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SENTIROPSIS VIETNAMENSIS N. SP., A NEW PSEUDOTACHIDIID (COPEPODA: HARPACTICOIDA) FROM THE SOUTH CHINA SEA

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ABSTRACT

Aiming at a better understanding of the harpacticoid diversity of the South China Sea, sediment samples were taken from Nha Trang Bay (Vietnam) during a sampling campaign carried out in April, 2004. Two female specimens of the monotypic genus *Sentiropsis* were found. These turned out to belong to a new species, *Sentiropsis vietnamensis* n. sp., which can be separated from the type species *S. minuta* by the shape of the setae of the female antennule, size of the seta of the second segment of the antennary exopod, lateral setation of the endopod of the mandible, armature of the arthrite of the maxillule, shape of the seta of the syncoxa of the maxilliped, shape of the seta of the basis of the maxilliped, ventral spinular ornamentation on the posterior half of the genital double-somite and fourth urosomite of the female, P1ENP1:P1ENP2 length ratio, armature formula of the female P5EXP, shape of the apical setae EXP3 and ENP2, length ratio of the outer spines of P4EXP1 and EXP2, the shape and size of the endopodal lobe of P5, and length of the apical seta on the P5 endopodal lobe. The diagnosis of the genus is amended.

KEY WORDS: Harpacticoida, *Sentiropsis vietnamensis*, Vietnam

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INTRODUCTION

Systematic studies of the marine fauna of Vietnam started in 1924 at the Kauda Marine Biological Station on Nha Trang Bay. The studies were continued later by the Oceanographic Institute of Indochina. Serène (1937) published a preliminary list of marine invertebrate species of Indochina, but it was far from complete. Fifteen years later, Dawydoff (1952) produced more complete species lists with remarks on the fauna. Vietnamese, Soviet, and Chinese scientists studied the faunal diversity and biogeography of the region, especially the northern part (Hainan Island and the Gulf of Tonkin) during the 1950s and 1960s (Gurjanova, 1959, 1972). New surveys of the marine invertebrate fauna in this region were undertaken during the 1980s and 1990s (Lukin et al., 1988; Britaev et al., 1991), and the Russian-Vietnamese Technical and Scientific Tropical Center was created in 1988 to coordinate ecologic and taxonomic studies of marine communities in Vietnamese waters. To date, the main area of investigations of marine fauna has been Nha Trang Bay; the high habitat diversity (from estuarine and mangrove forests to exposed beaches and coral reefs communities) and geographic position are potential causative factors explaining the high species diversity of different groups of marine animals. Despite recent intensive research, the marine species diversity of Nha Trang Bay (including crustaceans) is far from complete (Udalov et al., 2006). Even though several groups have been described in detail, e.g., the symbiotic shrimps associated with corals, sponges, and echinoderms (Marin, 2005; Marin et al., 2005a, b), the biodiversity of harpacticoid copepods, the most abundant meiobenthic group of crustaceans, is poorly known and has been underestimated. Chertoprud et al. (2008) pointed out that more than 50% of the species of harpacticoid copepods found in Nha Trang Bay are new to science.

Some specimens of the up-to-now monotypic genus *Sentiropsis* Huys and Gee, 1996 were found in sediment samples from Nha Trang Bay. These specimens turned out to belong to a second species of the genus, whose description is given below.

MATERIALS AND METHODS

Sediment samples were taken from coral sand at the upper sublittoral zone of Mot Island (Nha Trang Bay, southern Vietnam) using hand-held plastic corers. The sediment samples were fixed in 4% formalin and copepods were separated by flotation and sieved through 70 μm sieves. Observations and drawings at a magnification of 1000× were made from whole and dissected specimens mounted in lactophenol with a Leica DMLB compound microscope equipped with phase contrast and a drawing tube. Additional observations were done at a magnification of 2500×. The type material was deposited in the copepod collection of the Instituto de Ciencias del Mar y Limnología, Mazatlán Marine Station (Mexico). We adopted the terminology proposed by Huys and Boxshall (1991) for the general description. Abbreviations used in the text and tables are: ae = aesthetasc, ENP = endopod, EXP = exopod, P1-P6 = first to sixth swimming legs, and P1 (P2-P4) EXP (ENP) 1 (2, 3) denotes the proximal (middle, distal) exopodal (endopodal) segment of P1, P2, P3, or P4.

SYSTEMATICS

Pseudotachidiidae Lang, 1936
Paranannopinae Por, 1986
Sentiropsis Huys and Gee, 1996
Sentiropsis vietnamensis n. sp.
(Fig. 1-5)

Type material.—Female holotype (EMUCOP-280404-01) preserved in alcohol and dissected female paratype (EMUCOP-280404-02); Coll. I. N. Marin.

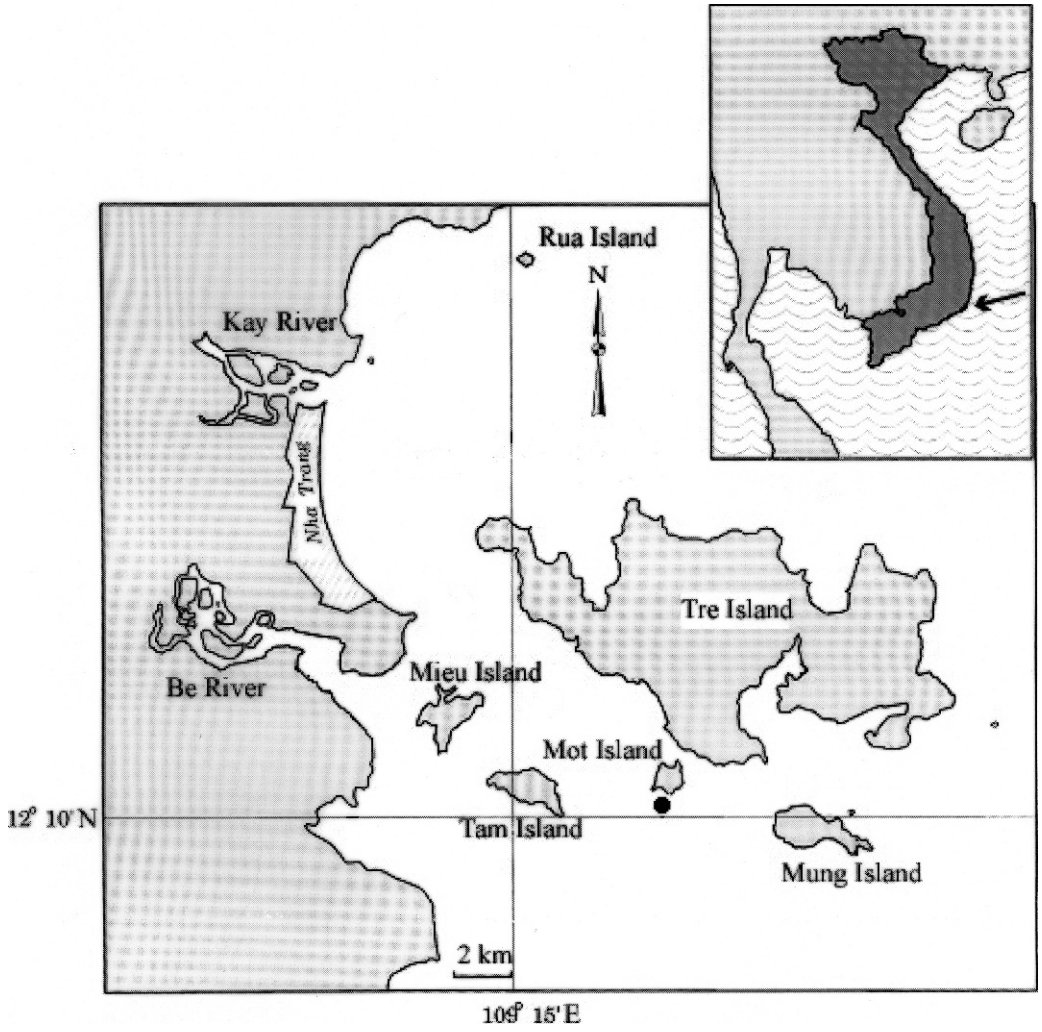

Fig. 1. Type locality in Nha Trang Bay.

Type locality.—Nha Trang Bay, southern Vietnam, in the upper sublittoral zone of Mot Island (12°10.413N, 109°16.701E) (Fig. 1); 28 April 2004; 5 m depth, coral sand, mean particle size 3 mm; silt 8%.

Etymology.—The specific name alludes to the region (South China Sea) where the species was found.

Description.—Female. Body subcylindrical, widest at posterior part of cephalothorax (Fig. 1A, B). Total body length of holotype, measured from tip of rostrum to posterior margin of caudal rami, 410 µm. Rostrum (Fig. 1A, B, 3A) distinct, articulation with cephalothorax narrow, large, hyaline, rounded distally and tapering proximally, with two pairs of dorsal sensilla and one mid-dorsal tube-pore. Cephalothorax, somites bearing P2 and P3 without spinular ornamentation; with transverse continuous spinular row close to posterior margin of somites bearing P4 and P5, in anterior half and close to posterior margin of genital-double somite, and close to posterior margin of fourth urosomite. Fifth urosomite with lateroventral spinules close to posterior margin. Cephalothorax, P2-P5-bearing somites, genital double-somite, and fourth urosomite with plain hyaline frills. Fifth urosomite with dentate pseudoperculum. Anal somite without anal operculum. Original segmentation of genital double-somite marked by internal chitinous ribs dorsally, laterally, and ventrally (Figs. 1A, B, 2A). Fourth and fifth urosomites with internal chitinous ribs ventrally (Fig. 2A). Urosomites with spinular pattern as depicted (Fig. 2A). Genital apertures (Fig. 2A) closed off by paired operculae derived from vestigial P6, each with long outer seta and tiny inner element (Fig. 2A). Midventral copulatory pore positioned halfway the length of the genital double-somite. Caudal rami short, wider than long; with one large tube-pore at posterior outer corner ventrally (arrow, Fig. 2A); ornamented with spinules as figured (Fig. 1C, D, 2A); with seven setal elements (Fig. 1C, D). Seta I very reduced and ventral to seta II, the latter as long as ramus; seta III arising from outer distal corner, about twice longer than ramus; distal three quarters of seta VI and distal half of seta V bipinnate, the latter about twice as long as former; seta VI arising from inner distal corner, nearly as long as seta III; seta VII inserted halfway along inner margin of ramus dorsally, tri-articulate at base.

Antennule (Fig. 3A) six-segmented; all setae smooth except for one element in second and last segments (arrow,

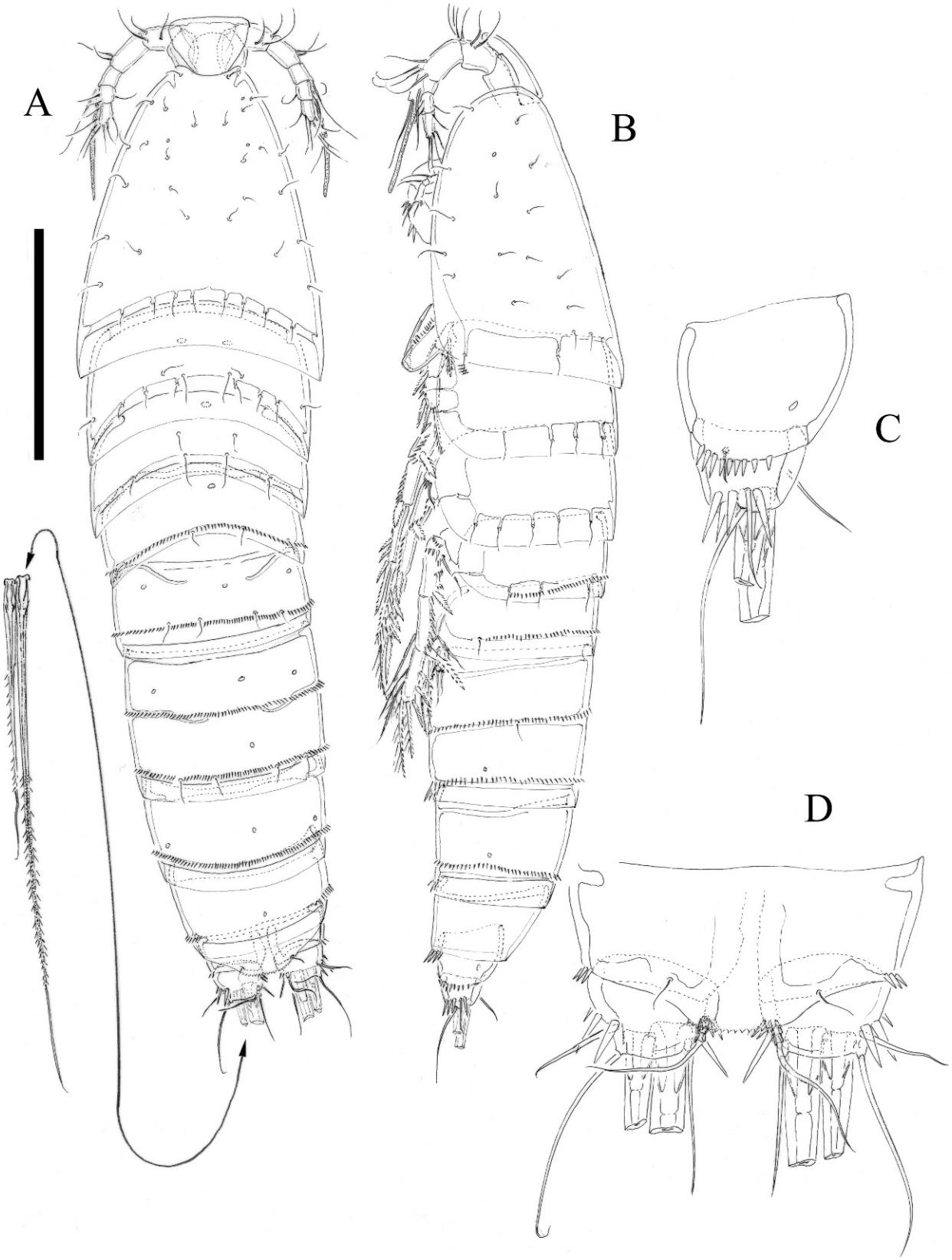

Fig. 2. *Sentiropsis vietnamensis* n. sp., female holotype (EMUCOP-280404-01). A, habitus, dorsal; B, habitus, lateral; C, anal somite and left caudal ramus, lateral; D, pseudoperculum, anal somite and caudal rami, dorsal. Scale bar: A, B, 100 µm; C, D, 38 µm.

Fig. 3A); with aesthetasc on fourth (fused to long seta basally) and apical segment (fused to two setae). Armature formula as follows: 1(1)-2(10)-3(8)-4(5+(1+ae))-5(6)-6(5+acrothek). Acrothek consisting of one aesthetasc and two setae.

Antenna (Fig. 3B-D) with small coxa. Allobasis with one abexopodal seta. Free endopodal segment with strong spinules medially and apically, with 11 elements [four geniculated (one of them fused to tiny seta basally, Fig. 3C), four strong spines, one slender long seta, and one reduced seta (arrowed in respective figures)]. Exopod three-segmented; relative length of segments as depicted; armature formula [2-1-2] (Fig. 3D).

Mandible (Fig. 3E). Gnathobase with pointed teeth and one naked dorsal seta. Palp biramous. Basis with subdistal spinules and three setae. Exopod and endopod of about same length. Endopod with two setae laterally (one of them reduced) and five fused elements apically (four setae and one aesthetasc with flagellate tip). Exopod with two lateral setae and two apical elements.

Maxillule (Fig. 2B). Praecoxal arthrite with eight spines and one lateral seta distally, and two anterior surface setae. Coxal endite with four elements (one of them claw-like). Basis with two endites. Proximal endite with two setae; distal endite with one spine, two setae, and one swollen aesthetasc with flagellate tip. Exopod distinctly larger than endopod; exopod with two setae, endopod with three.

Maxilla (Fig. 3F). Syncoxa and allobasis fused along anterior surface, distinct along posterior surface. Syncoxa with three endites. Proximal endite well developed, with three elements; middle endite small with two setae; distal endite with three setae. Allobasis drawn out into claw with one posterior and two anterior accessory setae. Endopod one-segmented, with one seta laterally, and two setae and swollen aesthetasc with flagellate tip distally.

Maxilliped (Fig. 3G). Syncoxa with two spinular surface rows and one seta at inner distal corner. Basis with inner longitudinal row of strong spinules, and with a few small outer spinules proximally; with one inner seta subdistally along palmar margin, ornamented with strong spinule (the latter arrowed in figure 3G). Endopod drawn out into strong claw with two accessory setae (one of them distinctly shorter than the other).

P1 (Fig. 4A). Praecoxa lost during dissection. Coxa and basis with spinules as depicted; the latter with strong and spinulose inner spine and long, strong bipinnate spine-like element at outer corner. Exopod three-segmented, each segment ornamented with spinules as figured. First segment smallest, without inner seta; second segment slightly shorter than third one, with inner seta; third segment with five setae/spines. Endopod slightly longer than exopod, two-segmented; inner margin of both segments with longitudinal row of spinules; first endopodal segment with inner seta; second segment with one inner seta and three apical elements.

P2 (Fig. 4B). Precoxa with spinule row close to joint with coxa, the latter with strong spinules at outer distal corner, small spinules close to joint with basis medially, and long and slender spinules and tube-pore close to inner distal corner. Basis with strong spinules close to insertion of outer seta, and with tiny spinules close to joint with endopod. Rami three-segmented; endopod slightly longer than exopod. Exopodal and endopodal segments with outer spinules as depicted. First exopodal segment without inner setae, second segment with one, third segment with two; second segment with tube-pore close to outer spine. First and second endopodal segments with one inner seta each; second segment with additional characteristic spinule proximal to insertion of inner seta; third endopodal segment with two inner setae and one tube-pore subdistally.

P3 (Fig. 5A). Basis, first and second endopodal and exopodal segments as in P2. Exopod and endopod of about same length; both with tube-pores as in P2. Third exopodal segment with three inner setae (distalmost reduced and slender). Third endopodal segment with three inner setae.

P4 (Fig. 5B). Precoxa, coxa, and basis as in P2, except for lack of long inner spinules on coxa of P4. With tube-pores as in P2. Exopod longer than endopod; rami three-segmented, with outer spinules as figured. First exopodal segment without inner seta; second segment with one inner seta and with very long and spinulose outer spine (much longer than other outer spines in any leg); third segment with three inner setae, the proximal and medial ones ornamented with spinules apically as figured (arrowed in figure), distal seta very short and slender. First and second endopodal segments with one inner seta each; third segment with two inner setae (Fig. 5B). Armature formulae of P1-P4 as in table 1.

P5 (Fig. 2C). Both legs not fused medially. Exopod small, oval; with three outer, one apical, and one inner apically serrate element reaching to distal margin of exopod. Endopodal lobe with outer margin expanded; reaching tip of exopod; with five elements as figured (second innermost seta apically serrate); with anterior surface tube-pore proximally and two marginal pores (arrowed in Fig. 2C).

Discussion

In their revision of Paranannopidae, Gee and Huys (1991) suggested the presence of claviform aesthetascs as a synapomorphy for *Paradanielssenia* Soyer, 1970, *Micropsammis* Mielke, 1975, *Leptotachidia* Becker, 1974, and *Telopsammis* Gee and Huys, 1991. They also suggested that the closest relative of this clade could be *Sentirenia* Huys and Gee, 1992 and/or *Danielssenia minuta* Coull, 1969. They proposed that within Paranannopidae the absence of oral aesthetascs as the more plesiomorphic condition, thus advocating that the claviform aesthetascs were derived from the intermediate and less modified aesthetascs found in *D. minuta*. Subsequently, Huys and Gee (1992) formally created the genus *Sentirenia* Huys & Gee, 1992 to accommodate two species, *D. perezi* Monard, 1935 (= *D. paraperezi* Soyer, 1970 [Huys and Gee, 1992)] and *D. eastwardae* Coull, 1971, as *S. perezi* (Monard, 1935) and *S. eastwardae* (Coull, 1971). This assignment was based on the presence of ''undifferentiated'' aesthetascs (different from the claviform aesthetascs observed in *Paradanielssenia*, *Micropsammis*, and *Leptotachidia*), secondary reductions in the mouthparts, and male sexual dimorphism (Huys and Gee, 1992). Later still, Huys and Gee (1993) suggested *S. perezi* as a synonym of *D. fusiformis* (Brady, 1880),

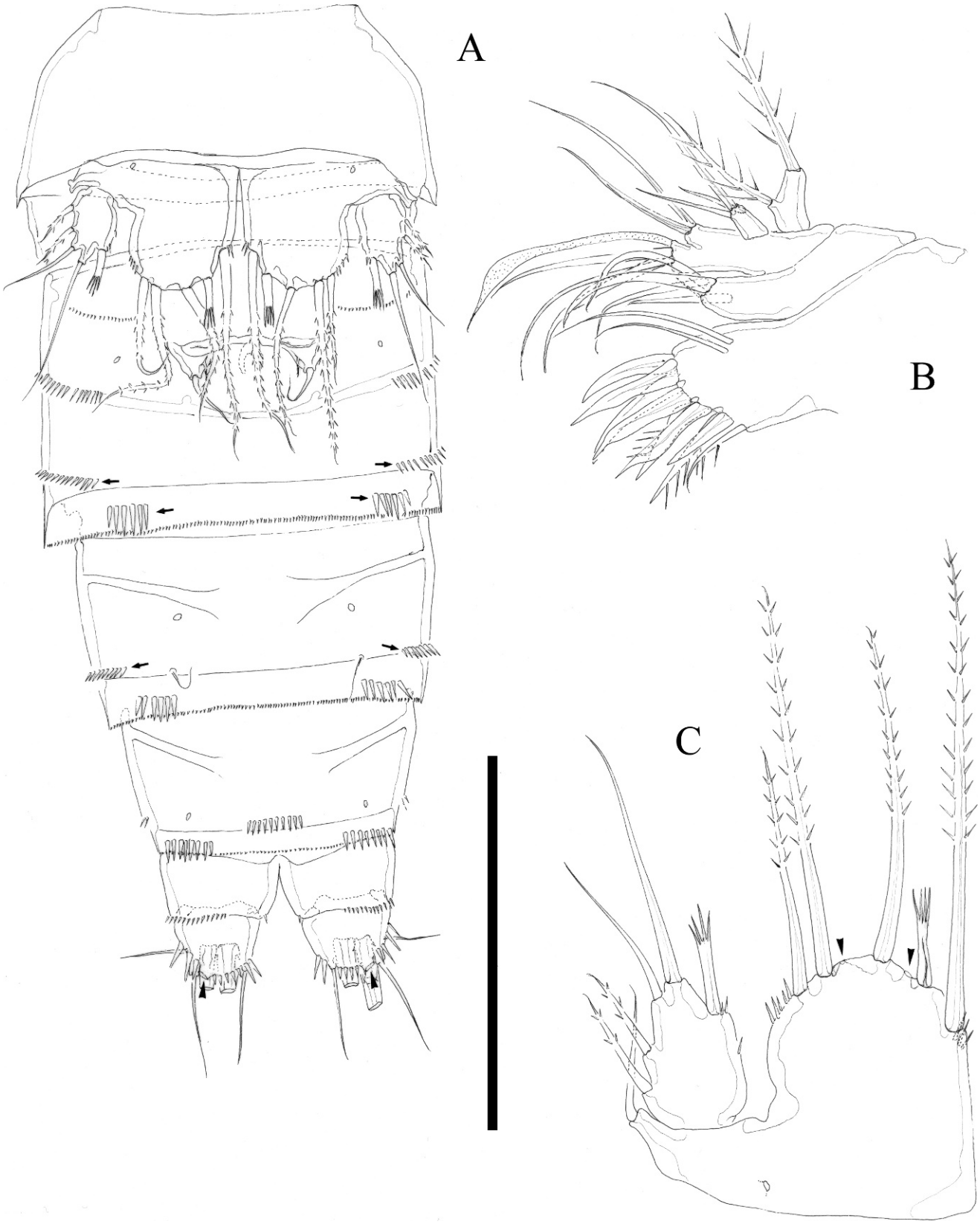

Fig. 3. *Sentiropsis vietnamensis* n. sp., female paratype (EMUCOP-280404-02). A, urosome, ventral; B, maxillule, anterior; C, P5, anterior (marginal pores arrowed). Scale bar: A, 100 µm; B, 33 µm; C, 50 µm.

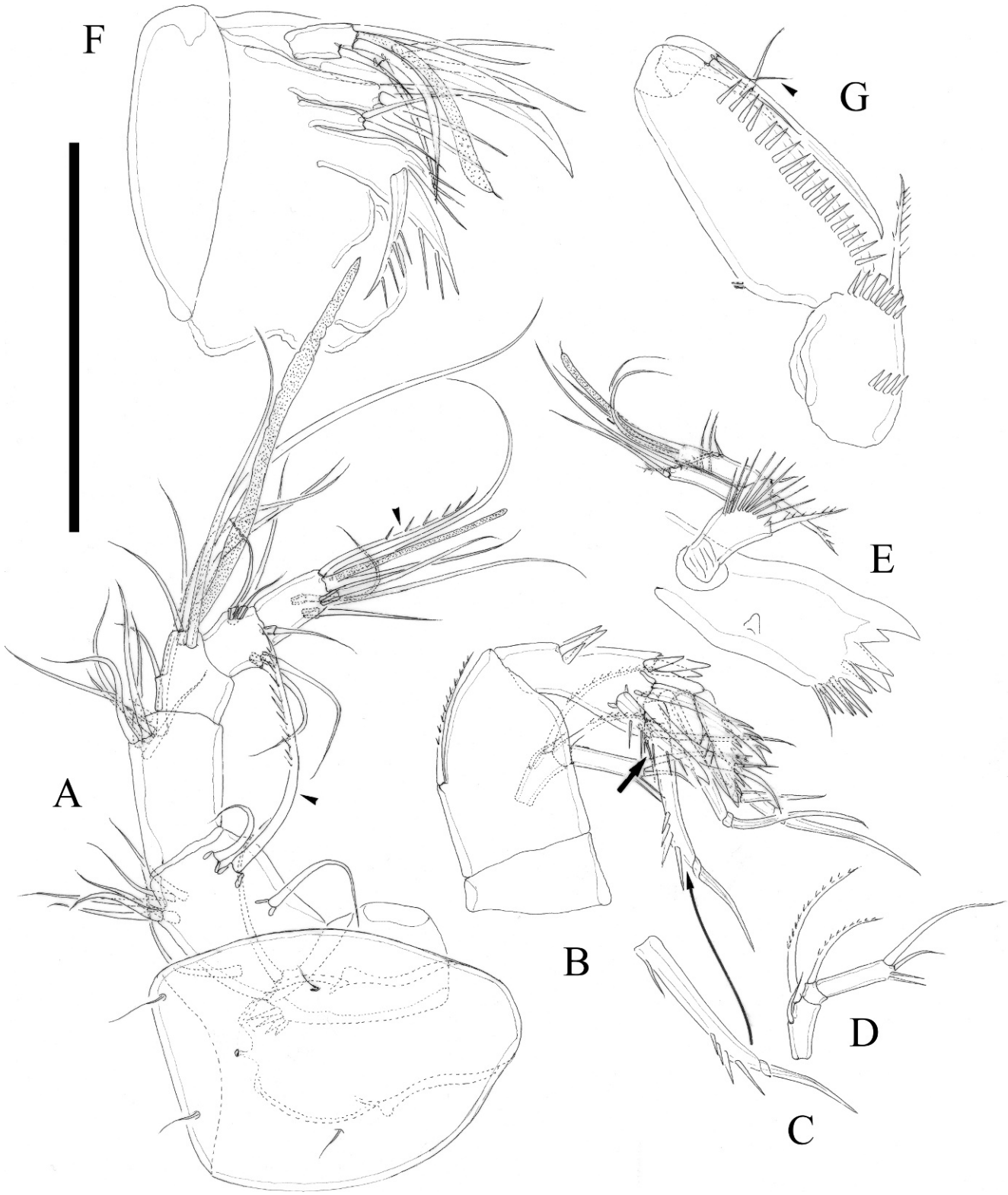

Fig. 4. *Sentiropsis vietnamensis* n. sp., female paratype (EMUCOP-280404-02). A, right antennule and rostrum (pinnate setae on second and apical segment arrowed), dorsal; B, antenna; C, outermost apical element of antenna fused to small seta basally; D, exopod of antenna; E, mandible; F, maxilla; G, maxilliped (spinule of palmar seta arrowed). Scale bar: A-E, G, 50 μm; F, 33 μm.

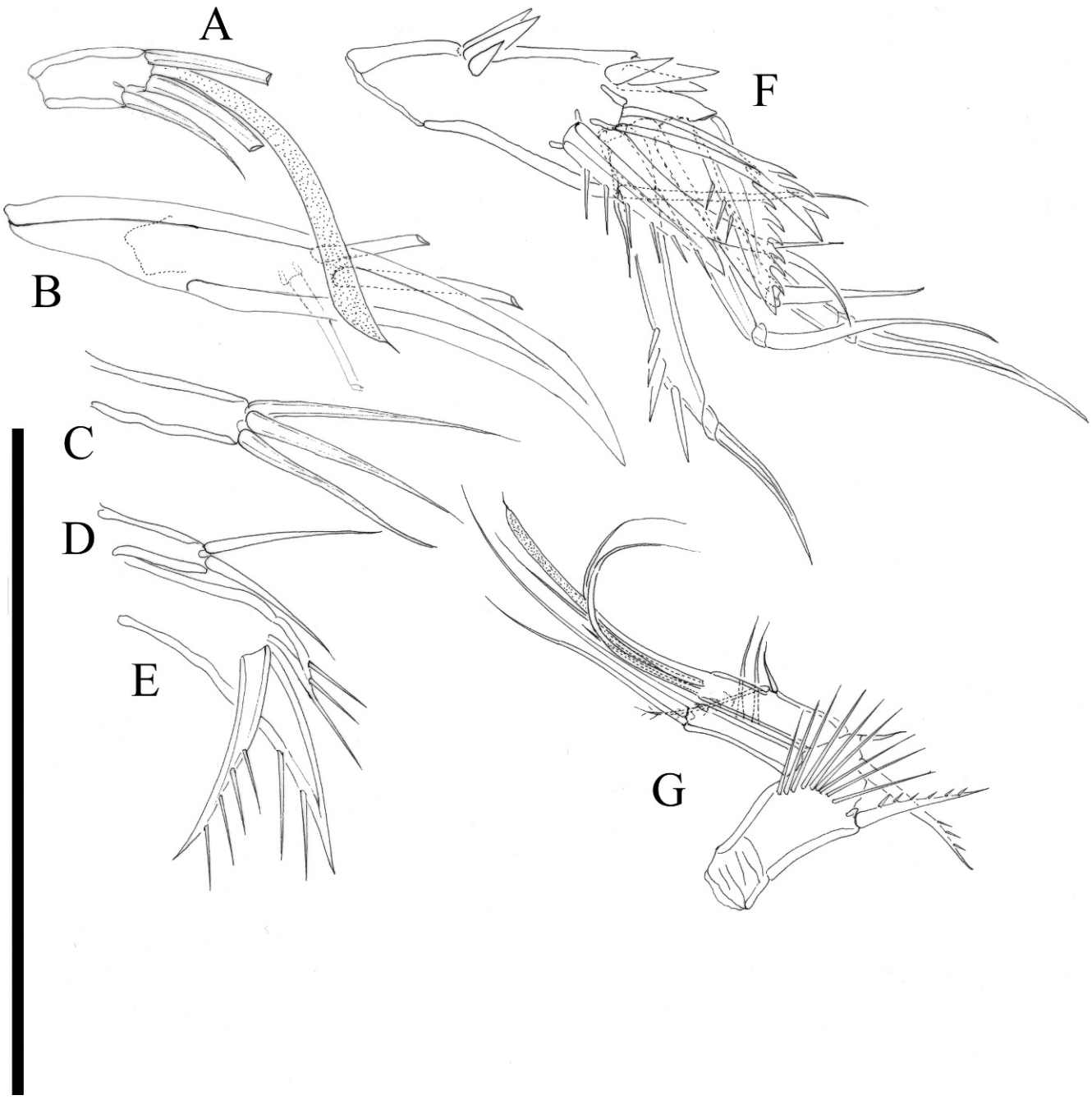

Fig. 5. *Sentiropsis vietnamensis* n. sp., female paratype (EMUCOP-280404-02). A-B, maxillary exopod and allobasis; C-E, distal, middle and proximal endite of maxillary syncoxa; F, free endopodal segment of the antenna; G, mandibular palp. Scale bar: A-E, 33 μm; F, G, 50 μm.

reinstated the genus *Jonesiella* Brady, 1880, and relegated the genus *Sentirenia* into a junior synonym of the former, thus encompassing *J. fusiformis* Brady, 1880 and *J. eastwardae* (Coull, 1971). In this same paper, Huys and Gee (1993) mentioned in passing the name of a new genus, *Sentiropsis*, but not formally diagnosed and erected within the Paranannopidae until Huys and Gee (1996). Although only a nomen nudum in 1993, Huys and Gee nevertheless suggested a close relationship between *Sentiropsis* and the genera *Jonesiella*, *Paradanielssenia*, *Micropsammis*, *Telopsammis*, *Leptotachidia*, and *Peltisenia* [this last also a *nomen nudum* in 1993] on the basis of the synapomorphic aesthetascs on the mouthparts (see Huys and Gee, 1996).

Finally, Huys and Gee (1996) removed *D. minuta* from *Danielssenia* Boeck, 1872. They did not place the species within *Jonesiella* because of a number of synapomorphies

Table 1. Armature formula or P1-P4 of the female of *Sentiropsis vietnamensis* n. sp.

	P1	P2	P3	P4
EXP	I-0;I-1;II,I2,0	I-0;I-1;III,2,2	I-0;I-1;III,2,3	I-0;I-1;III,2,3
ENP	0-1;0,I2,1	0-1;0-1;0,I2,2	0-1;0-1;0,I2,3	0-1;0-1;0,I2,2

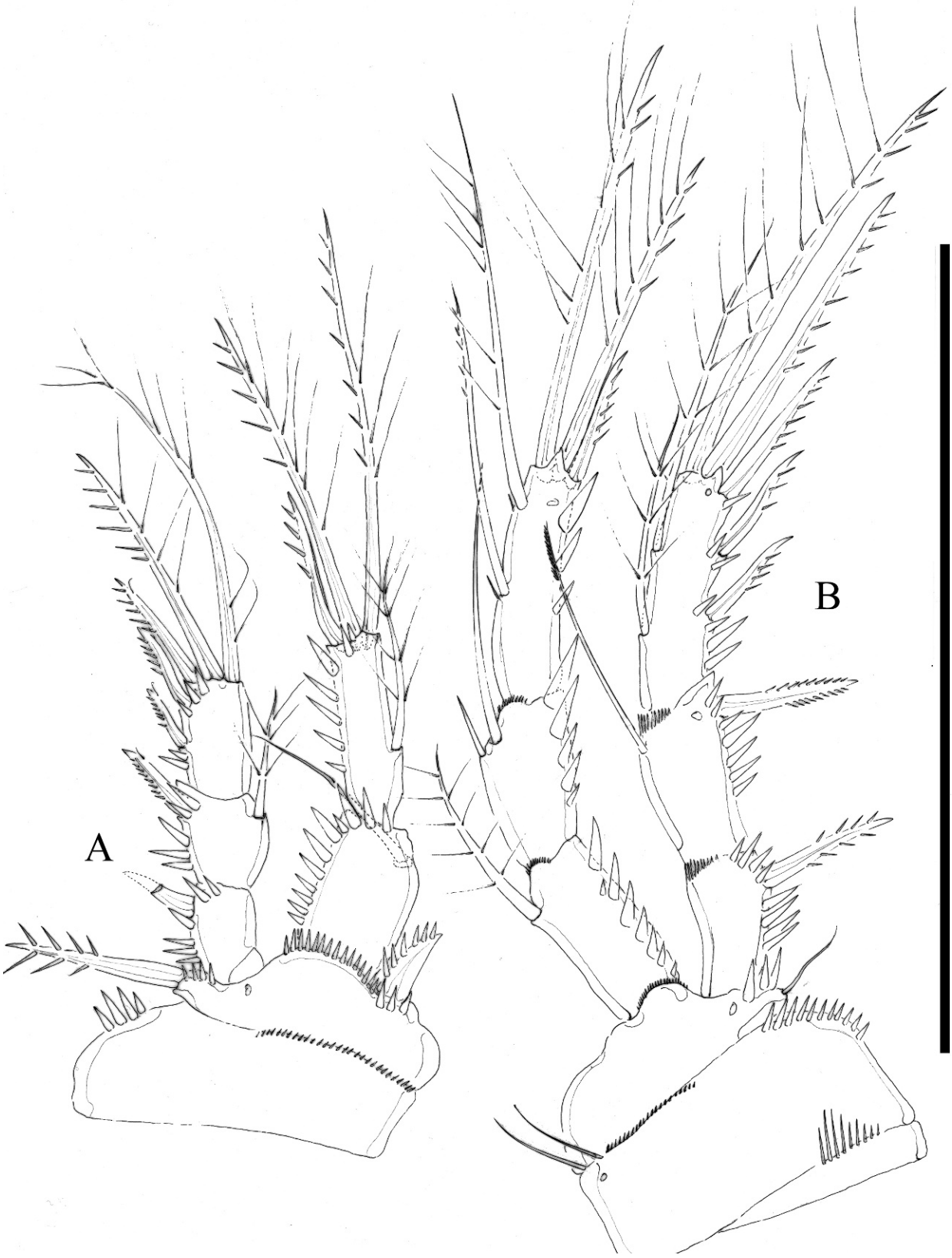

Fig. 6. *Sentiropsis vietnamensis* n. sp., female paratype (EMUCOP-280404-02). A, P1, anterior; B, P2, anterior. Scale bar: 100 µm.

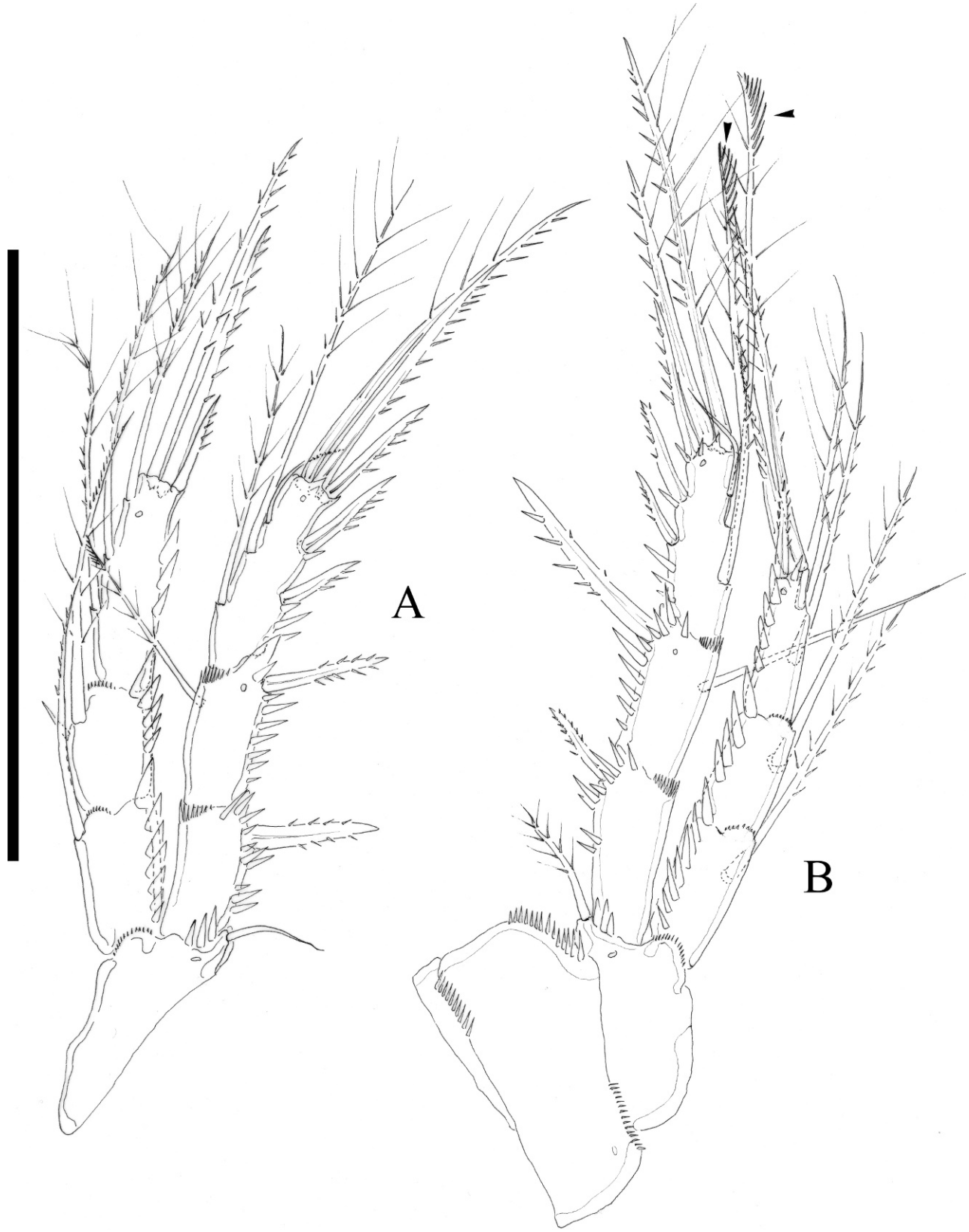

Fig. 7. *Sentiropsis vietnamensis* n. sp., female paratype (EMUCOP-280404-02). A, P3, anterior; B, P4 (ornamentation of proximal and meddle inner setae of EXP3 arrowed). Scale bar: 100 μm.

found in species of *Jonesiella*, but not shared by *D. minuta*. On the basis of autapomorphic character states of *D. minuta*, they formally created and diagnosed the genus *Sentiropsis*, with *S. minuta* (Coull, 1969) from Bermuda designated as its type and only species. According to Huys and Gee (1996), while *S. minuta* is similar to *J. fusiformis* and *J. eastwardae* in that they all share the presence of setiform aesthetascs on the oral appendages, *Sentiropsis* occupies an intermediate position between the genus *Jonesiella* and the genera with club-shaped aesthetascs. Huys and Gee (1996) also erected the genus *Afrosenia* to accommodate *Danielssenia spinipes* Wells, 1967 as *A. spinipes* (Wells, 1967) allocated on the basis of the five-segmented female antennule, the elongate mandibular palp, and the shape of the pseudoperculum. They also observed that the modified distal inner element of the third endopodal segment of P2 seen in *Afrosenia* has morphological parallels in *Jonesiella*, *Sentiropsis*, and *Paradanielssenia*; interpreted the lack of such modified element in *Micropsammis*, *Telopsammis*, and *Leptotachidia* as a secondary loss; and suggested that ''*Afrosenia* diverged from the basal node of the lineage leading to the genera with oral aesthetascs'' (Huys and Gee, 1996).

Within the genus *Sentiropsis*, a more derived position of *S. minuta* arises from consideration of these features: 1) the presence of one plumose seta on the second and last segments of the female antennule in *S. vietnamensis* (without plumose/spinulose elements in *S. minuta*), 2) the well-developed seta of the second exopodal segment of the antenna in *S. vietnamensis* (very small in *S. minuta*), 3) the number of distal elements in the arthrite of the maxillule (nine in *S. vietnamensis*, but eight in *S. minuta*), 4) the presence of pinnate setae on the syncoxa and basis of the maxilliped (with naked setae in *S. minuta*), 5) the presence of more spinular rows ventrally on the genital double-somite and fourth urosomite in *S. vietnamensis* than in *S. minuta*, and 6) the number of setae/spines in the exopod of the female P5 (five in *S. vietnamensis*, but four in *S. minuta*). On the other hand, the similar conical shape of the exopod of the female P5 (with one inner, one apical and three outer elements) of *Sentiropsis* and *Afrosenia*, and the presence of one spinule on the inner seta of the palmar margin of the maxilliped in *S. vietnamensis* and *Afrosenia*, suggest a closer relationship of *Sentiropsis* with *Afrosenia* than with *Jonesiella*. In addition, the presence of a two-segmented endopod of the mandible, the tri-setose middle endite of the maxillary syncoxa, the tri-setose last segment of the exopod of the antenna, and the longer accompanying seta of the claw and of the syncoxa of the maxilliped in *Afrosenia* suggest a more primitive condition relative to *Sentiropsis*. However, this suggestion remains questionable, particularly in regard to the five-segmented female antennule and the lack of aesthetascs on the mandible, maxillule, and maxilla in *A. spinipes*; and the six-segmented female antennule and presence of aesthetascs on the mandible, maxillule, and maxilla of *Jonesiella*.

Jonesiella exhibits some other plesiomorphic character states relative to *Afrosenia*: 1) the presence of two-segmented endopod and exopod of the mandible, 2) two spinules on the inner seta of the palmar margin of the maxilliped, 3) the insertion site of the setae of the exopod of the female P5 (all setae inserted nearly at the same level, except for the outermost element), 4) the longer accompanying setae of the claw of the maxilliped, 5) the relatively well-developed middle endite of the maxilla, and 6) the presence of an additional inner seta on P2 ENP 2 and on P3 EXP 3. This suggests a more primitive condition for *Jonesiella* relative to *Afrosenia*. Again, this scenario is far from complete since the five-segmented female antennule and the lack of aesthetascs on the mandible, maxillule, and maxilla of *Afrosenia* need to be fully interpreted.

Huys and Gee (1996) provided a number of autapomorphic character states for *S. minuta*, which also served as the basis for the generic diagnosis, i.e., the diagnosis of *Sentiropsis* largely corresponds with the description of its then sole species, *S. minuta*. Based on the present description, however, Huys and Gee's (1996: 50-51) diagnosis for *Sentiropsis* should be modified as follows:

Antennule short; 6-segmented in female, without or with only few plumose/pinnate setae (second and last segment with one pinnate seta each), with aesthetasc on segment 4 and as part of apical acrothek on segment 6; 7-segmented and chirocer in male (not in female as in Huys and Gee, 1996), with geniculation between segments 6 and 7, with aesthetasc on segment 6 and as part of apical acrothek on segment 7.

Mandibular coxa robust, with pointed teeth on gnathobase; basis with 1 small naked and 2 pinnate seta; endopod 1-segmented, with 2 or 3 lateral and 5 distal elements; exopod 1-segmented, with 2 lateral and 2 apical elements.

Maxilliped subchelate; syncoxa with 1 naked or pinnate seta; basis with short naked seta or with short seta with 1 spinule on palmar margin; endopodal claw with 1 short and 1 long accessory seta.

P1 coxa produced transversely forming large outer lobe; exopod 3-segmented, exp-3 with 3 outer spines (distal outer spine longer than middle outer spine), 1 geniculate or non-geniculate spine and 1 plumose seta; endopod 2-segmented, slightly longer than exopod with enp-1 longer than enp-2.

Exopod of the female P5 free, bearing 4 or 5 setae/spines; endopodal lobe with 5 setae/spines.

Sentiropsis minuta and *S. vietnamensis* can be separated from each other by the following: 1) ornamentation of the setae of the female antennule [all setae slender and naked in *S. minuta*, but second and last segment with one pinnate seta each in *S. vietnamensis* (arrow in Fig. 3A)]; 2) the size of the seta of the second segment of the antennary exopod (reduced in *S. minuta*, but well developed in *S. vietnamensis*) (Fig. 3D); 3) the lateral setation of the endopod of the mandible (three lateral setae in *S. minuta*, but two lateral setae in *S. vietnamensis*) (Fig. 3E); 4) distal armature of arthrite of maxillule (seven spines and one seta in *S. minuta*, but eight spines and one seta in *S. vietnamensis*) (Fig. 2B); 5) seta of syncoxa of maxilliped (naked in *S. minuta*, but pinnate in *S. vietnamensis*) (Fig. 3G); 6) seta of maxilliped basis [naked in *S. minuta*, but with long spinule in *S. vietnamensis* (arrowed in Fig. 3G)]; 7) ventral spinular

ornamentation on posterior half of female genital double-somite and fourth urosomite [with additional rows of spinules in *S. vietnamensis* (arrowed in Fig. 2A)]; 8) P1ENP1:P1ENP2 length ratio (P1ENP1 longer than ENP2 in *S. minuta*, but P1ENP1 shorter than P1ENP2 in *S. vietnamensis*) (Fig. 4A); 9) armature formula of female P5EXP (four elements in *S. minuta*, but five elements in *S. vietnamensis*) (Fig. 2C); 10) P1 without geniculate setae on EXP3 and ENP2 in *S. vietnamensis*, but present in *S. minuta*; 11) length ratio of the outer spines of P4EXP1 and EXP2 (not as pronounced in *S. minuta*); 12) the shape and size of the endopodal lobe of P5; and 13) the apically serrate seta on the P5 endopodal lobe is much shorter in *S. vietnamensis*.

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