

Postembryonic development of *Upogebia paraffinis* Williams, 1993 (Decapoda, Thalassinidea), reared under laboratory conditions.

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Abstract

Larval development of *Upogebia paraffinis* Williams, 1993 consists of five zoeal stages and a megalopa. One or two terminal additive zoeal stages can occur that are characterized by an increase in size and a few morphological alterations. Development to the megalopa was completed in 16 to 25 days; each stage spends 3.5 days in average. The first four-zoeal stages are easily identified by differences in the telson and the development of uropods. Zoea V is characterized by a distinct scaphognathite and the appearance of a mandible palp.

Key words: Larval development, Systematics, Thalassinidea, Upogebiidae, *Upogebia paraffinis*, Brazil.

Introduction

According to Poore (1994), the genus *Upogebia* belongs to the family Upogebiidae Borradaile, 1903, which is included in the Superfamily Callianassoidea Dana, 1852, within the infraorder Thalassinidea Latreille, 1831i. Recently Williams (1993) described eleven new species for a total of 23 species of Upogebiidae from the Western Atlantic region. Nine species of *Upogebia* are reported for the Brazilian coast: *Upogebia brasiliensis* Holthuis, 1956; *Upogebia omissa* Gomes-Corrêa, 1968; *Upogebia noronhensis* Fausto-Filho, 1969; *Upogebia acanthura* Coelho, 1973; *Upogebia marina* Coelho, 1973; *Upogebia vasquezi* Ngoc-Ho, 1989; *Upogebia omissago* Williams, 1993; *Upogebia careospina* Williams, 1993; and *Upogebia paraffinis* Williams, 1993. *Upogebia noronhensis*, *U. omissago*, *U. careospina*, and *U. paraffinis* are endemic to Brazil. In addition, most recently Nucci and Melo (pers.comm.), found *U. inomissa* Williams, 1993 from the State São Paulo, Brazil.

Few studies exist on *Upogebia* and most of these conducted in Brazil were related to geographic distribution and taxonomy: Gomes-Corrêa (1968), Fausto-Filho (1969), Coelho (1971, 1973), Coelho and Ramos-Porto (1987), Coelho and Rattacaso (1988) and Melo (1999). One of the less investigated aspects of this Brazilian group is the postembryonic development. The only laboratory-reared larvae to date are of *U. brasiliensis*, *U. omissa*, and *U. vasquezi*, by Melo (2001).

The present study describes in detail all larval stages of *U. paraffinis*, reared in the laboratory.

Material and methods

Ovigerous females of *U. paraffinis* were collected in April-June 1998 at a beach in Paranaguá Bay, Pontal do Paraná, Paraná State (25° 33' 00" S 48° 23' 46" W). This species usually lives in muddy slimy substrate. The animals were transported to the Zooplâncton Laboratory at the C.E.M. (Center for the Marine Studies) Zooplâncton, of the Federal University of Paraná. Each female was placed individually in a small plastic container with seawater and substrate from the place of collection.

At the laboratory, the animals were transferred to a small aquarium, fed, and observed daily until hatching.

The larvae newly hatched, were reared individually in small Petri dishes containing 30ml filtered sea water 32‰ of salinity, and maintained at constant 25°C, under a 12:12h light/dark photoperiod. The larvae were fed daily with nauplii of *Artemia*. Larvae and exuviae of each stage were preserved in a solution of ethyl alcohol (96%) and glycerin (1:1).

Drawings and measurements were made with a camera lucida equipped with an ocular micrometer in a Zeiss microscope. The carapace and body length were measured from the tip of the rostral spine to the posterodorsal margin of the carapace and to the distomedial margin of the telson, respectively. The measurements presented here are the average values obtained from the measurement of 12-20 individuals for each stage. The morphological analysis was based on 5-10 individual for each stage.

A set of morphological changes, evident after each ecdysis, established the different developing stages. Terminology was based on Shenoy (1967), Sandifer (1973), Ngoc-Ho (1977), Konishi (1989) and Calazans and Ingle (1998). The term megalopa was used for the first post-zoeal stage.

The larvae used in this study have been deposited in the "Laboratório de larvicultura de Crustáceos, UNESP, Rio Claro-SP-Brasil", and the adults specimens have been deposited in the "Museu de Zoologia, Universidade de São Paulo-Brasil" under accession numbers MZUSP12899-12902, MZUSP12910 and MZUSP13853.

Results

General Considerations

The eggs of *U. paraffinis* carried by females were in different stages of embryony development. During early development the eggs were dark green becoming grey for that females close to hatching. In the laboratory, eggs incubation periods of 4 to 28 days were observed. Hatching was completed over two nights, with each female produced an average of 1,300 larvae.

Upogebia paraffinis exhibited a larval development comprised of five zoeal stages, originated from five to seven ecdyses, before attaining the megalopa stage. When present, sixth and seventh ecdyses produced terminal additive stages. Of the larvae that reached the megalopa, 37% went through five ecdyses, 56% through six ecdyses, and 7 % through seven ecdyses.

Development to the megalopa was completed in 16 to 25 days. In average zoeae molted at regular 3-day intervals from the first to the fourth ecdysis, and at 4-day intervals from the fifth to the seventh ecdyses. The megalopae lasted 5.6 days in average.

Morphology of larval stages and megalopa

The first stage of *U. paraffinis* is described in detail. Only morphological changes are described for stages following the first one. The set of setae is described using the sequence from proximal to distal segments, for each appendix.

Zoea I

Body (Figure 1-I, 2-I): Fusiform, total length (TL) of 2.17mm (2.38-2.02mm). Carapace Length (CL) of 0.88mm (0.82-0.94mm), about 40% of total length of body and smooth. Distinct rostrum slightly curved downward, comprising about 23% of carapace length. Eyes sessile. Abdomen with 5 somites first covered by carapace. Fifth somite with pair of distolateral spines. Last somite fused with telson. Anal spine present in all zoeal stages.

Antennule (Fig.3-I): Uniramous; unsegmented peduncle with 2 terminal aesthetascs and 4 simple setae, small endopod with plumose seta.

Antenna (Fig.4-I): Biramous. Protopod with short plumose seta. Endopod with 3 plumose setae. Scaphocerite with strong distolateral spine and 9 plumose setae.

Mandibles (Fig.5A-I): Incisor and molar processes bearing several teeth. Palp absent.

Maxillule (Fig.5B-I): Coxal endite with 3 plumose and 3 plumodenticulate setae and simple seta. Basal endite with 2 cuspidate and 3 simple setae. Endopod 2-segmented, 2 plumose setae on proximal segment, 5 plumose setae and simple seta on distal segment.

Maxilla (Fig.6-I): Coxal and basal endite bilobed. Coxal endite with 3 plumose, 2 sparsely plumose setae and 3 plumodenticulate setae on proximal lobe, and 4 plumose setae on distal lobe. Basal endite with 5 plumose setae on each lobe. Endopod with 5 plumose setae and simple seta persisting on all zoeal stages. Scaphognathite with 5 plumose setae.

First maxilliped (Mxp1) (Fig.7-I): Coxopod with 2 plumose setae in all zoeal stages. Basipod with 7 plumose and 3 simple setae. Endopod 5-segmented, bearing proximally to distally respectively, 3,2,1,2,4 plumose setae. Distal segment with plumose seta on outer margin. Exopod with 4 long plumose setae.

Second maxilliped (Mxp2) (Fig.8-I): Coxopod naked. Basipod with 2 plumose setae. Endopod 4-segmented, with 2,2,2,4 plumose setae on inner margin, respectively, from proximal to distal segments. Distal segment with plumose seta on outer margin. Exopod with 4 long plumose setae.

Third maxilliped (Mxp3) (Fig.9-I): Rudimentary, biramous and without setae.

First (P1), second (P2) and third pereopod (P3) (Figs.10-I, 11P2-I, 11P3-I): Rudimentary, biramous and without setae.

Fourth (P4) and fifth pereopod (P5): Absent.

Telson triangular (Fig.13-I): Distal margin convex, a median cleft forming 2 symmetrical parts with 7 processes each ($T = 7+7$). Outermost process with inner plumes. Second process short hair-like, named "anomuran hair". Other terminal processes long plumose setae. Additional shorter subterminal setae on dorsal surface.

Pleopods: Absent.

Zoea II

Body (Fig. 1-II, 2-II): TL: 2.25mm (2.02-2.43mm). CL: 0.83mm (0.78-0.94mm), 37% of total length. Cervical groove incipient. Rostrum about 28% of carapace length. Eyes stalked.

Antennule (Fig.3-II): Biramous. Peduncle with 4 long plumose setae on inner margin, 2 small setae on outer margin, and 2 simple setae on distal margin. Endopod with small plumose seta. Exopod with 2-3 aesthetascs, and 3 simple setae.

Antenna (Fig.4-II): Protopod 2-segmented, with 2 small plumose setae on distal segment. Scaphocerite with additional and simple seta.

Mandible (Fig.5A-II): Incisive process of left mandible with 2 or 3 teeth, that of right mandible with only one. Molar process with rows of several small teeth.

Maxillule (Fig.5B-II): Coxal endite with 4 plumodenticulate, 2 plumose and 2 simple setae. Basal endite with 4 cuspidate and 3 simple setae. Endopod with 2+6 plumose setae, respectively, on proximal and distal segments.

Maxilla (Fig.6-II): Scaphognathite with 6 plumose setae.

Mxp1 (Fig.7-II): Basipod with 8 plumose setae, and 3 simple setae. Endopod with 3,3,1,2,5 plumose setae. Exopod with 6 plumose setae.

Mxp2 (Fig.8-II): Basipod with 3 plumose setae, as in all subsequent zoeal stages. Endopod with 2,2,3,6 plumose setae. Exopod with 6 plumose setae.

Mxp3 (Fig.9-II): Endopod unsegmented with plumose seta, exopod with 6 long plumose setae.

P1 and P2 (Figs.10-II, 11P2-II): Endopod rudimentary. Exopod with 6 plumose setae on P1, 4-5 plumose setae on P2.

P3 (Fig.11P3-II): Biramous and rudimentary.

P4 and P5 (Fig.12P4/P5-II): Small and rudimentary, segmentation indistinct.

Telson terminally (Fig.13-II): Small central spine and additional pair of plumose setae, conferring the formula $T = 8+1+8$.

Pleopods: Absent.

Zoea III

Body (Figs.1-III, 2-III): TL: 2.42mm (2.21-2.80mm). CL: 0.92mm (0.84-1.01mm), about 38% of total body. Cervical groove more pronounced. Carapace with pair of post-orbital spines. Rostrum about 30% of carapace length. Abdomen composed of six somites, last one twice length of others.

Antennule (Fig.3-III): Peduncle with some additional small simple or plumose setae on outer margin. Distal margin with 3 long plumose setae and 4 small setae (Fig.III-a). Endopod with a distal spine and 2 simple setae. Exopod with 3 aesthetascs and 3 simple setae.

Antenna (Fig.4-III): Endopod with terminal simple seta. Scaphocerite with 11 plumose setae.

Mandible (Fig.5A-III): Molar processes with some additional teeth.

Maxillule (Fig.5B-III): Coxal endite with 5 plumodenticulate, 2 plumose and 3 simple setae.

Maxilla (Fig.6-III): Coxal endite with about 10 plumose setae on proximal lobe; distal lobe unchanged. Basial endite with 2 additional plumose setae on distal lobe. Scaphognathite with 8-9 plumose setae.

Mxp1 (Fig.7-III): Endopod with 4,3,1,2,5 plumose setae.

Mxp2 (Fig.8-III): Endopod with 2,4,3,6 plumose setae.

Mxp3 (Fig.9-III): Exopod with additional plumose seta.

P1 and P2 (Figs.10-III, 11P2-III): Exopod with 7 plumose setae.

P3 (Fig.11P3-III): Exopod with 2-4 plumose setae.

P4 and P5 (Fig.12P4/P5-III): Slightly enlarged.

Pleopods (Fig.12-III): Four rudimentary pairs on abdominal 2-5 somites.

Telson semi-triangular (Fig.13-III): Fourth process new a long spine fused with telson.

Uropods (Fig.13-III): Freely articulate with last abdominal somite. Protopod indistinguishable. Exopod well developed, with about 10 to 11 plumose setae. Endopod rudimentary.

Zoea IV

Body (Figs.1-IV, 2-IV): T: 2.74mm (2.35-3.42mm). CL: 0.97mm (0.75-1.16mm), 35% of total length. Cervical groove complete. Rostrum about 32% of carapace length.

Antennule (Fig.3-IV): Peduncle with 7 long plumose setae on inner margin; outer and distal margin as in previous stage.

Antenna (Fig.4-IV): Endopod as long as scaphocerite, with terminal plumose seta. Scaphocerite with 12-13 plumose setae.

Mandibles (Fig.5A-IV): Incisor processes with 3 teeth on left mandible and 2 on right mandible. Palp present as a bud.

Maxillule (Fig.5B-IV): Coxal endite with 5 plumodenticulate, one simple and 3 sparsely plumose setae. Basial endite with 6 cuspidate setae, 3 simple setae and plumose seta.

Maxilla (Fig.6-IV): Coxal endite with about 5 plumose, 4 plumodenticulate and 2 sparsely plumose setae on proximal lobe and 5 sparsely plumose setae on distal lobe. Basial endite with 6 slightly plumose setae on proximal lobe, and 6 slightly plumose and simple seta on distal lobe. Scaphognathite with about 10 plumose setae.

Mxp1 (Fig.7-IV): Basipod with 8 plumose and 4 simple setae.

Mxp2 (Fig.8-IV): Unchanged.

Mxp3 (Fig.9-IV): Endopod elongated. Exopod with 7-8 plumose setae.

P1, P2 and P3 (Fig.10-IV, 11P2-IV, 11P3-IV): P1 and P2 unchanged. Seven plumose setae on exopod of P3.

P4 and P5 (Fig.12P4/P5-IV): Slightly enlarged.

Pleopods (Fig.12-IV): Uniramous, about twice size as in previous stage.

Telson (Fig.13-IV): Sub rectangular with the formula $T = 8+1+8$, same processes as in previous stage.

Uropods (Fig.13-IV): Segmented protopod, endopod and exopod. Endopod with 6-9 plumose setae. Exopod with 12-13 plumose setae and small distolateral spine.

Zoea V

Body (Figs.1 and 2-V): TL: 3.10mm (2.74-3.33mm). CL: 1.12mm (1.03-1.27mm), 36% of total body. Rostrum about 33% of carapace with a small median carina.

Antennule (Fig.3-V): Some additional setae on outer margin.

Antenna (Fig.4-V): Endopod longer than scaphocerite, latter with 14-15 plumose setae.

Mandible (Fig.5A-V): Palp differentiated. Teeth more developed on molar and incisor processes.

Maxillule (Fig.5B-V): Coxal endite with about 5 plumodenticulate, 4 slightly plumose setae and simple seta. Basial endite with 6 cuspidate and 4 simple setae and plumose seta.

Maxilla (Fig.6-V): Coxal endite with about 5 plumose, 2 slightly plumose, 5 plumodenticulate and simple setae on proximal lobe. Distal lobe of coxal endite with 5-6 slightly plumose setae. Basial endite with 5-6 and 8 slightly plumose setae on proximal lobe and distal lobe. Scaphognathite 11-12 plumose setae.

Mxp1 (Fig.7-V): Exopod with 7 plumose setae.

Mxp2 (Fig.8-V): Endopod lost plumose seta on distal segment.

Mxp3 (Fig.9-V): Endopod now naked.

P1, P2 and P3 (Figs.10-V, 11P2-V, 11P3-V): Endopod longer than exopod.

P4 and P5 (Fig.12P4/P5-V): Endopods longer, indistinct segmentation.

Pleopods (Fig.12-V): Uniramous, long and indistinctly segmented.

Uropods (Fig.13-V): Endopod with about 11-13 plumose setae and subdistal simple seta. Exopod with about 14-15 marginal plumose setae and 2-3 smaller subterminal simple setae. Spine on distal angle more developed, than in previous stage.

Megalopa

Body (Fig.14A/B): TL: 3.90mm (3.58-4.32mm), CL: 1.34mm (1.25-1.46mm), about 34% of total body. Anterolateral projection with one terminal spine followed by one or two spines. Rostrum broad, short, bluntly tipped, flanked by 3-4 pairs of spines and several plumose setae, dorsally. Abdomen flattened, with pleura, from third to fifth somites, fringed by plumose setae.

Antennule (Fig.14-C): Peduncle 3-segmented. Proximal segment enlarged medially and bearing numerous setae, distal margins with plumose setae and 2 spines. Medial and distal segments bearing 3-4 setae each. Exopod 3-segmented, with 2 aesthetascs and 3 simple setae on distal segment, median segment with 1-2 aesthetascs and 2 simple setae, proximal segment naked. Endopod 2-segmented, with simple seta on proximal segment and 8 setae on distal segment.

Antenna (Fig.14-D): Uniramous, with vestigial exopod. Peduncle 4-segmented, second segment with 2 tubercles and spine distally. Antennal flagellum with 18-22 segments bearing plumose and some simple setae.

Mandible (Fig.14-E): Palp 2-segmented. Distal segment with several setae. Proximal segment with 0-1 seta, and indistinct segmentation. Molar and incisor processes distinct, latter quadrangular, with about 4 large teeth on cutting face. Molar processes with several strong teeth.

Maxillule (Fig.14-F): Coxal endite expanded, with about 15 plumose and 6 simple setae. Protopod with long basal slightly plumose seta. Basial endite with about 11 cuspidate, 4 simple and 6 plumose setae. Endopod unsegmented, with 1-3 setae.

Maxilla (Fig.15-A): Proximal lobe of coxal endite with distal set of long, thin, plumose and plumodenticulate setae (Fig. 15a-1), and one subterminal set of several shorter plumose setae (Fig.15a-1). Distal lobe of coxal endite with about 8 marginal plumose setae. Proximal lobe of basial endite with about 7 plumose setae. Distal lobe of basial endite with about 24 simple setae or sparsely plumose setae. Endopod with 1-2 plumose setae. Scaphognathite well developed with about 29 plumose setae.

Mxp1 (Fig.15-B): Coxopod wider than long, with 8-10 plumose setae on inner margin and small epipod on outer distal margin. Basipod long and wide on base, with simple setae, and plumose setae on inner margin. Endopod unsegmented and with about 8 plumose setae and simple seta. Exopod 2-segmented, with 6 plumose setae only on distal segment.

Mxp2 (Fig.15-C): Coxopod wider than long, with two plumose setae. Basipod with 5 plumose setae. Endopod 5-segmented. Ischium without setae. Merus with several simple, plumose and plumodenticulate setae. Carpus with single seta. Propodus and dactylus with about 8 plumose setae and 10 slightly plumose setae, respectively. Naked exopod 2-segmented.

Mxp3 (Fig.15-D): Coxopod with 5 plumose setae, distally, and small epipod. Basipod with about 6 plumose setae. Endopod 5-segmented, with numerous plumose setae on inner margin of all of segments. Dactylus, propodus and carpus with some simple and plumodenticulate setae. Exopod rudimentary.

P1 (Fig.16-P₁): Uniramous and 7-segmented. Coxopod with about 5 small plumose setae and a spine on ventral face. Basipod with 4 plumose setae and spine. Other segments with numerous plumose setae. Ischium, merus, carpus and propodus with 1,3,4,2 spines, respectively. Propodus with large propodal process forming the fixed finger, latter with 2-3 small teeth. Dactylus about 3 times length of fixed finger. Exopod vestigial.

P2 (Fig.16-P₂): Uniramous and 7-segmented. Coxopod, basipod and isquium sparsely setose. Several plumose setae on merus, carpus, propodus and dactylus. Merus with 2 rows of plumose setae. Merus and carpus with 1 and 2 spines, respectively. Exopod vestigial.

P3 (Fig.16-P₃): Uniramous, slender and 7-segmented. Plumose setae present on all segments. Merus with 2 spines. Small exopod, with 5 plumose setae.

P4 (Fig.16-P₄) and P5 (Fig.16-P₅): 7-segmented and shorter, with some short, simple, plumose or plumodenticulate setae on all segments.

Pleopods (Fig.17-PL₂₋₅): Biramous and paired, on second to fifth abdominal somites. Endopods about 1/4 exopod, bearing about 9-11 plumose setae. Exopods with about 22-25 plumose setae and some simple setae.

Telson (Fig.17-E): Rectangular with distal border convex, bearing small central spine, plumose and simple setae, and 3 spines on distolateral margin. Anal spine absents.

Uropods (Fig.17-T): Endopods with straight naked outer margin. Distal and inner margin densely fringed by simple and plumose setae. Exopod densely plumose on all margins.

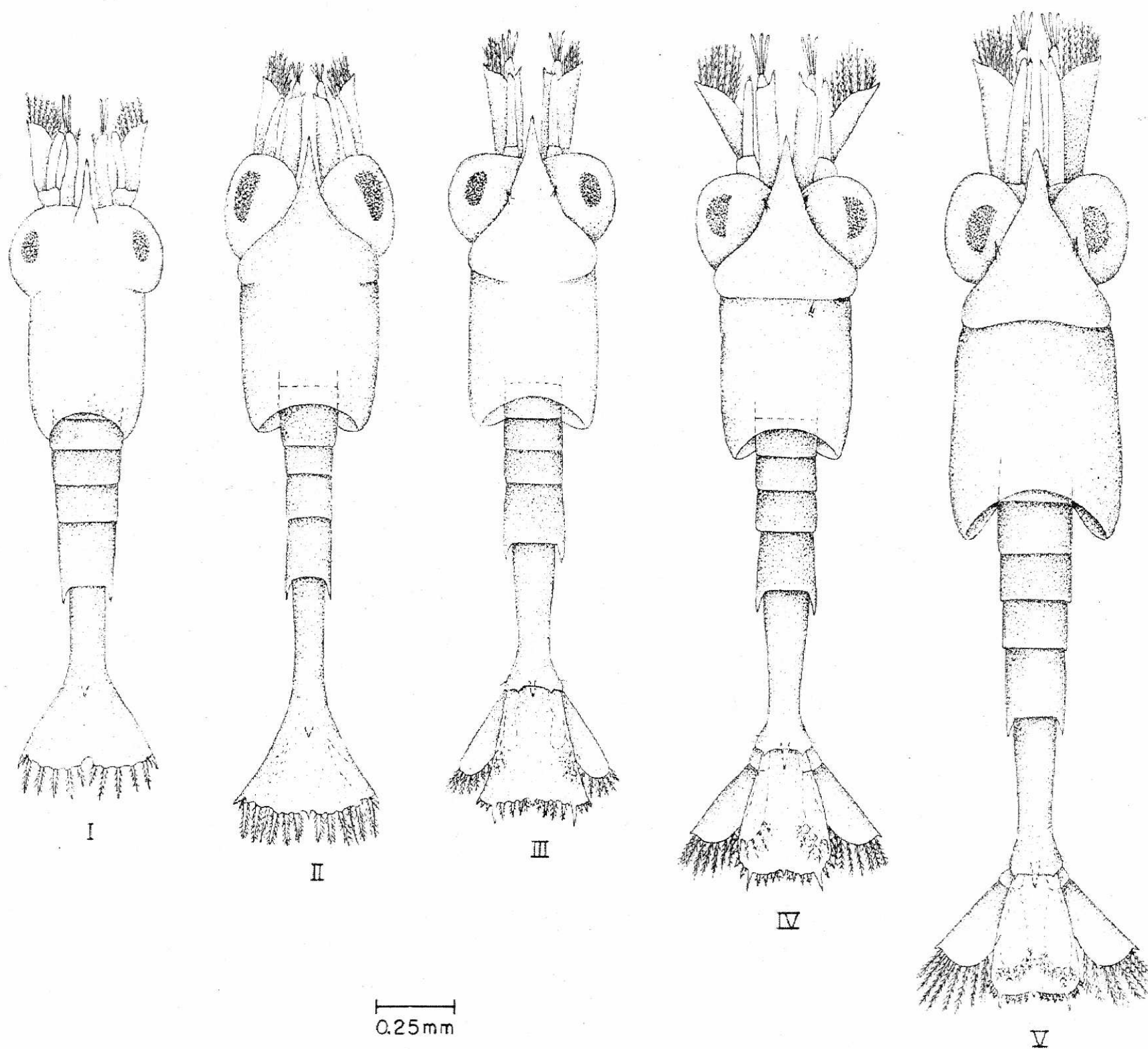


Figure 1: *Upogebia paraffinis*. Dorsal view of zoeal stages (I- V).

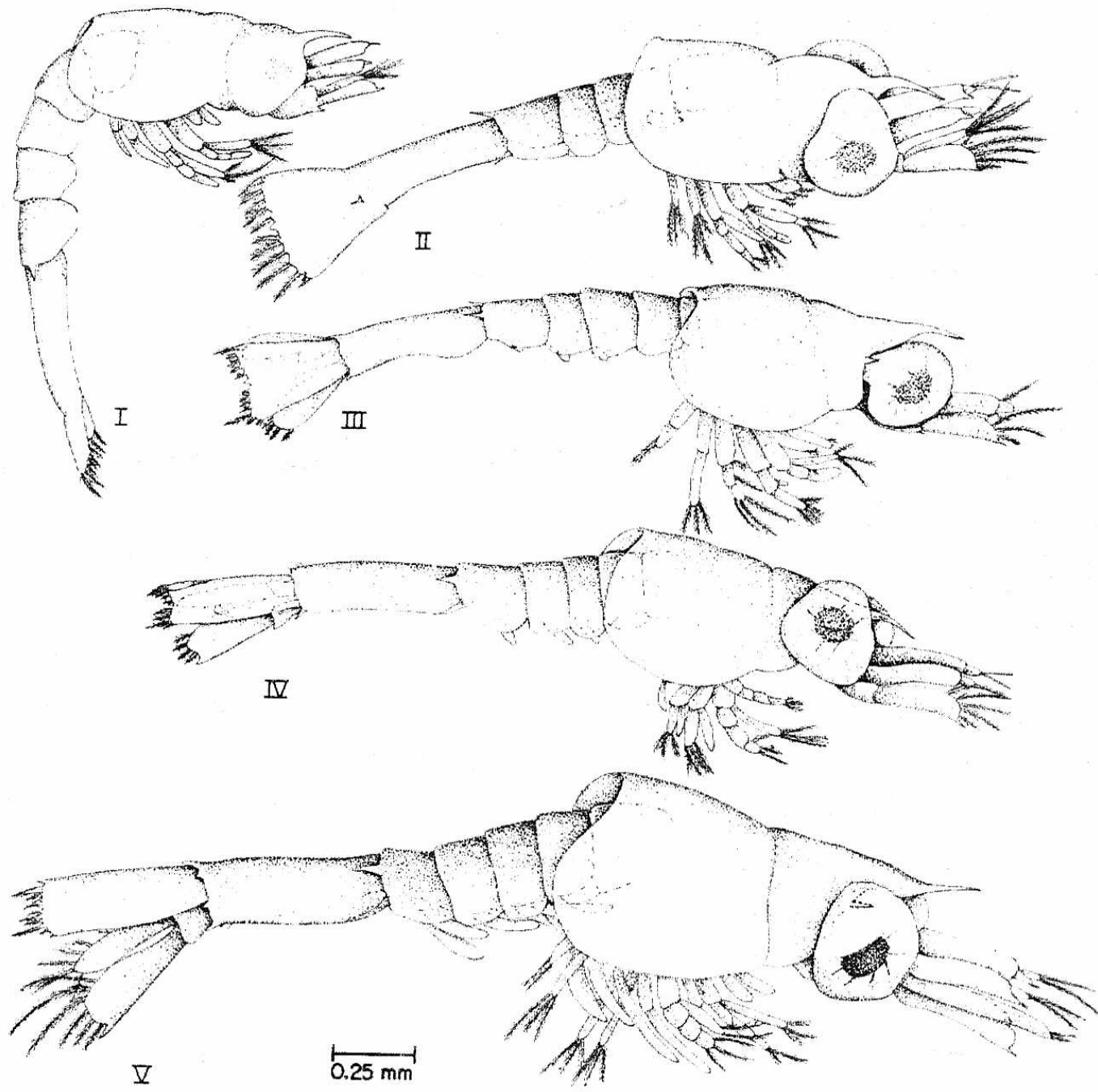


Figure 2: *Upogebia paraffinis*. Lateral view of zoeal stages (I-V)

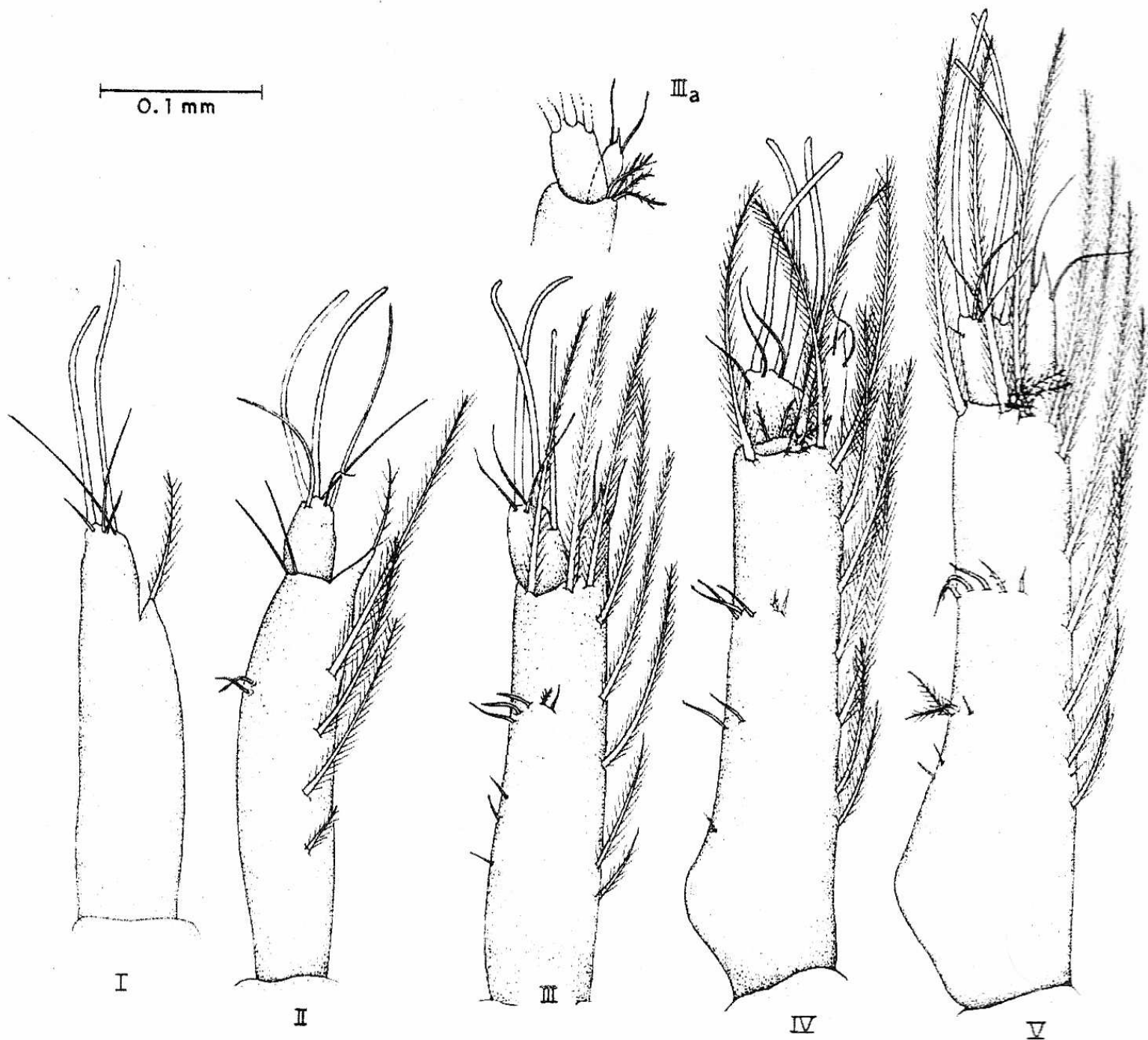


Figure 3: *Upogebia paraffinis*. Antennule of zoeal stages (I-V).

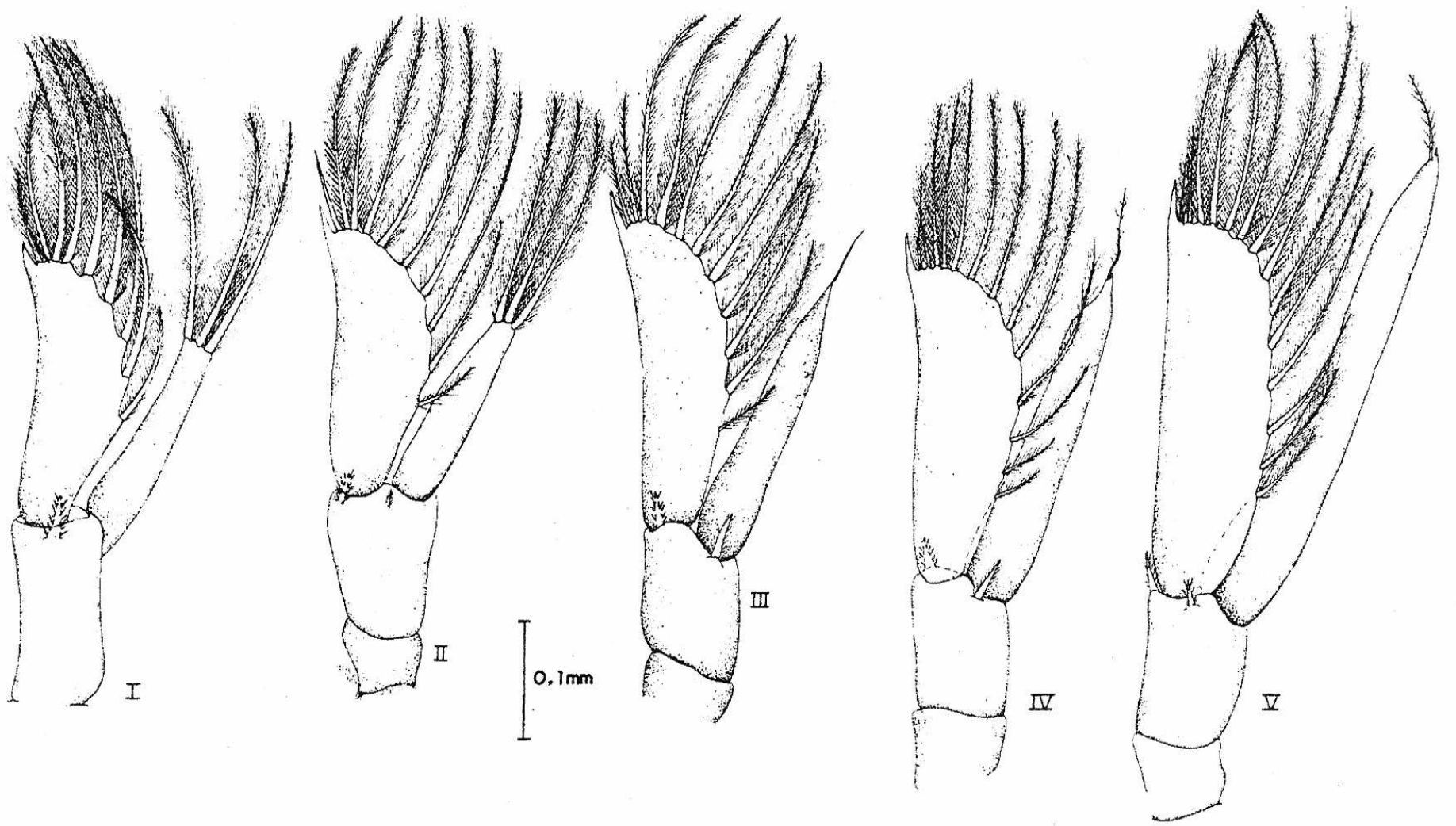


Figure 4: *Upogebia paraffinis*. Antenna of zoeal stages (I-V).

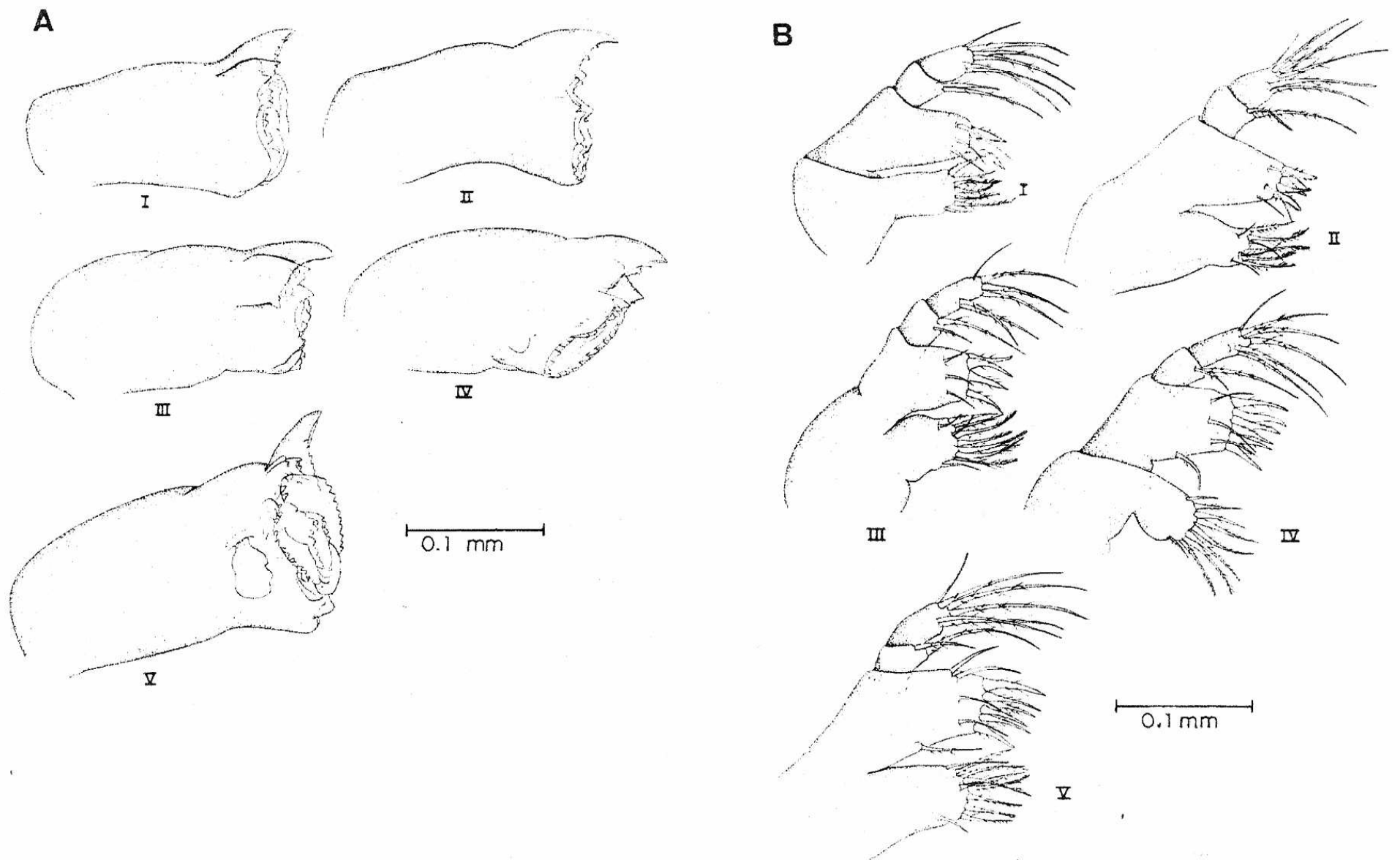


Figure 5: *Upogebia paraffinis*. Mandible (A) and maxillule (B) of zoeal stages (I-V).

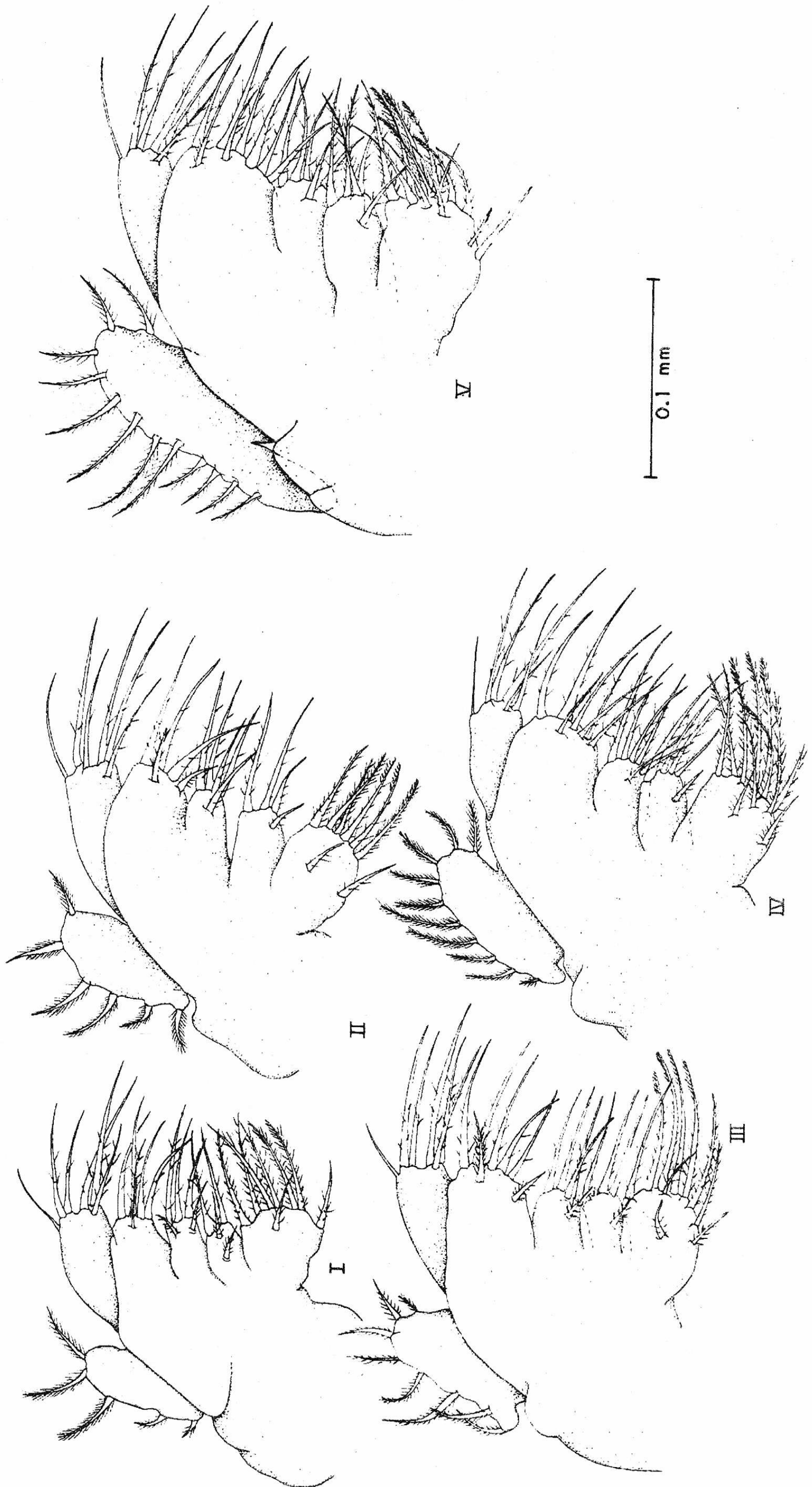
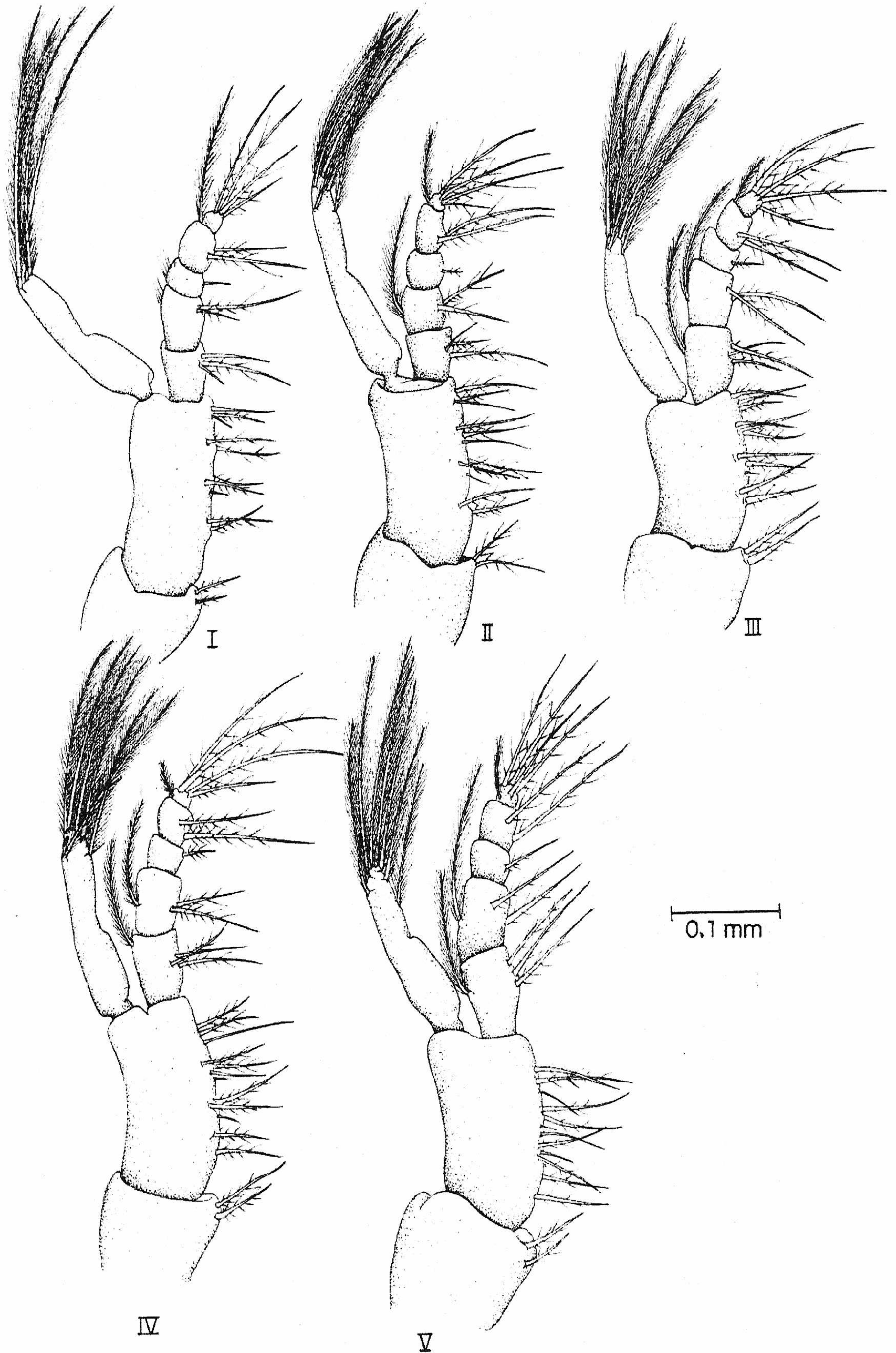


Figure 6: *Upogebia paraffinis*. Maxilla of zoeal stages (I-V).



Nauplius

Figure 7: *Upogebia paraffinis*. First maxilliped of zoeal stages (I-V).

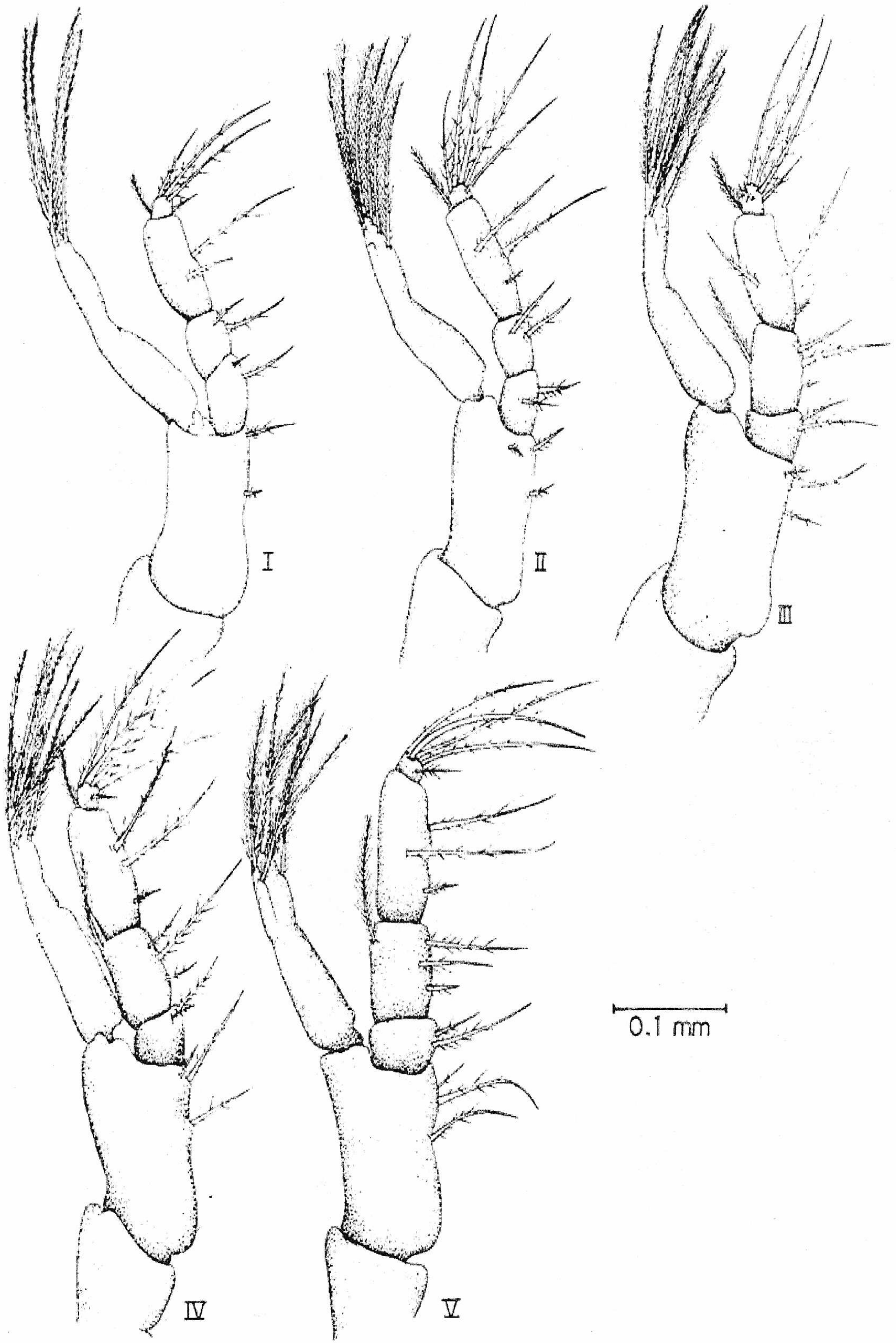


Figure 8: *Upogebia paraffinis*. Second maxilliped of zoeal stages (I-V).

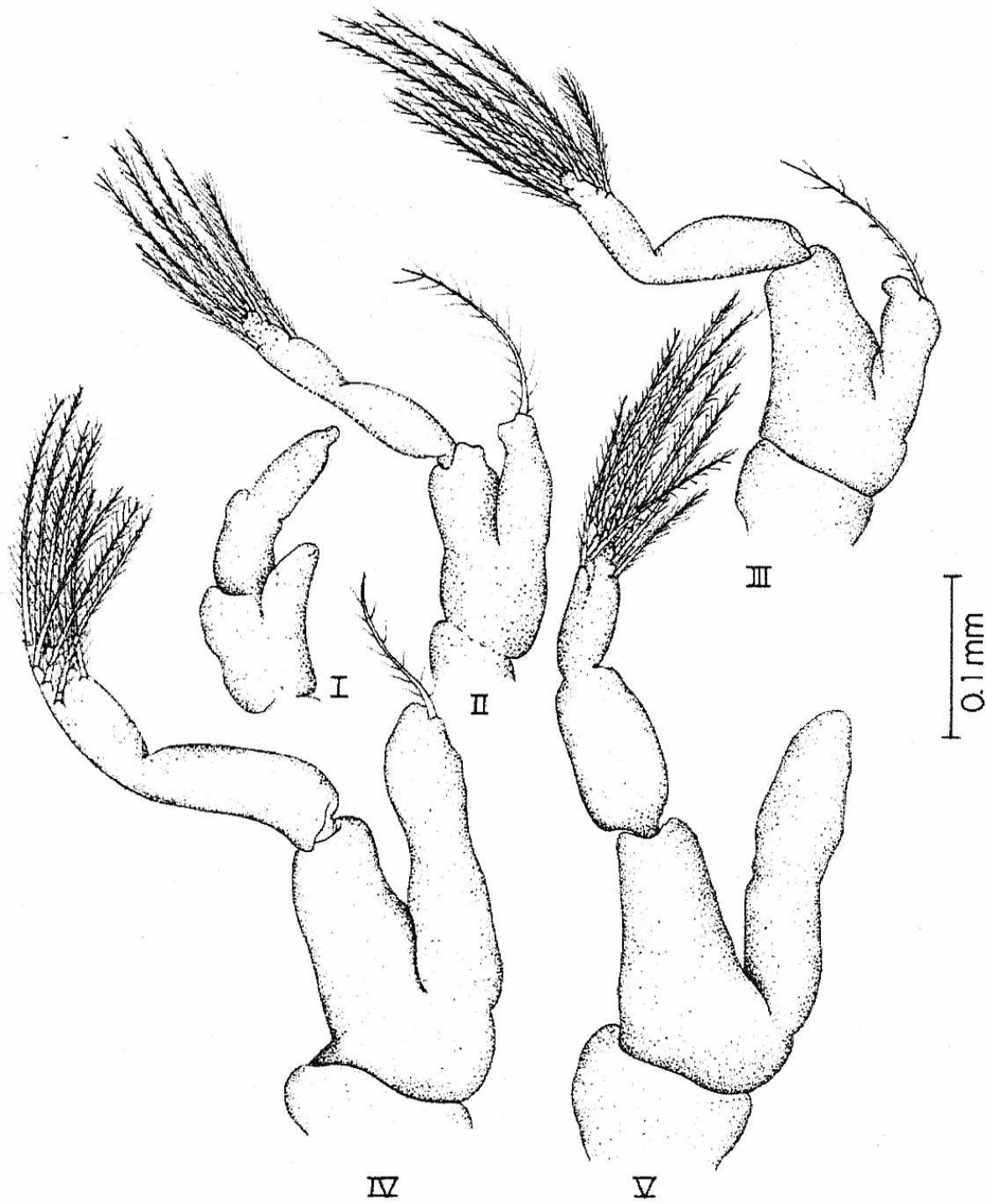


Figure 9: *Upogebia paraffinis*. Third maxilliped of zoeal stages (I-V).

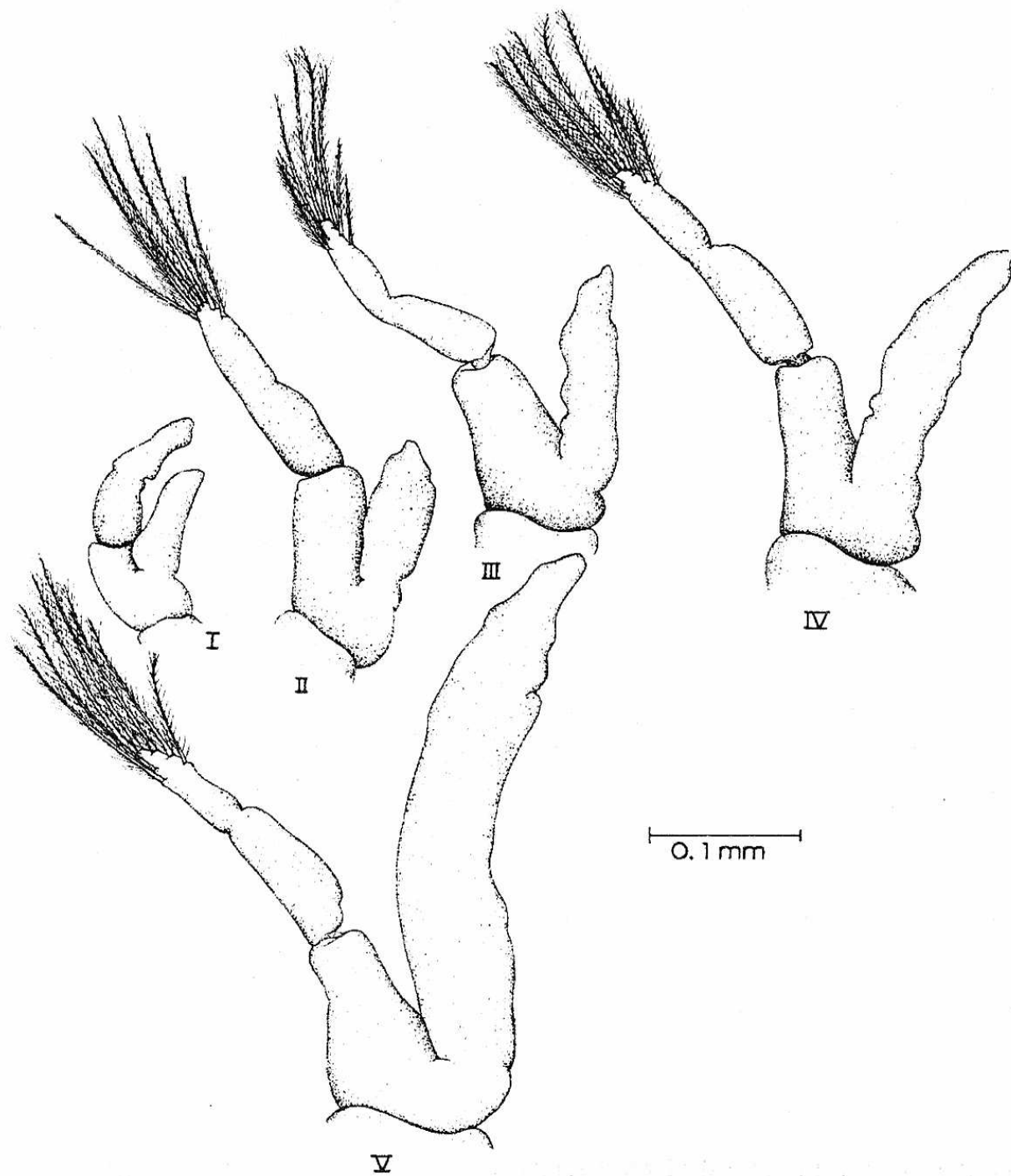


Figure 10: *Upogebia paraffinis*. First pereopod of zoeal stages (I-V).

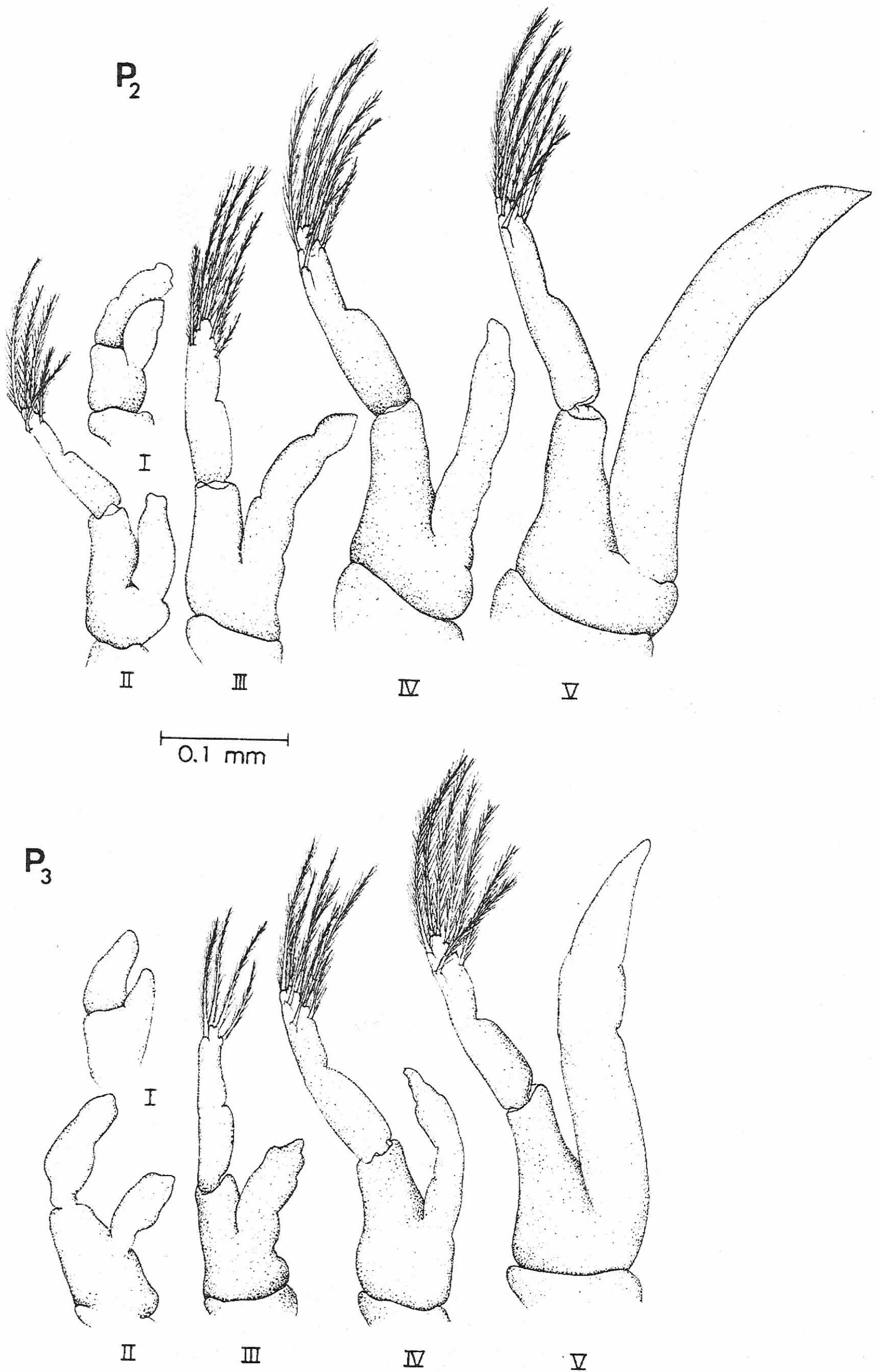


Figure 11: *Upogebia paraffinis*. Second pereopod (P₂) and third pereopod (P₃) of zoal stages (I-V).

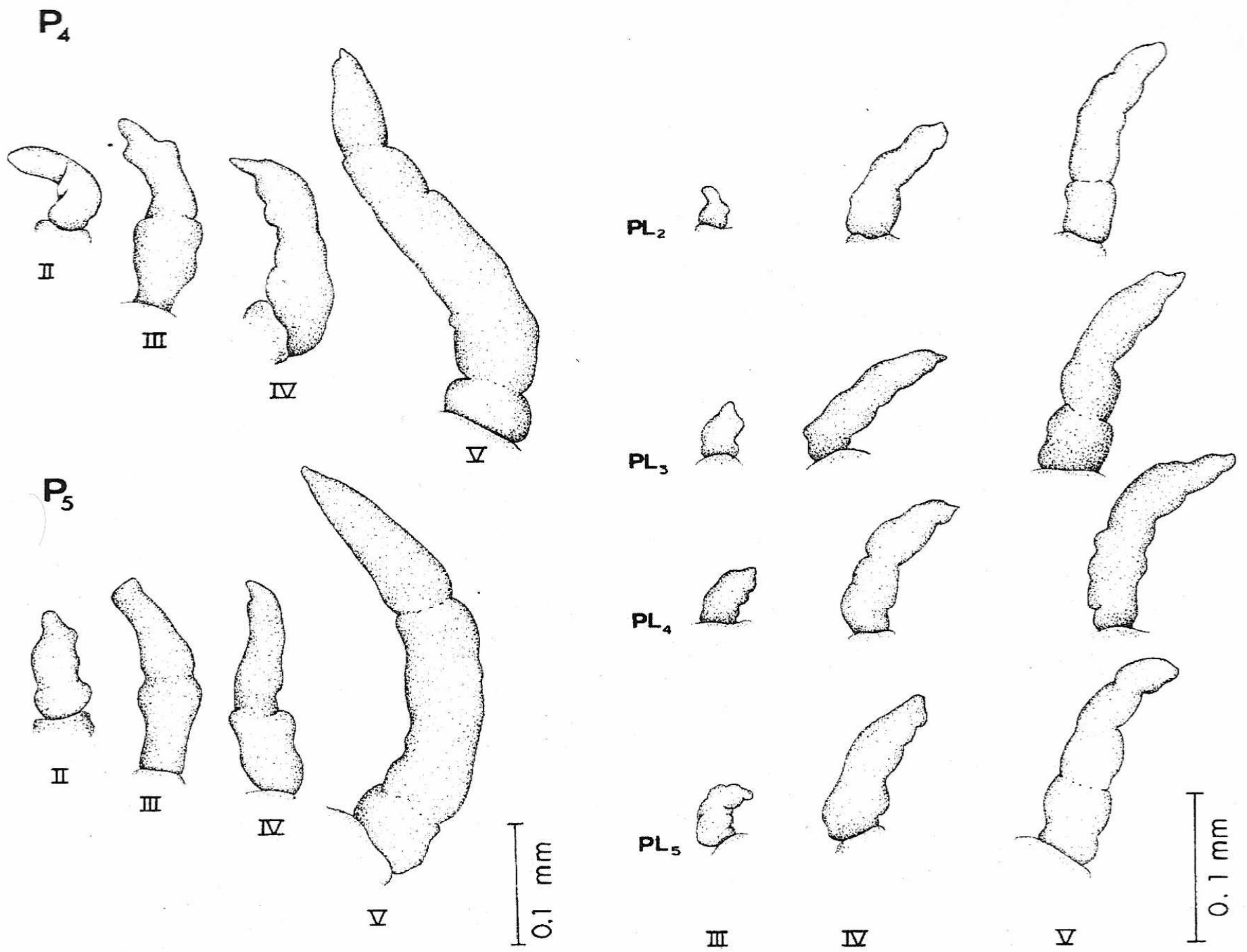


Figure 12: *Upogebia paraffinis*. Fourth pereopod (P4) and fifth pereopod (P5) of zoeal stages (II-V), and pleopods (PL2 to PL5) of zoeal stages (III-V).

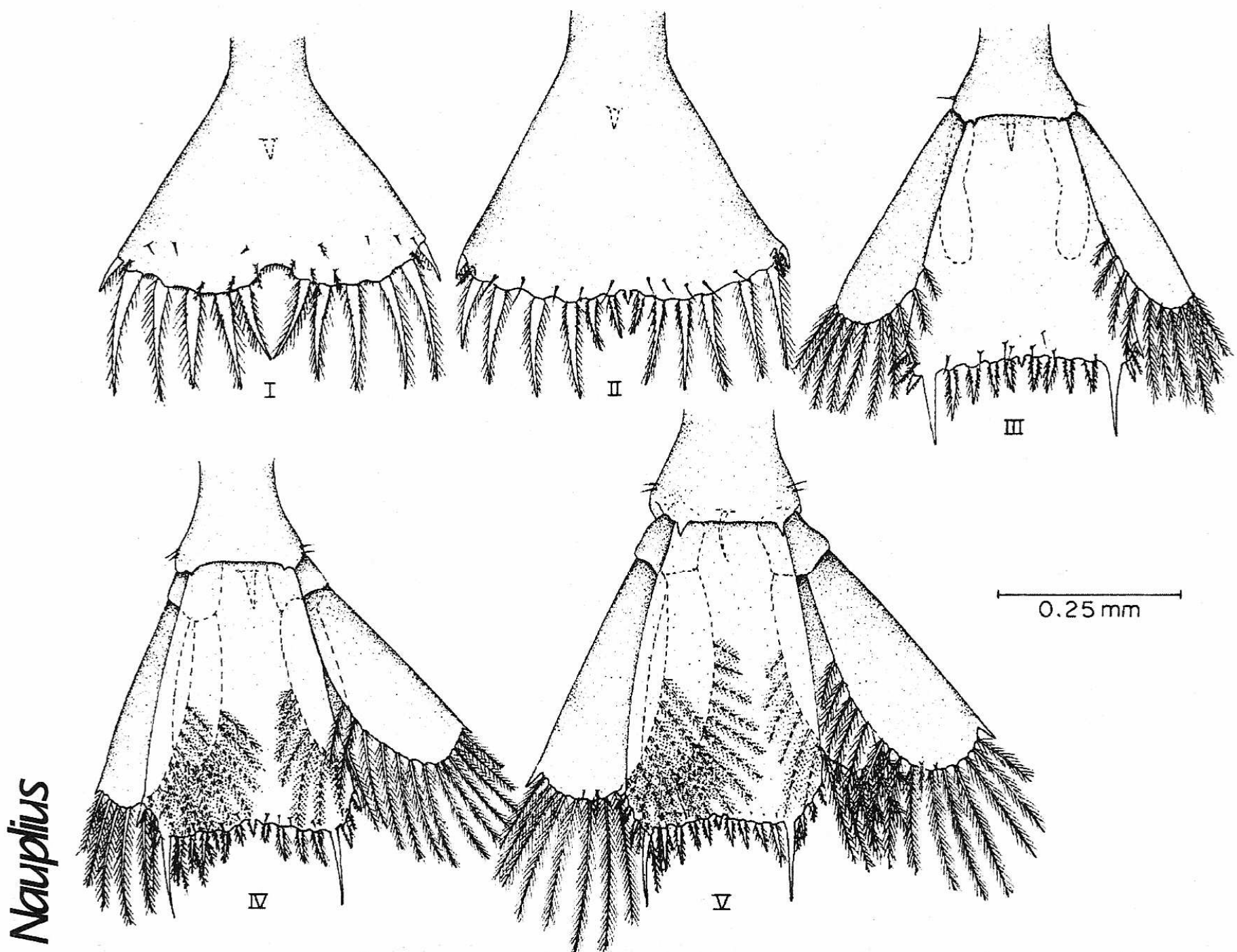


Figure 13: *Upogebia paraffinis*. Telson and uropods of zoeal stages (I-V).

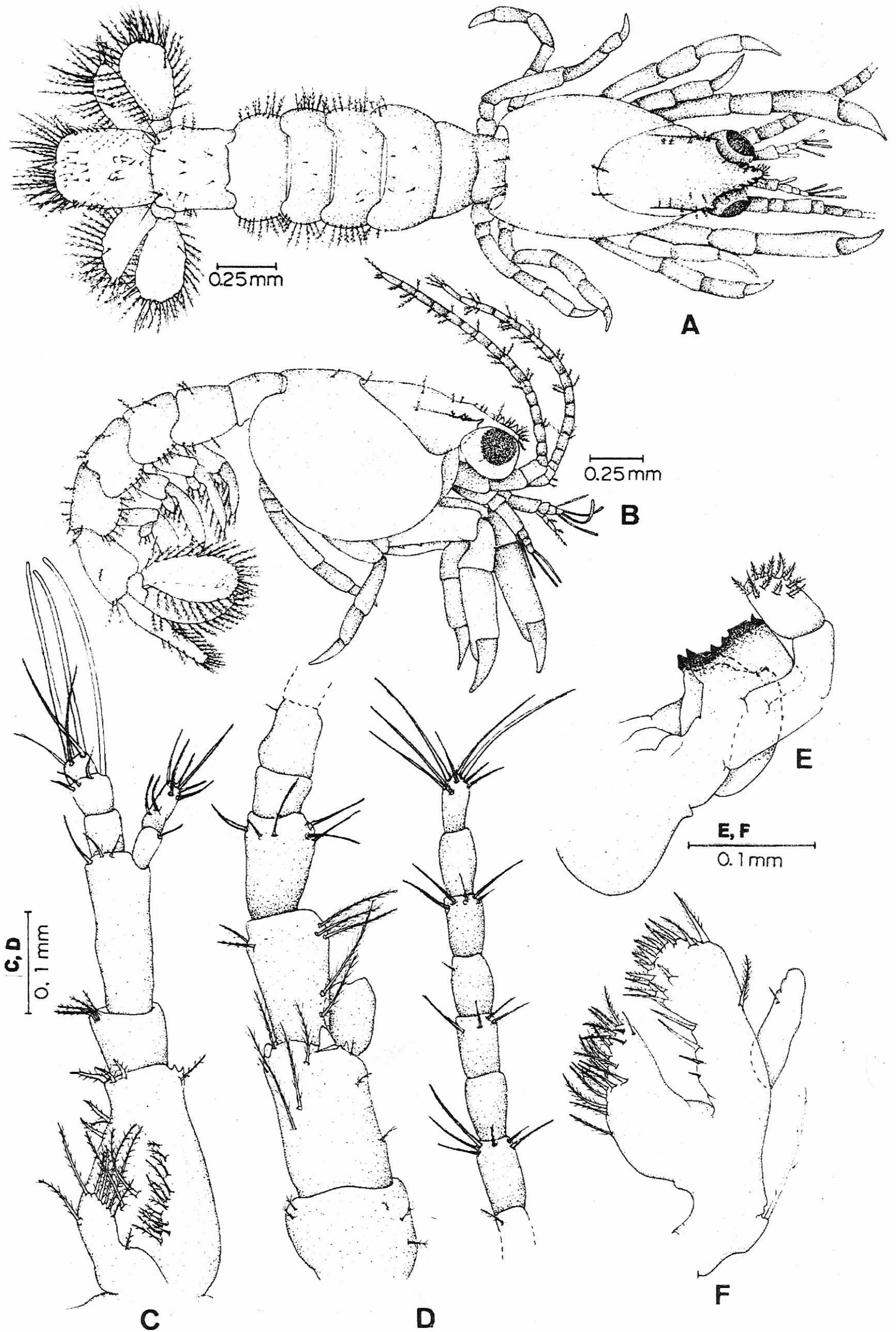
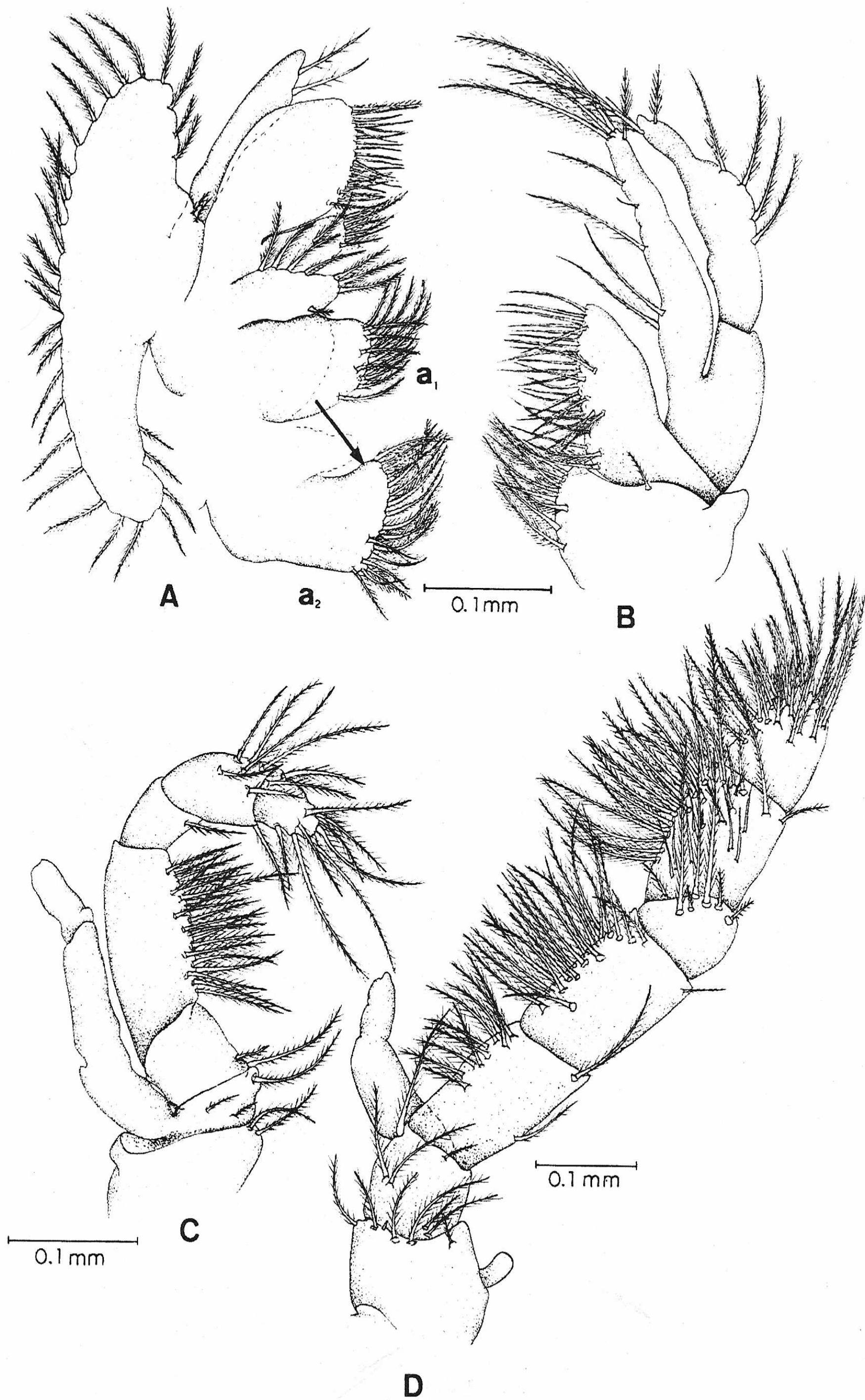


Figure 14: *Upogebia paraffinis*. Megalopa: Dorsal view (A), lateral view (B), antennule (C), antenna (D), mandible (E) and maxillule (F).



Nauplius

Figure 15: *Upogebia paraffinis*. Megalopa: maxilla (A), first (B), second (C) and third (D) maxillipeds.

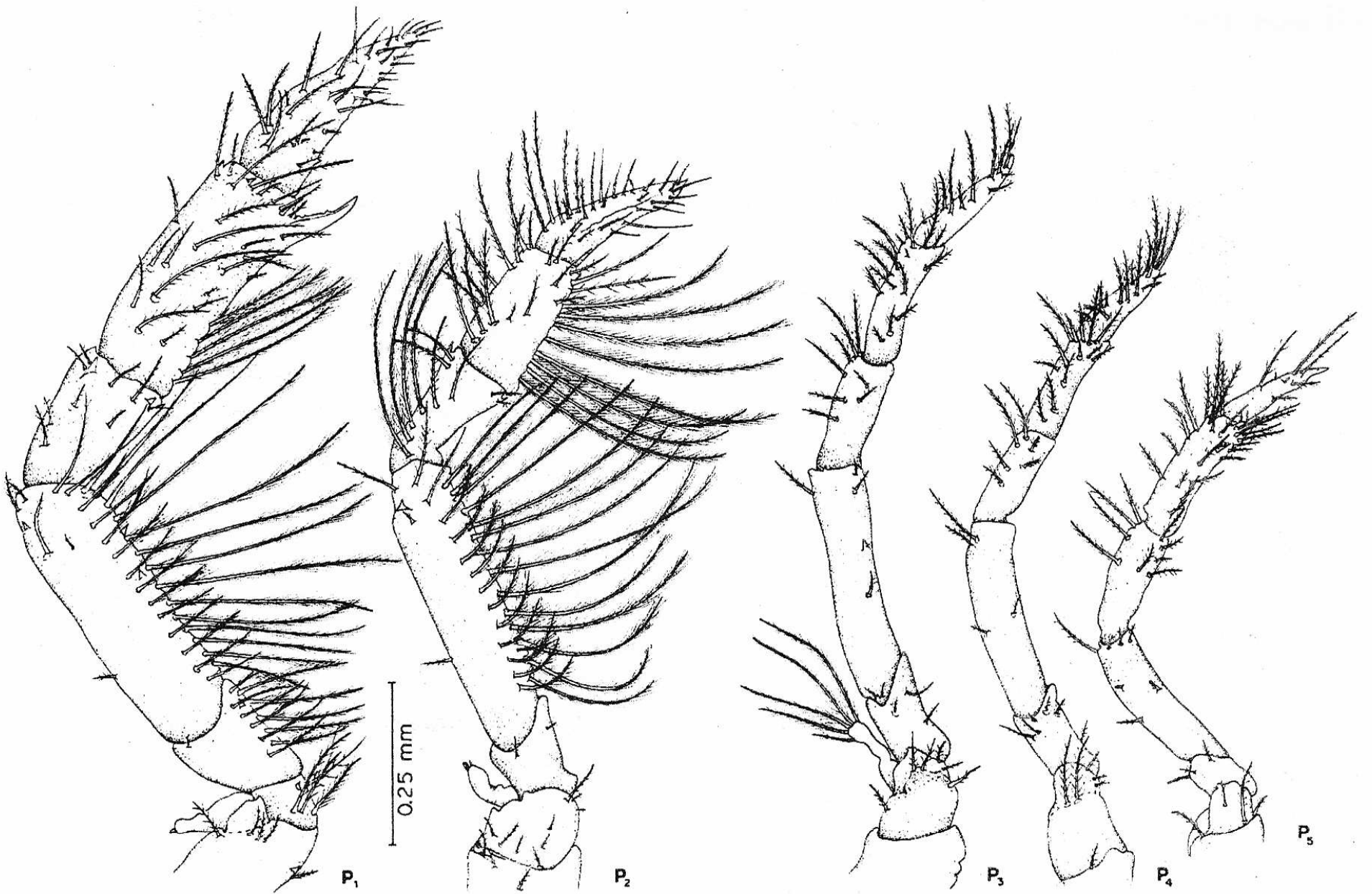


Figure 16: *Upogebia paraffinis*. Pereopods (P1 to P5) of megalopa.

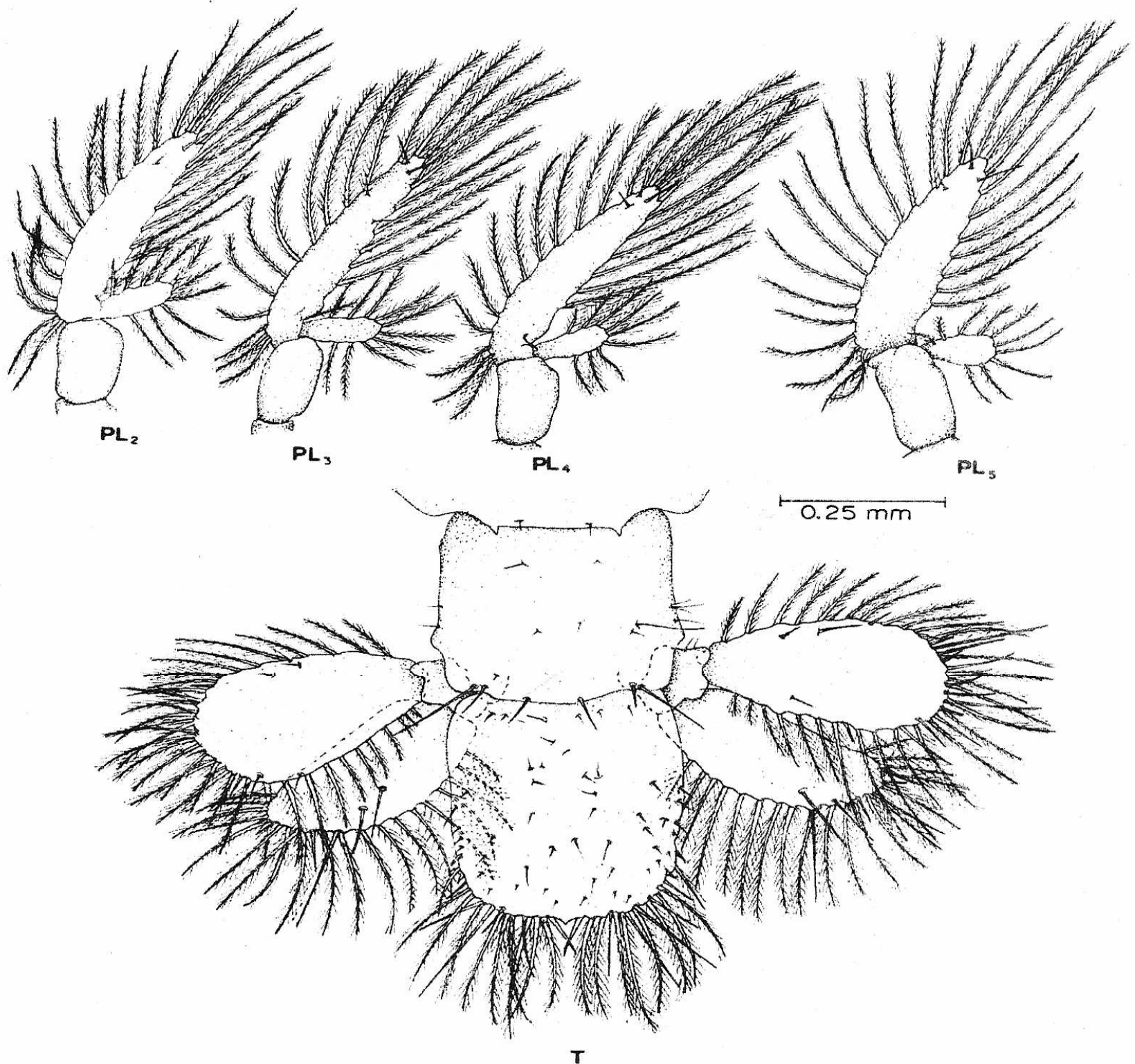


Figure 17: *Upogebia paraffinis*. Pleopods (PL2 to PL5), telson and uropods (T) of megalopa.

Discussion

Species of *Upogebia* in general, pass through two to four zoeal stages, before metamorphosis to the megalopa stage (Rabalais and Gore, 1985). However abbreviated A shorten development, composed of one to three stages, has been observed in some species, including *U. savignyi* (Strahl, 1862), *U. edulis* Ngoc-Ho and Chan, 1992, and *U. darwini* Miers, 1884, described by Gurney (1937), Shy and Chan (1996) and Ngoc-Ho (1977), respectively.

Webb (1919) believes that *Upogebia* exhibits a trend toward abbreviated development. On the other hand, the occurrence of prolonged development was discussed by Sandifer (1973) and confirmed by Ngoc-Ho (1981), with the description of a fifth stage for *U. affinis* (Say, 1818). The existence of prolonged development for *Upogebia* can be corroborated with the confirmation of zoeal 5 stage for *U. paraffinis* and also *U. omissa*, *U. brasiliensis*, and *U. vasquezzi* studied by Melo (2001).

The number of zoeal stages also varies intraspecifically, additional stages, Variation in the number of zoea stages, in the same species, has been registered by many authors variously interpreted as "substages", "intercalated", "extranumerary", or "terminal additive stages". Knowlton (1974), provided a list of suprageneric taxa in which considers supernumerary stages as consequence of laboratory culture. However, Goy and Provenzano (1978) recorded terminally additive molting in the laboratory for *Naushonia crangonoides* Kingsley and also found the same stages in plankton samples. This may indicate that to some extent these stages are a natural occurrence.

According to Lebour (1950), substages for decapods are largely characterized only by an increase in size and progress of development in the maxilliped and pleopods. This appears to be the case for *U. paraffinis*, where the sixth and seventh ecdyses produced larvae with insignificant morphological changes that were not sufficient to define a new stage. Such larvae were considered as terminal additive stages, according to the definition of Gore (1985).

According to Ngoc-Ho (1981) larvae of different *Upogebia* species present a high degree of morphological similarity. Differences are seen mainly in the presence or absence of lateral abdominal spines on the fifth abdominal somite. *Upogebia paraffinis* bears these spines and other characters that enabling the distinction with others species.

The appearance of the cervical groove and mandibular palp can also differ among species. In *U. darwini*, *U. affinis*, and *U. major* De Han, the cervical groove appears in zoea I. In *U. paraffinis* it is only evident in zoea II, whereas in *U. edulis*, and *U. quddusiae* Tirmizi and Ghani, 1978, the cervical groove appears only in the megalopa (Shy and Chan, 1996; Siddiqui and Tirmizi, 1995).

The appearance of the mandibular palp also varies considerably. In *U. paraffinis* the mandibular palp appears first as a bud in zoea IV zoea IV. In *U. darwini* and *U. major* it appears in zoea II. In *U. affinis* and *U. quddusiae*, the palp appears in zoea III. In contrast, in *U. edulis* and *U. kempfi* Shenoy, 1967, the palp is first evident in the megalopa. The presence of a vestigial palp or even its absence in more developed zoeal stage does not mean that the larva is near metamorphosis. Otherwise, the presence of a developed mandibular palp always characterizes a post-zoeal phase of *Upogebia*, as appointed for *Pandalus* in Rothlisberg (1980).

The zoeal maxillular endopod of *Upogebia* is, in general, tri-segmented. This characteristic is shared with the Axiidae, Callianassidae and Upogebiidae. However, *U. paraffinis* showed a 2-segmented maxillulare endopod, comparable to the Thalassinidea. Furthermore, *U. edulis* shows an unsegmented endopod of zoea (Shy and Chan, 1996), as in the Laomediidae. Thus, the variations showed on segmentation of maxillular endopod of *Upogebia* can support the concluded for Konishi (1989), "the Upogebiidae larval characters shows intermediate condition between the most primitive Axiidae and the most advanced Laomediidae one".

The maxilla scaphognathite consistently bears five setae for zoea I of *U. paraffinis*, *U. affinis*, *U. kempfi*, *U. omissa*, *U. brasiliensis*, and *U. vasquezzi*. In comparison, this number varies from 7 to 12 in *U. darwini*, *U. major*, *U. quddusiae*, and *U. edulis*. Probably, despite the largest size of the second group (2.5-3.56mm), probably, this is a character related to species with more prolonged development for first group (1.8-2.2mm).

In general, *Upogebia* species with 1-3 zoeal stages hatching with five pairs of pereopods. However, larvae of *U. paraffinis* hatch with only three pairs of rudimentary pereopods. Possibly, that's occur because the more prolonged development of the *U. paraffinis*.

From all analyzed characters, the only one that cannot be used to differentiate larvae of *Upogebia* species is the telson. It has a high degree of similarity among the studied species. However, it is the most valuable character to distinguish the different zoeal stages within species. In the megalopa, the telson, unlike the zoeal stage, shows some interspecific differences. The more distinct differences are related to shape and the number of distolateral spine. For example the telson is rectangular in *U. paraffinis*, *U. affinis*, *U. kempi*, *U. deltaura* (Leach), *U. pugettensis*, *U. stellata* (Montagu), *U. brasiliensis*, *U. vasquezii*, and *U. omissa*, while *U. major*, *U. quiddusia*, and *U. savignyi*, have a square telson.

Finally, the megalopa of *U. paraffinis* is similar to that of *U. affinis* described by Andryszak (1986). These species are also very similar as adults. Probably these species are more closely related than to other species.

Other characteristics that make it possible to distinguish the megalopae of different species of *Upogebia* are: shape and length of rostrum, segmentation of mandibular palp, exopod segmentation in maxilliped, presence of epipod in maxillipeds, vestiges of the exopods in the three first pereopods, and the degree of cheliped development.

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Received: 15th / 12 / 2000

Approved: 15th / 12 / 2001