), one male and two female paratypes (EMUCOP-020591-33), three female and one male fifth copepodid paratypes (EMUCOP-240691-22), and two males, four females, and one CIV copepodid paratypes (EMUCOP-090301-16) preserved in alcohol; two dissected male (EMUCOP-300491-31, EMUCOP-300491-32) and eight dissected female paratypes (EMUCOP-230691-38, EMUCOP-300491-30, EMUCOP-010591-46, EMUCOP-010591-47, EMUCOP-240691-23, EMUCOP-020591-34, EMUCOP-090301-17, EMUCOP-090301-18); collected from stations 2, 3, 4, 5, 9, 12, 13, and 14 in Ensenada del Pabellón lagoon in April, May, and June 1991 (see Gómez-Noguera and Hendrickx, 1997), and from station 9 in Urías estuary in March 2001 (unpublished data); collected from intertidal fine sand, lime and clay in Ensenada del Pabellón lagoon (see Gómez-Noguera and Hendrickx, 1997), at 0–9 cm deep sediment, and from fine sand in Urías estuary, at 0–1 cm deep sediment (unpublished data); coll. S. Gómez.

Etymology.—The specific name alludes to the resemblance to *Enhydrosoma propinquum* (Brady, 1880).

Description.—Female. Body (Fig. 1A, B), tapering from posterior margin of cephalothorax, curved in lateral view; length ranging from 420 to 500 μm from tip of rostrum to end of caudal rami (holotype, 500 μm); greatest width near posterior edge of cephalic shield, the latter nearly as large as one-fourth body length, with strongly folded lateral and dorsal surface, with serrate posterior margin, with six sensilla arising from distinct cones. Rostrum triangular, fused to cephalic shield; with produced bilobed tip; with subdistal sensillum on each side. Dorsal surface of free thoracic somites (P2–P4-bearing somites) covered with minute spinules and with serrate posterior margin; first free thoracic somite with eight and two, second and third free thoracic somite with eight sensilla arising from distinct cones and four sensilla without cones. Dorsal surface and posterior margin of first urosomite (P5-bearing somite) ornamented as preceding somites; with only eight sensilla arising from distinct cones. Surface of genital double somite covered with minute spinules, with dorsolateral division between first and second genital somite (second and third urosomites), with serrate posterior margin of first and second genital somite; first and second genital somite with four sensilla arising from distinct cones and two additional sensilla arising from bulbous structure on second genital segment laterally; lateral bulbous structure of first genital segment seemingly without sensilla. Dorsal surface of fourth urosomite covered with tiny spinules, with serrate posterior margin, with two sensilla arising from distinct cones and one sensillum arising from bulbous structure laterally. Dorsal surface of fifth urosomite ornamented as preceding somite, without sensilla, lateral bulbous structure without sensillum. Ventral surface of double genital somite (Fig. 2) plain except for a short spinulose row close to insertion of setae representing P6, the latter located in proximal half of first genital somite; first and second genital somites fused midventrally; ventral surface of second genital somite plain, with short spinules along posterior margin, and with two sensilla arising from distinct cones. Ventral view of fourth and fifth urosomite as in preceding somite; fourth urosomite with, fifth urosomite without sensilla arising from distinct cone. Anal somite ornamented with minute spinules dorsally and along posterior margin close to caudal rami; with dentate rounded operculum accompanied by two setae arising from distinct cones; ventral surface (Fig. 2) plain except for minute spinules close to caudal rami and two tube pores (right tube pore arrowed in Fig. 2). Caudal rami (Fig. 1C) slightly longer than anal segment; rather cylindrical; L/W ratio ranging from 3.1 to 5; with spinules near posterior edge ventrally (Fig. 2); setae I and II arising rather laterally halfway along outer margin, equal in size; seta III arising in distal third; seta IV small and fused to seta V; seta VI slightly shorter than seta IV; seta VII arising rather internally, at the same level as setae I and II (Fig. 1C).

Antennule (Fig. 3A, C, D), five-segmented; surface of segments smooth except for three rows of spinules on first segment and some spinules on second and third ones; third segment nearly as long as wide; fourth segment narrow; fifth segment nearly twice as long as wide; all setae smooth except for one and three spinulose elements on first and third, and last segment, respectively (Fig. 3C, D). Armature formula as follows: 1-(1), 2-(7), 3(8 + ae), 4(1), 5(11 + ae).

Antenna (Fig. 3B, E), with spinules along inner edge of allobasis; with abexopodal seta. Exopod one-segmented, with one lateral and one distal seta. Endopodal segment with strong

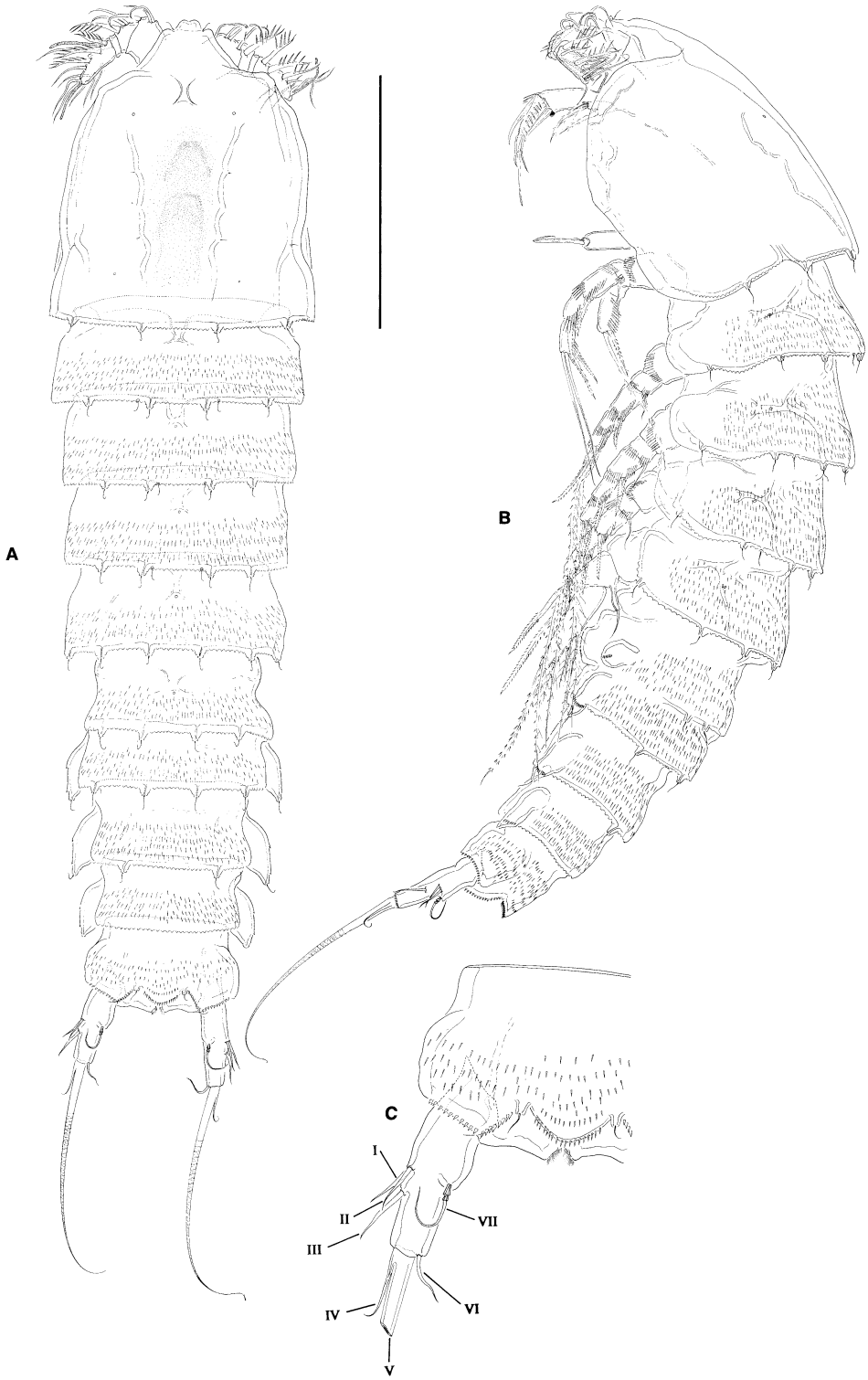

Fig. 1. *Enhydrosoma parapropinquum* sp. nov., female. A, habitus, dorsal; B, habitus, lateral; C, anal somite and caudal ramus. Scale bars, A, B = 100 μm, C = 50 μm.

Fig. 2. *Enhydrosoma parapropinquum* sp. nov., female. Urosome, ventral (P5-bearing somite omitted). Scale bar, 100 μm.

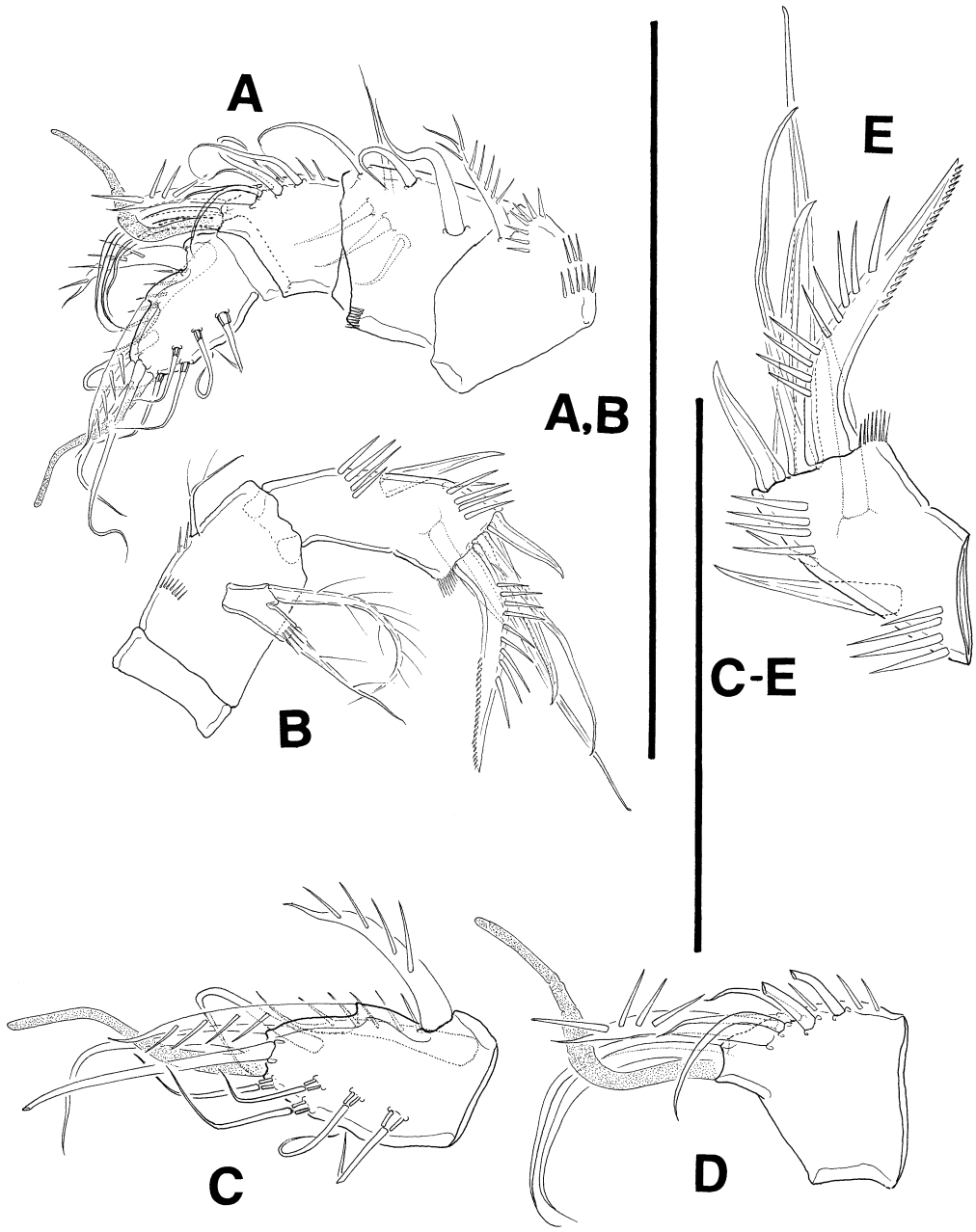

Fig. 3. *Enhydrosoma parapropinquum* sp. nov., female. A, antennule; B, antenna; C, last antennulary segment; D, third antennulary segment; E, distal part of second endopodal segment of antenna. Scale bars, A, B = 100 μm, C–E = 50 μm.

spinules on inner margin medially and distally; with seven spines/setae (Fig. 3E).

Mandible (Fig. 4A), with slender gnathobase; biting edge with five short and two long teeth; palp short, one-segmented, ornamented with spinules and armed with one lateral and two distal setae.

Maxillule (Fig. 4B), with arthrite ornamented with four distal and two lateral elements, and one surface setae; coxa basis with three apical and one lateral seta; endopod represented by single seta.

Maxilla (Fig. 4C, E), with spinules on inner and outer edge of syncoxa; proximal endite with one spinulose element and two smooth setae;

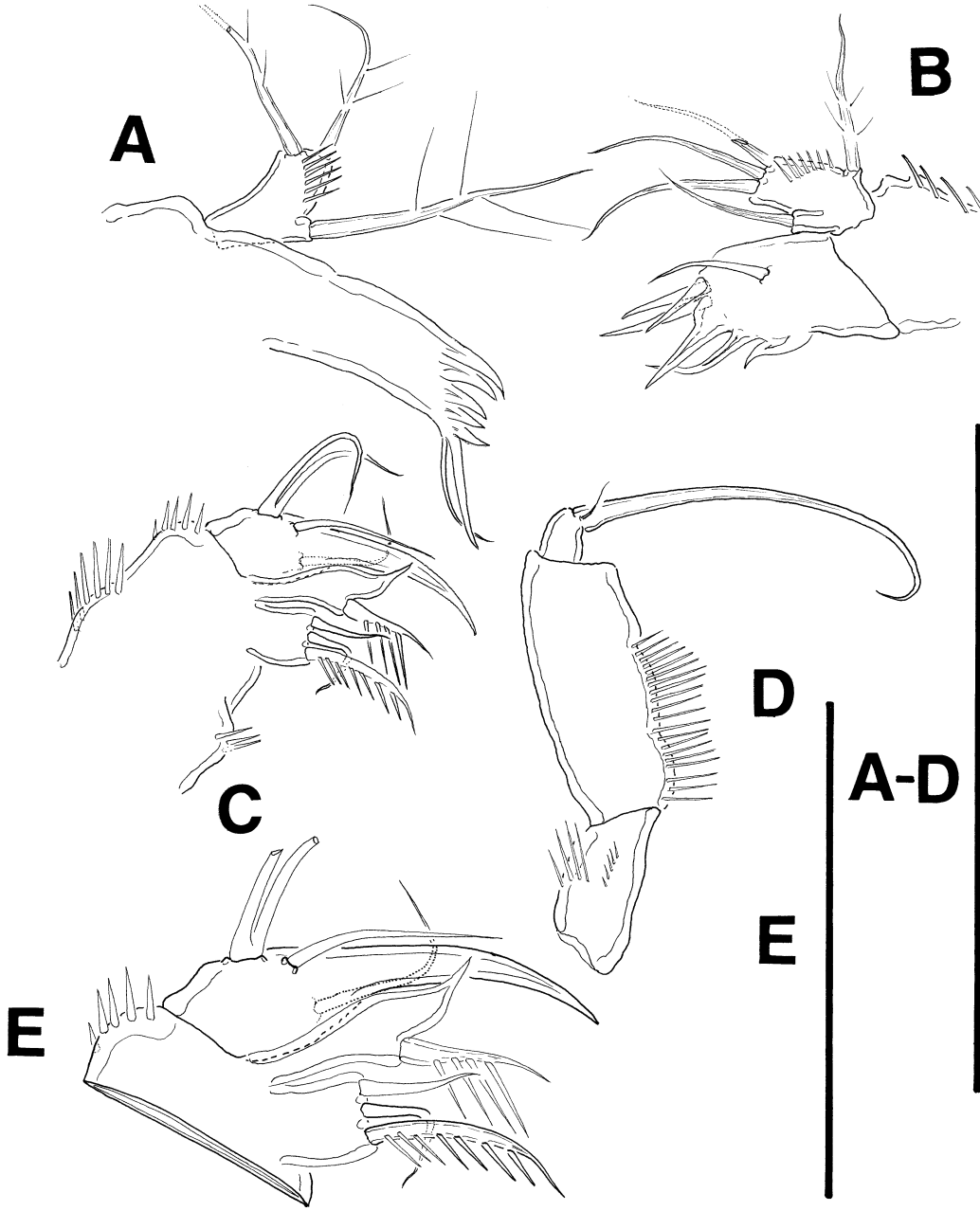

Fig. 4. *Enhydrosoma parapropinquum* sp. nov., female. A, mandible; B, maxillule; C, maxilla; D, maxilliped; E, distal part of maxillary syncoxa showing proximal and distal endite, and basis with claw, accompanying setae and endopod. Scale bars, A–D = 50 μm, E = 25 μm.

distal endite with one spinulose seta and a strong smooth element (Fig. 4E). Claw of basis with two accompanying setae. Endopod represented by two slender elements fused at their base.

Maxilliped (Fig. 4D), prehensile, with short syncoxa furnished with spinules, unarmed; basis with inner spinules; claw slender and curved distally, with accessory seta.

P1 (Fig. 5A), with coxa ornamented with several rows of spinules medially and close to outer and inner distal corners. Basis ornamented with strong spinules between rami and at base of inner and outer elements. Exopod three-

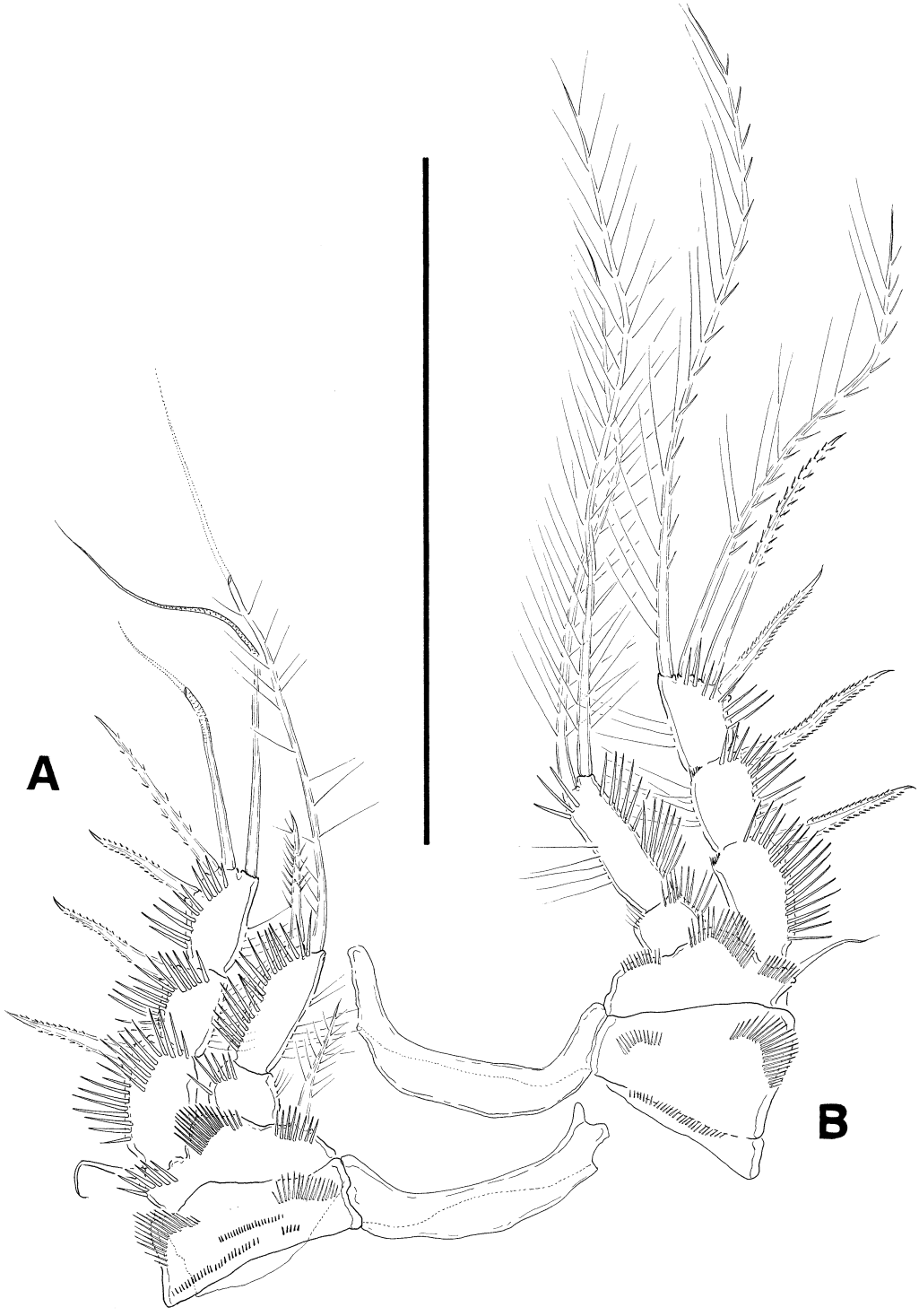

Fig. 5. *Enhydrosoma parapropinquum* sp. nov., female. A, P1; B, P2. Scale bar, 100 μm.

segmented; each segment ornamented with an outer spinular row; without inner elements; last segment with four setae/spines. Endopod two-segmented; first segment ornamented with outer spinules and inner fragile setules, small, as long as wide, and about one-third length of second segment; second segment reaching middle of third exopodal segment, about three times as long as wide, ornamented with an outer spinular row. Armature formula as below.

P2–P3 (Fig. 5B, 6A), with slender praecoxa ornamented with minute spinules close to joint with coxa. The latter with spinular rows close to inner and outer distal corners. Basis with spinules between rami, close to inner distal corner and at base of outer seta. Exopod three-segmented; each segment ornamented as in P1; first and second segment without inner element; third segment of P2 with four setae/spines, without inner element; third segment of P3 with five elements, one of them on inner margin. Endopod two-segmented, reaching joint between second and third exopodal segment; first segment small, as long as wide, about one-third length of second segment, ornamented with outer spinules and inner setules; second segment about three times as long as wide, ornamented with outer spinules, some apical inner spinules and inner setules; second segment of P2 with two setae, of P3 with two setae and one outer spine. Armature formula as below.

P4 (Fig. 6B), with praecoxa ornamented as preceding legs. Coxa as in P2 and P3 except for absence of inner spinular rows. Basis as in P2 and P3 except for fewer spinules on outer distal corner and absence of inner spinule row. Exopod as in P3. Endopod two-segmented; armature and ornamentation as in P3 except for absence of inner spinules on first endopodal segment of P4; first endopodal segment small, as wide as long, and about half length of second segment; the latter reaching joint between first and second exopodal segment. Armature formula as below.

P5 (Fig. 6C), baseoendopod with long, cylindrical outer extension bearing an outer seta; with produced endopodal lobe reaching about proximal third of exopod, ornamented with three transverse rows of long spinules and armed with two lateral inner spinulose setae and one apical element. Exopod elongate, with some spinules at base of apical seta, with three outer setae and one inner tube pore (arrowed in Fig. 6C).

P6 (Fig. 2), vestigial; each P6 represented by single seta ornamented with row of spinules close to insertion site. Copulatory pore in anterior half of genital double somite.

Armature formula of P1-P4 as follows:

	EXP	ENP
P1	I-0;I-0;II,2,0	0-0;0,1,0
P2	I-0;I-0;II,2,0	0-0;0,2,0
P3	I-0;I-0;II,2,1	0-0;I,2,0
P4	I-0;I-0;II,2,1	0-0;I,2,0

Male. Body (Fig. 7A, B), as in female dorsally and laterally, except for genital double somite. Length ranging from 360 to 470 μm from tip of rostrum to posterior margin of caudal rami (allotype, 360 μm). Ventral surface of second urosomite (P6-bearing somite) plain except for vestigial P6; third to fifth urosomite with long spinules along posterior margin (Fig. 8).

Antennule (Fig. 9A), six-segmented, subchirocer; surface of segments smooth except for three spinular rows on first segment and one row of long spinules on fourth segment, the latter globose. Armature formula difficult to define.

Mouthparts, P1, P2, and P4 (not shown), as in female.

Basis, first and third exopodal segment, and first endopodal segment of P3 as in female (Fig. 9B). Second exopodal segment with robust outer spine. Endopod two-segmented; second segment with long, hyaline outer distal process reaching tip of third exopodal segment; inner extension of second endopodal segment (third segment?) with two long apical setae.

Baseoendopod of P5 (Fig. 9C) as in female, except for only two strong elements in male P5 and only two transverse rows of long spinules. Exopod elongate, with one lateral outer seta, one apical strong element, and one inner tube pore (arrowed in Fig. 8C).

P6 (Fig. 8), vestigial, represented by two ventral plates close to posterior margin of somite, and ornamented with long spinules along posterior margin.

Variability.—The caudal rami L/W ratio of female specimens were found to range from 3.1 to 5. One female had the third exopodal segment of P2 with only three elements, one female had an aberrant exopod of P5, and another female had an aberrant left and right P5.

Enhydrosoma casoae sp. nov.
Figs. 10–14

Enhydrosoma sp. 1: Gómez, in press.

Type Locality.—Ensenada del Pabellón lagoon, Sinaloa, México (24°19′–24°35′N, 107°28′–107°45′W).

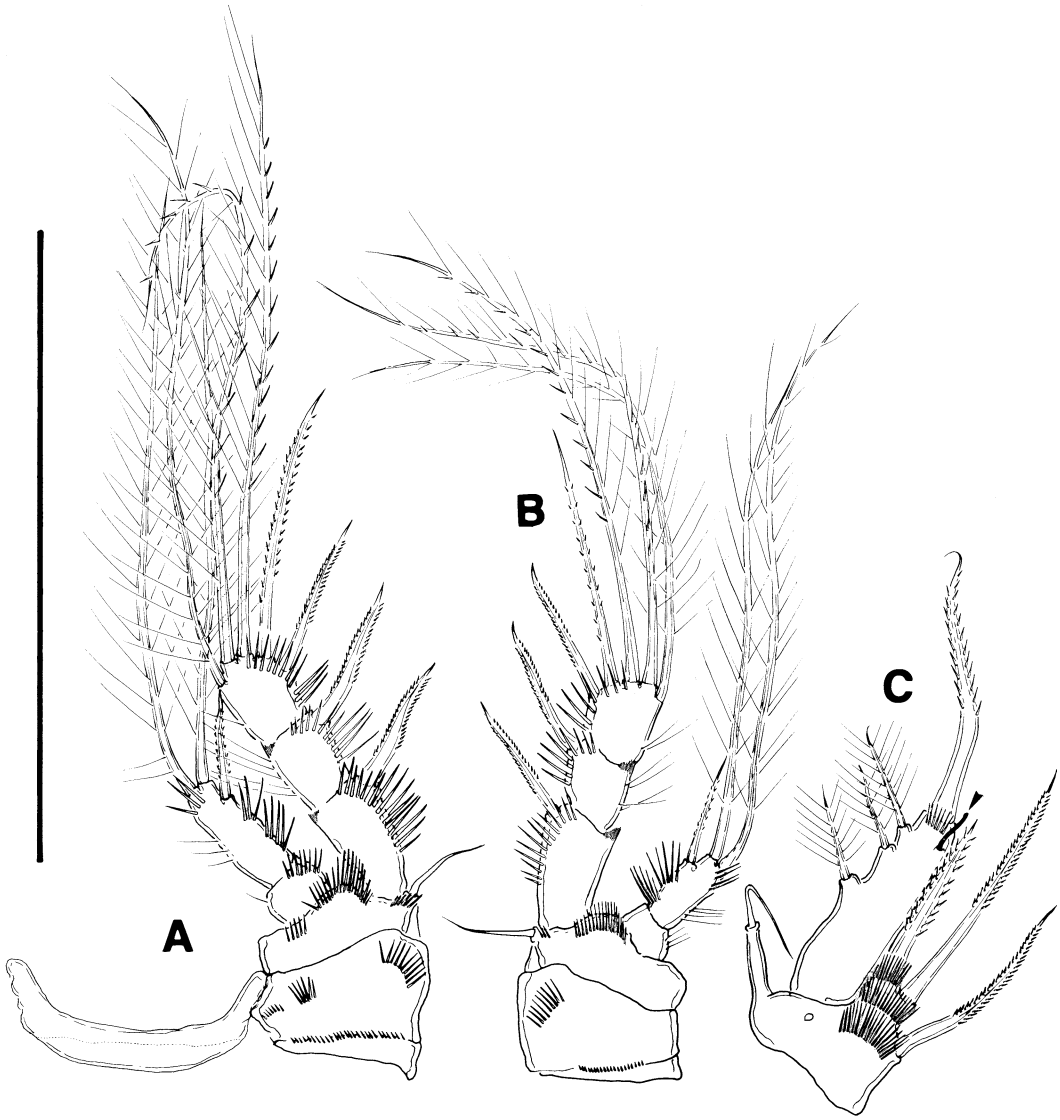

Fig. 6. *Enhydrosoma parapropinquum* sp. nov., female. A, P3; B, P4; C, P5 (tube pore arrowed). Scale bar, 100 μm.

Type Material.—One dissected female holotype (EMUCOP-240691-24); collected from station 15 in Ensenada del Pabellón lagoon in June 1991 (see Gómez-Noguera and Hendrickx, 1997); found in intertidal, lime, at 0–3 cm deep sediment; coll. S. Gómez.

Etymology.—The species is dedicated to the memory of Dr María Elena Caso Muñoz for her extensive work on Mexican echinoderms.

Description.—Female. Body (not illustrated) badly damaged during sample processing, tapering from posterior margin of cephalothorax. Body typically curved in lateral view. Approximate length 476 μm from anterior margin of rostrum to posterior margin of caudal rami. Rostrum as in *E. parapropinquum* sp. nov. Surface of prosomites seemingly ornamented with transverse rows of minute spinules and with rounded pleurites. Sensilla along posterior margin of cephalic shield, and first to third free thoracic somites and first urosomite difficult to see because of extensive damage during sample processing (presumably as in *E. parapropinquum* sp. nov.). Dorsal surface of genital double somite (Fig. 10A) ornamented with some rows of minute spinules; with

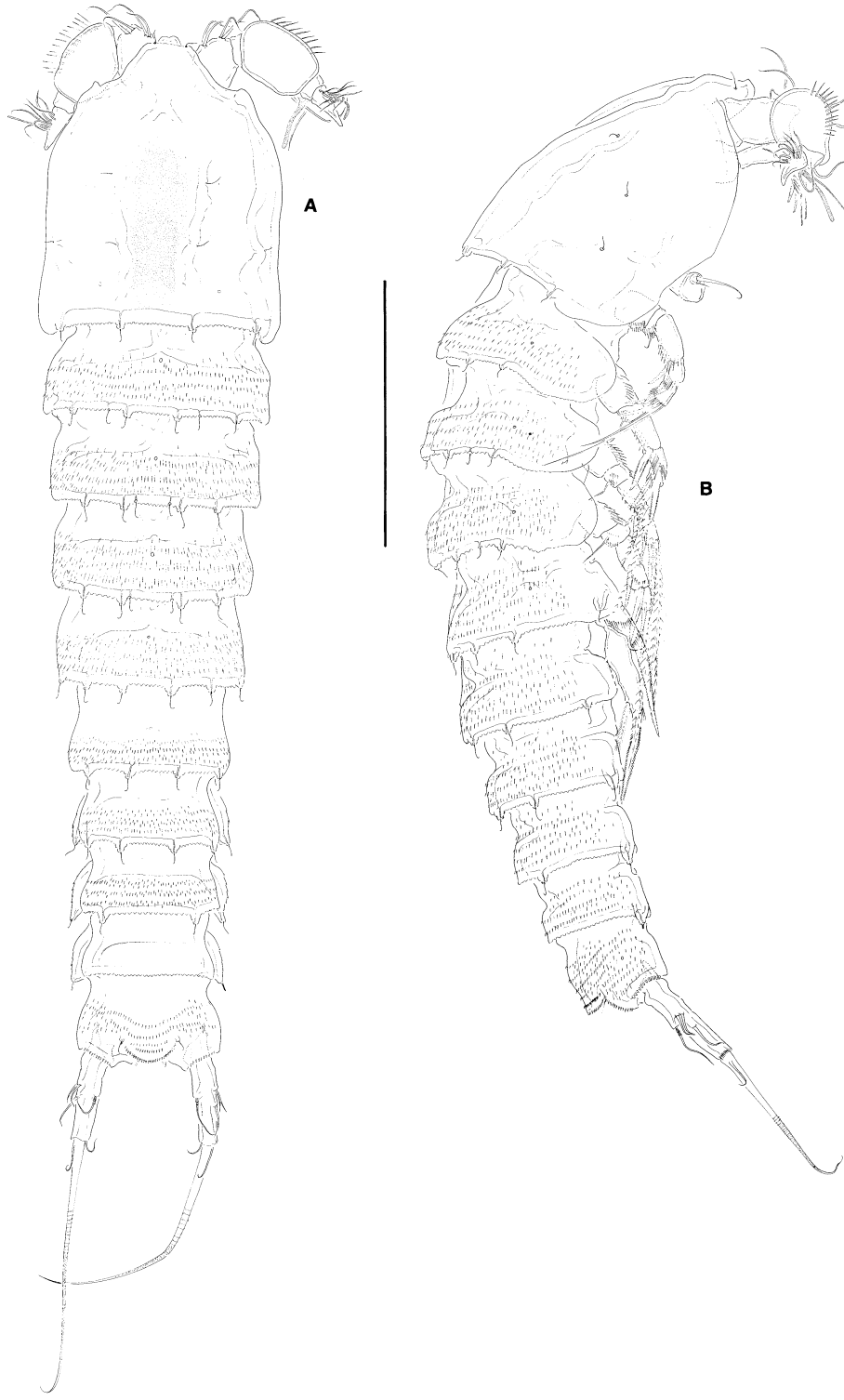

Fig. 7. *Enhydrosoma parapropinquum* sp. nov., male. A, habitus, dorsal; B, habitus, lateral. Scale bar, 100 μm.

dorsolateral indication of division between genital somites; with serrate posterior margin of first genital somite dorsally; second genital somite with serrate posterior margin; first genital somite (second urosomite) with one sensillum arising from lateral bulbous structure; second genital somite (third urosomite) with four sensilla arising from distinct cones dorsally and two sensilla arising from lateral bulbous structure; genital somites fused midventrally; ventral surface plain except for two spinular rows close to seta representing vestigial P6 and row of minute spinules along posterior margin of second genital somite, the latter with two sensilla arising from distinct cones ventrally (Fig. 10B). Fourth and fifth urosomites with rows of minute spinules and with serrate posterior margin dorsally; fourth urosomite with two dorsal and two ventral sensilla arising from distinct cones, and two sensilla arising from bulbous structure laterally; fifth urosomite without sensilla; ventral surface of fourth and fifth urosomite plain except for row of minute spinules along posterior margin of somites. Dorsal surface of anal somite smooth, except for transverse spinular row on anal operculum, the latter with dentate posterior margin and accompanied by two sensilla arising from distinct cones; with minute spinules close to joint with caudal rami dorsally and ventrally. Caudal rami rather cylindrical; longer than anal segment; about five times longer than wide; with long tube pore in proximal and distal quarters; with seven elements; setae I and II arising rather laterally halfway along outer margin, equal in size; seta III arising in distal third; seta IV small and fused to seta V; seta VI slightly shorter than seta IV; insertion site of seta VII comparatively more distal than in *E. parapropinquum* sp. nov.

Antennule (Fig. 11A, C, D), five-segmented; surface of segments smooth except for spinules on first, second, and third segment; fourth segment narrow; fifth segment nearly twice as long as wide; all setae smooth except for one and three spinulose elements on first and third, and last segment, respectively (Fig. 11C, D). Armature formula as follows: : 1-(1), 2-(5), 3(10 + ae), 4(1), 5(11 + ae). Setae on second segment could have fallen off during dissection.

Antenna (Fig. 11B, E), with long spinules along inner edge of allobasis; without abexopodal seta. Exopod one-segmented, with one lateral and one distal pinnate seta. Endopodal segment (Fig. 11E) with long, slender spinules on inner margin proximally and distally; with seven spines/setae.

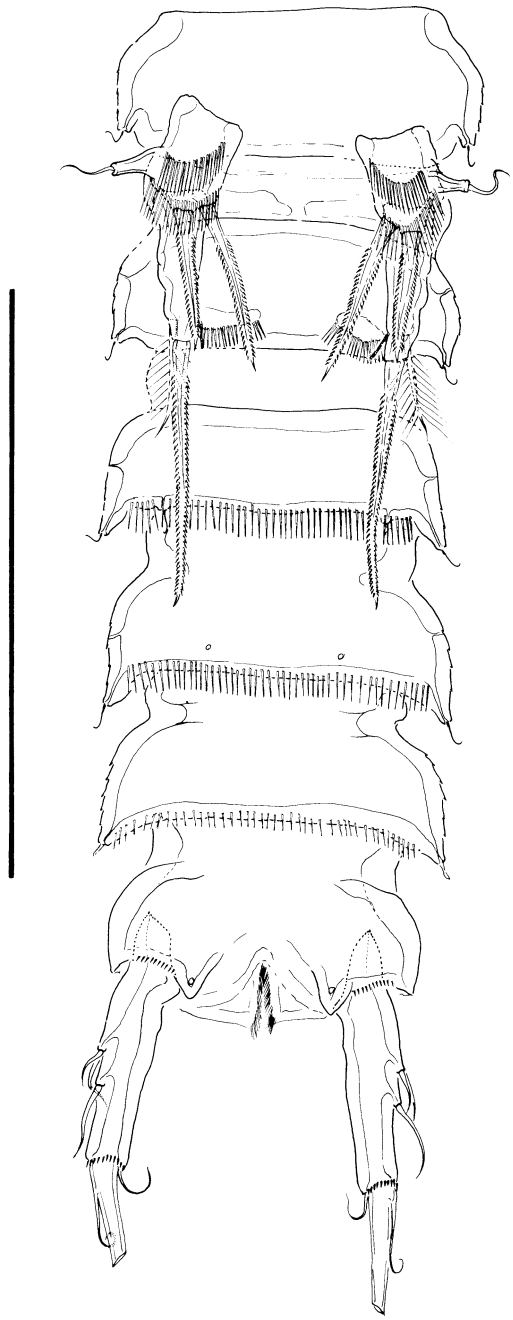

Fig. 8. *Enhydrosoma parapropinquum* sp. nov., male. Urosome, ventral. Scale bar, 100 μm.

Mandible (Fig. 12A), with slender gnathobase; biting edge with five short and two long

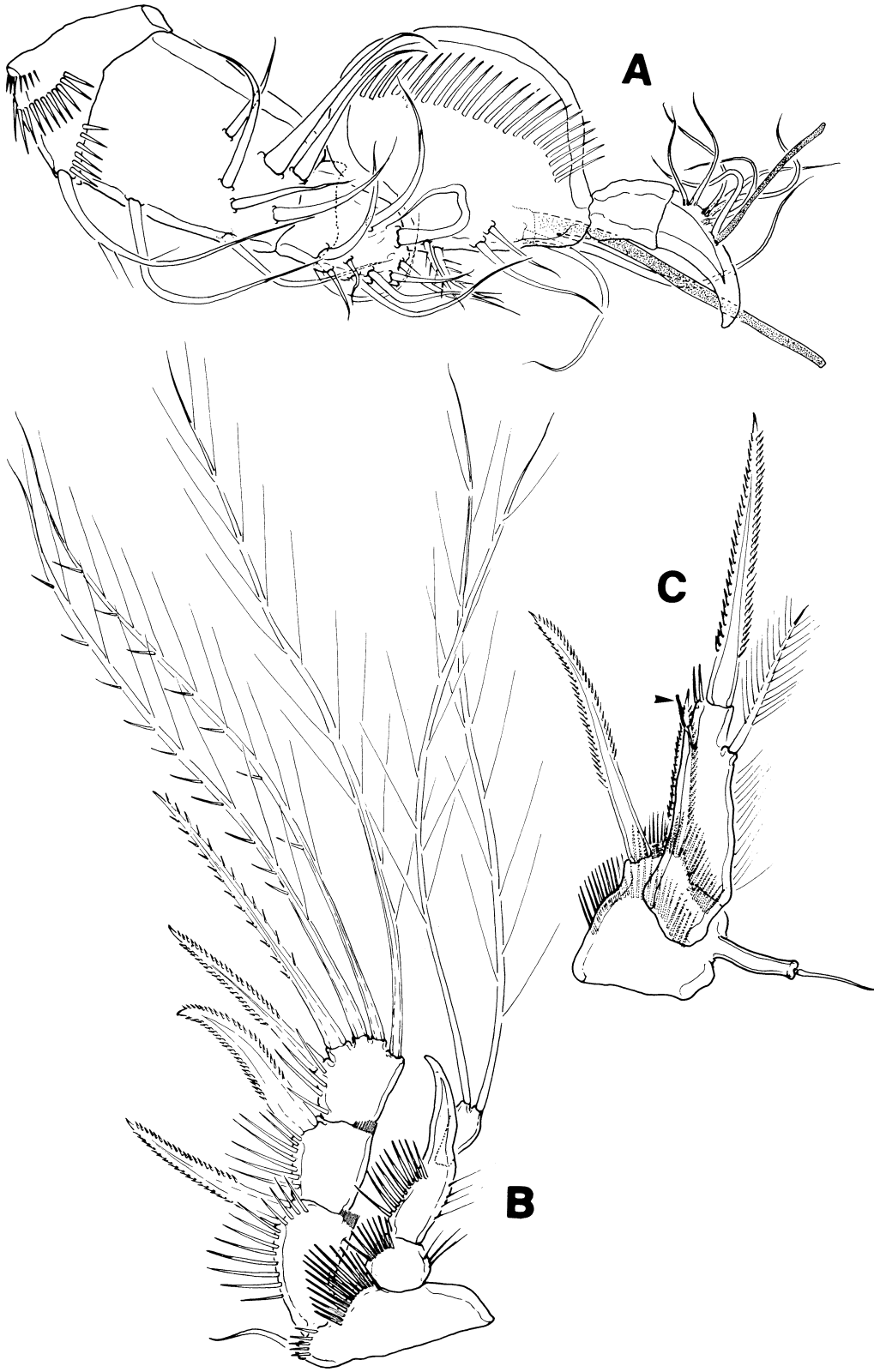

Fig. 9. *Enhydrosoma parapropinquum* sp. nov., male. A, antennule; B, P3; C, P5 (tube pore arrowed). Scale bar, 50 μm.

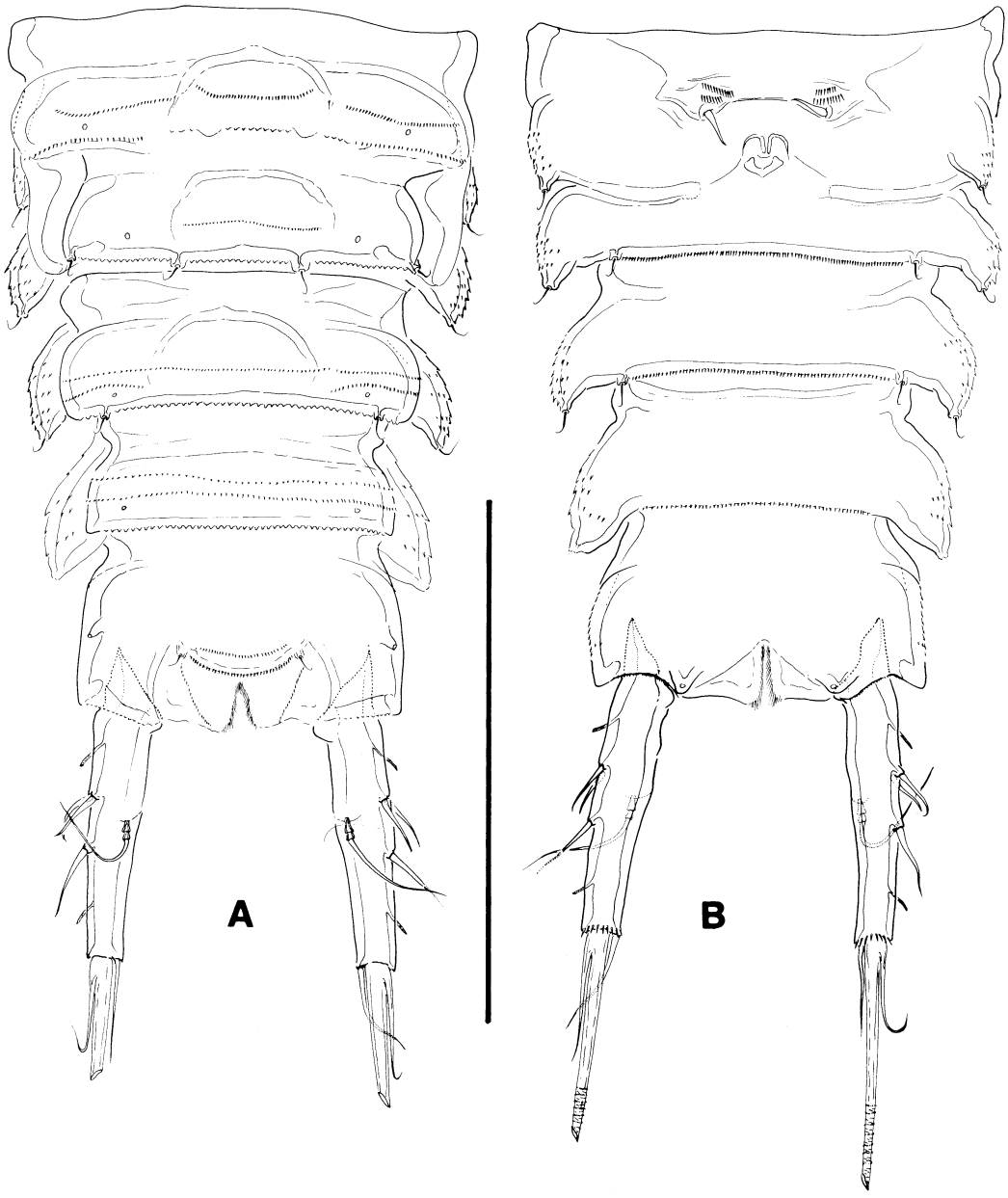

Fig. 10. *Enhydrosoma casoae* sp. nov., female. A, urosome, dorsal (P5-bearing somite omitted); B, urosome, ventral (P5-bearing somite omitted). Scale bar, 100 μm.

teeth; palp short, one-segmented, armed with three distal setae.

Maxillule (Fig. 12B), with arthrite ornamented with five distal and two lateral elements, and one surface setae; coxa basis with three apical and one lateral setae; endopod represented by single seta.

Maxilla (Fig. 12C), with spinules on inner and outer edge of syncoxa; proximal endite with one spinulose element and two smooth setae; distal endite with one spinulose seta and a strong element. Claw of basis unarmed, with two accompanying setae. Endopod represented by two slender elements fused at base.

Maxilliped lost during dissection. Presumably as in the morphologically very similar *E. solitarium* sp. nov. (see below).

P1–P2 (Fig. 13A, B), as in *E. parapropin-*

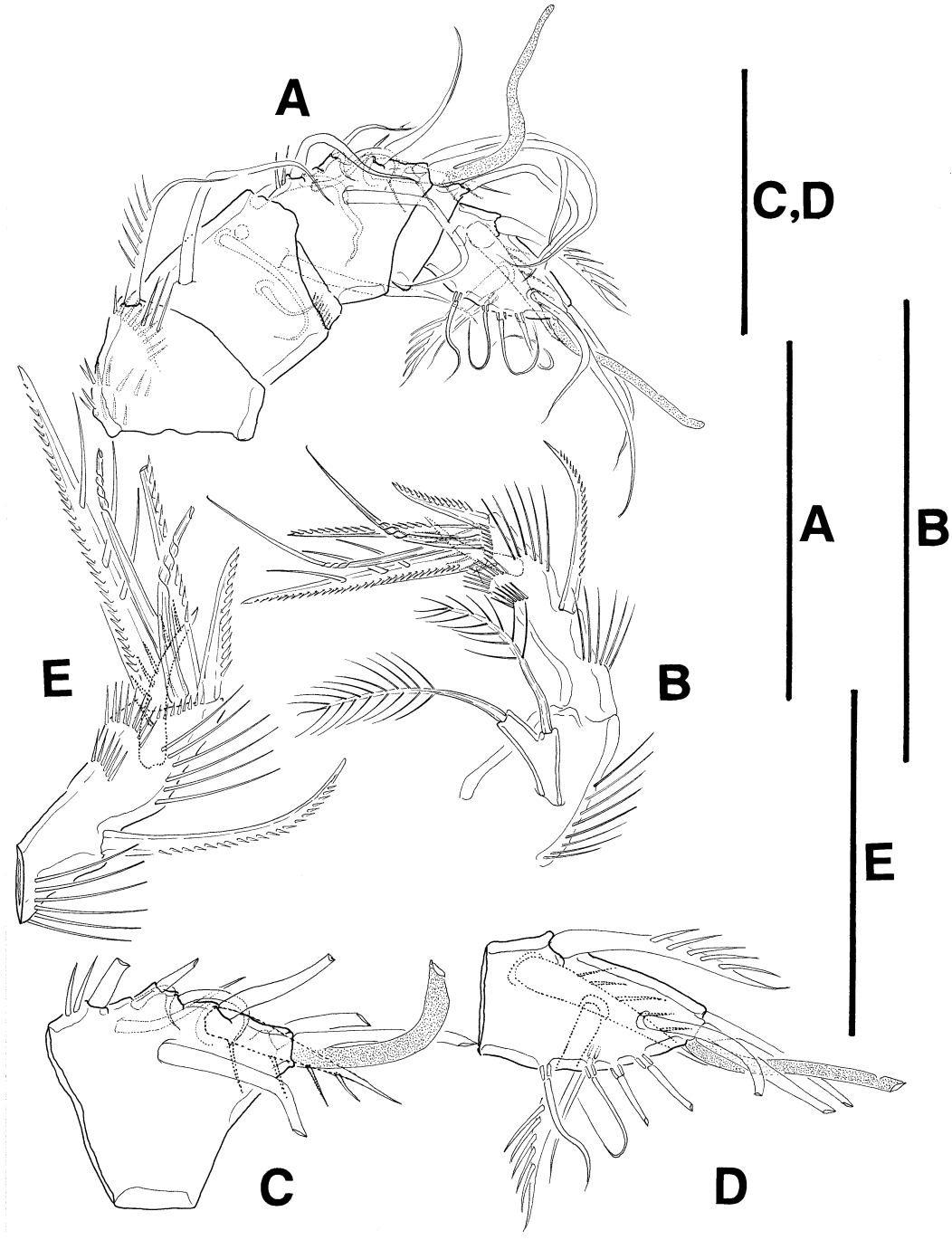

Fig. 11. *Enhydrosoma casoae* sp. nov., female. A, antennule; B, antenna; C, third antennulary segment; D, last antennulary segment; E. distal part of second endopodal segment of antenna. Scale bars, A, B = 50 μm; C–E, 25 μm.

quum sp. nov. except for comparatively longer P1 and P2 ENP 2 of *E. casoae* sp. nov. Armature formula identical to *E. parapropinquum* sp. nov. (see above).

P3–P4 (Fig. 14A, B), as in *E. parapropinquum* sp. nov. except for comparatively longer P3 ENP 2 and P4 ENP 2 of *E. casoae* sp. nov., and for more spinular rows on coxa of P3 and P4, and on basis of P4 of *E. casoae* sp. nov.

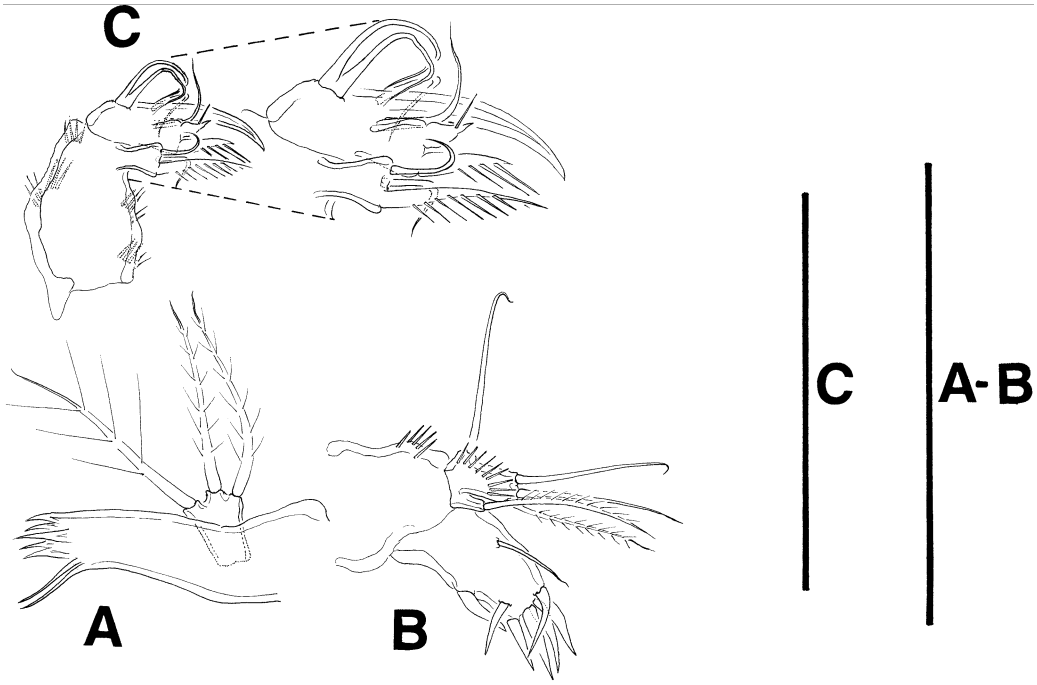

Fig. 12. *Enhydrosoma casoae* sp. nov., female. A, mandible; B, maxillule; C, maxilla. Scale bars, 50 μm.

Armature formula identical to *E. parapropinquum* sp. nov. (see above).

P5 (Fig. 14C), baseoendopod with long, cylindrical outer extension bearing an outer seta, with produced endopodal lobe reaching about proximal third of exopod, ornamented with one transverse row of small spinules proximally and two rows of longer spinules at level of innermost element and at base of distal seta. Exopod elongate, without spinules, ornamented with fragile setules along outer margin; armed with two outer setae and one apical strong element; with pore (arrowed in Fig. 14C).

P6 (Fig. 10B), vestigial; each P6 represented by single seta ornamented with two rows of spinules. Copulatory pore in anterior half of genital double somite.

Male. Unknown.

Enhydrosoma solitarium sp. nov.
Figs. 15–18

Enhydrosoma sp. 2: Gómez, in press.

Type Locality.—Ensenada del Pabellón lagoon, Sinaloa, México (24°19′–24°35′N, 107°28′–107°45′W).

Type Material.—One dissected female holotype (EMUCOP-030192-63); collected from station 9 in Ensenada del Pabellón lagoon in January 1992 (see Gómez-Noguera and Hendrickx, 1997); found in intertidal, lime, at 0–3 cm deep sediment; coll. S. Gómez.

Etymology.—The specific name refers to the fact that only one specimen of the species was found.

Description.—Female. Body (not illustrated) badly damaged during sample processing, tapering from posterior margin of cephalic shield, and curved in lateral view. Approximate length 356 μm from anterior margin of rostrum to posterior margin of caudal rami. Rostrum as in *E. parapropinquum* sp. nov. Surface of prosomites as in *E. casoae* sp. nov. Sensilla along posterior margin of cephalic shield, and first to third free thoracic somites and first urosomite difficult to see because of extensive damage during sample processing. Dorsal surface of genital double somite (Fig. 15A) ornamented with spinules distributed evenly; with indication of division between genital somites dorsally; with serrate posterior margin of second genital somite; first genital somite (second urosomite) with two sensilla arising from distinct cones dorsally, two arising from bulbous structure laterally, and two arising midway along lateral margin of first genital somite ventrolaterally;

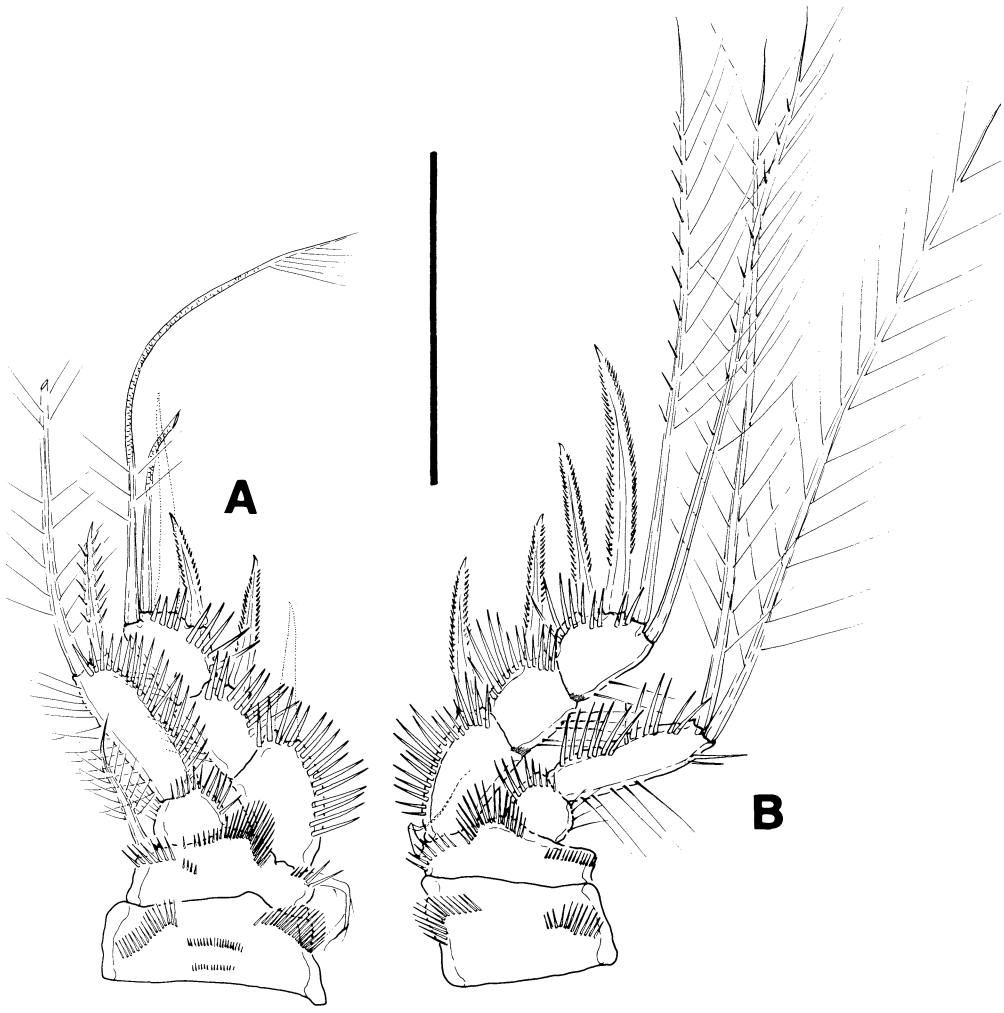

Fig. 13. *Enhydrosoma casoae* sp. nov., female. A, P1; B, P2. Scale bar, 50 μm.

dorsal surface of second genital somite ornamented with spinules as preceding somite, with four sensilla arising from distinct cones dorsally, one arising from bulbous structure laterally, and one sensillum arising from distinct cone ventrally; both genital somites fused midventrally; ventral surface of genital double somite plain except for vestigial P6 and copulatory pore and row of long spinules along posterior margin of second somite (Fig. 15B). Fourth urosomite ornamented as second genital somite dorsally and ventrally, except for number of dorsal sensilla arising from distinct cones. Fifth urosomite ornamented as preceding somite, except for ventral sensillum-bearing cones; dorsal distinct cones and lateral bulbous structure without sensillum but with tube pore (difficult to see). Anal segment covered with tiny spinules; rounded anal operculum ornamented with minute spinules on dorsal surface and along posterior margin, and accompanied by two sensillum-bearing cones. Caudal rami longer than anal segment; rather cylindrical; with seven elements in all; setae I and II inserted in distal half; seta III situated laterally in distal fifth; setae IV, V, VI as in preceding species; insertion of seta VII slightly more proximal than in *E. parapropinquum* sp. nov.

General shape of antennule (Fig. 16A–C), as in *E. parapropinquum* sp. nov. Armature formula as follows: 1-(1), 2-(7), 3(8 + ae), 4(1), 5(11 + ae). (Anterior part of the only representative of the species was badly damaged during sample processing. Some setae on third

Fig. 14. *Enhydrosoma casoae* sp. nov., female. A, P3; B, P4; C, P5 (pore arrowed). Scale bar, 50 μm.

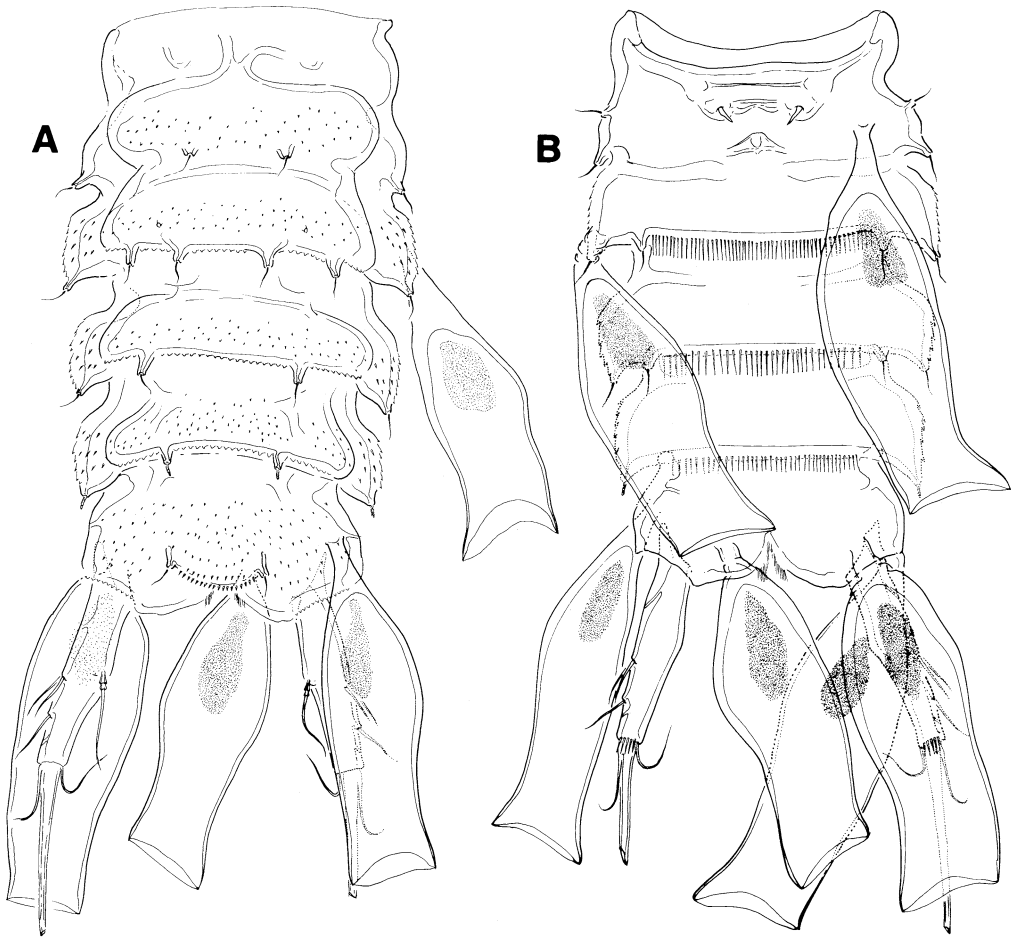

Fig. 15. *Enhydrosoma solitarium* sp. nov., female. A, urosome, dorsal (P5-bearing somite omitted); B, urosome, ventral (P5-bearing somite omitted). Scale bar, 100 μm.

segment could have fallen off either during sample processing or during dissection.)

Antenna (Fig. 16D, E), seemingly with few slender, long spinules along inner edge of allobasis; without abexopodal seta. Exopod one-segmented, with one lateral and one distal pinnate seta. Endopodal segment with spinules on inner margin proximally and subdistally; with seven spines/setae (Fig. 16E).

Mandible, maxillule, and maxilla (not illustrated), as in *E. parapropinquum* sp. nov. and *E. casoae* sp. nov.

Maxilliped (Fig. 16F), prehensile, with short syncoxa furnished with sparse spinules, unarmed; basis with inner spinules; claw slender and curved distally, with (or without?) accessory seta (arrowed in Fig. 16F, difficult to see).

P1–P4 (Fig. 17A, B, 18A, B), corresponds largely to those of *E. casoae* sp. nov. except for: a) comparatively longer outer spinules on exopod and endopod; b) comparatively longer spinules on basis between rami; c) absence of spinules at base of inner element of basis of P1; d) fewer and less dense spinular rows on coxa of P1, P3, and P4. Armature formula as in *E. parapropinquum* sp. nov.

P5 (Fig. 18C), similar in shape and armature formula to that of *E. casoae* sp. nov. With row of spinules at base of innermost and apical seta of baseoendopod, and at base of exopod (spinules comparatively stronger than in *E. casoae* sp. nov.). Exopod with two lateral and one apical element and inner tube pore (arrowed in Fig. 18C). Spinular ornamentation of baseoendopodal and apical exopodal setae comparatively coarser than in *E. casoae* sp. nov.

P6 (Fig. 15B): represented by median plate in middle of first genital somite; each leg repre-

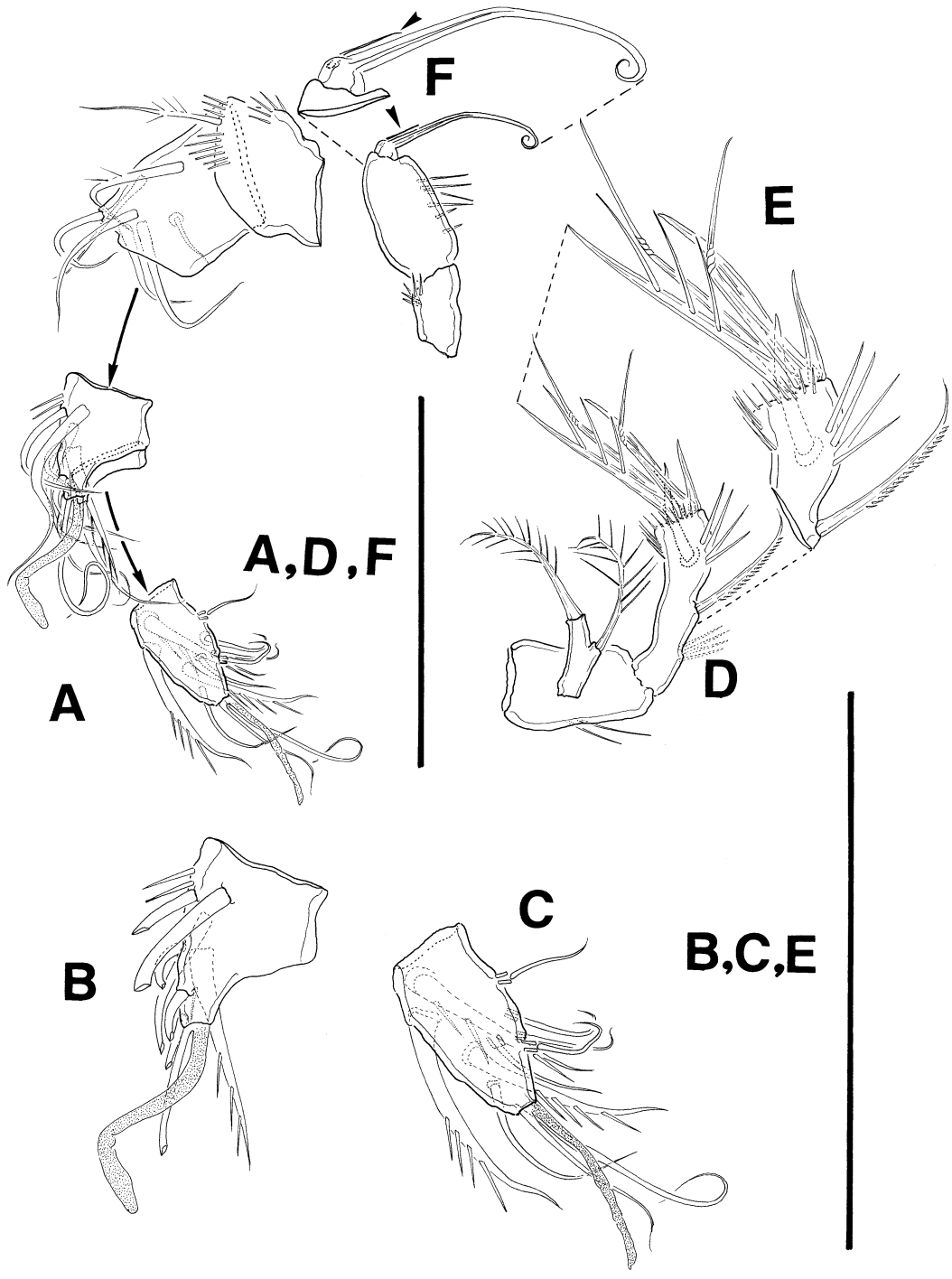

Fig. 16. *Enhydrosoma solitarium* sp. nov., female. A, antennule; B, third segment of antennule; C, last segment of antennule; D, antenna; E, second endopodal segment of antenna; F, maxilliped (accessory seta arrowed). Scale bars, A, D, F = 50 μm, B, C, E = 50 μm.

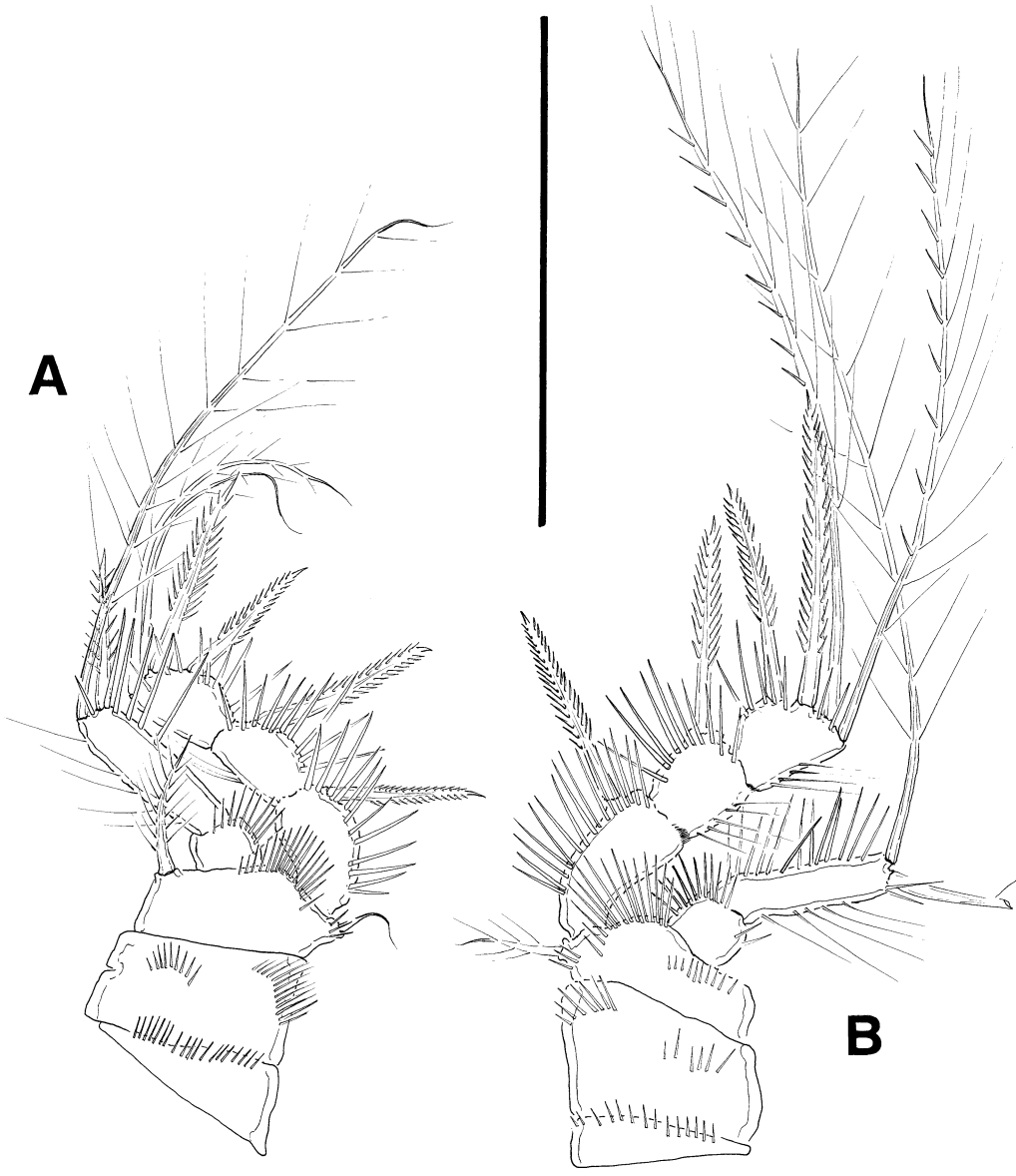

Fig. 17. *Enhydrosoma solitarium* sp. nov., female. A, P1; B, P2. Scale bar, 50 μm.

sented by single seta. Copulatory pore in anterior half of genital double somite.

Male. Unknown.

Enhydrosoma lacunae Jakubisiak, 1933
Fig. 19

Enhydrosoma woodini Thistle, 1980 (after Fiers, 1996: 2, 3, 19).

Enhydrosoma gerlachi Jakobi, 1955 (after Fiers, 1996: 3, 19).

Enhydrosoma mangroviae Jakobi, 1955 (after Fiers, 1996: 3, 20).

Type Locality.—Lagoon near Matanzas (North coast of Cuba) (Jakubisiak, 1933).

Distribution.—Brazil: Cananeia (Sao Paulo) (= *E. gerlachi* Jakobi, 1955; = *E. mangroviae* Jakobi, 1955) (Jakobi, 1955); Cuba: lagoon near Matanzas (Jakubisiak, 1933); México: Celestún lagoon (Yucatán Peninsula) (Fiers, 1996), Ensenada del Pabellón lagoon and Urías estuary (Sinaloa, northwestern México) (Gómez, in press; present study); U. S. A.: Beaufort (North Carolina) (= *E. woodini* Thistle, 1980) (Thistle,

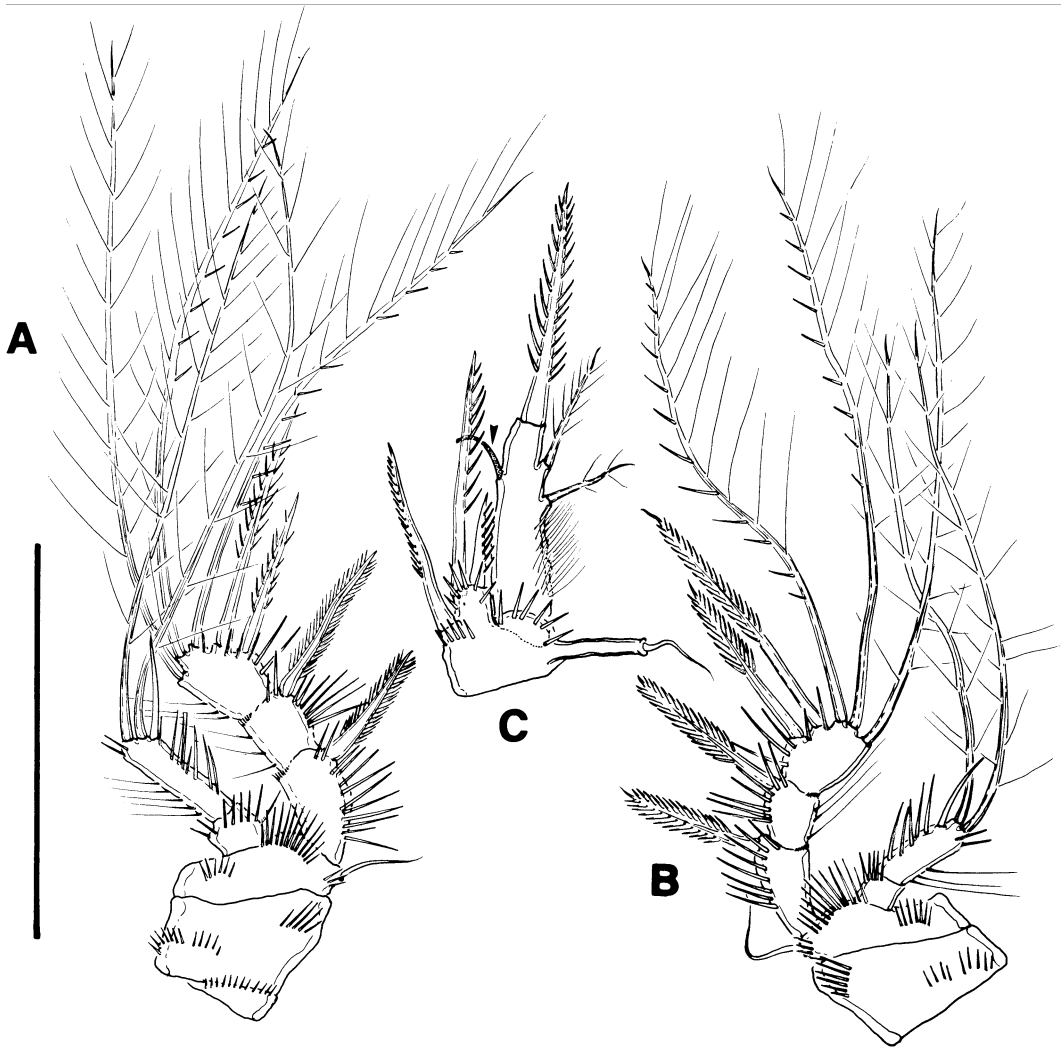

Fig. 18. *Enhydrosoma solitarium* sp. nov., female. A, P3; B, P4; C, P5 (tube pore arrowed). Scale bar, 50 μm.

1980), near Cocodrie (Louisiana) (Decho and Fleeger, 1988).

Citations.—For a complete list see Fiers (1996: 18).

Material Examined.—Two adult females preserved in alcohol (EMUCOP-090301-20, EMUCOP-300491-36), six dissected females (EMUCOP-020591-35, EMUCOP-030192-64, EMUCOP-090301-19, EMUCOP-240691-25, EMUCOP-300491-33, EMUCOP-300491-35), and one dissected male (EMUCOP-300491-34); collected from stations 8, 10, 11, and 15 in Ensenada del Pabellón lagoon in May, June, and April 1991, and January 1992 (see Gómez-Noguera and Hendrickx, 1997), and from station 9 in March 2001 in Urías estuary (unpublished data); found in intertidal, lime, at 0–6 cm deep sediment in Ensenada del Pabellón lagoon (see Gómez-Noguera and Hendrickx, 1997), and at 0–3 cm deep sediment in Urías estuary (unpublished data); coll. S. Gómez.

Redescription.—Female. Total body length ranging from 335 to 388 μm from tip of rostrum to posterior margin of caudal rami. Body (not illustrated) and caudal rami (Fig. 19A–C), antennule, mandible, maxillule, maxilla, maxilliped, P1–P6 (not shown) identical to those described by Fiers (1996) from Yucatan.

P5 (Fig. 19D, E), corresponds largely to those of *E. lacunae* from Yucatan as described by Fiers (1996: 7; Fig. 4F, G), except for the

relative length of the baseoendopodal elements of specimens found in Urías estuary (compare Fig. 19D and E).

Male. Total body length, 392 μm from tip of rostrum to caudal rami. Body, antennule, P3 (not illustrated), and caudal rami (Fig. 19F) as in Fiers (1996). Mandible, maxillule, maxilla, maxilliped, P1, P2, and P4 (not illustrated) as in female. P5 (Fig. 19G) as in Fiers (1996).

Comparison and Discussion

Enhydrosoma parapropinquum sp. nov. bears a strong resemblance to *E. propinquum*. Unfortunately, the descriptions of *E. propinquum* are poor in detail or deal only with female caudal rami, P1, P2, and P5 (Brady, 1880; Por, 1960; Marinov, 1971; Apostolov, 1973; Mielke, 1975), exceptionally with mouth appendages (Sars, 1909), and only Por (1960) shows the genital field of the species, although poor in detail. Besides, Brady (1880) stated that the mouth-organs of *E. propinquum* are as in *Stylicletodes longicaudatus* (Brady and Robertson in Brady, 1880) (which is clearly a misinterpretation, Fiers *in litt.*), and *Cletodes limicola* Brady, 1872. However, the above authors concur in the subovate shape of caudal rami and in the rather broad exopod of female P5. These are different from that of *E. parapropinquum* sp. nov. (caudal rami rather cylindrical and exopod of female P5 less broad).

The male P3 endopod of *E. propinquum* remains unknown. That only a few species (*E. latipes* (A. Scott, 1909); *E. gariene* Gurney, 1930; and *E. pericoense* Mielke, 1990) have been reported bearing one or more enlarged outer spines on the exopod of P3 has been documented earlier (Gee, 1994). *Enhydrosoma parapropinquum* sp. nov. is the fourth species known to bear enlarged outer exopodal spines on the male P3 exopod. With regard to the segmentation patterns of the male endopod of P3 proposed by Gee (1994), *E. parapropinquum* sp. nov. lies in Gee's (1994) second category (with a two-segmented endopod with second segment having the same number and form of armature elements as in female, with enlarged outer apophysis (spine) fused to the outer margin of the second endopodal segment, and with ornamentation pattern different to that of the outer spine in the female). Gee (1994) pointed out that some species (*Stylicletodes stylicaudatum* (Willey, 1935); *E. hopkinsi* Lang, 1965; *E. vicinum* Por, 1967; *E. littorale* Wells, 1967; *E. baruchi* Coull, 1975; *E. herrerai* Bell and Kern, 1983; and *E. pericoense*) have been reported having a three-segmented male P3 endopod, and suggests the possibility that this can, in fact, be a misinterpretation, as the presence of the fused spine may make it appear from certain viewing angles that the distal portion of the segment is separate even though there is no true articulation present. This is the case for male P3 endopod of *E. parapropinquum* sp. nov. that at first glance appears to be three-segmented.

There are only few *Enhydrosoma* species in which the female P5 exopod possesses only two outer and one apical seta, and the endopodal lobe possesses three setae and reaches only the proximal third of exopod: *E. hopkinsi*; *E. vicinum*; *E. longifurcatum* Sars, 1909; *E. casoae* sp. nov.; and *E. solitarium* sp. nov.

Por (1967) pointed out that *E. vicinum* could be separated from *E. hopkinsi* and *E. propinquum* by the rostrum, caudal rami, and armature formula of P5. However, some years later, Coull (1975: 117) questioned the identity of *E. vicinum* and regarded this species as a synonym of Lang's *E. hopkinsi* based mainly on the great similarity in caudal rami (the variability observed in *E. vicinum* (Por, 1967: 150, Figs. 219, 220) includes the caudal rami observed in *E. hopkinsi*, for which no variability was observed), rostrum, and armature of female and male P5.

The presence/absence of syncoxal armature and accessory seta of endopodal claw have been used to separate species-groups and could be of taxonomic value (Gee, 1994). The fact that the syncoxal armature of maxilliped can be knocked off during dissection (Gee, 1994) is of less relevance when a large number of specimens have been dissected as in the case of *E. vicinum* (it is improbable that the syncoxal armature and accessory seta of the endopodal claw of maxilliped of 10 specimens of *E. vicinum* analysed by Por (1967) were lost during dissection). Taking all the above into account, it is clear that the maxilliped of *E. vicinum* and *E. hopkinsi* are different. *Enhydrosoma vicinum* lacks the syncoxal seta and endopodal accessory seta of the maxilliped, whereas *E. hopkinsi* shows a large pinnate seta on inner distal corner of syncoxa and an accessory seta accompanying the endopodal claw. Moreover, in my opinion, it is difficult to believe that *E. vicinum*, known from the Red Sea, and *E. hopkinsi*, known from California, are the same species. Even though

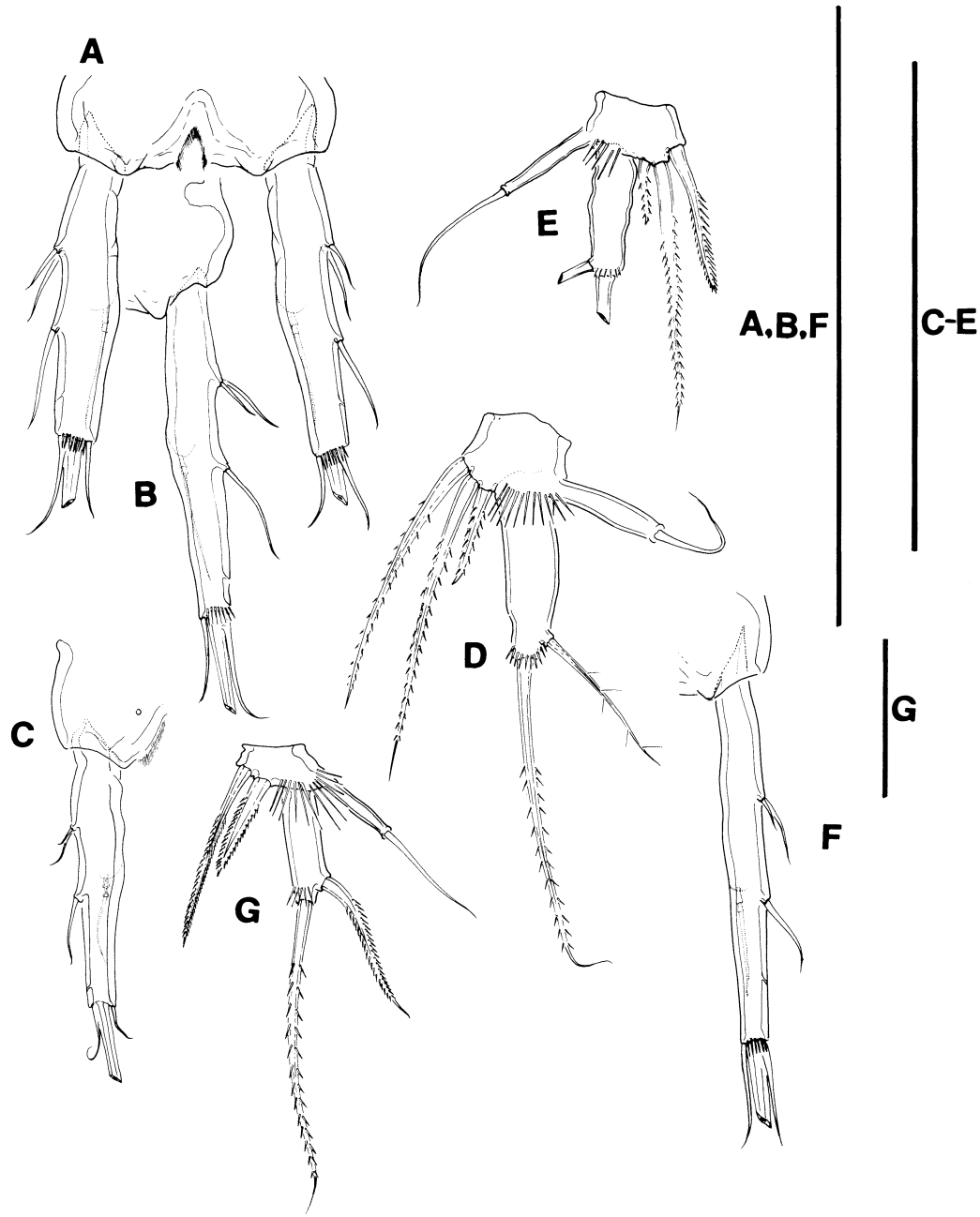

Fig. 19. *Enhydrosoma lacunae* Jakubisiak, 1933. A–E, female; F, G, male. A, caudal rami, ventral; B, another female, left caudal ramus, ventral; C, another female, right caudal ramus, ventral; D, P5 from specimen collected in Ensenada del Pabellón lagoon; E, P5 from specimen collected in Urías estuary; F, left caudal ramus, ventral; G, P5. Scale bars, A, B, F, 70 μm; C, 100 μm; D, E, 70 μm; G, 25 μm.

amphiatlantic harpacticoid sister species may exist, this must be a very rare phenomenon among truly interstitial harpacticoids. That *E. vicinum* and *E. hopkinsi* are different species was implicitly suggested by Gee (1994) and are considered as such in the present contribution.

Enhydrosoma casoae sp. nov. and *E. solitarium* sp. nov. seem to be related to *E. vicinum*, *E. longifurcatum*, and *E. hopkinsi* by the unique

shape and armature of female P5. However, *E. hopkinsi* as illustrated by Lang (1965: 433; Fig. 234a, i) differs from the other four species in the caudal rami (oval and two times longer than broad in *E. hopkinsi*, but rather cylindrical and more than two times longer than broad in *E. casoae* sp. nov., *E. solitarium* sp. nov., *E. vicinum*, and *E. longifurcatum*), and armature of syncoxa of maxilliped (absent in *E. casoae* sp. nov., *E. solitarium* sp. nov., and *E. vicinum*, but present in *E. hopkinsi*). *Enhydrosoma longifurcatum* has been reported repeatedly. Despite the fact that some of its appendages have been illustrated by different authors (i.e., Sars, 1909; Lang, 1936; Bodin, 1970; Arlt, 1983; Apostolov and Marinov, 1988), the maxilliped remains unknown and no comments on its armature can be given.

The only report available on *E. vicinum* is the original description provided by Por (1967), in which he gave no comment on mandibular structure, and the description of other mouth appendages and caudal rami is rather brief and poor in detail. However, from his illustrations, it seems that *E. casoae* sp. nov., *E. solitarium* sp. nov., and *E. vicinum* lack the seta on the syncoxa of maxilliped.

The males of *Enhydrosoma casoae* sp. nov. and *Enhydrosoma solitarium* sp. nov. were not found, and no comments on the dimorphism of P3 endopod can be given.

Enhydrosoma casoae sp. nov. and *Enhydrosoma solitarium* sp. nov. can be separated by the ventral spinular ornamentation of urosome and spinular ornamentation of female P5 baseoendopod.

Jakubisiak (1933) gave a brief description of *Enhydrosoma lacunae* from a lagoon near Matanzas in the north coast of Cuba. Jakubisiak's (1933) description deals mainly with the gross morphology of swimming legs and caudal rami, and only a brief description of the antennule and antenna was provided, whereas the remaining mouth appendages were regarded as resembling those of the type. This species was redescribed by Fiers (1996) from Celestún Lagoon, an estuary in the northwest corner of the Yucatan Peninsula. In the present study, *E. lacunae* is reported again, but this time from Ensenada del Pabellón Lagoon, a coastal system in southeastern Gulf of California, México. The specimens found in Ensenada del Pabellón lagoon proved to be identical to those upon which Fiers (1996) based his redescription of the species.

Amphiamericanism within Harpacticoida is a rather common phenomenon. Western Atlantic species could have colonized the Eastern Pacific sometime during the Early Tertiary before the consolidation of the Central American Isthmus (Woodring, 1966; Malfait and Dinkelman, 1972; Rosen, 1975; Gómez, 2000, 2001, in press). However, this does not explain the great similarity between these two populations. One would expect at least some morphological differences. Therefore, some other means of passive transport should be taken into account when explaining the present-day distribution of Amphiamerican species. There is strong evidence that supports the hypothesis of planktonic organisms being transported in ballast water of ships (Lavoie et al., 1999, and references cited therein). However, harpacticoids are known to have benthic nauplii. Although harpacticoid copepodids and adult organisms inhabit the benthic realm, it is well known that they do migrate vertically in the water column. Benthic copepodid and adult stages of species inhabiting shallow coastal systems, such as enhydrosomids, could well be transported to new systems in the ballast water of ships.

That *E. lacunae* originated somewhere in the Caribbean Sea seems to be the most plausible hypothesis, given its relationships with some other enhydrosomid taxa (see Fiers, 1996). Whatever its origin might be, *E. lacunae* could have been transported in the ballast water in ships from the Caribbean to the Eastern Pacific and *vice versa* since the early 1900s. The presence of *E. lacunae* in northwestern Mexico could be explained either by transport in ballast water or alongshore dispersal. The species has not been found anywhere else in the Eastern Pacific, but this could be the result of the low number of studies about harpacticoids in the area. Given the above, *E. lacunae* can be considered as an invasive species. Of course, this hypothesis needs to be tested in the future through examination of ballast water of ships. Although the distribution of the species seems to be restricted to the neotropics, some light on its origin can be shed through phylogentic analyses of the species within Cletodidae and related taxa.

Acknowledgements

I am grateful to Dr F. Fiers (Koninklijk Belgisch Instituut voor Natuurwetenshappen) and Dr E. Schockaert (Limburgs Universitair Centrum, Belgium) for their support during my stay in Belgium. This paper is a contribution to project CONACyT 129884-B ("Effects of organic enrichment on the distribution, abundance and diversity of harpacticoid copepods (Copepoda, Harpacticoida) from the bay of Mazatlán, Sinaloa"), and project G.0086.96, the latter

financed by the Fund of Scientific Research-Flanders (Belgium) and the General Office for Affairs of the Academic Staff of the National Autonomous University of Mexico.

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Received: 8 February 2002.
Accepted: 19 June 2002.