

## Two new species of *Bulbamphiascus* (Copepoda: Harpacticoida: Diosaccidae) and a related new genus, from the Bohai Sea, China.

Fanghong MU<sup>1</sup> and J. Michael GEE<sup>2</sup>

<sup>1</sup> Department of Life Sciences, Ocean University of Qingdao, 5, Yushan Road, Qingdao 26003, Peoples Republic of China.

E-mail: hongmu@mail.ouqd.edu.cn

<sup>2</sup> Centre for Coastal and Marine Sciences, Plymouth Marine Laboratory,

Prospect Place, West Hoe, Plymouth PL1 3DH, U.K.

E-mail: jmge@wpo.nerc.ac.uk

**Abstract:** *Bulbamphiascus plumosus* sp.nov. and *B. spinulosus* sp. nov. are described from the Bohai Sea, China, provisionally placed in the genus *Bulbamphiascus*, and compared with specimens of the type species, *B. imus*, from near the type locality (off the Northumberland coast, U.K.). Both *B. plumosus* and *B. spinulosus* can be distinguished from *B. imus* by the spinulation patterns on the urosome, the form of the setae on the P5 exopod, and by the lack of sexual dimorphism on the basis of the male P2. *B. plumosus* can be distinguished from *B. spinulosus* by the lack of the ventral spinule row on the preanal somite, by the presence of a large plumose seta VI on the female caudal ramus (cf. short and smooth), by segment 4 of the female antennule being only 1.5 times longer than broad (cf. 2.5 times) and by the lack of spinules on the anterior face of the male P2 endopod (cf. pronounced spinule patches). The relationship of the two new species to others in the genus is discussed.

*Bulbamphiascus imus* is briefly redescribed and a neotype established. The flexible spine-like structure on the male P2 endopod is described for the first time and its homology discussed. It is shown that, as presently constituted, *B. imus* is a complex of species, and probably is not cosmopolitan in distribution, as previously postulated.

*Sinamphiascus* gen. nov. is established, to accommodate *S. dominatus* sp. nov., the most common sublittoral diosaccid in the Bohai Sea. The setation of the swimming legs identifies it as a *Bulbamphiascus* but the form of the P1 endopod (non-prehensile, segments almost equal in length), the antennule, the antenna, the female genital field, the spinulation of the urosome and caudal ramus, and sexually dimorphic characters on the male P1 basis and P2 endopod, all suggest a closer relationship with *Haloschizopera*.

**Résumé :** Deux espèces nouvelles de *Bulbamphiascus* (Copepoda: Harpacticoida: Diosaccidae) et un nouveau genre apparenté, de la mer de Bohai, Chine.

Les espèces *Bulbamphiascus plumosus* sp.nov. et *B. spinulosus* sp. nov. provenant de la mer de Bohai, sont décrites, classées provisoirement dans le genre *Bulbamphiascus* et comparées avec des spécimens de l'espèce type, *B. imus*, provenant de la localité type (près de la côte du Northumberland, Royaume Uni). *B. plumosus* et *B. spinulosus* peuvent être distinguées de *B. imus* par les motifs de spinulation sur l'urosome, la forme des soies sur l'exopodite P5, et par l'absence de dimorphisme sexuel à la base de la P2 mâle. *B. plumosus* peut être distinguée de *B. spinulosus* par l'absence de rangée de spinules ventrales sur le somite préanal, par la présence d'une large soie VI plumeuse sur la rame caudale de la femelle (cf. courte et lisse), par le segment 4 de l'antennule qui est seulement 1,5 fois plus long que large (cf. 2,5 fois) et par l'absence de spinules

sur la face antérieure de l'endopode mâle P2 (cf. taches de spinule prononcées). La parenté des deux nouvelles espèces avec les autres espèces du genre est discutée.

*Bulbamphiascus imus* est brièvement redécrite et un néotype est établi. L'épine flexible sur l'endopode mâle P2 est décrite pour la première fois et son homologie est discutée. Il est montré que, dans son acception actuelle, *B. imus* est un complexe d'espèces, et n'est probablement pas cosmopolite dans sa distribution, contrairement à ce qui a été avancé auparavant.

*Sinamphiascus* gen. nov. est établi, pour contenir *S. dominatus* sp. nov., le Diosaccidae le plus commun de la mer de Bohai. La sétation des pattes natatoires l'identifie à *Bulbamphiascus*, mais la forme de l'endopode P1 (non-préhensile, et à segments presque identiques en longueur), l'antennule, l'antenne, l'appareil génital de la femelle, la spinulation de l'urosome et de la rame caudale, et les caractères de dimorphisme sexuel à la base de la P1 mâle et sur l'endopode P2, suggèrent une parenté plus proche avec *Haloschizopera*.

**Keywords:** Harpacticoida, *Bulbamphiascus*, *Sinamphiascus*, Bohai Sea, China.

## Introduction

The genus *Bulbamphiascus* Lang was erected by Lang (1944) and distinguished from *Amphiascus* Sars and other new diosaccid genera primarily on the structure of the P1 endopod, the setal formula of P2-P5 and the usually bulbous form of the distal outer seta on P5 exopod. He designated *Canthocamptus imus* Brady, 1872 (renamed *Stenhelia ima* by Brady, 1880) as the type species. Lang (1948) also included *Stenhelia denticulata* Thompson, 1893 in the genus, distinguished from the type species by the chitinous spur on the proximal two segments of the antennule. Lang (1948), in discussing the provenance of the type species, concluded that *Stenhelia reflexa* T. Scott, 1895, *Stenhelia longirostris* Norman & T. Scott, 1905 (renamed *Amphiascus Normani* by Sars, 1911) and *Amphiascus sahelensis* Monard, 1936 were all synonyms of *Bulbamphiascus imus*. This conclusion was based entirely on the rather brief and inadequate descriptions and figures of the relevant species and led to the impression that *B. imus* was a rather variable species, particularly with respect to the form and setation of the female P5 (the male of the species being inadequately known).

Since Lang (1948), six species of *Bulbamphiascus* have been described, *B. inermis* (Sewell, 1940) (based on one male from the Indian Ocean); *B. angustifolius* Klie, 1950 (from Kiel Bight in the Baltic Sea); *B. chappuisi* Rouch, 1962 (from Brazil); *B. minutus* Dinét, 1971 (based on one female from Marseille) and *B. cibimae* Pallares, 1982 (from Argentina). Wells (1961) and Bodin (1964) figured the P5 of the male of specimens they identified as *B. imus* from the Scilly Isles (S.W. Britain) and near Marseille (Mediterranean) respectively but these figures differ from each other. In addition, Dinét (1971) figured the female antennule, mouthparts, P1 and P5 of specimens he identified as *B. imus* and found in abundance off Marseille. Wells & Rao (1987) in discussing the one female they identified as *B. imus* from the Andaman Islands (Indian Ocean), concluded that, in view of the variability of *B. imus*, both *B. inermis*

and *B. angustifolius* should be synonymized with *B. imus* but *B. chappuisi* and *B. minutus* be retained as valid species.

In a recent survey of the sublittoral harpacticoid copepods from the central region of the Bohai Sea, a shallow northern extension of the Yellow Sea, two of the most common taxa were tentatively assigned to *Bulbamphiascus*. One of these agreed with the published descriptions of *B. imus* and the other did not completely fit the generic diagnosis given in Lang (1948). Detailed examination of the former revealed the presence of two closely related species. This necessitated the re-examination of *B. imus* from northwest Europe. In this paper we describe in detail the taxa from the Bohai Sea; justify the erection of a new genus and new species in the light of our observations on the type species from the North Sea; and draw some tentative conclusions about the cosmopolitan distribution of *B. imus* and the relationship of *Bulbamphiascus* to other diosaccid genera.

## Material and methods

The Chinese specimens described here were recovered, in 1997 - 1999, from 26 sites in the central region of the Bohai Sea (38° 30'N: 120°E) in which the sediments range from muddy sand to mud at an average depth of 20 m (range 11-70 m). Sediment samples were collected in a 0.1 m<sup>2</sup> box core and the harpacticoid copepods extracted, using a 48 µm sieve and Ludox flotation, from a standard subsample taken from the box core in three 26 mm diameter plastic tubes inserted to a depth of 5 cm.

Animals were fixed in 10%, and preserved in 4%, formalin. Before dissection the habitus was drawn and body length measurements made from whole specimens temporarily mounted in lactophenol. Specimens were dissected in lactophenol, the parts individually mounted in lactophenol under coverslips subsequently sealed with clear nail varnish. All drawings were prepared using a camera lucida on a Nikon Optiphot 20 differential interference

contrast microscope. The terminology of the body and appendage morphology follows that of Huys & Boxshall (1991). Abbreviations used in the text and figures are P1-P6 for thoracopods 1-6; exp(enp)-1(-2-3) to denote the proximal (middle, distal) segment of a ramus; and a for aesthetasc. Body length was measured from the base of the rostrum to the median posterior border of the anal somite. All type material has been deposited in the Natural History Museum (NHM), London.

## Systematics

### Family DIOSACCIDAE

#### Genus *Bulbamphiascus* Lang, 1944

#### Diagnosis

Diosaccidae. Body semi-cylindrical, cephalothorax tapering anteriorly, prosome unornamented, urosome with ventrolateral and ventral spinule rows. Female genital double-somite with dorsal and lateral subcuticular rib, genital field with separate gonopores, each covered by vestigial P6 bearing three setae, median copulatory pore obscured by copulatory bulb; male genital segment separate; genital field with one fused and one functional flap, each with three setae. Caudal rami almost square, seta III well developed, seta VI variable in length and ornamentation. Female antennule 8-segmented, segment 4 variable in length; male antennule 10-segmented, haplocer. Antennal allobasis with one seta on abexopodal margin; exopod 3-segmented with 1:1:4 setae; endopod with four elements on lateral margin and seven elements on distal margin. Mandibular palp with basis bearing three setae, exopod 2-segmented with 2:3 setae, endopod 1-segmented with eight setae. Maxillulary coxal endite with two setae, basis with seven setae, rami 1-segmented, exopod with two setae, endopod with four setae. Maxilla with three coxal endites with 2:2:3 elements (proximal to distal), allobasal endite with a fused spine and four setae/spines, endopod 1-segmented with five setae. Maxilliped sub-chelate, syncoxa with four setae, basis with two setae on palmar margin, endopod 1-segmented bearing a claw and three accessory setae. P1 rami 3-segmented; exp-2 with inner seta, exp-3 with two distal geniculate setae and three outer spines; endopod prehensile; enp-1 longer than enp-2 and -3 combined, reaching at least to middle of exp-3; enp-2 usually much shorter than enp-3. Male P1 basis with one chitinous projection at inner distal corner. P2-P4 basis with chitinous projection at inner distal corner; rami 3-segmented, except P2 endopod 2-segmented in male; proximal two segments of both rami with spiniform extension of outer distal margin; distal inner seta on exp-3 weakly developed. Male P2 basis sometimes with flexible, papillate projection at inner distal corner; P2 enp-2

attenuated, with three setae on inner margin and one seta on distal margin, outer margin with a large articulating spine and an articulating sinuous element with a smooth tip. Male P3 exp-3 with dimorphic tube-pore. Setal formula as follows:

	Exopod	Endopod
P1	0:1:023	1:1:021
P2	1:1:223*	1:2:121 (1:312)
P3	1:1:223*	1:1:221
P4	1:1:323*	1:1:121*

Brackets denote male condition.

\**Bulbamphiascus minutus* has 1/1/2 inner setae on exp-3 of P2-P4 respectively and 2 inner setae on enp-3 of P4, but this species probably does not belong in this genus.

P5 baseoendopod and exopod separate in both sexes; endopodal lobe with five setae in female, two setae in male; exopod oval, with six setae in female and five to seven setae in male, middle and/or distal outer seta(e) sometimes swollen at base.

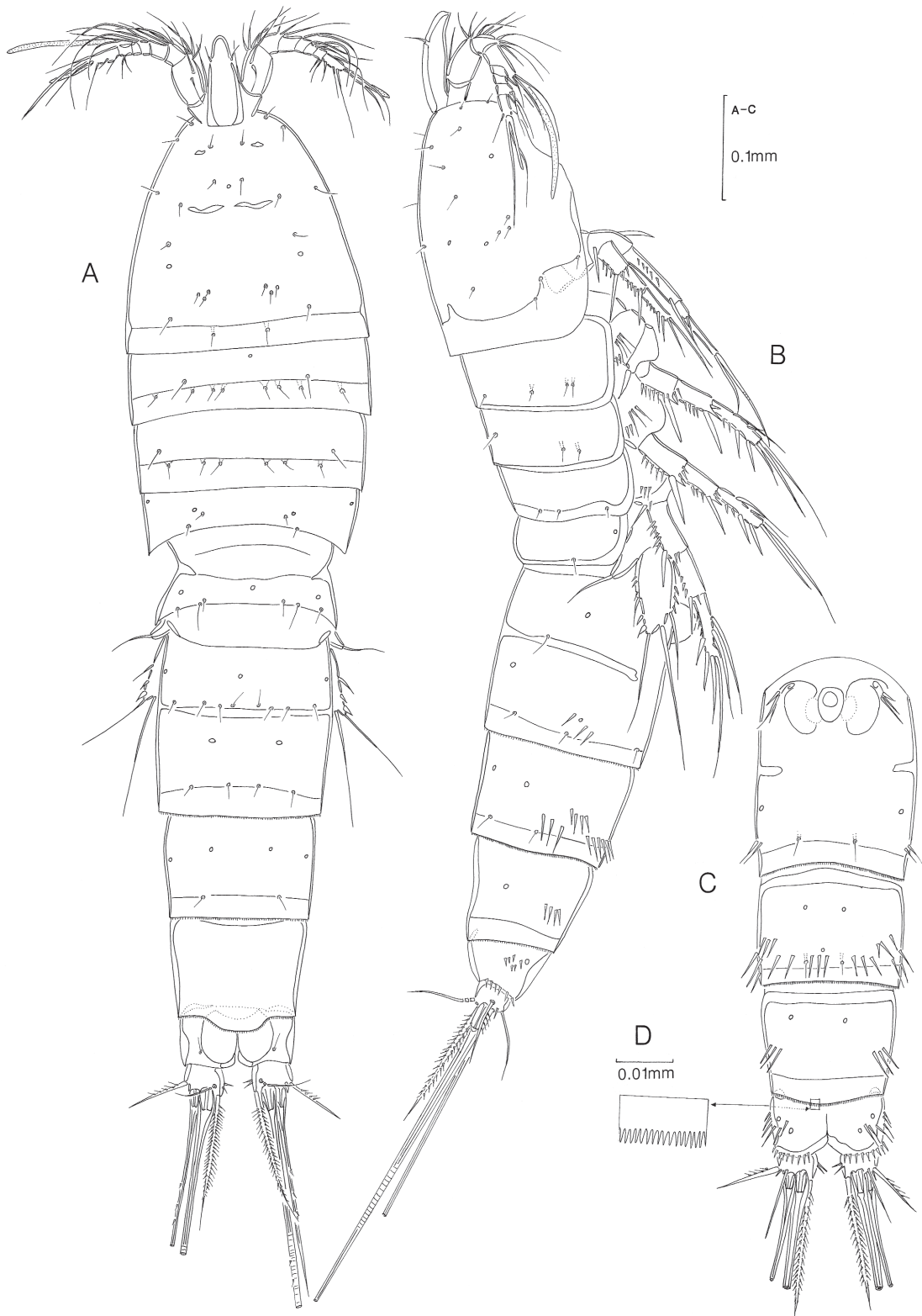
#### *Bulbamphiascus plumosus* sp. nov. (Figs 1-8C)

#### Material examined

Holotype: Adult female (dissected on four slides) collected by F-h. Mu from the Bohai Sea, China, (38°N, 120°E) over muddy sand bottom at a depth of 11 – 70 m. NHM Reg. No. 2000.292. Paratypes: 16 females and 36 males (one dissected on four slides) from the same locality as the holotype, NHM Reg Nos. 2000.293-344.

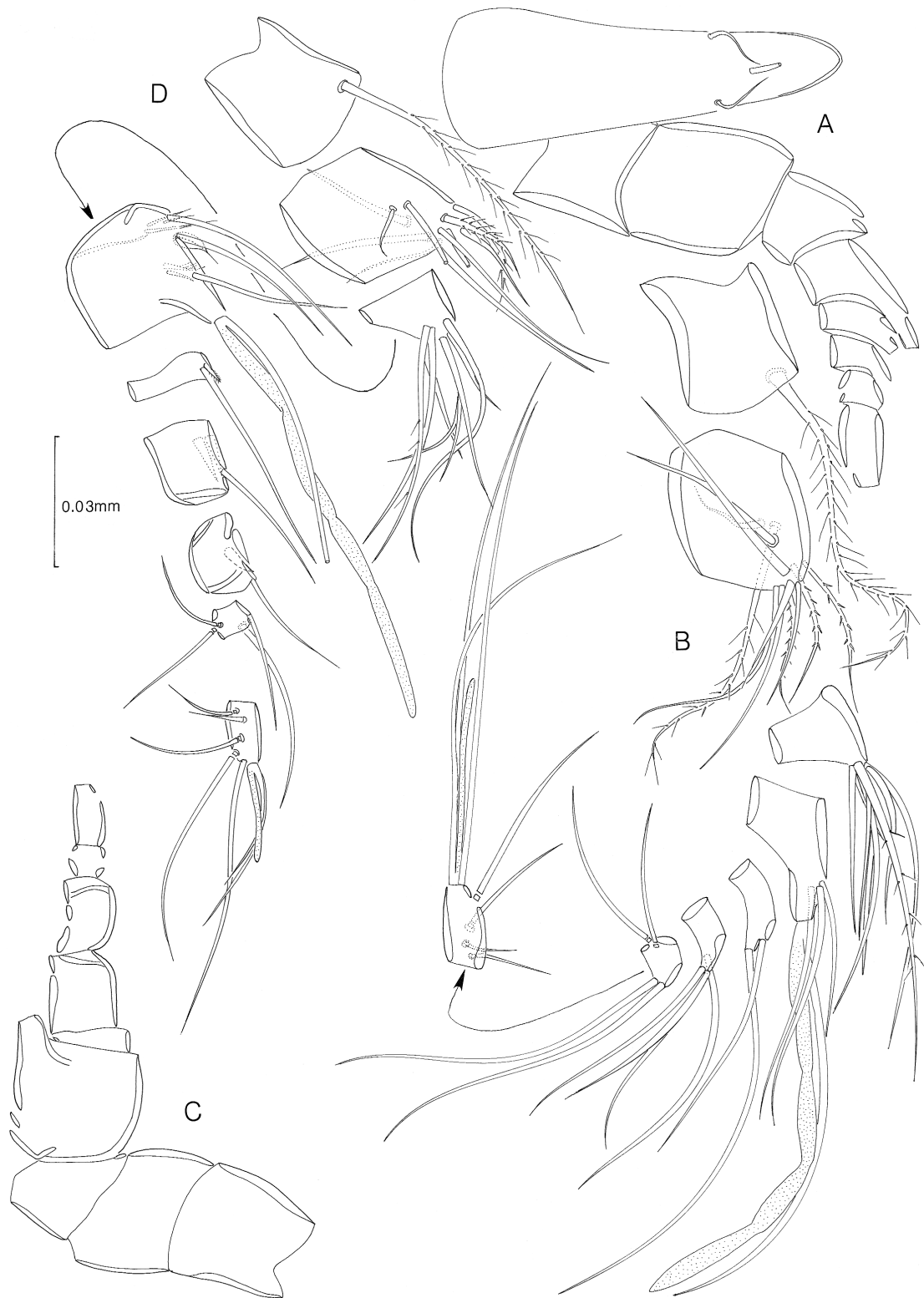
#### Description of female

Body (Figs 1A-C). Length 0.61 - 0.86 mm (mean = 0.755 mm, n = 15). Body subcylindrical, widest at posterior margin of cephalothorax, tapering gradually posteriorly. Rostrum (Fig. 2A) defined at base, elongate, triangular, extending beyond the second antennular segment, with a small tube pore middorsally and a pair of small sensilla on lateral margins. Cephalothorax (Figs 1A, B) tapering anteriorly, as long as free prosomites. Genital double-somite divided dorsally and laterally by subcuticular rib. Genital field (Fig. 6A) with separate genital apertures covered by vestigial P6, each bearing one short pinnate spine, one long pinnate seta and one slightly shorter, smooth seta; copulatory pore situated medially, slightly posterior to genital apertures, in a depression formed by two cuticular folds, and obscured by large oval-shaped copulatory bulb forming part of seminal duct outside body surface; internal seminal receptacles kidney-shaped. Anal somite (Fig. 1) with small semicircular operculum near median dorsal anterior border and overlain by a pseudoperculum. Caudal rami (Fig. 6D) as long as broad with a slender tube pore on ventral posterior margin and a few spinules along inner



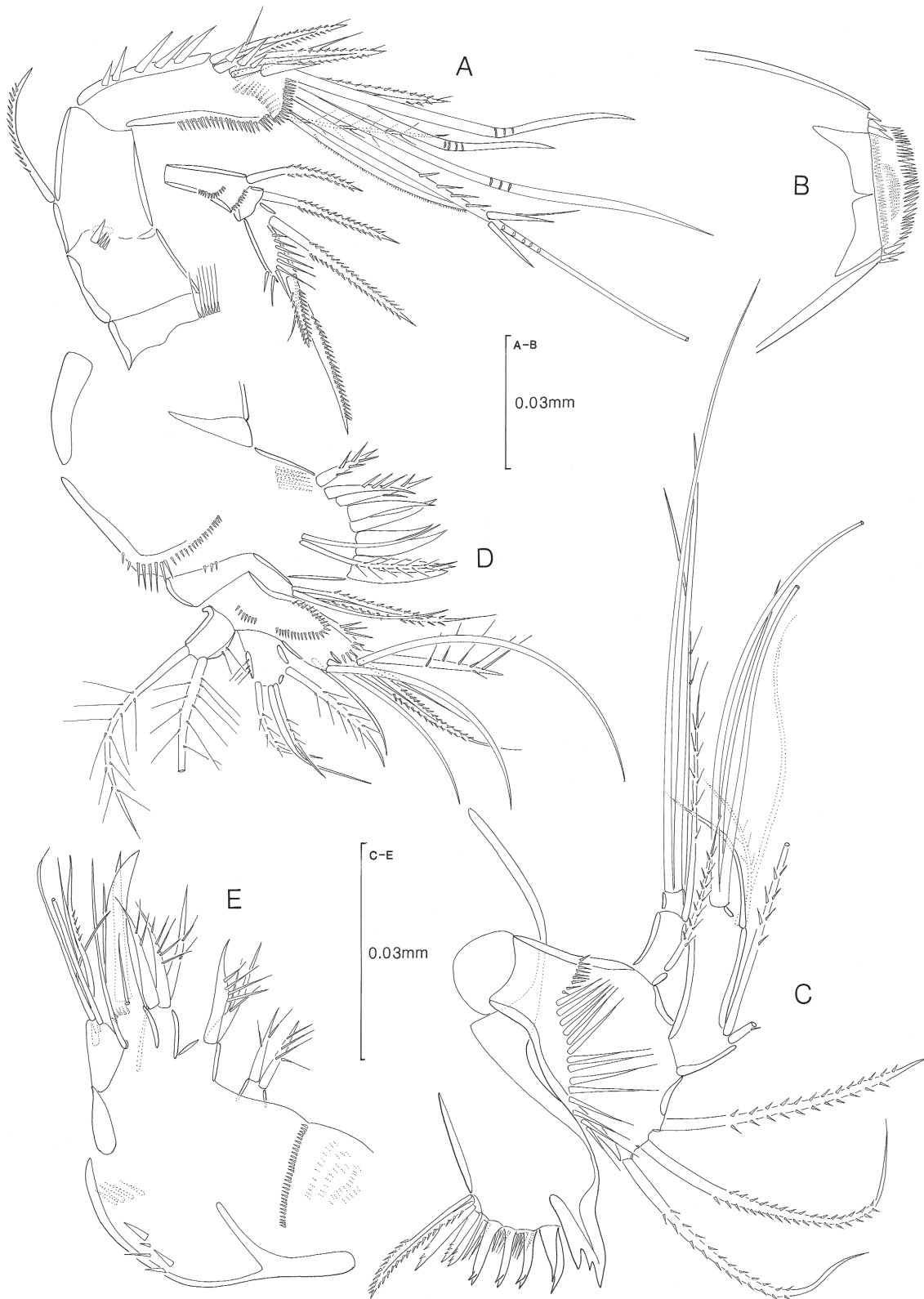
**Figure 1.** *Bulbamphiascus plumosus* sp. nov. Female, **A** habitus, dorsal view; **B** habitus, lateral view; **C** urosome, excluding P5-bearing somite, ventral view; **D** hyaline frill of preanal somite.

**Figure 1.** *Bulbamphiascus plumosus* sp. nov. Femelle **A** habitus, vue dorsale ; **B** habitus, vue latérale ; **C** urosome, sauf le somite portant P5, vue ventrale ; **D** frange hyaline du somite préanal.

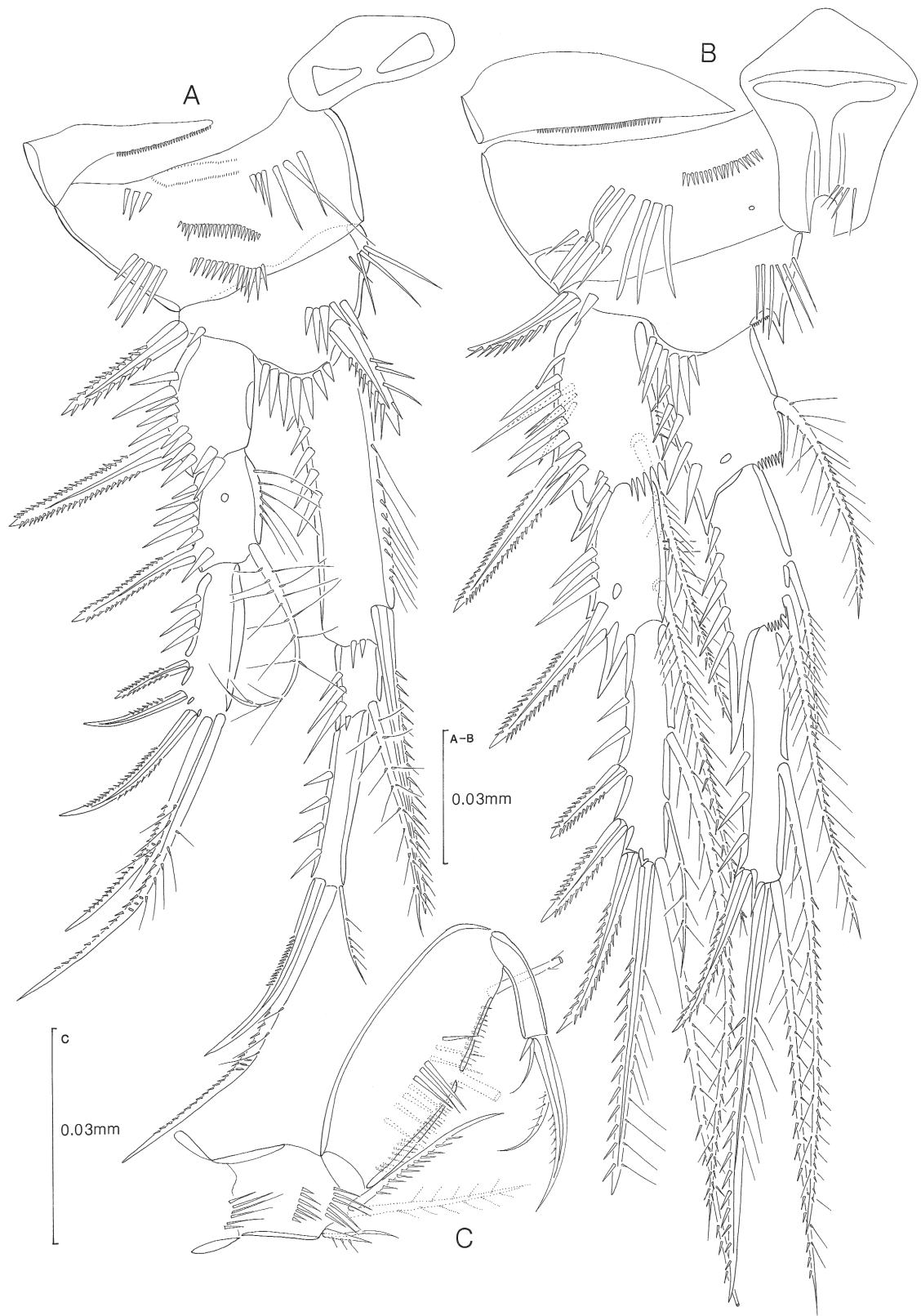


**Figure 2.** *Bulbamphiascus plumosus* sp. nov. **A-B** female antennule, **A** rostrum and segmentation; **B** disarticulated. **C-D** male antennule, **C** segmentation; **D** disarticulated.

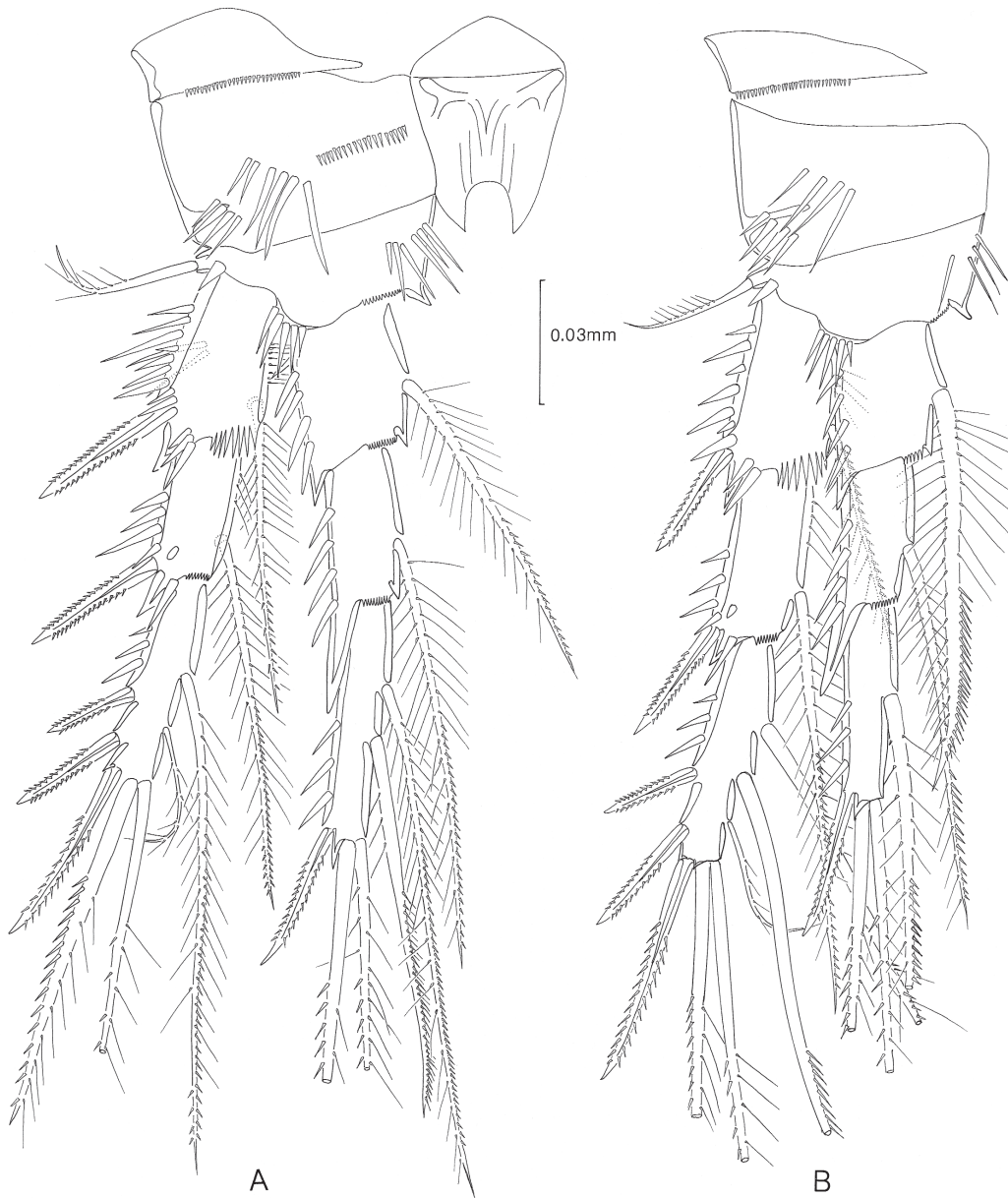
**Figure 2.** *Bulbamphiascus plumosus* sp. nov. **A-B** antennule femelle **A** rostre et segmentation ; **B** désarticulée. **C-D** antennule mâle **C** segmentation ; **D** désarticulée.



**Figure 3.** *Bulbamphiascus plumosus* sp. nov. Female, **A** antenna; **B** labrum; **C** mandible; **D** maxillule; **E** maxilla.  
**Figure 3.** *Bulbamphiascus plumosus* sp. nov. Femelle, **A** antenne ; **B** labrum ; **C** mandibule ; **D** maxillule ; **E** maxille.



**Figure 4.** *Bulbamphiascus plumosus* sp. nov. Female, A P1; B P2; C maxilliped.  
**Figure 4.** *Bulbamphiascus plumosus* sp. nov. Femelle, A P1 ; B P2 ; C maxillipède.



**Figure 5.** *Bulbamphiascus plumosus* sp. nov. Female, **A** P3; **B** P4.  
**Figure 5.** *Bulbamphiascus plumosus* sp. nov. Femelle, **A** P3 ; **B** P4.

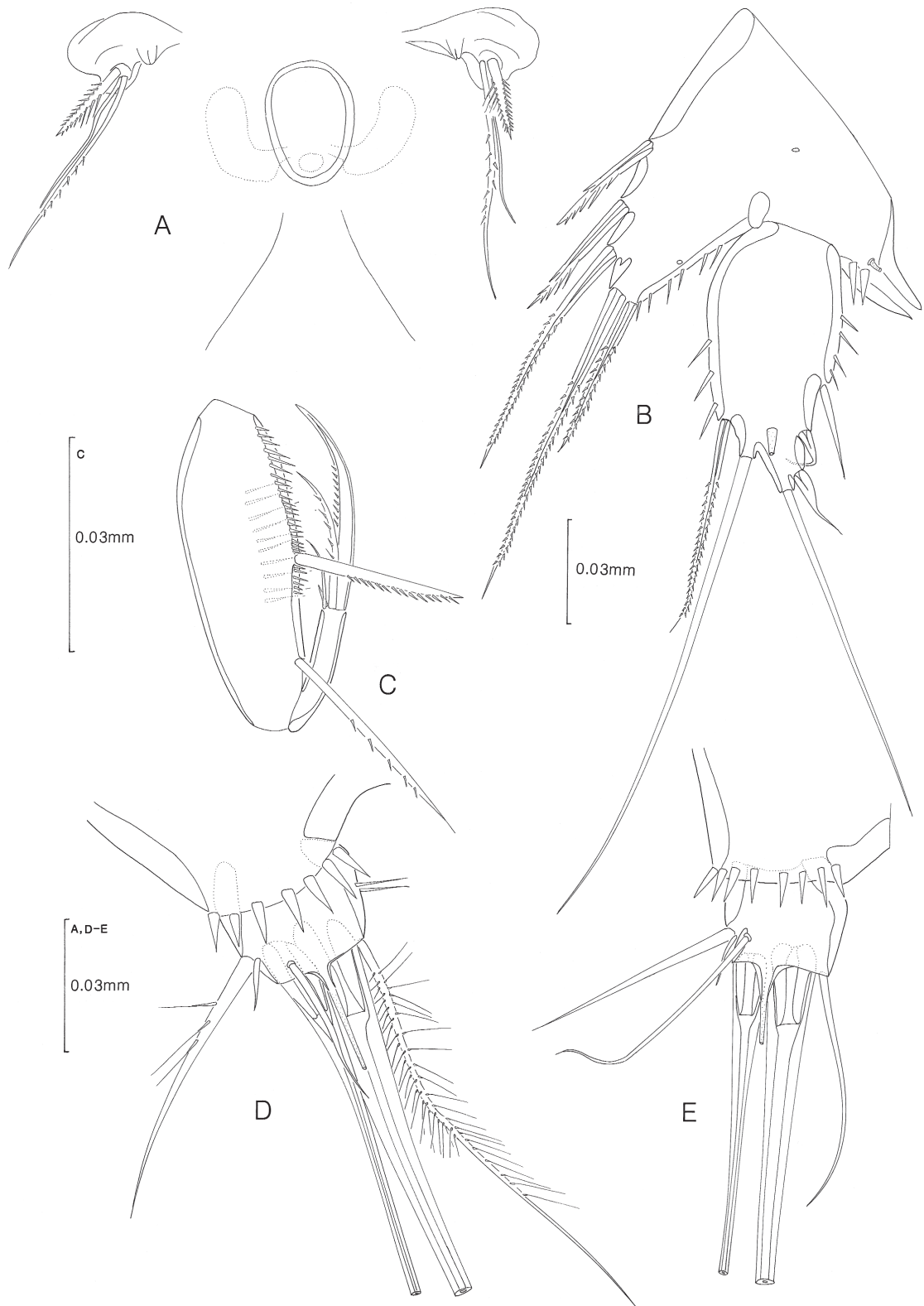
margin; seta I (antero-lateral accessory seta) small and naked, seta II (antero-lateral seta) long and slightly plumose; seta III (postero-ventral seta) long and smooth; terminal setae IV and V well developed with few short spinules in central region; seta VI (terminal accessory seta) long and heavily plumose; seta VII (dorsal seta) triarticulate.

Somatic ornamentation (Fig. 1). Body surface appears smooth under light microscope, all somites except preanal furnished with numerous sensilla and pores distributed as in Fig. 1. Prosome without spinule rows. Distribution of

spinules on urosome as follows: posterior part of genital double-somite with a short ventro-lateral row; urosomite-4 with two short ventro-lateral and one ventral row; preanal somite with a short ventro-lateral row; anal somite with a lateral group and a lateral and ventral row at base of caudal rami. Hyaline frills of urosomites striated, with strongly dentate margin visible with x20 objective (Fig. 1D).

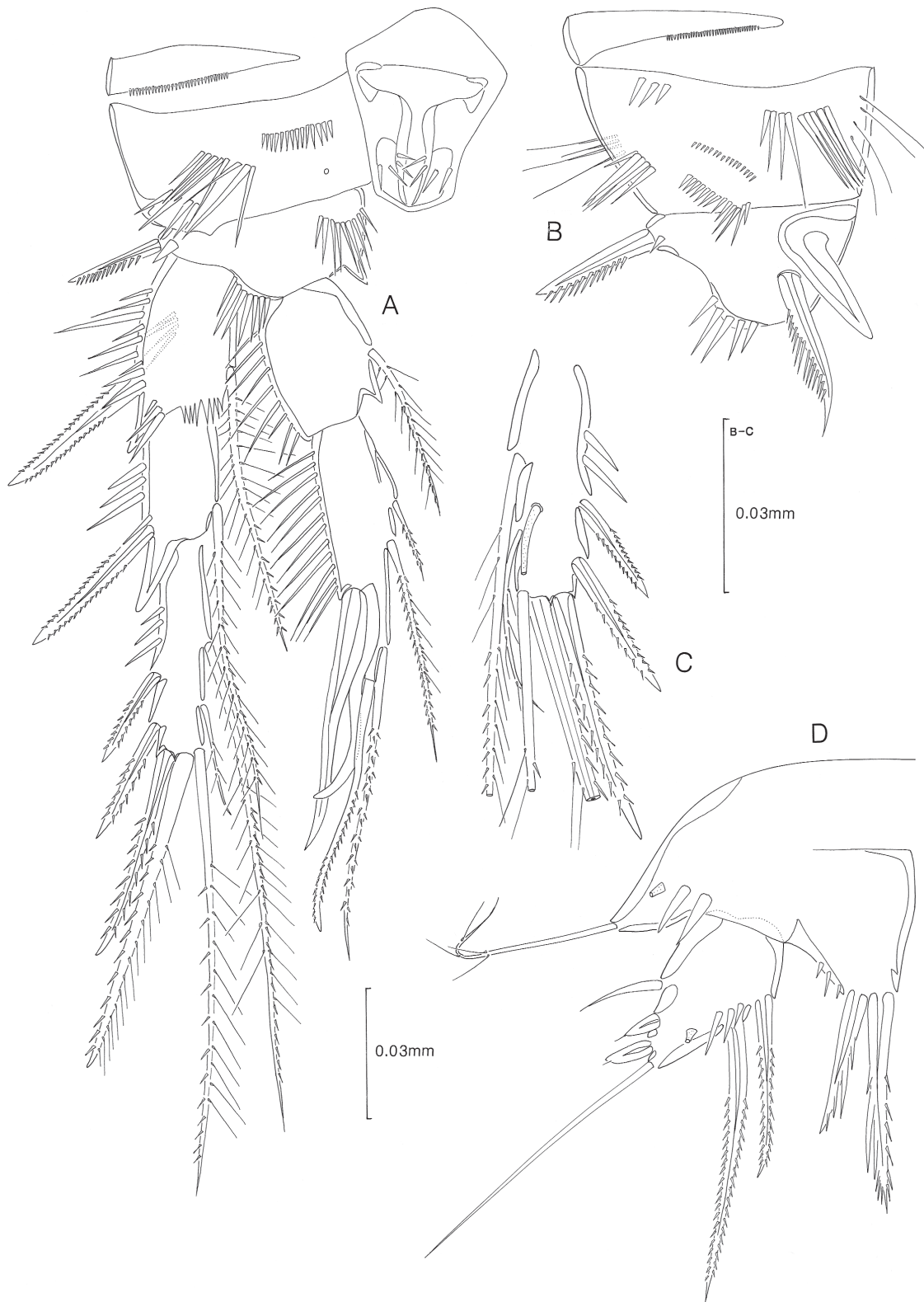
Antennule (Figs 2A, B) 8-segmented, segment 2 largest, segment 4 1.5 times longer (on anterior margin) than broad; aesthetascs on fourth and distal segments; some weakly pinnate setae on segments 1(1), 2(4) and 3(1); Setal formula





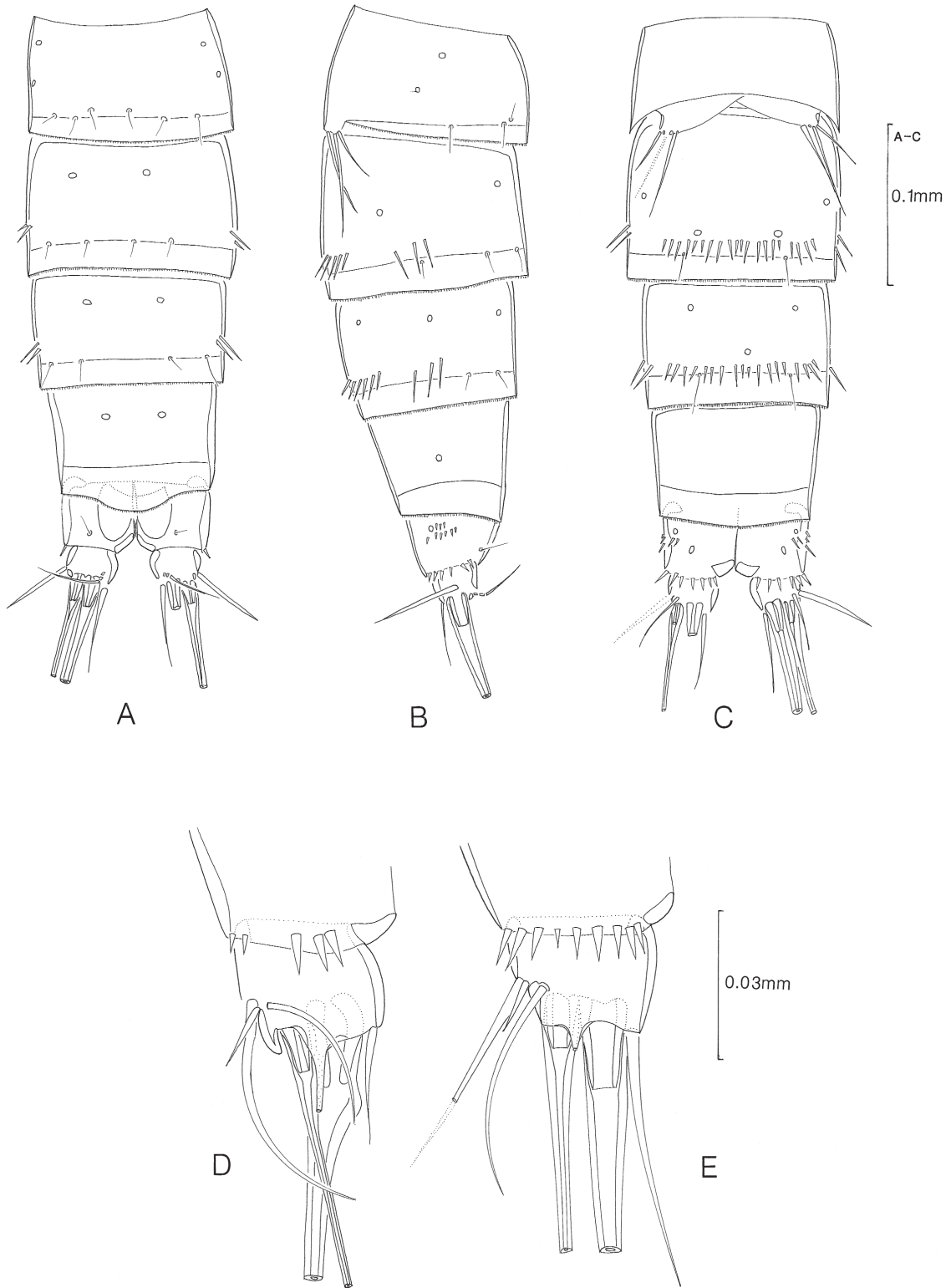
**Figure 6.** *Bulbamphiascus plumosus* sp. nov. **A-D** female, **A** genital field; **B** P5; **C** maxilliped basis and endopod; **D** caudal ramus, ventral view. **E** male caudal ramus, ventral view.

**Figure 6.** *Bulbamphiascus plumosus* sp. nov. **A-D** femelle, **A** aire génitale ; **B** P5 ; **C** basis et endopodite du maxillipède ; **D** rame caudale, vue ventrale. **E** mâle rame caudale, vue ventrale.



**Figure 7.** *Bulbamphiascus plumosus* sp. nov. Male, **A** P2; **B** P1 basis; **C** P3 exp-3; **D** P5.

**Figure 7.** *Bulbamphiascus plumosus* sp. nov. Mâle, **A** P2 ; **B** basis de P1 ; **C** exp-3 de P3 ; **D** P5.



**Figure 8.** A-C *Bulbamphiascus plumosus* sp. nov., male urosome, excluding P5-bearing somite; **A** dorsal view; **B** lateral view; **C** ventral view. **D-E** *Bulbamphiascus spinulosus* sp. nov., caudal ramus ventral view; **D** female; **E** male.

**Figure 8.** A-C *Bulbamphiascus plumosus* sp. nov., urosomite mâle, sauf le somite portant P5 ; **A** vue dorsale ; **B** vue latérale ; **C** vue ventrale. **D-E** *Bulbamphiascus spinulosus* sp. nov., rame caudale vue ventrale ; **D** femelle ; **E** mâle.

as follows: 1-[1], 2-[11], 3-[8], 4-[3+(1+a)], 5-[2], 6-[4], 7-[4], 8-[5+(2+a)].

Antenna (Fig. 3A). Coxa well developed with row of setules. Allobasis with partial suture and row of spinules dorsally at base of exopod; one seta on abexopodal margin. Exopod 3-segmented, proximal segment with two rows of short spinules and one pinnate seta; middle segment short, with a pinnate seta; distal segment with an oblique row of strong spinules; with one pinnate seta on lateral margin and two stout pinnate spines and one naked seta on distal margin. Free endopod segment with two rows of strong spinules on outer margin, row of smaller spinules on distal and inner margin and on ventral face; lateral armature of two large pinnate spines and two setae; distal margin armed with two pinnate spines, four geniculate setae (one pinnate medially) and one plumose seta.

Labrum (Fig. 3B) posterior margin armed with two groups of three teeth and three median rows of spinules (one marginal and two submarginal).

Mandible (Fig. 3C). Coxa stout, gnathobase armed with one large tricuspid tooth, four bicuspid and three unicuspid teeth, and two pinnate setae at inner distal corner. Basis broad, with two rows of spinules on anterior face and three pinnate setae on distal margin. Exopod indistinctly 2-segmented, proximal segment with two lateral pinnate setae (one proximal, one distal); distal segment with three setae (one pinnate) fused at base. Endopod large, 1-segmented; with eight setae (two pinnate setae proximally, three setae subdistally and, on distal margin, three naked setae fused at base).

Maxillule (Fig. 3D). Praecoxa with two rows of spinules on anterior face. Arthrite of praecoxa with two setae (one pinnate) on anterior face and a row of spinules on posterior face; distal margin with three pairs of recurved naked spines, and three pectinate spines. Coxa with one naked seta and one pinnate spine on distal margin. Basis with two rows of spinules on anterior face and distal margin; bearing seven elements (two naked setae and two pinnate spines distally and three naked setae subdistally). Exopod 1-segmented; with a row of spinules and two plumose setae. Endopod 1-segmented; with a row of spinules and four setae (three pinnate).

Maxilla (Fig. 3E). Syncoxa with three rows of spinules and three endites, proximal and middle endite armed with two, distal endite with three, pectinate spines. Allobasal endite with a subterminal row of spinules, a large fused spine, a smaller articulating spine and three naked setae. Endopod 1-segmented with five setae

Maxilliped (Figs 4C, 6C). Syncoxa with three surface rows of spinules; distal margin with four setae (two large and one small pinnate setae and one small naked seta). Basis with two setae on palmar margin and a submarginal row of spinules on each face. Endopod 1-segmented, with a

terminal, partially pinnate claw and three accessory setae (one pinnate).

P1 (Fig. 4A). Intercoxal sclerite small, ovoid, without ornamentation. Praecoxa with a row of minute spinules along distal margin. Anterior face of coxa with five rows of well-developed spinules and two rows of minute spinules. Basis with rows of spinules on inner and median distal margin and at base of inner and outer pectinate spines. Exopod 3-segmented, each segment with row of strong spinules on outer margin, exp-2 with row of setules and a plumose seta on inner margin, exp-3 with two geniculate setae on distal, and three spines on outer, margin. Endopod 3-segmented; enp-1 as long as enp-2 and -3 combined, reaching to middle of exp-3, row of strong spinules on outer margin, row of setules and a strong pinnate seta on inner margin; enp-2 less than half length of enp-3, with row of spinules on outer margin and a pinnate seta on inner margin; enp-3 with row of spinules on outer margin and, on distal margin, a small pinnate seta, a large geniculate seta and a spine.

P2-P4 (Figs 4B, 5). Intercoxal sclerite strongly developed, almost square, sclerite of P2 normally with two rows of spinules. Protopod ornamented as for P1 except coxa with only three rows of spinules on anterior face and basis without inner spine but with a small chitinous extension on inner distal margin. Rami 3-segmented, equal in length in P2 and P3, endopod slightly shorter than exopod in P4; distal segment longest; all segments with row of strong spinules on outer margin; proximal two segments of both rami with spiniform extension of outer distal margin, particularly pronounced on enp-2; inner distal seta on exp-3 weakly developed. Setal formula of swimming legs as for genus.

P5 (Fig. 6B). Elements of each side not fused medially. Baseoendopod and exopod separate. Inner expansion of baseoendopod reaching about half length of exopod; with a few spinules on outer margin and three small pores on anterior surface; armed with five pectinate or pinnate spines (three on inner and two on distal margin). Exopod about twice as long as broad, with few spinules on inner and outer margin and a tube pore on anterior surface; with six setae, proximal inner seta pinnate, distal inner seta and terminal seta naked, borne on a short peduncle, proximal outer seta short and normal, two distal outer setae markedly thickened at base and with fine tip.

#### Description of male

Similar to female except for urosome, caudal ramus, antennule, P1 basis, P2 endopod, P3 exp-3 and P5.

Body length 0.48 - 0.76 mm (mean = 0.61 mm, n = 15), urosomites-2 and -3 not fused. Genital somite (Fig. 8C) with vestigial P6 forming one fixed and one articulating plate each bearing three setae. Caudal ramus (Fig. 6E) as in

female except that seta VI is naked and seta III slightly longer.

Somatic ornamentation (Figs 8A-C) as in female except that a ventral row of spinules present on both urosomites-3 and -4 and ventro-lateral row absent on preanal somite.

Antennule (Figs 2C,D) haplocer, 10-segmented with segment 4 a small segment overlaying the proximal portion of swollen segment 5; geniculation between segments 7 and 8; segments 6-8 with modified elements; aesthetascs on fifth and distal segments. Setal formula as follows: 1-[1], 2-[11], 3-[8], 4-[2], 5-[7+(1+a)], 6-[2], 7-[3], 8-[3], 9-[4], 10-[5+(2+a)].

P1 basis (Fig. 7B) with a single, long chitinous projection at inner proximal corner; inner spine slightly larger than in female, unipectinate and recurved at tip

P2 (Fig. 7A). Protopod and exopod as in female. Endopod modified, 2-segmented; enp-1 as in female except inner seta slightly shorter; distal segment with three pinnate setae in inner margin (proximal seta small and arising from a small cuticular projection), a pinnate seta on distal margin, and a large spine and a sinuous process (with a smooth rounded tip) articulating subdistally on outer margin.

P3 (Fig. 7C): As in female except that hyaline tube pore present on anterior face of exp-3.

P5 (Fig. 7D). Baseoendopods of each side fused medially. Endopodal lobe with two terminal pectinate spines and a few spinules on outer margin; outer peduncle with two spinules, a tube pore and a pinnate seta. Exopod about 1.5 times as long as broad with a row of spinules along inner margin, a small tube pore on anterior surface and six setae, of which inner two setae pinnate, distal seta naked, long and slender, proximal outer seta short and normal, second and third outer setae thickened at base with a flagellate tip.

#### Etymology

The specific name is indicative of the plumose nature of seta VI of the female caudal ramus.

#### Variability

No variation was found in the structure and setation of the appendages. The ornamentation of the urosome was very consistent; in the 15 females and 15 males examined, only one female lacked the group of small spinules on both sides of the anal somite, and one female lacked this group of spinules on one side.

*Bulbamphiascus spinulosus* sp. nov.  
(Figs 8D-10D)

#### Material examined

Holotype: Adult female (dissected on four slides) collected by F-h. Mu in the Bohai Sea, China, (38°N, 120°E) over muddy sand bottom at a depth of 11 – 70 m. NHM Reg. No. 2000.345. Paratypes: 4 females and 7 males (one dissected on four slides) from the same locality as the holotype. NHM Reg. Nos 2000.246-356.

This species is morphologically very similar to *B. plumosus*, only points of difference with that species will be described below.

#### Description of female

Body length 0.67 - 0.78 mm (mean = 0.718 mm, n = 3). Caudal ramus (Fig. 8D) as in *B. plumosus* except that seta VI small, (only as long as caudal ramus) and naked.

Somatic ornamentation (Figs 9A-C,G). Body surface appears covered in minute denticles under light microscope. As in *B. plumosus* except that posterior portion of genital double-somite without ventro-lateral row of spinules and preanal somite with a ventral row of spinules.

Antennule (Fig. 10D) as in *B. plumosus* except that segment 4 is 2.5 times longer (measured on anterior margin) than broad.

P5 (Fig. 10C) as in *B. plumosus* except that inner expansion of baseoendopod reaching about 1/3 length of exopod; outer peduncle without spinules. Exopod about 2.8 times as long as broad, with six setae, inner and terminal setae similar to *B. plumosus*, distal outer seta only slightly thickened at base, middle and proximal outer setae normal.

#### Description of male

Sexually dimorphic characters same as in *B. plumosus*. Similar to males of that species except in following characters.

Body (Figs 9D-F) length 0.45 - 0.62 mm (mean = 0.559 mm, n = 6). Caudal rami (Fig. 8E) with seta VI longer than that in female.

Somatic ornamentation (Figs 9D-F). Preanal somite with ventro-lateral and ventral row of spinules. Anal somite without lateral group of spinules.

P2 endopod (Fig. 10A) with anterior surface of segments characteristically bearing dense patches of setules; distal inner seta on enp-2 longer than in *B. plumosus* and outer spine with a rounded tip.

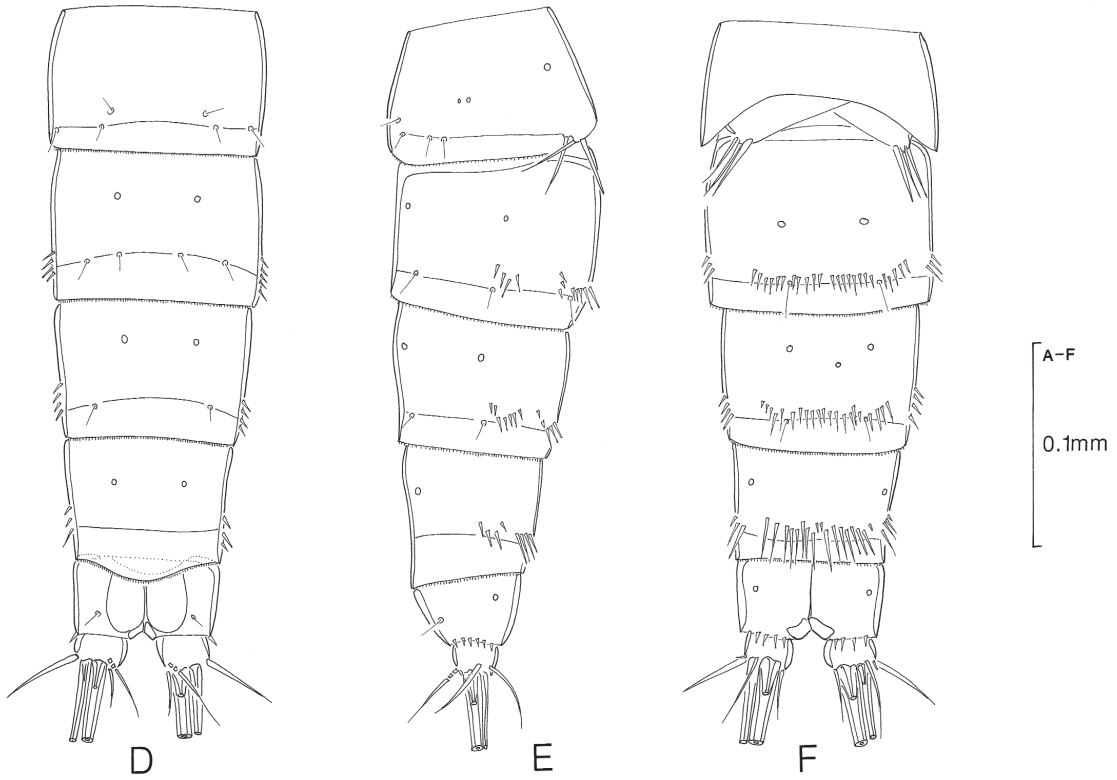
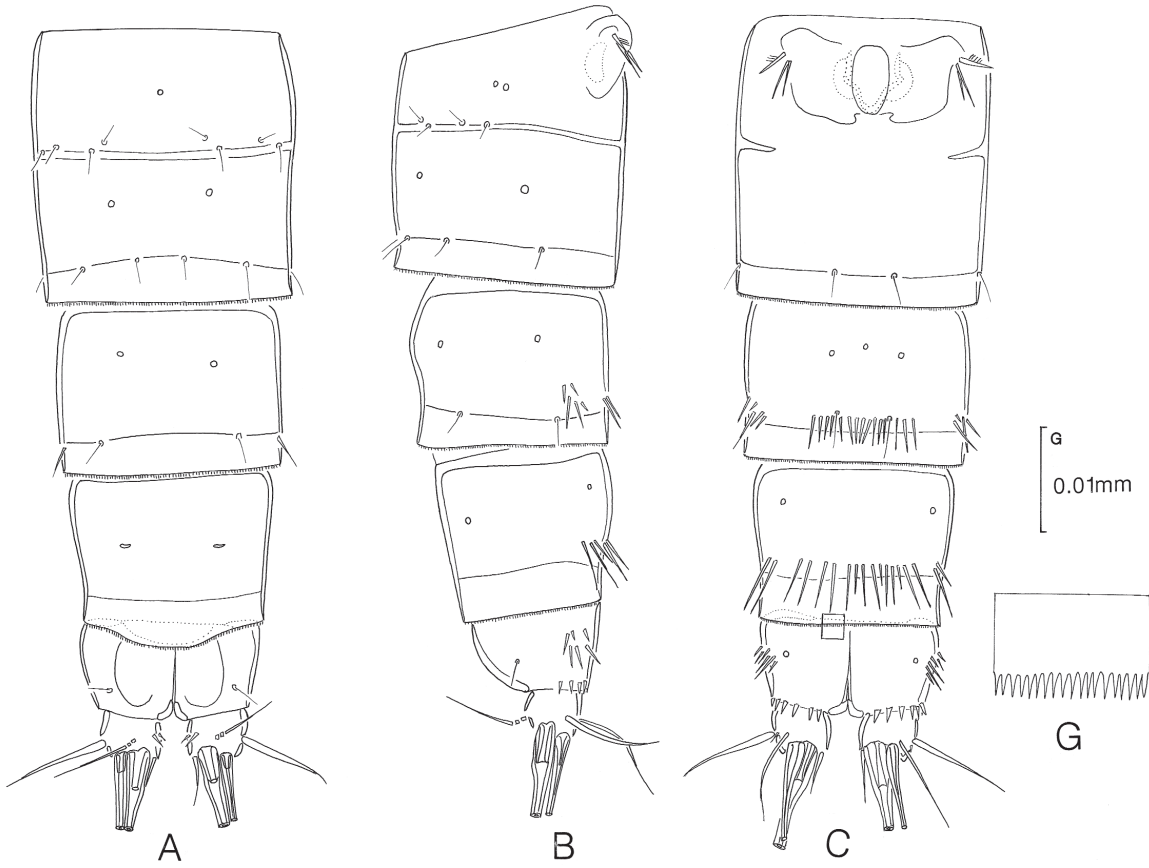
P5 (Fig. 10B) as in *B. plumosus* except that median outer element of exopod a normal pinnate spine and distal outer element a normal naked seta.

#### Etymology

The specific name refers to the additional row of spinules on the ventral urosome, and the setulose nature of the anterior surface of P2 endopod.

#### Variability

No variation was found in the structure, setation and ornamentation of the appendages. The somatic ornamentation on the urosome was stable except that of the 3 females and 6 males examined, only one female lacked the group of small spinules on both sides of anal somite and one female (holotype) had a lateral group of spinules on the posterior portion of the genital double-somite.



*Bulbamphiascus imus* (Brady, 1872)  
(Figs 11-14)

Synonyms: *Canthocamptus imus* Brady, 1872; *Stenhelina ima* Brady, 1880. Other synonyms listed in Lang (1948) and Wells & Rao (1987) may be of doubtful validity.

We have been unable to trace any type material of *Bulbamphiascus imus*. It is not in the Natural History Museum London, nor in the National Museum of Scotland. Although the types of some of Brady's species are housed in the Hancock Museum in Newcastle-upon-Tyne, that of *B. imus* is not among them. For the present, therefore, it must be assumed to have been lost. Consequently, we have designated a neotype in accordance with ICZN article 75 and the Tyne sewage disposal site becomes the new type locality.

Material examined

Neotype: an adult female, spirit preserved, collected by P.J. Somerfield from the Tyne sewage sludge disposal site (North Sea, 55°04'N, 01°17'W), muddy sand bottom at 50 m depth, NHM Reg. No. 2000.257. Other material: 4 females and 3 males (1 dissected onto 5 slides) from the same locality as the neotype, NHM Reg Nos 2000.258-364; 11 females (1 dissected onto 4 slides) and 13 males (1 dissected onto 4 slides), collected by Dr. R. Hamond from off the Norfolk coast (53°10.34'N, 00°56.34'E. NHM Reg. Nos. 1993.352-361.

Description of female

Body size and general facies more or less as in *B. plumosus*. Genital double-somite and genital field (Fig. 12B) as in *B. plumosus* except that middle and inner setae on vestigial P6 shorter and both pinnate. Caudal ramus as in *B. spinulosus* in that seta VI short, only as long as ramus, and naked.

Somatic ornamentation (Figs 11A-C, 14A). Dorsal and lateral surface of prosome and all surface of urosome covered in pattern of minute denticles (Fig. 14A), most of which are not easily visible under the light microscope. Pattern of spinule rows on urosome (Figs 11A-C) as

follows: posterior portion of genital double-somite with paired short ventro-lateral rows; urosomite-4 with ventral row, anal somite with lateral and ventral row at base of each caudal ramus. Hyaline frill of urosomites striated, with minutely dentate margin (only discernable under x100 oil objective).

Antennule as in *B. spinulosus*, i.e. segment 4 is 2.5 times as long (measured on anterior margin) as broad.

Antenna and mouthparts as described for *B. plumosus*.

P1-P4 as figured for *B. plumosus* except that spinules in outer and median rows on anterior face of coxa much more weakly developed. In addition, chitinous extension on inner margin of P2 basis (Figs 12A, 14C) and on outer distal corner of P2 exp-2 (Fig. 12A) more strongly developed.

P5 (Fig. 13C) as in *B. spinulosus* except that distal outer seta of exopod is distinctly bulbiform whilst middle outer seta is normal and pinnate.

Description of male

Sexually dimorphic characters as in *B. plumosus* except for following:

Body (Figs 11D-F). Urosomites-3, -4 and -6 without ventro-lateral rows or groups of spinules; caudal ramus seta VI only as long as ramus.

P1 basis with single, large chitinous spur (arrowed in Fig. 14B) on inner margin but with spinules around base of inner spine in female fused to base of spur in male.

P2 basis (Figs 13A, 14D) with a large, flexible, tapering projection (arrowed in Figs 13A, 14D), ornamented with papillae, near inner distal margin

P5 (Fig. 13B) with patches of pits on surface of baseoendopod and exopod; proximal outer seta on exopod more strongly developed and pinnate.

Variability

No variation was observed in the segmental armature and ornamentation of the swimming legs and P5 in either sex. The somatic ornamentation of the urosome was constant, with only one female (out of 20 females and 18 males examined from Northumberland and Norfolk) lacking the small ventro-lateral spinule row on the posterior portion of the genital double-somite.

Genus *Sinamphiascus* gen. nov.

Diagnosis

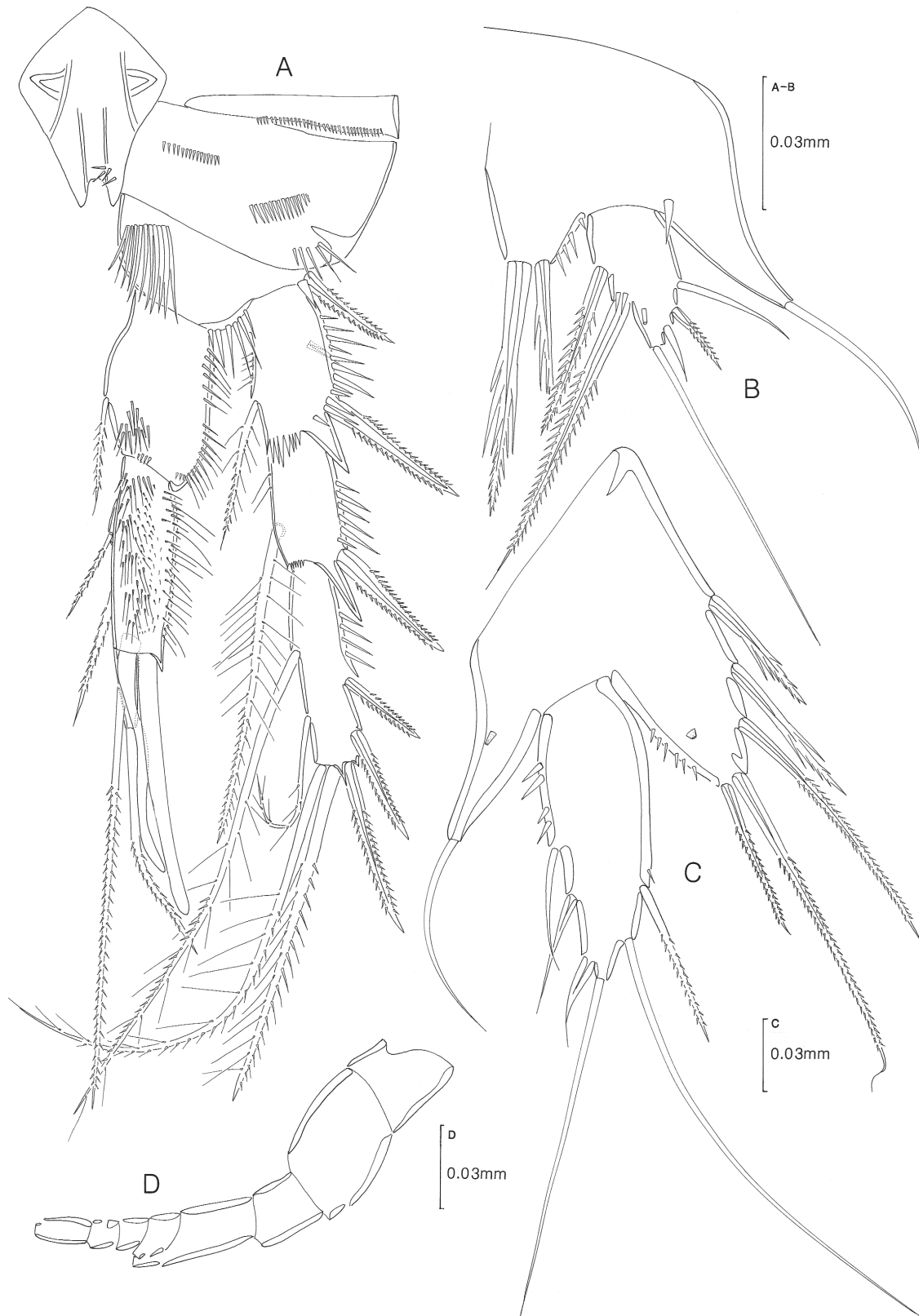
Diosaccidae. Body semi-cylindrical, cephalothorax tapering anteriorly, prosome unornamented, urosome with dorso-lateral, lateral and ventral spinule rows. Female genital double-somite with dorsal and lateral subcuticular rib, genital field with separate gonopores, each covered by vestigial P6 with one very large and two small setae, median copulatory pore obscured by external copulatory bulb; male genital field with one functional and one fused flap each

---

←

**Figure 9.** *Bulbamphiascus spinulosus* sp. nov. **A-C, G** female urosome, excluding P5-bearing somite; **A** dorsal view; **B** lateral view; **C** ventral view; **G** hyaline frill of preanal somite. **D-F** male urosome, excluding P5-bearing somite; **D** dorsal view; **E** lateral view; **F** ventral view.

**Figure 9.** *Bulbamphiascus spinulosus* sp. nov. **A-C, G** urosomite femelle, sauf le somite portant P5 ; **A** vue dorsale ; **B** vue latérale ; **C** vue ventrale ; **G** frange hyaline du somite préanal. **D-F** urosomite mâle, sauf le somite portant P5 **D** vue dorsale ; **E** vue latérale ; **F** vue ventrale.



**Figure 10.** *Bulbamphiascus spinulosus* sp. nov. A-B male; A P2; B P5. C-D female; C P5; D segmentation of l'antennule.  
**Figure 10.** *Bulbamphiascus spinulosus* sp. nov. A-B mâle ; A P2 ; B P5. C-D femelle ; C P5 ; D segmentation de l'antennule.



with three setae. Caudal rami almost square; seta III very small, setae IV and V strongly spinulose. Female antennule 8-segmented, male antennule haplocer, 10-segmented, both sexes with large, posteriorly directed pinnate seta on segment 2. Antennal allobasis with one seta on abexopodal margin; exopod 3-segmented with 1:1:3 setae. Mandibular palp with basis bearing three setae, exopod 2-segmented with 1:3 setae, endopod 1-segmented with eight setae. Maxillulary coxal endite with two setae, basis with six setae, rami 1-segmented, exopod with two, endopod with four, setae. Maxilla with three coxal endites bearing 2:2:3 elements (proximal to distal), allobasal endite with a fused spine and three setae/spines, endopod 1-segmented with six setae. Maxilliped sub-chelate, syncoxa with three, basis with two, setae; endopod segment with a fused claw and three setae. P1 rami 3-segmented; exp-2 with inner seta; exp-3 with five armature elements of which proximal outer element is a small seta; endopod non-prehensile, segments almost equal in length; P1 basis in male with two chitinous projections. P2-P4 rami 3-segmented, except P2 endopod 2-segmented in male; distal inner seta on exp-3 weakly developed. P2 enp-2 in female with small apophysis at outer distal corner; P2 enp-2 in male attenuated, with three setae on inner margin, one seta on distal margin and inner margin with a large articulating spine and an articulating sinuous element with a concave tip and one small tooth. P3 exp-3 in male with dimorphic tube-pore. Setal formula as follows:

	Exopod	Endopod
P1	0:1:023	1:1:021
P2	1:1:223	1:2:121 (1:312)
P3	1:1:223	1:1:221
P4	1:1:323	1:1:121

(brackets denote male condition).

P5 baseoendopod and exopod separate in both sexes. Baseoendopodal lobe with a small hyaline area at base of exopod and with five setae in female, two setae in male. Exopod with six setae in both sexes but with a pedunculate pore on proximal outer margin only in male.

#### Etymology

The prefix indicates that this genus is discovered in China and the suffix indicates that it is related to the *Amphiascus* group of genera. Gender masculine.

#### Type species

*Sinamphiascus dominatus* sp. nov. by monotypy.

*Sinamphiascus dominatus* sp. nov.  
(Figs 15-21)

#### Material examined

Holotype: Adult female (dissected on four slides) collected by F-h. Mu from the Bohai Sea, China, (38°N, 120°E) over muddy sand bottom at a depth of 11 – 70 m. NHM Reg. No. 2000.265. Paratypes: 16 females and 15 males (one

dissected on four slides) from the same locality as the holotype, NHM Reg Nos 2000.366-396.

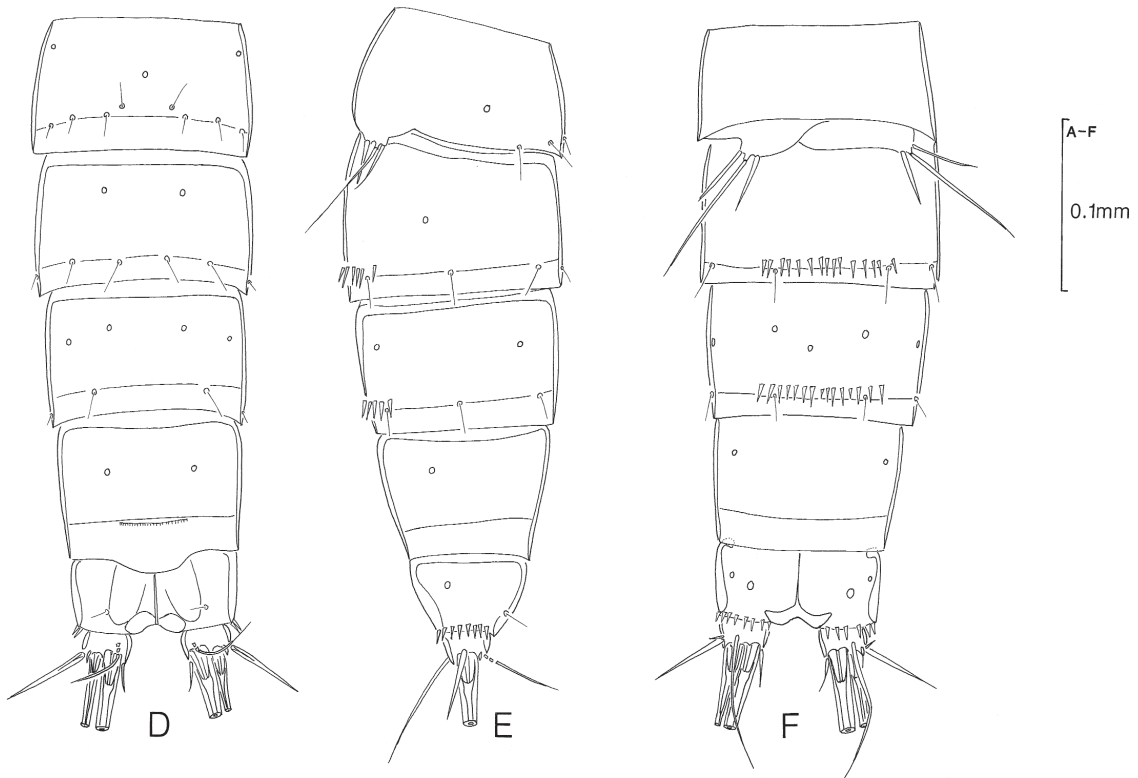
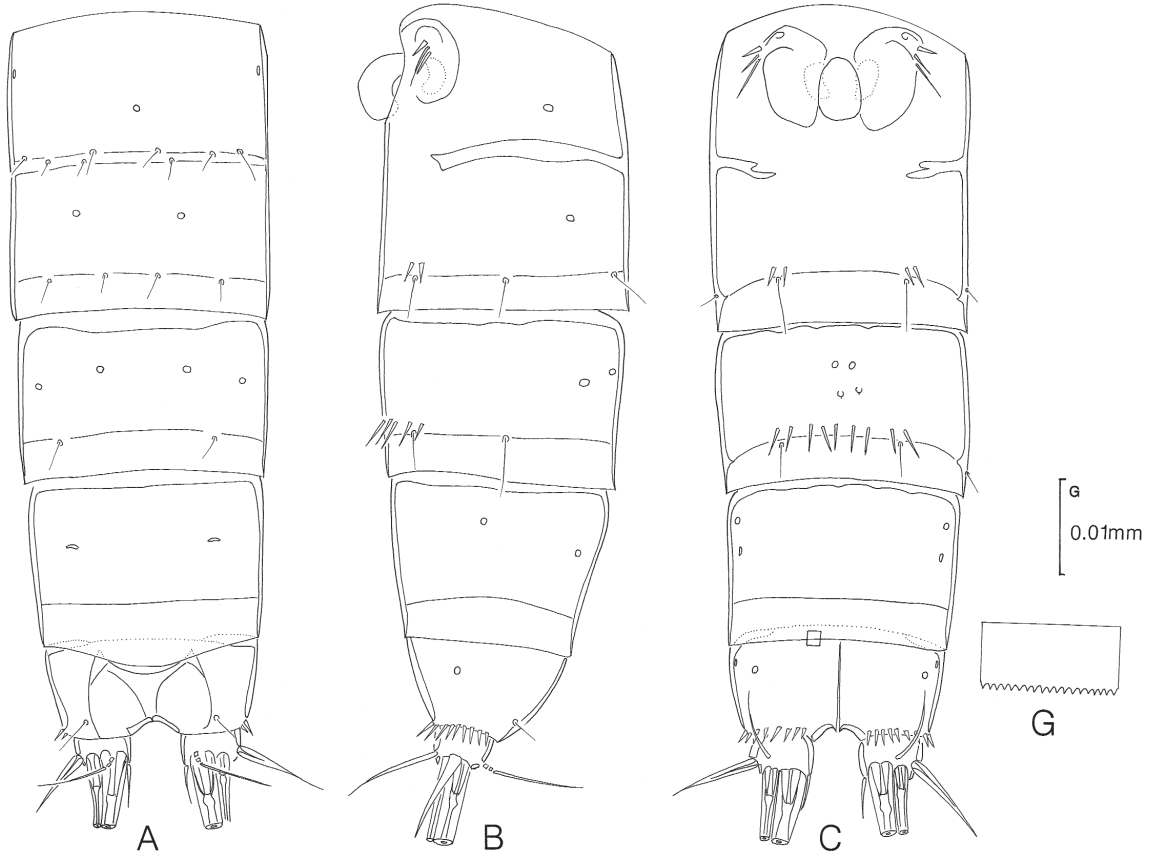
#### Description of female

Body (Figs 15A-C). Length 0.37 - 0.54 mm (mean = 0.43 mm, n = 15). Body subcylindrical, widest at posterior margin of cephalothorax, tapering only slightly posteriorly. Rostrum (Fig. 17A) defined at base, elongate, triangular, semi-hyaline distally and extending beyond the second antennular segment; with a pair of small sensilla on lateral margins. Cephalothorax (Figs 15A,B) tapering anteriorly, as long as free prosomites. Genital double-somite divided dorsally and laterally by subcuticular rib. Genital field (Fig. 16G) with separate genital apertures, each covered by vestigial P6 bearing one long, stout seta with blunt teeth on inner edge, one shorter pinnate seta and a small, plumose spine; copulatory pore situated medially, slightly posterior to genital apertures, in a depression formed by two cuticular folds, and obscured by oval-shaped copulatory bulb forming external portion of seminal duct; seminal receptacles kidney-shaped. Anal somite (Fig. 15) with small semicircular operculum near median dorsal anterior border and overlain by a small pseudoperculum. Caudal rami (Figs 15, 16E) as long as broad with a slender tube pore on ventral posterior margin and a few spinules on inner and distal margin; setae I and II naked and well-developed, seta III small and smooth, located on a small peduncle; terminal setae IV and V well developed and strongly spinulose in median portion; seta VI well-developed and slightly plumose; seta VII triarticulate.

Somatic ornamentation (Fig. 15). Body surface appears smooth under light microscope, all somites furnished with numerous sensilla and pores distributed as in Fig. 15. Prosome without spinule rows. Distribution of spinules on urosome as follows (Fig. 15): anterior and posterior parts of genital double-somite each with a dorso-lateral row on each side; urosomite-4 with, anteriorly, a short ventro-lateral row on each side and a very short median ventral row and, posteriorly, a lateral row on each side and a long ventral row; posterior border of preanal somite with two short ventro-lateral rows on each side and a short median ventral row; anal somite with a lateral and ventral row at base of caudal rami. Hyaline frills of urosomites striated, with dentate margin visible with x20 objective (Fig. 15).

Antennule (Figs 17A, B) 8-segmented, segment 2 with a large, posteriorly directed, pinnate seta; distinctly pinnate setae also on segments 1 and 3; aesthetascs on fourth and distal segments; Setal formula as follows: 1-[1], 2-[11], 3-[7], 4-[3+(1+a)], 5-[2], 6-[4], 7-[4], 8-[5+(2+a)].

Antenna (Fig. 18A). Coxa well developed with row of setules. Allobasis with row of spinules proximally; one seta on abexopodal margin. Exopod 3-segmented, proximal segment with one pinnate seta; middle segment short, with



a pinnate seta; distal segment with a subdistal row of strong spinules; with one smooth seta on lateral margin and two stout pinnate spines on distal margin. Free endopod segment with two rows of strong spinules on outer margin, row of smaller spinules on distal and inner margin and on ventral face; lateral armature of two large pinnate spines and one seta; distal margin armed with one pinnate spine, four geniculate setae (one pinnate medially) and two smooth setae.

Labrum (Fig. 18B) posterior margin armed with two groups of five teeth and two median submarginal rows of spinules.

Mandible (Fig. 18C). Coxa stout, gnathobase armed with one large bicuspid tooth, three bicuspid, one multicuspid and two unicuspid teeth, with two setae (one unipinnate) at inner distal corner. Basis broad, with row of spinules on posterior face and, on distal margin, one pinnate and two plumose setae. Exopod indistinctly 2-segmented, proximal segment with one lateral pinnate seta; distal segment with three setae (one pinnate). Endopod large, 1-segmented; with eight setae (one pinnate and one naked setae proximally, three setae subdistally (one pinnate) and, on distal margin, three setae fused at base (one pinnate)).

Maxillule (Fig. 18D). Praecoxa with row of spinules on anterior face. Arthrite of praecoxa with two smooth setae on anterior face; distal margin with nine spines (one pectinate) and a naked seta on inner margin. Coxa with two naked setae on distal margin. Basis bearing six elements (two naked setae and one pinnate spine distally and three naked setae subdistally). Exopod 1-segmented; with a row of spinules and two plumose setae. Endopod 1-segmented; with a row of spinules and four setae (three pinnate).

Maxilla (Fig. 18E). Syncoxa with three endites, proximal and middle endite armed with two spines (one smooth, one pectinate), distal endite with three spines (two pectinate). Allobasal endite with a subterminal row of spinules, a large fused spine, a smaller articulating spine and two naked setae. Endopod one-segmented with six setae.

Maxilliped (Fig. 18F). Syncoxa with two surface rows of spinules; distal margin with three pinnate setae. Basis with two setae on palmar margin and a submarginal row of

spinules. Endopod 1-segmented, with a terminal claw and three accessory setae (one pinnate).

P1 (Fig. 19A). Intercoxal sclerite small, ovoid, without ornamentation. Praecoxa with a row of minute spinules along distal margin. Coxa with four rows of well-developed spinules and one row of minute spinules on anterior face and a row of spinules near outer margin on posterior face. Basis with row of setules on inner margin and row of spinules on median distal margin and at base of inner, pectinate spine; outer spine pinnate. Exopod 3-segmented, each with row of strong spinules on outer margin, exp-2 with row of setules and a plumose seta on inner margin, exp-3 with two geniculate setae on distal margin, and three elements on outer margin, of which, proximal element is a small seta and distal elements are spines. Endopod 3-segmented, longer than exopod, non-prehensile, enp-1 reaching just past middle of exp-2, and all segments almost equal in length; each with row of spinules on outer margin and enp-1 with row of setules on inner margin; enp-1 and enp-2 with a pinnate seta on inner margin; enp-3 with a small plumose seta, a large, geniculate, pinnate seta and a spine on distal margin.

P2-P4 (Figs 19B, 20). Intercoxal sclerite strongly developed, almost square, sclerite of P2 with paired row of spinules. Protopod ornamented as for P1 except coxa with only two rows of spinules on anterior face and basis without inner spine but with a small chitinous extension on inner distal margin. Rami 3-segmented, endopod slightly longer than exopod in P2 and P3 and slightly shorter than exopod in P4; distal segment longest; all segments with row of strong spinules on outer and distal margin; small apophysis at outer distal corner of enp-2; inner distal seta on exp-3 weakly developed. Setal formula of swimming legs as in generic diagnosis.

P5 (Fig. 16F). Baseoendopods not fused medially. Baseoendopod and exopod separate. Inner expansion of baseoendopod reaching about half length of exopod and with a small hyaline area near base of exopod; with a few spinules on outer margin and one small pore on anterior surface; armed with five pinnate spines equal in length (three on inner and two on distal margin). Exopod about twice as long as broad, with few spinules on inner and outer margin and a small pore on anterior surface; with six elements, (inner spine pinnate, distal two setae slightly plumose and borne on short peduncles, outer three spines pinnate).

#### Description of male

Similar to female except for urosome, caudal ramus, antennule, P1 basis, P2 endopod, P3 exp-3 and P5.

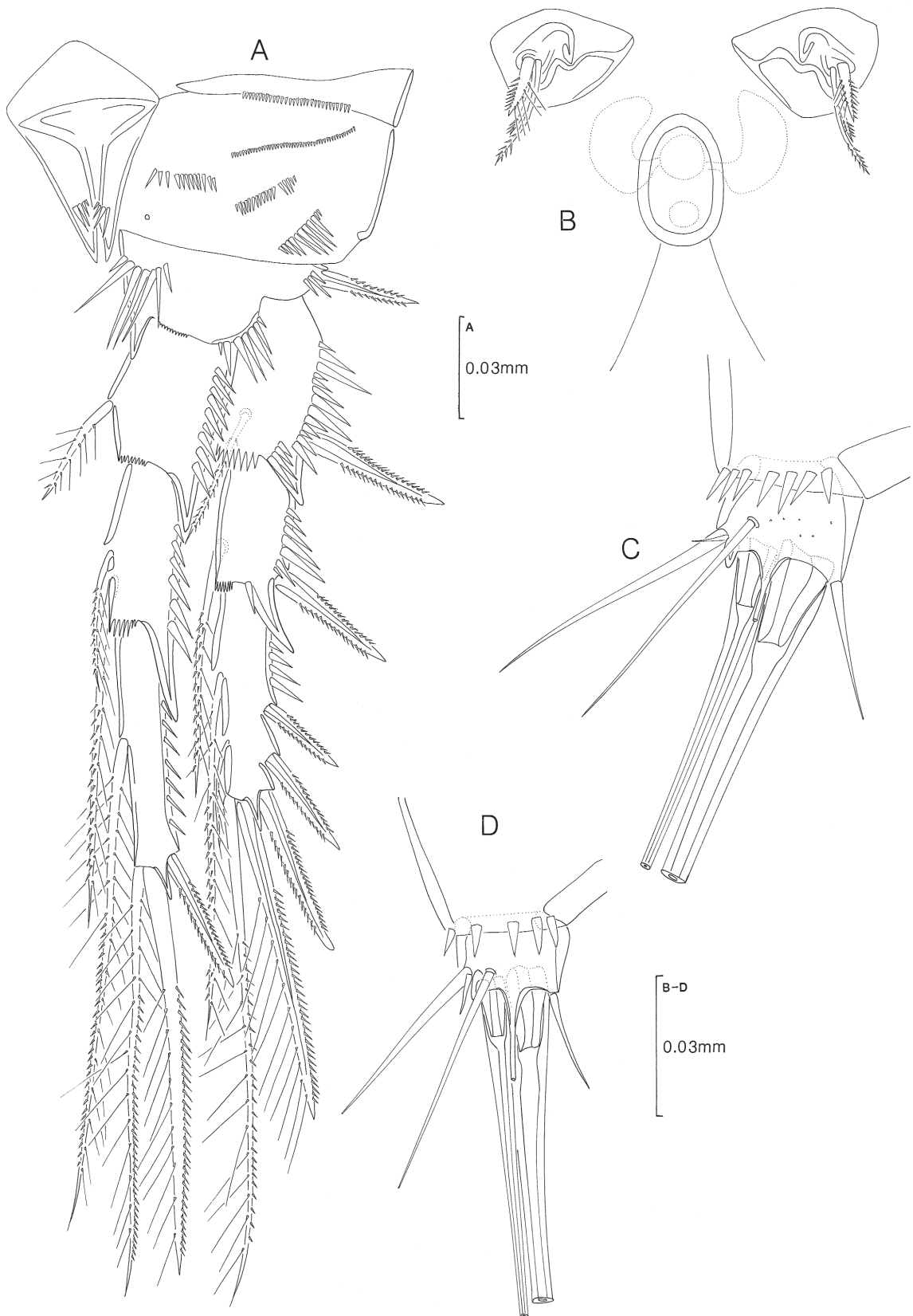
Body length 0.27 - 0.36 mm (mean = 0.31 mm, n = 15), urosomite-2 and -3 not fused. Genital somite (Fig. 16C) with vestigial P6s forming one fixed and one articulating

---

←

**Figure 11.** *Bulbamphiascus imus* (Brady). A-C, G female urosome, excluding P5-bearing somite; A dorsal view; B lateral view; C ventral view; G hyaline frill of preanal somite. D-F male urosome, excluding P5-bearing somite D dorsal view; E lateral view; F ventral view.

**Figure 11.** *Bulbamphiascus imus* (Brady). A-C, G urosomite femelle, sauf le somite portant P5 ; A vue dorsale ; B vue latérale ; C vue ventrale ; G frange hyaline du somite préanal. D-F urosomite mâle, sauf le somite portant P5 ; D vue dorsale ; E vue latérale ; F vue ventrale.

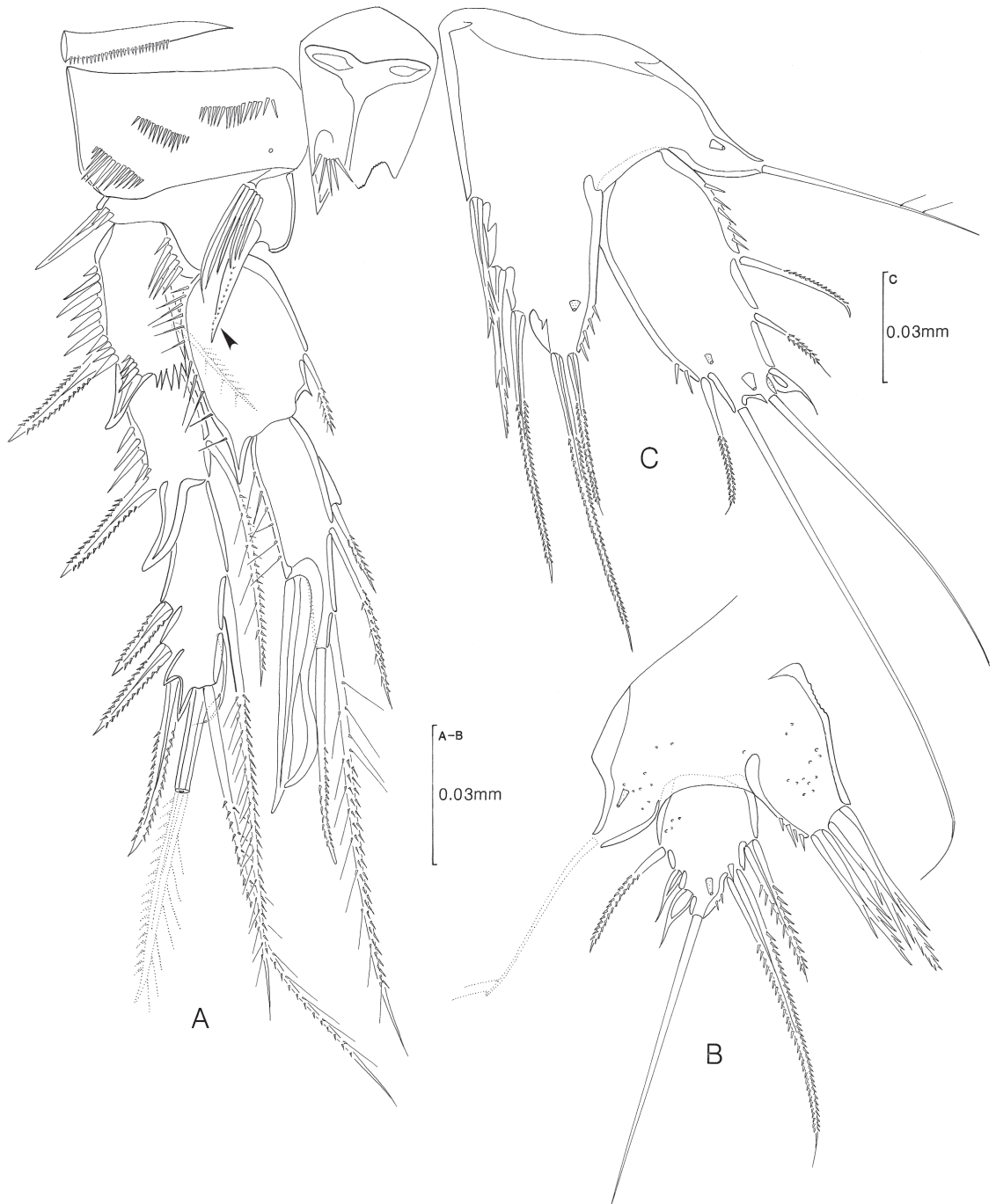
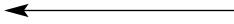


**Figure 12.** *Bulbamphiascus imus* (Brady). **A-C** female; **A** P2; **B** genital field; **C** caudal ramus, ventral view. **D** male caudal ramus ventral view.

**Figure 12.** *Bulbamphiascus imus* (Brady). **A-C** femelle ; **A** P2 ; **B** aire génitale ; **C** rame caudale, vue ventrale. **D** rame caudale mâle, vue ventrale.

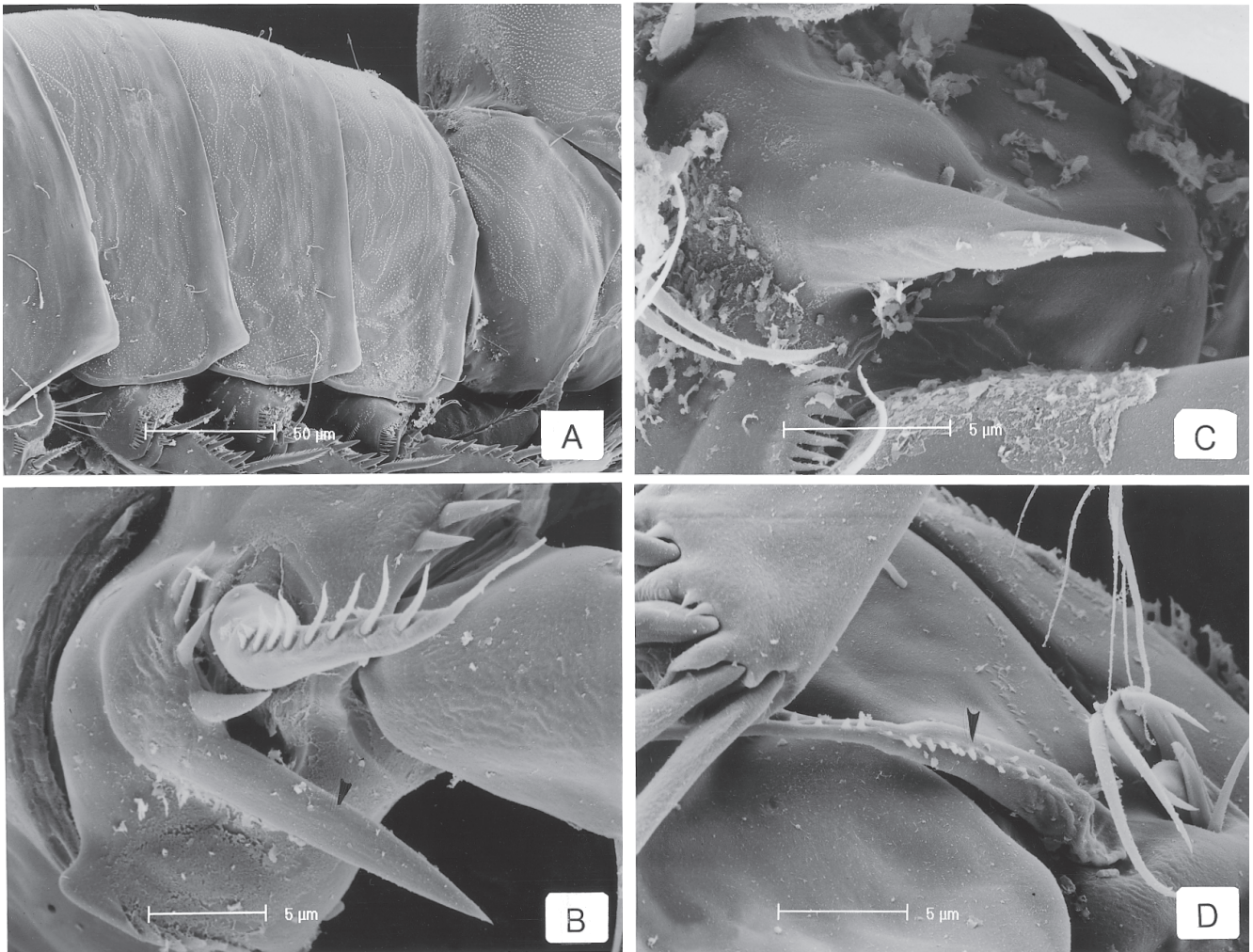
plate each bearing three setae. Caudal ramus (Fig. 16D) as in female except that seta VI is naked.

Somatic ornamentation (Figs 16A-C) as in female except that a ventral row of spinules present on urosomite-3 and anterior rows absent on urosomite-4.



**Figure 13.** *Bulbamphiascus imus* (Brady). **A-B** male; **A** P2; **B** P5. **C** female P5.

**Figure 13.** *Bulbamphiascus imus* (Brady). **A-B** mâle; **A** P2; **B** P5. **C** femelle P5.



**Figure 14.** SEM views of *Bulbamphiascus imus* (Brady). **A** female prosome, lateral view; **B** male P1 basis; **C** female P2 basis; **D** male P2 basis.

**Figure 14.** Vues au MEB de *Bulbamphiascus imus* (Brady). **A** prosome femelle, vue latérale; **B** P1 basis mâle ; **C** P2 basis femelle ; **D** P2 basis mâle.

Antennule (Figs 17C,D). Haplocer, 10-segmented with segment 4 a small segment overlaying the proximal portion of swollen segment 5; geniculation between segments 7 and 8; segments 6-8 with modified elements; aesthetascs on fifth and distal segments. Setal formula as follows: 1-[1], 2-[11], 3-[7], 4-[2], 5-[7+(1+a)], 6-[2], 7-[2], 8-[2], 9-[4], 10-[5+(2+a)].

P1 basis (Fig. 21B) with two chitinous projections near inner margin; inner spine unipectinate.

P2 (Fig. 21A). Protopod and exopod as in female. Endopod modified, 2-segmented; enp-1 as in female except inner seta slightly shorter; distal segment with three pinnate setae on inner margin (proximal seta small and arising from a small cuticular projection), a pinnate seta on distal margin, and a large spine and a sinuous element, with a concave tip

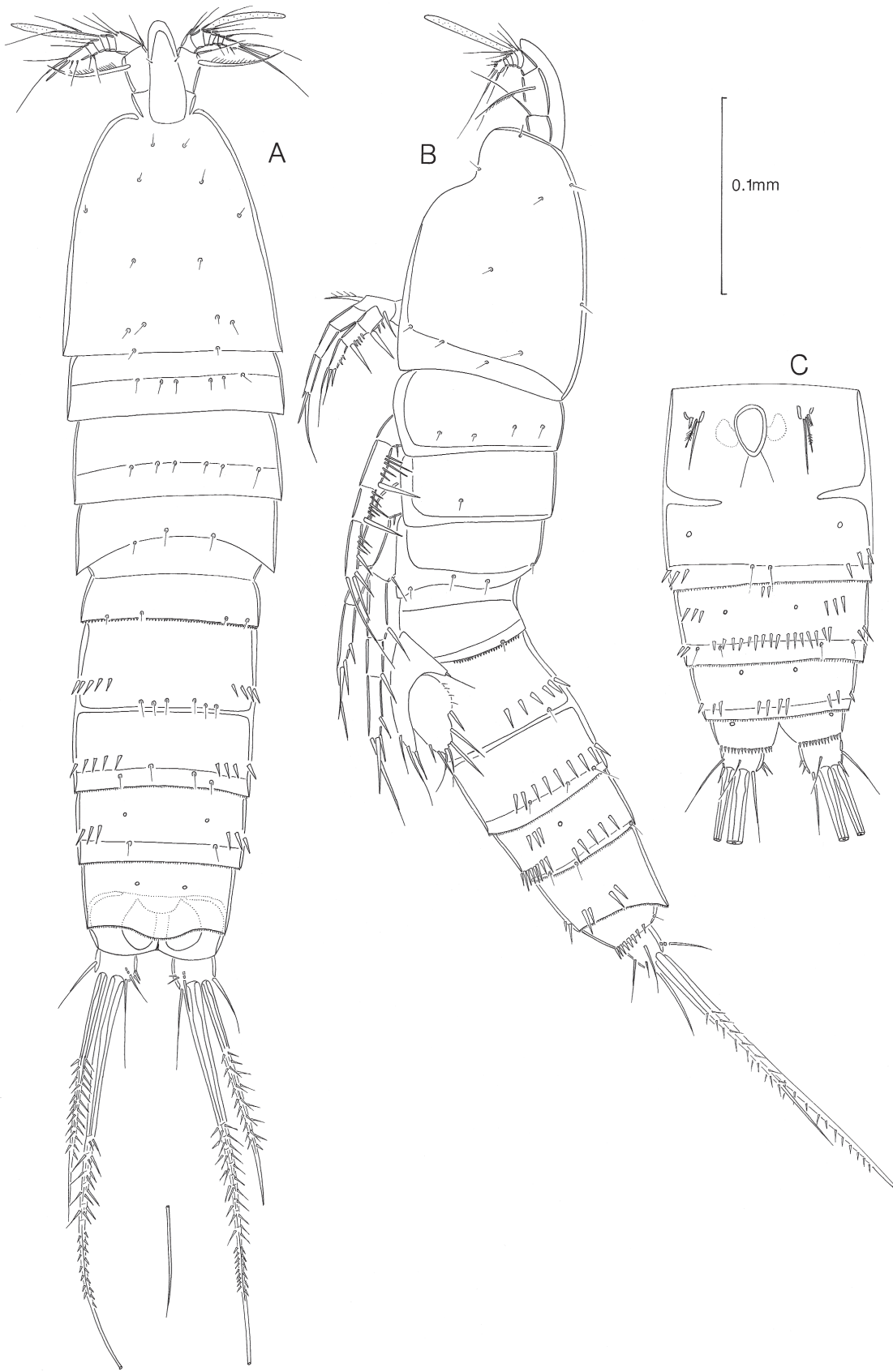
and a minute subdistal tooth, articulating subdistally on outer margin.

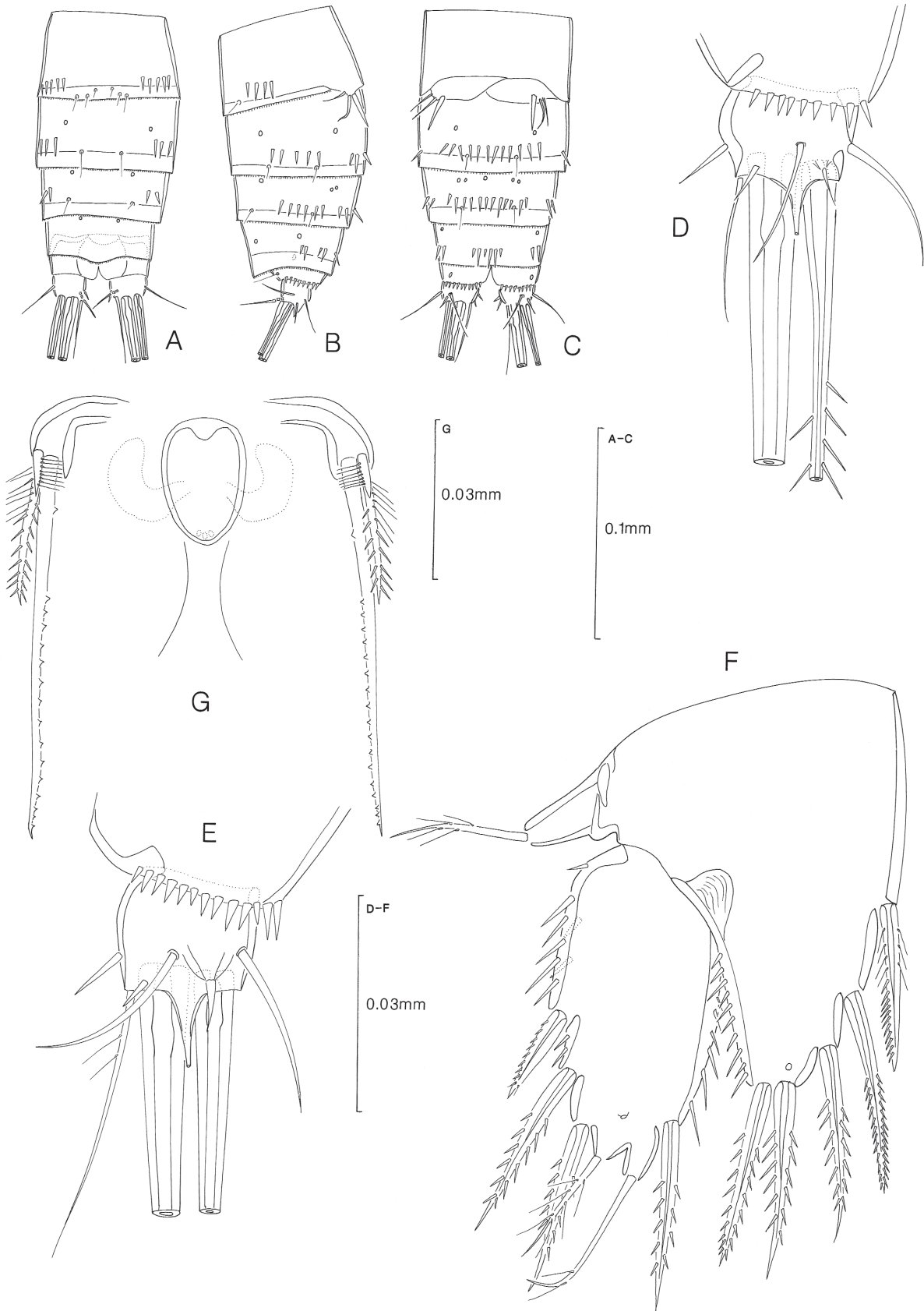
P3 (Fig. 21C) as in female except that hyaline tube pore present on anterior face of exp-3.

P5 (Fig. 21D). Baseoendopods of each side fused medially. Baseoendopod endopodal lobe with a small hyaline area at base of exopod, two terminal pectinate

**Figure 15.** *Sinamphiascus dominatus* gen. et sp. nov. **A-C** female; **A** habitus, dorsal view; **B** habitus, lateral view; **C** urosome excluding P5-bearing somite, ventral view.

**Figure 15.** *Sinamphiascus dominatus* gen. et sp. nov. **A-C** femelle ; **A** habitus, vue dorsale ; **B** habitus, vue latérale ; **C** urosome sauf le somite portant P5, vue ventrale.







spines and a few spinules on outer and inner margin. Exopod about 1.5 times as long as broad, with six elements, (two pinnate spines on inner margin, a naked terminal seta and three pinnate spines on outer margin); a large pore, borne on a pronounced peduncle, present on proximal outer margin along with a row of spinules on each face.

#### Etymology.

The specific name *dominatus* (Latin for power, or absolute mastery) reflects the fact that this is the most abundant diosaccid in the Bohai Sea samples.

## Discussion

### Species of the genus *Bulbamphiascus*

Based on the discussion and keys in Lang (1948) *Bulbamphiascus imus* has been regarded as a variable species which now appears to have a cosmopolitan distribution, having been recorded, according to Wells & Rao (1987), from the Arctic; northwest Europe, the Mediterranean and Black Sea; the Atlantic coast of North and South America from Puget Sound, through the eastern Caribbean to Brazil and Argentina; and around the Indian Ocean from Mozambique, the Andaman and Nicobar Islands to west and south Australia and New Zealand. However, our examination of material from the Bohai Sea led us to believe that two species co-existed, both of which fitted the published descriptions of *B. imus* in gross morphology. The notion that we were dealing with one variable species was rejected because it was possible to distinguish the taxa by a combination of constant characters in the fine structural detail. In both sexes of *B. plumosus*, the preanal somite does not have a ventral row of spinules and the middle and distal outer setae of the P5 exopod are always noticeably to markedly bulbous at the base; in females, seta VI of the caudal ramus is large and plumose, and the antennular segment 4 is only 1.5 times as long as broad; in males the anterior surface of the P2 endopod is smooth. Conversely in both sexes of *B. spinulosus*, the preanal somite always has a ventral row of spinules and the middle and distal outer setae of the P5 exopod are normal;

in females seta VI of the caudal ramus is short (only as long as the ramus) and naked, and the antennular segment 4 is 2.5 times longer than broad; in males the anterior surface of the P2 endopod is ornamented with patches of spinules.

Unfortunately none of the existing descriptions of *B. imus* (or its supposed synonyms), published by Brady (1872, 1880), T. Scott (1895), Norman & T. Scott (1906), Sars (1911), Klie (1950) and Dinét (1971), is detailed enough in any of the above mentioned characters for comparison with those from the Bohai Sea. Further, type material of *B. imus* is unavailable (presumed lost), but Brady (1872) gives the type locality as "about 10 miles off Seaham harbour in a depth of 30 fathoms [60 m] on a muddy bottom". We were able to examine specimens (five females and three males) collected by Dr. P.J. Somerfield from a muddy bottom at 51 m depth, off the mouth of the River Tyne (Northumberland), approximately 12 miles due north of the type locality. The females agreed with the description of Brady (1872) but the males did not agree with the subsequent description given in Brady (1880). However this latter description (based on material from other locations on the northeast coast of England, the islands of Arran and Bute in Scotland, the Isles of Scilly in southwest England and Clew Bay in Ireland) is suspect in that the accompanying illustrations of the female does not entirely agree with his earlier description. Lang (1948) has pointed out that the male described by Brady (1880) was, in fact, the male of *Amphiascus varians* (Norman & T. Scott, 1906).

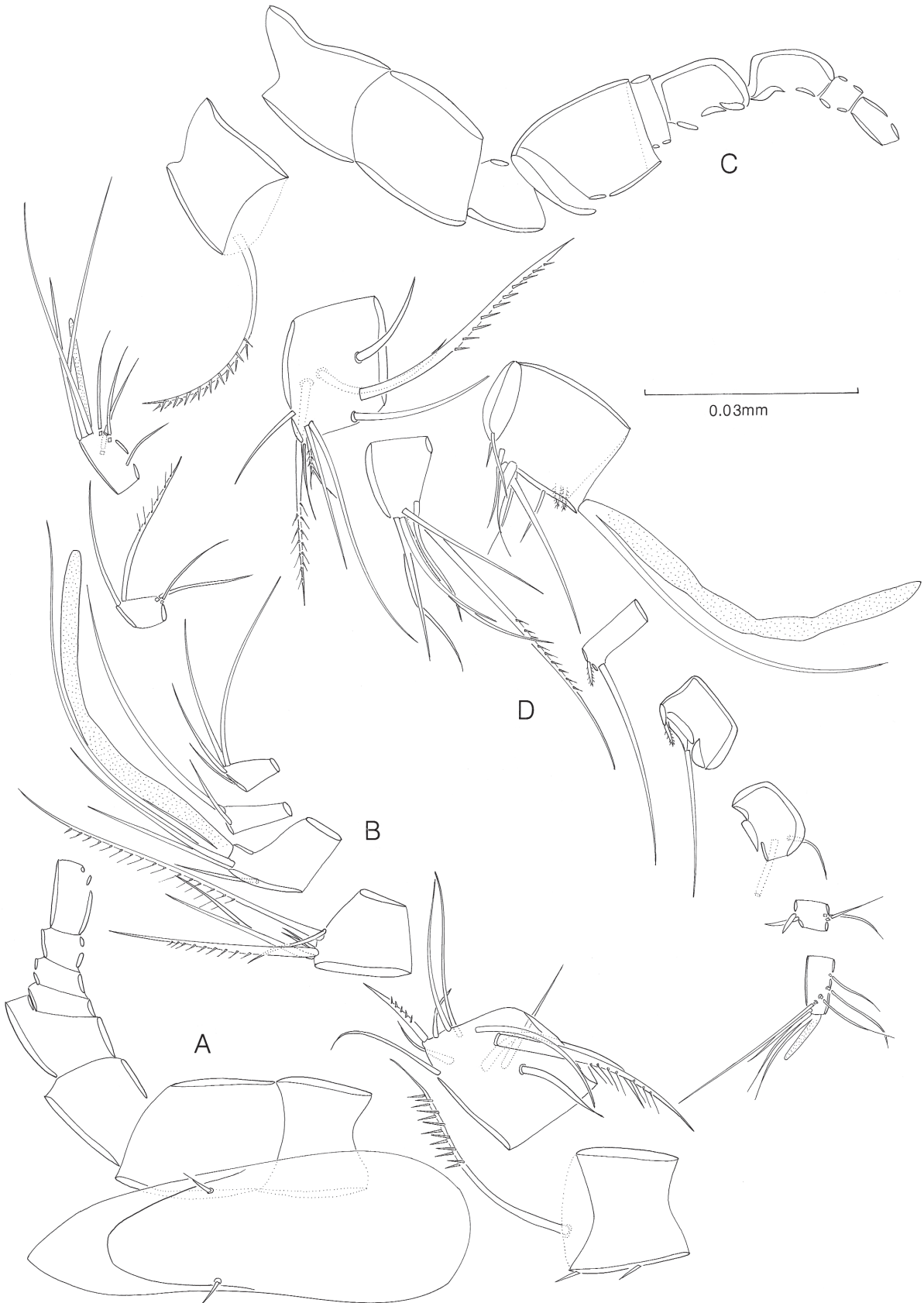
Our Northumberland and Bohai Sea material was identical in gross morphology, but differed in fine structure. The Northumberland specimens of both sexes had no ventro-lateral rows or groups of spinules on urosomites -4, -5 (preanal) or -6 (anal) and no ventral row of spinules on the preanal somite. Segment 4 of the female antennule was 2.5 times longer than broad and seta VI on the caudal rami of both sexes was naked (as in *B. spinulosus*). On the P5 exopod in both sexes, the distal outer element was markedly swollen at the base but the middle outer element was a normal pinnate seta in the female and only slightly swollen in the male. However, the Northumberland material of *B. imus* could most clearly be distinguished from the Chinese material by the presence in the former of a peculiar flexible (semi-hyaline), papillate, spine-like structure on the P2 basis in the male (Fig. 14D). No specimens recovered from China possessed this structure and we know of no other described species (or genus) within the Diosaccidae which has such a sexually dimorphic element on the P2 basis. It was first thought that this may be derived from a pore, similar to the thin walled structure described by Huys & Conroy-Dalton (1993) on the protopod of the male P3 in the cylindropsyllid *Willemsia calceola* Huys & Conroy-Dalton, and to the hyaline tubes attached to sexually dimorphic pores on the P3 exopod of the male in some diosaccid

---

←

**Figure 16.** *Sinamphiascus dominatus* gen. et sp. nov. A-D male; A-C urosome, excluding P5-bearing somite; A dorsal view; B lateral view; C ventral view; D caudal ramus, ventral view. E-G female; E caudal ramus, ventral view; F P5; G genital field.

**Figure 16.** *Sinamphiascus dominatus* gen. et sp. nov. A-D mâle ; A-C urosome, sauf le somite portant P5 ; A vue dorsale ; B vue latérale ; C vue ventrale ; D rame caudale, vue ventrale. E-G femelle ; E rame caudale, vue ventrale ; F P5 ; G aire génitale.



genera (Gee & Fleeger, 1990). However, careful examination under the electron microscope failed to reveal any clear signs of a pore-like opening either on the basis or on the element itself. We conclude, therefore, that this flexible structure in the male is homologous to the chitinous apophysis present on the basis of the female (Figs 12A, 14C) but otherwise absent in the male (Fig. 13A).

In addition to the Northumberland material, we examined a large number of specimens identified as *B. imus* by Dr. R. Hamond from off the Norfolk coast (NHM Reg. No. 1993.352-361); two females and one male from the Isles of Scilly (NHM Reg. No. 1967.10.31.48); and some specimens taken from Kiel Bight in the Baltic Sea. The Norfolk material was identical in every respect to that from Northumberland and the within population variability minimal, even in urosome ornamentation (one out of 15 females lacked the short ventro-lateral spinule row on the posterior portion of the genital double-somite). In the Scilly Isles material, both females lacked this spinule row and one female also lacked the ventral row on urosomite -4. In addition the male had only five setae on P5 exopod (exactly as drawn in Wells, 1961, fig. 2F) and the flexible apophysis on the basis of P2 was a different shape, being distinctly T-shaped in the distal portion. This suggests that the Scilly Isles specimens belong to a different species. In the Kiel Bight material (which came from near the type locality of *B. angustifolius*, a supposed synonym of *B. imus*) the females had a completely different spinulation pattern on the urosome and the P5 outer setae were all completely normal. Unfortunately no males were examined but this also clearly represents a different species.

A re-examination of material ascribed to *B. imus* from other parts of the world is outside the scope of this paper but our observations on north west European and Chinese material suggest that *B. imus* is probably not a cosmopolitan species but represents a complex of closely related and similar species. In anticipation of further study of this composite taxon, and in accordance with the International Code of Zoological Nomenclature, Article 75 (1985 edition), we have designated a neotype of *B. imus* from the material taken from the Tyne sewage disposal site, which now becomes the new type locality. The secondary sexually dimorphic characters may assume greater significance in future revisions of the genera of Diosaccidae and it is

possible that the material from China and other parts of the world will eventually have to be placed in a new genus because of the lack of the sexually dimorphic structure on the basis of the male P2.

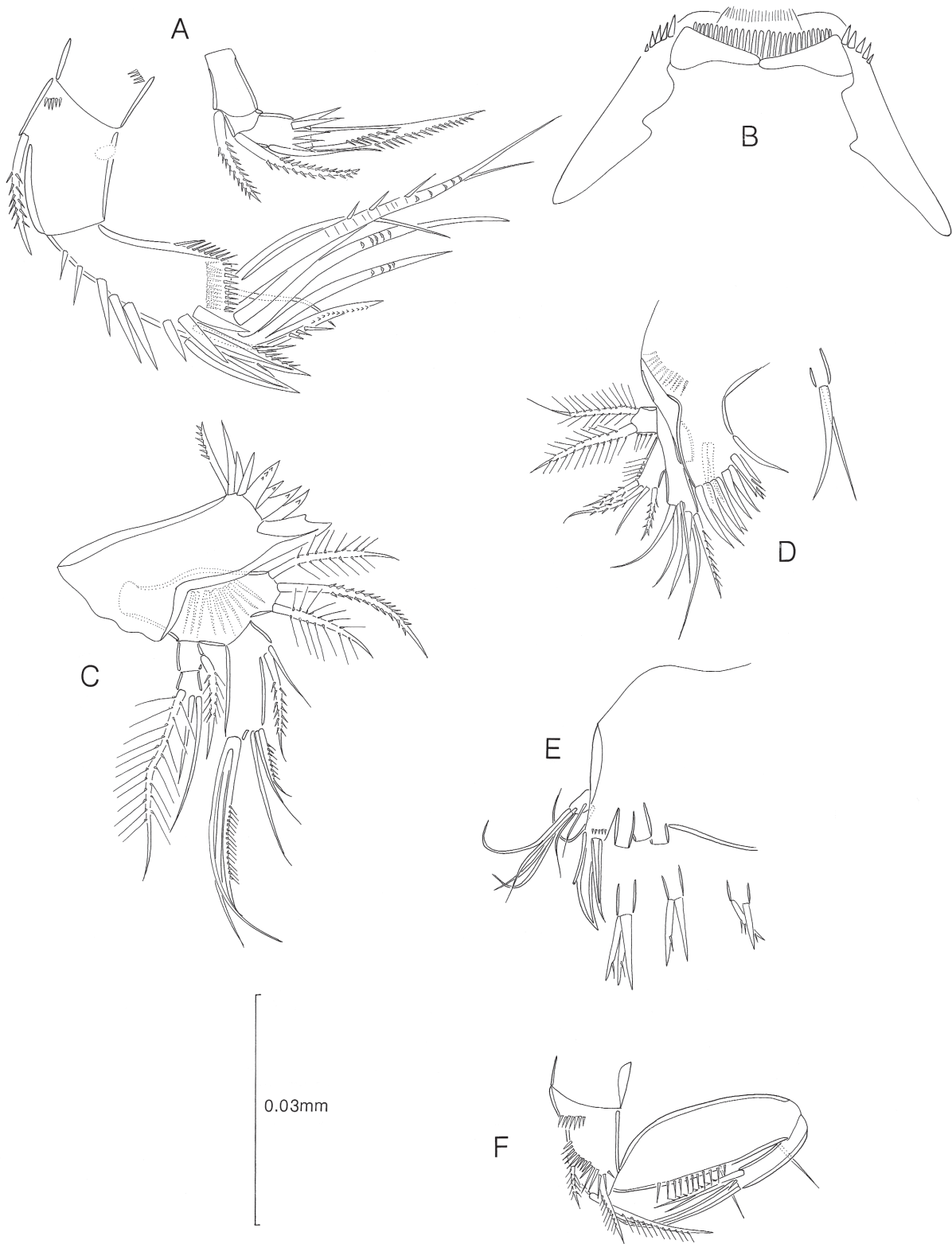
It is interesting to note that *Bulbamphiascus* seems to occur most abundantly in sublittoral sediments high in organic matter (Dinet, 1971; Marcotte & Coull, 1975; Moore & Bett, 1989; Moore & O'Reilly, 1993a). In habitats high in organic matter, or heavily polluted, the occurrence of sibling species complexes appears to be frequent, e.g. in the harpacticoid genera *Tisbe* Lilljeborg (Bergmans, 1979), *Harpacticus* Milne-Edwards (Hamond, pers.com.) and *Leptocaris* T. Scott (Somerfield et al., 1998); in the nematode genus *Pontonema* Leidy (Warwick & Robinson, 1999) and in the polychaete genera *Capitella* de Blainville (Grassle & Grassle, 1976) and *Ophryotrocha* Claparède & Mecznikow (Åkesson, 1984).

With respect to the other species currently assigned to *Bulbamphiascus*, *B. plumosus* and *B. spinulosus* both can be distinguished from *B. chappuisi* by the abdominal ornamentation and the P5 exopod. According to the text in Rouch (1962) there are no spinule rows on the urosome except on the anal somite at the base of the caudal rami; and, in figs 35 & 38 of that paper, the bulbous distal outer seta of P5 exopod in both sexes appears to be fused to the exopod, although it is described as a bulbous seta in the text. The Chinese species can be distinguished from *B. minutus* (known only from a single specimen) by the P1 endopod (enp-1 much longer than the exopod) and the reduced setal formula. Dinet (1971) noted that this species may not belong to *Bulbamphiascus* (the swimming leg armature being like that of *Typhlamphiascus*) but he placed it in that genus on the form of the P5 (but without any swollen setae), the short caudal ramus and the structure of the antennule, antenna and maxilliped. It should be noted here that a mistake in the species key produced by Dinet (1971) probably led to the *Bulbamphiascus* from the region of Arcachon in western France being identified as *B. inermis* by Lasserre et al. (1976) and later authors. *B. cibimae* is different from the species described here in that the P5 exopod of the male bears seven setae. According to the description given by Pallares (1982), there are also differences in the number of setae (1 fewer than normal for the genus) on the mandibular endopod, basis of the maxillule, the syncoxa of the maxilliped and in the number of segments in the endopod of the maxilla (two rather than one). However, these could be attributed to slight errors of observation. Pallares (1982) does not figure the ornamentation of the urosome, but figures the female antennule with segment 4 2.5 times longer than broad, a naked seta VI longer than the caudal ramus and a P5 exopod without any bulbous setae, in which characters *B. cibimae* is more like *B. spinulosus* than *B. plumosus*.

---

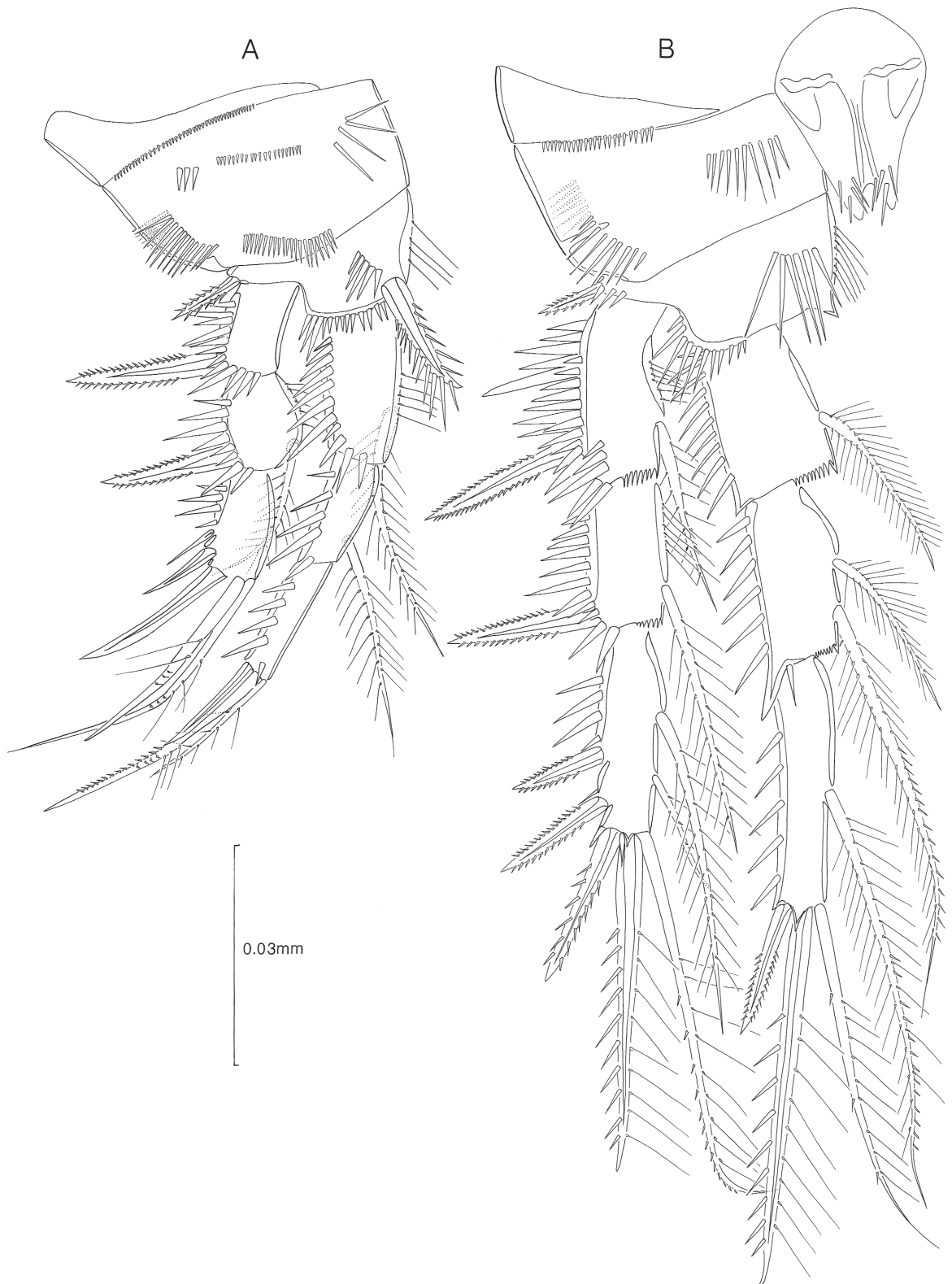
←  
**Figure 17.** *Sinamphiascus dominatus* gen. et sp. nov. **A-B** female antennule **A** rostrum and segmentation; **B** disarticulated. **C-D** male antennule **C** segmentation; **D** disarticulated.

**Figure 17.** *Sinamphiascus dominatus* gen. et sp. nov. **A-B** antennule femelle **A** rostre et segmentation ; **B** désarticulée. **C-D** antennule mâle **C** segmentation ; **D** désarticulée.

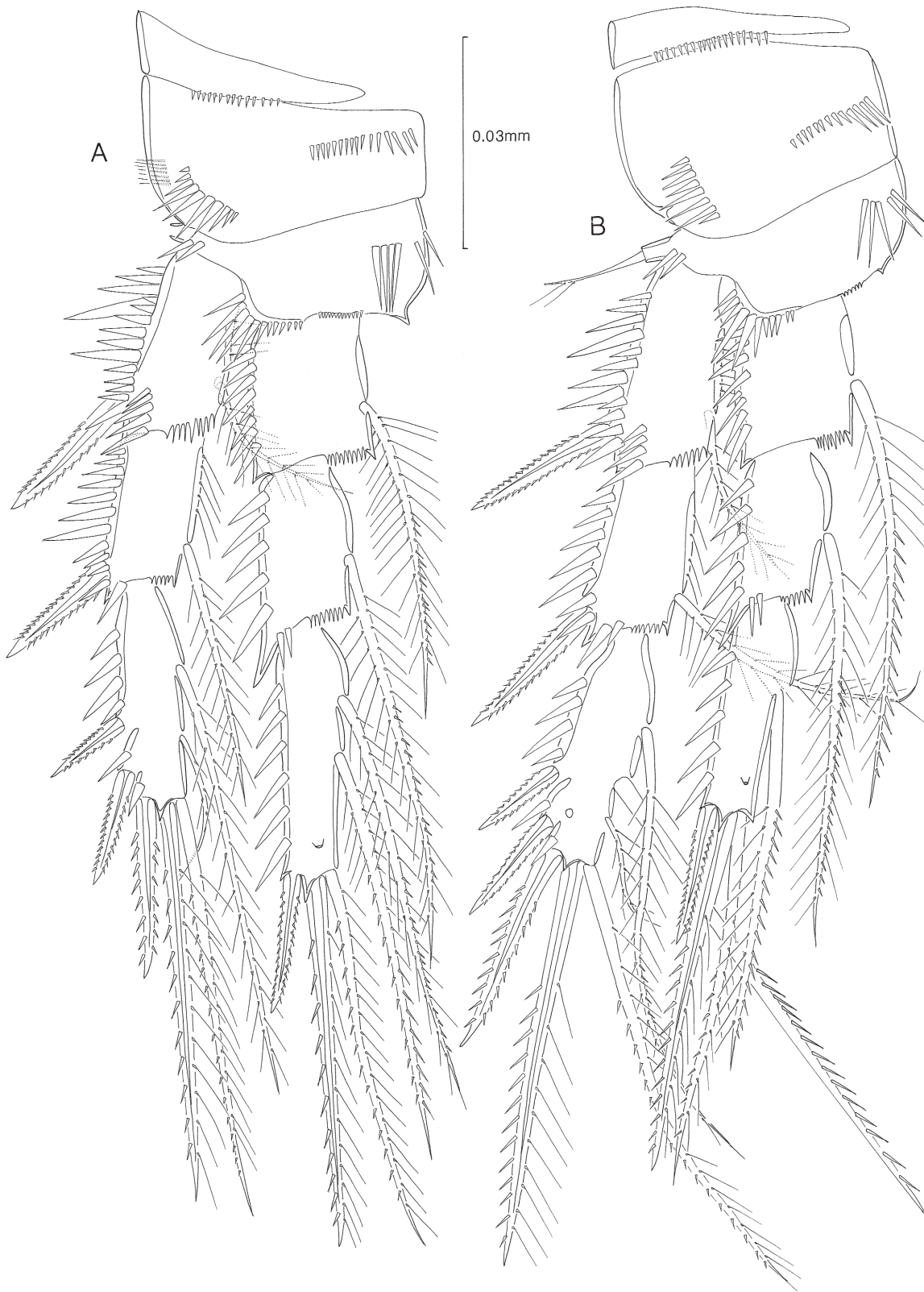


**Figure 18.** *Sinamphiascus dominatus* gen. et sp. nov. Female **A** antenna; **B** labrum; **C** mandible; **D** maxillule, coxal endite separate; **E** maxilla, syncoxal endites separate; **F** maxilliped.

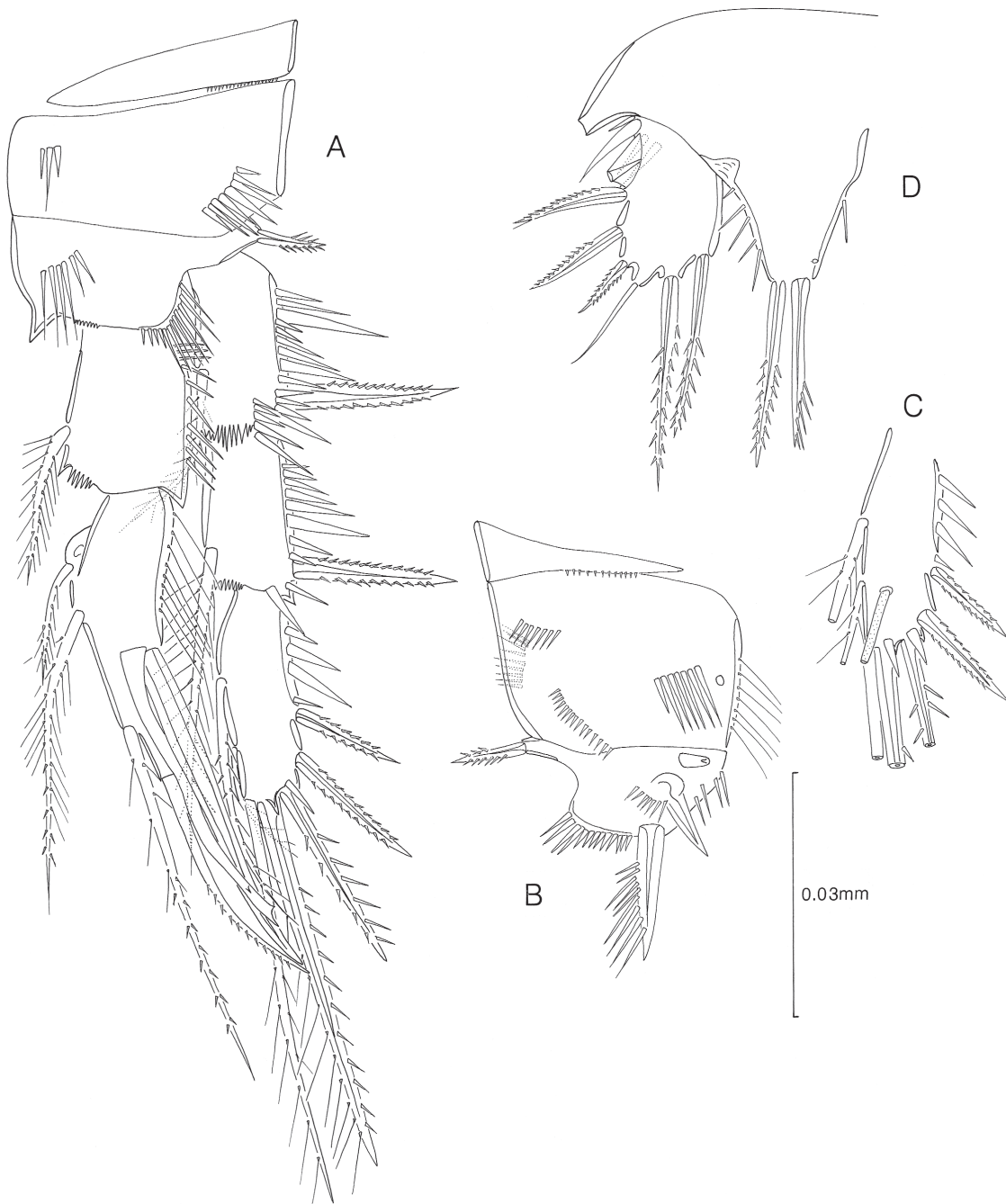
**Figure 18.** *Sinamphiascus dominatus* gen. et sp. nov. Femelle **A** antenne ; **B** labrum ; **C** mandibule ; **D** maxillule, endite du coxa séparé ; **E** maxille, endites du syncoxa séparés ; **F** maxillipède.



**Figure 19.** *Sinamphiascus dominatus* gen. et. sp. nov. Female **A** P1; **B** P2.  
**Figure 19.** *Sinamphiascus dominatus* gen. et sp. nov. Femelle **A** P1 ; **B** P2.



**Figure 20.** *Sinamphiascus dominatus* gen. et sp. nov. Female A P3; B P4.  
**Figure 20.** *Sinamphiascus dominatus* gen. et sp. nov. Femelle A P3 ; B P4.



**Figure 21.** *Sinamphiascus dominatus* gen. et sp. nov. Male **A** P2; **B** P1 basis; **C** P3 exp-3; **D** P5.

**Figure 21.** *Sinamphiascus dominatus* gen. et sp. nov. Mâle **A** P2 ; **B** basis de P1 ; **C** exp-3 de P3 ; **D** P5.

*Sinamphiascus* gen. nov.

We have placed the new species *Sinamphiascus dominatus* in a new genus because we have been unable to find a known genus into which it will fit satisfactorily. The structure of the female genital field and the male sexually dimorphic characters on the P1 basis (chitinous projections),

P2 endopod (see Fig. 21A) and P3 exp-3 (tube pore) of *Sinamphiascus* clearly indicates that it belongs to the *Amphiascus* evolutionary line as suggested in Lang (1948) and Gee & Fleeger (1990). Within this group, the P1 exopod with an inner seta on exp-2 and five elements on exp-3 indicates that the taxon belongs to the *Amphiascus* /

*Bulbamphiascus* / *Typhlamphiascus* / *Robertgurneya* / *Rhyncholagena* grouping. The armature of the antennal exopod and the presence of a weakly developed distal seta on P2-P4 exp-3 of *Sinamphiascus* indicates closest affinity with *Amphiascus* and *Bulbamphiascus*. However, the form of the P1 endopod (non-prehensile, enp-1 not reaching past the middle of exp-2, all segments more or less equal in length) is quite unlike that found in any of the above mentioned genera, where the P1 endopod is prehensile, with the proximal segment as long as, to much longer than, the exopod, and the second segment small and equal to or much shorter than the distal segment.

Within the other group of genera in this lineage, i.e. those with P1 exp-2 without an inner seta and exp-3 with only 4 armature elements, the P1 endopod of *Sinamphiascus* approaches that found in *Paramphiascella* Lang and is almost identical with that found in *Haloschizopera* Lang. The form of the sexual dimorphism in P2 enp-2 is unlike that found in the former genus but again identical to that found in *Haloschizopera*. There are a number of other characters exhibited by *Sinamphiascus* which distinguish it from *Bulbamphiascus* and *Amphiascus* and which indicate a relationship with *Haloschizopera* (see Moore & O'Reilly, 1989, 1993b): (1) Antennular segment 2 with a large posteriorly directed pinnate seta: (2) Exp-3 of the antenna with only two elements on distal margin: (3) Maxilliped syncoxa with only three setae: (4) P5 baseoendopod with distinct hyaline area: (5) Caudal rami with strongly spinulose setae IV and V: (6) Female genital field with a very long inner seta on vestigial P6 (reaching posterior margin of genital double-somite): (7) Male P1 basis with two chitinous projections: (8) Sinuous element on outer margin of the P2 endopod-2 in the male with a distinctive tip. Small size and the ornamentation of the urosome are also more similar to *Haloschizopera* than to *Bulbamphiascus*.

Clearly, *Sinamphiascus* appears to be closely related to *Haloschizopera* but must be distinguished from it on the basis of its much more primitive setal formula of the swimming legs and P5 in which it is closer to *Bulbamphiascus* and *Amphiascus*. It is difficult to find convincing autapomorphies defining *Sinamphiascus* but it is suggested that the small seta as the proximal outer element of P1 exp-3 and the marginal pedunculate pore of the male P5 exopod are unique to this genus. In a group (also including *Typhlamphiascus*, *Rhyncholagena* and *Robertgurneya*) where the structure of the head appendages and the sexual characteristics of the male P2 endopod are remarkably constant, reduction in setal armature and in the length of the proximal segment of the P1 endopod seem to be the main evolutionary trends.

## Acknowledgements

The authors wish to thank the Curator of Crustacea at the Natural History Museum, London, and Dr. P.J. Somerfield, for the loan, or gift, of material of *Bulbamphiascus imus*. Thanks are also due to Miss S. Conroy-Dalton for preparation of material for electron microscopy and Dr. R. Huys for producing the photomicrographs and for useful discussions on this work. For the first author this work forms part of a PhD thesis and for the second author, is part of the Biodiversity programme of the Centre for Coastal and Marine Sciences. The work was funded by DETR under the Darwin Initiative for the Survival of Species programme; The National Science Foundation of China (Project No. 39770145; 497901001) and The Chinese Ministry of National Education Special Funds for PhD studies (Programme No. 970423306).

## References

- Åkesson B. 1984. Speciation in the genus *Ophryotrocha* (Polychaeta, Dorvilleidae). *Fortschritte der Zoologie*, **29**: 299-316.
- Bergmans M. 1979. Taxonomic notes on species of *Tisbe* (Copepoda, Harpacticoida) from a Belgian sluice dock. *Zoologica Scripta*, **8**: 211-220.
- Bodin P. 1964. Recherches sur la systématique et la distribution des Copépodes Harpacticoides des substrats meubles des environs de Marseille. *Recueil des Travaux de la Station Marine d'Endoume, Faculté des sciences de Marseille*, Bulletin **33** (51): 107-183.
- Brady G.S. 1872. Contributions to the study of the Entomostraca No. VII. A list of the non-parasitic marine copepods of the northeast coast of England. *Natural History Transactions of Northumberland and Durham*, **4**: 423-445.
- Brady G.S. 1880. *A Monograph of the free and semi-parasitic Copepoda of the British Islands, Volume II*. Ray Society, London 182pp.
- Dinet A. 1971. Copépodes Harpacticoides d'un sable fin organogène des environs de Marseille. *Téthys*, **2** (3): 747-762.
- Gee J.M. & Fleeger J.W. 1990. *Haloschizopera apprisea*, a new species of harpacticoid copepod from Alaska, and some observations on sexual dimorphism in the family Diosaccidae. *Transactions of the American Microscopical Society*, **109**: 282-299.
- Grassle J.P. & Grassle J.F. 1976. Sibling species in the marine pollution indicator species *Capitella* (Polychaeta). *Science*, **192**: 5676-569.
- Huys R & Boxshall G.A. 1991. *Copepod Evolution*. The Ray Society, London. 468pp.
- Huys R. & Conroy-Dalton S. 1993. *Willemsia* gen. nov. and *Boreopontia* Willems, 1981 revisited (Harpacticoida: Cyliindropsyllidae). *Sarsia*, **78**: 273-300.
- Klie W. 1950. Harpacticoida (Cop.) aus dem Bereich von Helgoland und der Kieler Bucht. *Kieler Meeresforschungen*, **7**: 76-128.



- Lang K. 1944.** *Monographie der Harpacticiden (Vorläufige Mitteilung)*. Almqvist & Wiksells Bøkrtryckeri Ab, Uppsala. 39pp.
- Lang K. 1948.** *Monographie der Harpacticiden*. 2 vols. Lund, Håkan Ohlsson's Bøkrtryckeri. Stockholm, Nordiska Bøkhandeln. 1682pp.
- Lasserre P., Renaud-Mornant J. & Castel J. 1976.** Metabolic activity of meiofaunal communities in a semi-enclosed lagoon. Possibilities of trophic competition between meiofauna and mugilid fish. In: G. Persoone & E. Jaspers (eds), *Proceedings of 10<sup>th</sup> European Marine Biology Symposium*, Ostend, Belgium **2**: 393-414.
- Marcotte B.M. & Coull B.C. 1975.** Pollution, diversity and meiobenthic communities in the north Adriatic (Bay of Piran, Yugoslavia). *Vie et Milieu*, **24**(B): 281-300.
- Moore C.G. & Bett B.J. 1989.** The use of meiofauna in marine pollution impact assessment. *Zoological Journal of the Linnean Society*, **96**: 263-280.
- Moore C.G. & O'Reilly M.G. 1989.** A re-examination of some problematical species of *Haloschizopera* (Copepoda, Harpacticoida). *Journal of Natural History*, **23**: 93-110.
- Moore C.G. & O'Reilly M.G. 1993a.** Commensalism between the polychaete, *Capitella capitata* (Fabricius), and the copepod *Bulbamphiascus imus* (Brady)? *Marine Pollution Bulletin*, **26**(11): 653-654.
- Moore C.G. & O'Reilly M.G. 1993b.** A description of *Haloschizopera bulbifera* (Sars) and three similar new species of harpacticoid copepod. *Journal of Natural History*, **28**: 53-74.
- Norman A.M. & Scott T. 1906.** *The Crustacea of Devon and Cornwall*. The Ray Society, London. 232pp.
- Pallares R.E. 1982.** Copépodos Harpacticoides marinos de Tierra del Fuego (Argentina) IV. Bahía Thetis. *Contribuciones Científicas del Centro de Investigación de Biología Marina Buenos Aires, Argentina* **186**: 1-39 (plates I-XII).
- Rouch R. 1962.** Harpacticoides (Crustacés, Copépodes) d'Amérique Sud. *Biologie de l'Amérique Australe*, C.N.R.S. éditions, Paris, **1**: 237-280.
- Sars G.O. 1911.** *An account of the Crustacea of Norway with short descriptions and figures of all the species. Vol V.* Bergen Museum: Bergen. 449pp & 285 plates.
- Scott T. 1895.** Additions to the fauna of the Firth of Forth – part VII. *Report of the Fishery Board for Scotland*, **13**(3): 165-173.
- Somerfield P.J., Gee J.M. & Aryuthaka C. 1998.** Meiofaunal communities in a Malaysian mangrove forest. *Journal of the Marine Biological Association of the United Kingdom*, **78**: 717-732.
- Warwick R.M. & Robinson J. 1999.** Sibling species in the marine pollution indicator genus *Pontonema* Leidy (Nematoda, Oncholaimidae), with a description of *P. mediterranea* sp. nov.. *Journal of Natural History* (in press).
- Wells J.B.J. 1961.** Interstitial copepods from the Isles of Scilly. *Crustaceana*, **2**: 262-274.
- Wells J.B.J. & Rao G.C. 1987.** Littoral Harpacticoida (Crustacea: Copepoda) from Andaman and Nicobar Islands. *Memoirs of the Zoological Survey of India*, **16**(4): 1-385.