

**UPOGEBIA EDULIS, NEW SPECIES, A MUD-SHRIMP
(CRUSTACEA: THALASSINIDEA: UPOGEBIIDAE)
FROM TAIWAN AND VIETNAM, WITH A NOTE ON
POLYMORPHISM IN THE MALE FIRST PEREIOPOD**

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ABSTRACT. - A new species of mud-shrimp (Thalassinidea: Upogebiidae), *Upogebia edulis*, from Taiwan and Vietnam, is described. It shows sexual dimorphism in the morphology of the first pereopod and polymorphism of the same appendage in the late mature phase of the males. The first pereopod can be differentiated into two types, one stout, the other much more slender. This new taxon is most closely related to *U. wuhsienweni* Yu, 1931, with which it is compared.

INTRODUCTION

Upogebia edulis new species, is found in Taiwan and North Vietnam. It is abundant in Luk-kong, Central West of Taiwan and is a traditional food in the area. It represents one of the very few species of *Upogebia* of some economic importance and most of our specimens were obtained from the Luk-kong local markets. Some others were collected at sea in October 1990. All specimens were sexually mature and none carried parasites.

The new species is here described and figured. As often found in *Upogebia*, it shows marked sexual dimorphism in the morphology of the first pereopod. This new species is unusual in the genus however in that there is also polymorphism of this appendage in the late mature phase of the males. The male first pereopods are approximately similar in smaller adults but differ strongly in some larger specimens and can be divided into two types: (i) a "stout type" and (ii) a "slender type" resembling that of the female. These aspects are discussed.

This new taxon is closely related to *U. wuhsienweni* Yu, 1931, from Northeast China, to which some specimens were assigned by Sakai (1982). The two species are nevertheless distinct and the distinguishing characters are presented.

The measurements given (in mm) in the descriptions are: the carapace length (cl.) measured from the tip of the rostrum to the posterior border of the carapace and the total length (tl.)

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measured from the tip of the rostrum to the posterior border of the telson. For a few partly dried specimens, only the carapace length is provided.

The material examined came from the following collections - MNHN: Muséum National d'Histoire naturelle, Paris, France; USNM: United States National Museum, Smithsonian Institution, Washington D.C., U.S.A.; NTOU: Graduate School of Fisheries, National Taiwan Ocean University, Taiwan.

Male specimens are designated as: St. - male in late mature phase, "stout type"; sl. - male in late mature phase, "slender type"; Y. - male in early mature phase, and occasionally, Y.St. - young male, "stout type"; Y. sl. - young male, "slender type".

TAXONOMY

FAMILY UPOGEBIIDAE

Genus *Upogebia* Leach, 1814

Upogebia edulis, new species

(Figs. 1-3)

Upogebia wuhsienweni - Sakai, 1982: 59 (in part: figs. 11d, 12f and material USNM 59070, 59071, 59072, 59073, non *U. wuhsienweni*, Yu, 1931).

Material. - Holotype - male ((St.): cl. 21 mm, tl. 64 mm) (MNHN-Th 1234), Luk-Kong, Chang-Hua County, Taiwan, coll. T-Y. Chan, 13.i.1990.

Paratypes. - 3 males ((St.) cl. 19.5-21 mm, tl. 60-64 mm) (MNHN-Th 1235), 11.xii.1988; 1 male ((sl.) cl. 18 mm tl. 54.5 mm), 2 males ((Y.St.) cl. 19 mm tl. 57.5 mm and 58.5 mm) (MNHN-Th 1236), 9.x.1990; 2 males ((sl.) cl. 16 mm and 20.5 mm, tl. 48 mm and 62.5 mm) (MNHN-Th 1237), 13.i.1990; 2 ovig. females (cl. 18 mm and 20.5 mm, tl. 54.5 mm and 63 mm) (MNHN-Th 1238), 13.i.1990; 2 females (cl. 18 mm and 18.5 mm, tl. 53.5 mm and 54.5 mm) (MNHN-Th 1239), 9.x.1990; 3 males ((St.) cl. 22.5-24 mm tl. 70-73 mm), 1 ovig. female (cl. 18.5 mm tl. 60.5 mm) (NTOU 1990-1-13), 13.i.1990; 5 males ((St.) cl. 17-19 mm tl. 52-58.5 mm), 3 males ((sl.) cl. 16-17 mm tl. 52-56 mm), 2 males ((Y.St.) cl. 17.5 mm and 18.5 mm tl. 56 mm and 58.5 mm), 1 female (cl. 20 mm tl. 60 mm), (NTOU 1990-2) ii.1990; 1 female (cl. 16 mm, tl. 50 mm) (NTOU 1990-10-9), 9.x.1990, Luk-kong, Chang-Hua County, Taiwan, coll. T-Y. Chan. --- 1 male ((Y.St.) cl. 14 mm, tl. 46.5 mm) (NTOU 1991-5-11), How-long, Mali County, coll. T-Y. Chan, 11.v.1991.

Others. - 1 female (cl. 18.5 mm, tl. 54.5 mm) (MNHN-Th 1240), 11.xii.1988; 2 males ((St.) cl. 16.5 mm and 17.5 mm tl. 50.5 mm and 52.5 mm), 1 male ((sl.) cl. 20 mm tl. 61 mm) (MNHN-Th 1241) ii.1990; 16 females (cl. 10.5-16 mm, tl. 30-48.5 mm) (MNHN-Th 1242), 9.x.1990; 7 males ((St.) cl. 19.5-20.5 mm, tl. 59-63 mm) (MNHN-Th 1243), 9.x.1990; 11 males ((Y.) cl. 7-19 mm, tl. 20-57.5 mm) (MNHN-Th 1244), x.1990, Luk-kong, Chang-Hua County, Taiwan, coll. T-Y Chan. --- 1 female (cl. 17 mm) (USNM 59070), Taichu; 1 male ((St.) cl. 18.5 mm) (USNM 59073), Taichu; 1 female (cl. 17.5 mm) (USNM 59071), Daito, Taichu; 1 male ((St.) cl. 22 mm) (USNM 59072), Tainan; coll. M. Maki (don. M. Oshima). --- 4 females (cl. 7.5-14 mm tl. 22-40 mm); 2 males ((St.) cl. 13.5 mm and 14 mm tl. 38 mm and 40 mm); 1 male ((Y.St.) cl. 12 mm tl. 35.5 mm), (MNHN-Th 512), North Vietnam.

Description. - Rostrum (figs. 1A, 1B) triangular with blunt tip projecting far beyond eyes, bearing 6-7 rounded teeth on each slightly convex lateral margin, ventral surface with 2-5 spines. Rostrum as well as gastric region covered dorsally with dense setae concealing short medio-dorsal rostral groove and small tubercles most of them alongside lateral grooves which are wider anteriorly and narrowing in posterior half. Lateral ridges divided by weak mid-dorsal notch: anterior half very setose dorsally, unarmed or with 1-2 tubercles, and spine at tip followed by 1-3 others more ventrally placed; posterior half with 4-5 spiniform teeth. Anterolateral border of carapace bearing 4-5 spines and dorsal to it, anterolateral region (limited dorsally by gastric ridge and posteriorly by *linea thalassinica*) has 3-4 spinules. *Linea thalassinica* distinct, terminating at level of cervical groove, latter deep and continuous, shoulders lateral to it prominent, armed with spinules and tubercles. Arthrobranchs with large tubular structure on either side of rachis.

Antennule (fig. 1B) peduncle unarmed.

Antenna (fig. 1B) third peduncular article with small ventral subdistal spine, scale terminating in blunt tip.

Mandible without mesio-anterior tooth.

First and third pereiopod both with epipod.

First pereiopod of male in late mature phase, "stout type" (figs. 1C, 1D): subcheliform. Ischium with 2-3 ventral spines. A dorsal subdistal spine and 9-10 ventral spines on merus. Carpus bearing large ventral spine; lower half of outer surface with longitudinal crest of more or less conspicuous tubercles and terminating in large blunt tooth; upper half with fine longitudinal groove; carpal dorsal margin with 2-5 spines on proximal half and 4-5 spines distally of which medial one large and 3-4 external spines smaller; large distal spine present on upper half of mesial surface. Palm of propodus about twice as long as broad, measured from base of fixed finger, latter region twice as broad as distal part; row of 13-17 spines on dorsal margin; outer dorsal surface with few proximal and median spinules; ventral longitudinal row of strong rounded tubercles and large acute ventral distal spine; mesial surface bearing 1-2 large proximal dorsal spines, numerous spinules, and round tubercles on proximal dorsal half; slender elliptic stridulating ridge on ventral distal half and large ventral distal spine; fixed finger unarmed, placed near middle of ventral margin, long, erect, moderately curved distally, tip well separated from palm. Dactylus two-thirds as long as propodus with corneous tip, large quadrate tooth on proximal half of cutting edge and much smaller one in front of it; shallow longitudinal dorsal groove on external surface; longitudinal dorsal dentate carina on mesial surface alongside fine corneous one, latter only extending to proximal half and terminating at level of somewhat large rounded tubercle.

Setae very dense especially on dorsal part of carpus, propodus and dactylus, concealing most of the carinae, tubercles and spines.

First pereiopod of female (fig. 1F, 1G), slender and less spinose than in male: merus nearly three times and propodus four times as long as broad at mid-length, fewer spines on dorsal margin of both carpus (1-3) and propodus (8-9), propodal mesial and external surfaces unarmed. Propodus large proximally, regularly narrowing distally and devoid of stridulating ridge on mesial distal surface; fixed finger distally placed, small, hardly one-eighth as long as palm.

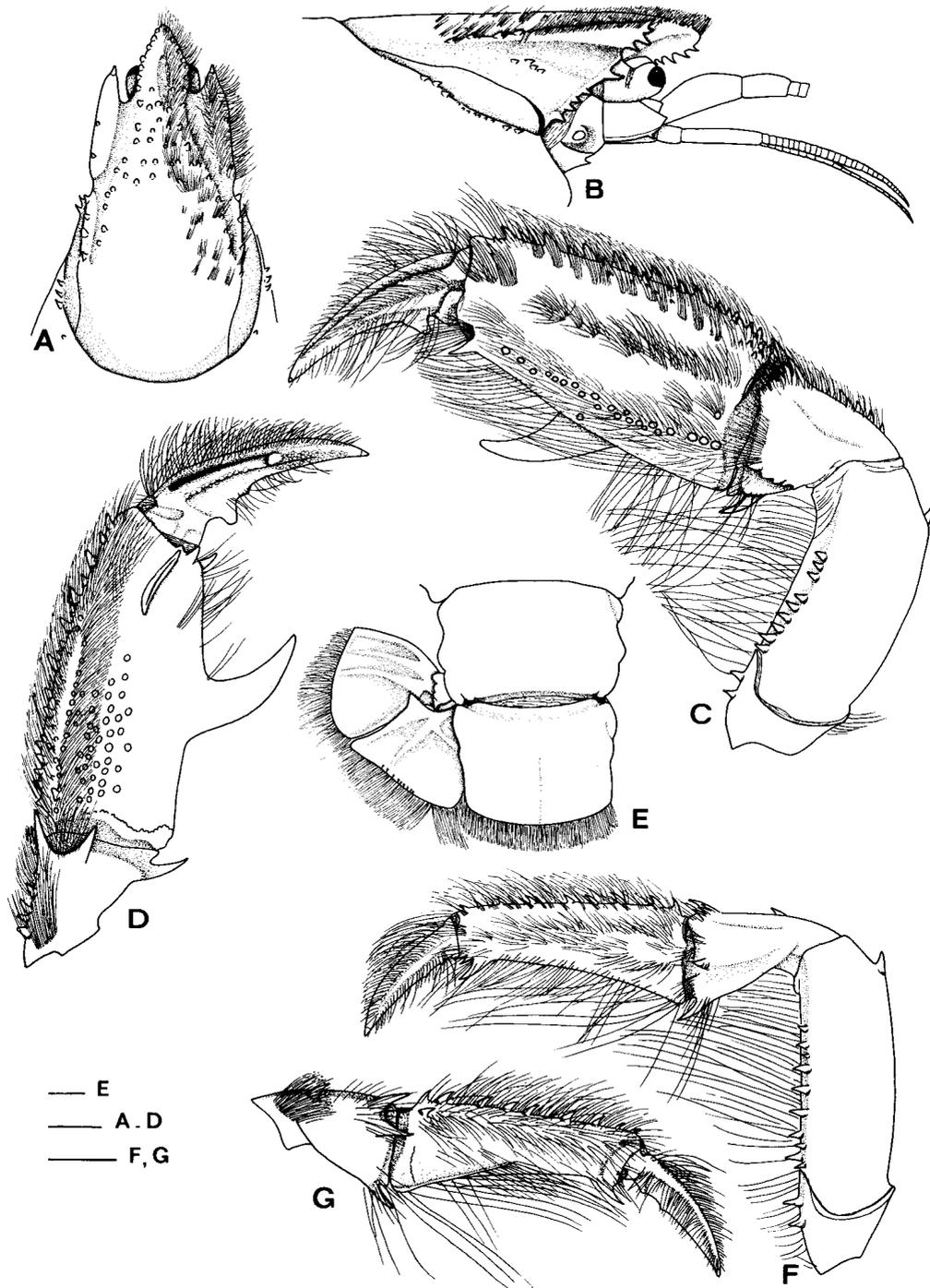


Fig. 1. *Upogebia edulis*, new species. (Scale: 2 mm). A-E: holotype male, (St.), tl. 64 mm (MNHN-Th1234); F, G: paratype female, ovig., tl. 54.5 mm (MNHN-Th1238). A, B, anterior part of carapace, dorsal and lateral view; C, F, first pereiopod, lateral view; D, G, distal part of first pereiopod, meisal view; E, telson and uropods.

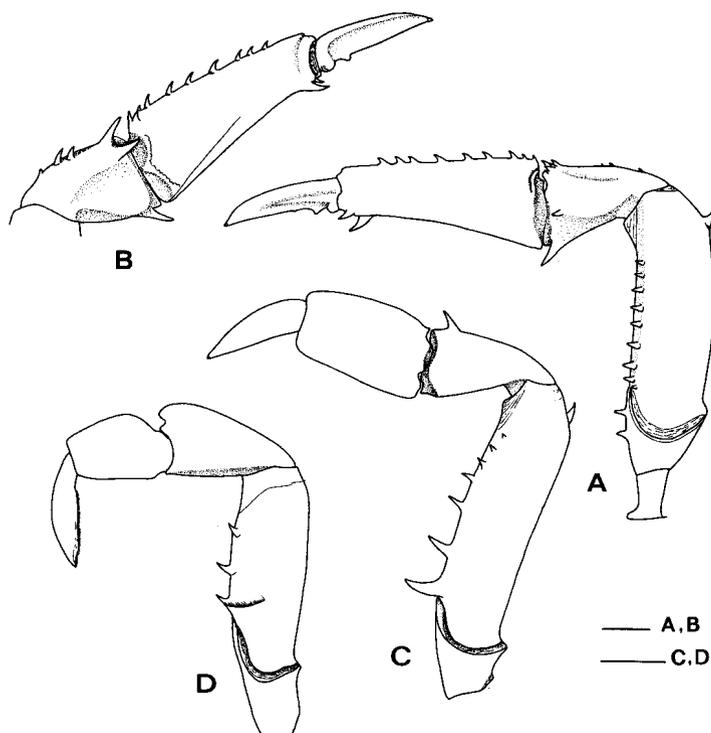


Fig. 2. *Upogebia edulis*, new species. (Scale: 2 mm). A, B: paratype male, (sl.), tl. 62.5 mm (MNHN-Th1237); C, D: paratype female, ovig., tl. 54.5 mm (MNHN-Th1238). A, first pereopod, lateral view; B, distal part of first pereopod, mesial view; C,D, second and third pereopod, lateral view.

Dactylus with corneous tip and two low triangular teeth on proximal half of cutting edge.

Setae are less dense than in male though often longer.

First pereopod of male in late mature phase, "slender type" (figs. 2A, 2B) similar to that of female, with a few variations usually more spines on dorsal margin of carpus, sometimes a faint stridulating ridge on mesio-distal surface of propodus and a larger proximal tooth on cutting edge of dactylus.

First pereopods of young mature males very similar at approx. 25-30 mm tl. but begin to show differentiation into "stout" and "slender" forms.

Compared with mature males in late stage, "stout type" young have a relatively smaller first pereopod (Fig. 3F) with fixed finger about one-third as long as palm, placed subdistally and more closely to it. The ventro-distal spine on the propodal mesial surface is often small or absent and the proximal quadrate tooth on the dactyl cutting edge is not large. Setation not nearly as dense as in late phase male.

First pereopod of male in early mature phase of "slender type" (fig. 3G), differs from "stout type" by shape of propodus which is slightly more slender, nearly three times as long as broad at mid-length, narrowing slightly distally, and has a shorter distal fixed finger, about one-fifth as long as dactylus.

Second pereopod (fig. 2C): Merus with dorsal subdistal spine and 5-7 ventral spines of which the two proximal are large. Another large dorsal subdistal spine on carpus.

Third pereopod (fig. 2D). Merus with dorsal subdistal spine and 5-7 ventral spines of which the two proximal are large. Another large dorsal subdistal spine on carpus.

Third pereopod (fig. 2D). Ventral margin of merus bearing 3-4 spines and a fine transverse setose crest near base of the proximal one.

Telson (fig. 1E) nearly 1.4 times as broad as long, posterior margin slightly convex.

Uropods (fig. 1E) with a spine on protopod overhanging base of endopod. Latero-external and posterior margin of exopod, both slightly convex, meeting nearly at a right angle exteriorly. Latero-external margin of endopod with pronounced proximal shoulder; posterior margin with a few spinules in median part.

Etymology. - The specific name (*edulis* = edible) refers to the shrimp's use as food.

Distribution. - Western Taiwan, North Vietnam.

Remarks. - This new taxon is most closely related to *U. wuhsienweni* Yu, 1931, (described from two specimens of 31 mm and 46 mm in total length). Liu (1955) also described this species from abundant material of tl. 50-70 mm from many localities in northern China. Neither of the two authors reported polymorphism in the male first pereopod.

The following material of *U. wuhsienweni* Yu has been examined: 1 male (cl. 12.5 mm tl. 38 mm), 1 female (cl. 15 mm tl. 47 mm) (MNHN-Th 59) Yentai (Chefoo), China (figs. 4A, 4B); 1 female (cl. 14.5 mm tl. 45 mm) (USNM 170878) Amoy, China; 1 female (cl. 11 mm tl. 31.5 mm), 1 male (cl. 14 mm tl. 44 mm) (USNM 170877) Amoy, China, (figs. 4C, 4D); 1 female (cl. 12.5 mm tl. 37.5 mm), (USNM 170876), Guantao near Foochow, China.

Upogebia edulis resembles *U. wuhsienweni* by the following characters: possession of infrarostral spines, similar shaped rostrums, lateral ridges of the carapace divided into two parts by a median notch, similarly shaped telson and uropods. Furthermore, the size and colour are very similar in both species as are the female first pereopods.

Distinguishing characters which can readily be used are:

1. Distal half of lateral ridges unarmed or provided with 1-2 tubercles in *U. edulis* (fig. 1B), with 6-9 spiniform teeth in *U. wuhsienweni* (fig. 4A).
2. Basis of first pereopod bears a blunt tooth (fig. 2A), coxae of second and third pereopods unarmed or with a spinule in *U. edulis*; basis of first pereopod with a large and sharp spine (fig. 4C), coxal spine present on second and third pereopods in *U. wuhsienweni*.
3. Female first pereopod with a sharp ventro-distal spine on external surface near base of fixed finger and two low triangular teeth on cutting edge of dactylus in *U. edulis* (fig. 1F), these spine and teeth absent in *U. wuhsienweni* (fig. 4B).
4. Male first pereopod with subdistal fixed finger, cutting edge unarmed, dactylus with a

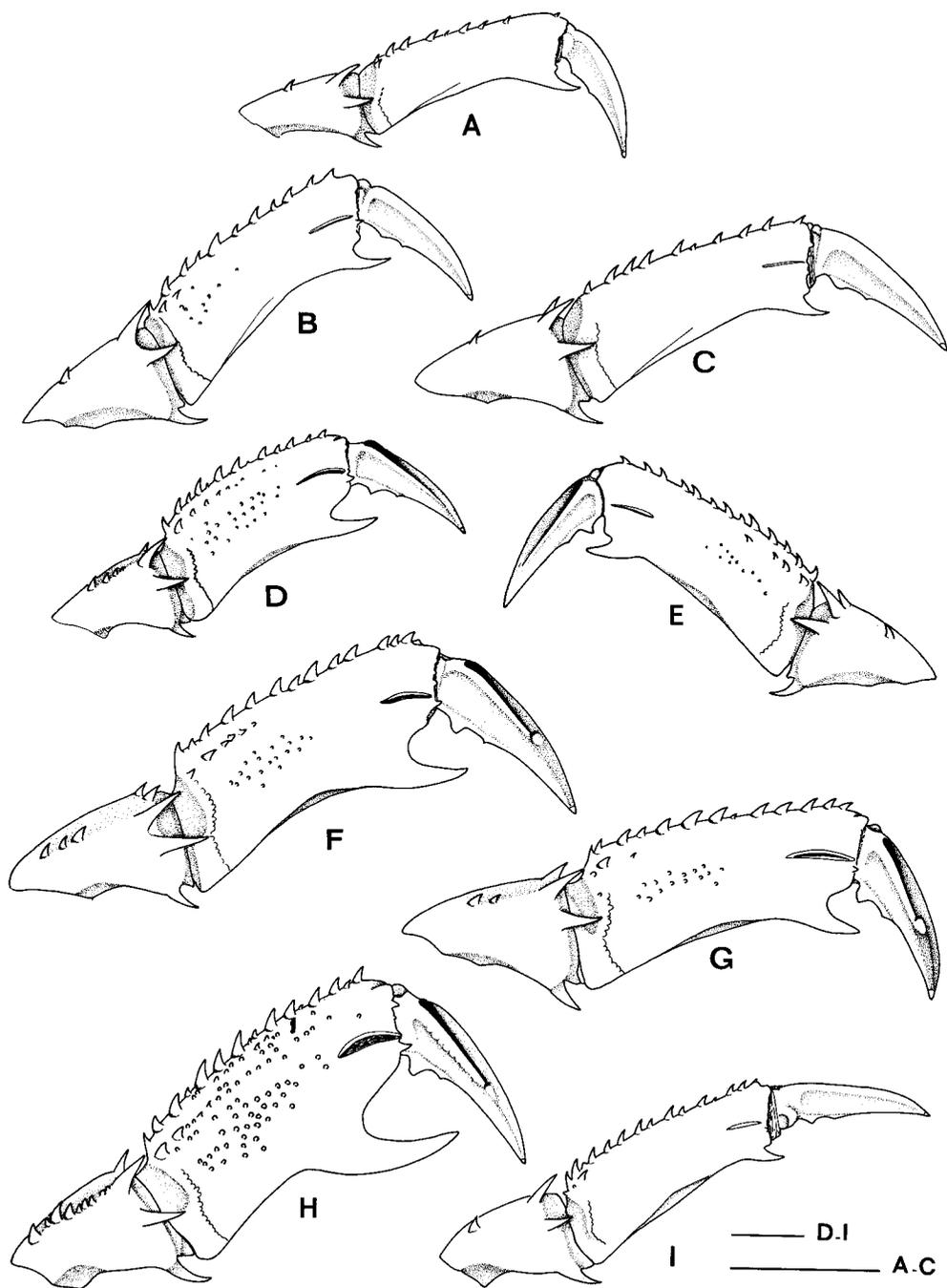


Fig. 3. *Upogebia edulis*, new species, male. Distal part of first pereiopod, mesial view. (Scale: 2mm). A-E & G from (MNHN-Th1244). A, (Y. undiff.), tl. 19mm; B, (Y.St.), tl. 28.5mm; C, (Y.sl), tl. 29mm; D, (Y.St), tl. 41mm; E, (Y.sl), tl. 47.5mm; F, paratype, (Y.St), tl. 58.5mm, (MNHN-Th1236); G, (Y.sl), tl. 57.5mm; H, (St.), tl. 50.5mm, (MNHN-Th1241); I, (sl), tl. 48mm, (MNHN-Th1237).

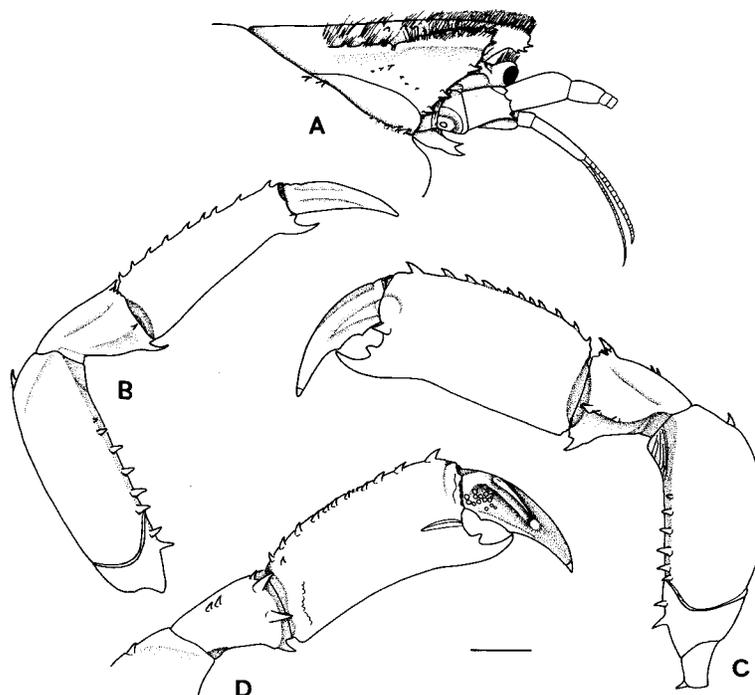


Fig. 4. *Upogebia wuhsienweni*, Yu. (Scale: 2mm). A, B: female, tl. 47mm, (MNHN-Th59); C, D: male, tl. 44mm, (USNM170877). A, anterior part of carapace, lateral view; B, C, first pereiopod, lateral view; D, distal part of first pereiopod, mesial view.

large quadrate proximal tooth on cutting edge in *U. edulis* (figs. 1D, 2B, 3D, 3F, 3H); fixed finger distal, cutting edge with a large tooth, but no large tooth on cutting edge of dactylus in *U. wuhsienweni* (figs. 4C, 4D).

Ecology. - *Upogebia edulis* is especially valued as food in winter when its gonads are large and have become yellowish. The species inhabits tidal areas with sandy-muddy bottoms, and apparently is not found in areas with only sand or mud. The burrows of large specimens can usually be as deep as 1.5 m while smaller ones are more easily dug out from about 0.5 m or less. Burrows are narrow with a straight upper part and small openings. Live specimens are bluish grey in colour with pereiopods somewhat whitish.

Polymorphism. - We use the term polymorphism as defined by Hartnoll (1982). It refers to allometric differences not caused by sex or maturity and which may be exhibited by specimens in the same phase of growth. Prior to the present report, polymorphism in the male first pereiopod of *Upogebia* was noted in material of *U. pugnax* de Man, 1905 from New Caledonia (see Ngoc-Ho, 1991). Only two males were then available for study, both with genital openings on the coxae of the third as well as the fifth pereiopods. The first pereiopod of the larger specimen (tl. 45 mm) is robust but in the smaller one (tl. 35 mm), it is much more slender (Ngoc-Ho, 1991, fig. 10). Given the morphology of their chelipeds and the fact that the two were captured at the same station, it was considered possible that they were a heterosexual pair and it was questioned whether the species was showing proterogenic hermaphroditism, with the smaller specimen actually being a functional female.

In *U. edulis*, all males bear genital openings on coxae of both the third and fifth pereiopods.

Nevertheless, as sexual dimorphism is well marked and adult males and females of all sizes were found, this species is unlikely to be hermaphrodite. On the other hand, males of the "slender type", though very similar to females, have apparently developed from normal young males and not from females which have lost their first pleopods and gained genital openings on the coxae of the fifth pereopods. Examination of the first pereopod in a range of males of different sizes shows that its polymorphism starts early in life although weakly at first. A summary of all data is presented in Table 1. A number of conclusions can be drawn.

1. Up to a total length of approx. 25 mm, the first pereopod is slender and undifferentiated (fig. 3A).

2. In larger specimens (25 mm < tl. < 50-60 mm), the first pereopod starts differentiating into two types and is figured here for specimens of increasing sizes of the "stout type" (figs. 3B, 3D, 3F) and "slender type" (figs. 3C, 3E, 3G) respectively. The main differences, though not obvious, concern the propodus, which, in the "stout type", is robust, more spinose, slightly dilated distally and also with a longer subdistal fixed finger. In the "slender type", it is not dilated distally, and the fixed finger is comparatively shorter and nearly distal. In their general

Table 1. Characteristics of the first pereopod in males of different sizes, with comparison of the "stout" and "slender" types.

	tl.<25mm	25mm <tl. <50-60mm	50-60mm <tl.
"Stout~type"	Undifferentiated (fig. 3A)	Propodus robust, spinose, slightly dilating distally long fix.finger subdistal (figs. 3B, 3D, 3F)	Propodus stout, spinose, long fix.finger on middle of ventral border, tip widely apart from palm. Stridulating ridge well marked. (figs. 3H, 1C, 1D)
"Slender type"	Undifferentiated (fig3A)	Propodus slightly more slender, less spinose, short fix.finger distal. (figs.3C, 3E, 3G)	Propodus slender, narrowing distally, fix. finger very small, distal. Stridulating ridge faint or absent. (figs. 3I, 2A, 2B)
Common characters		Stridulating ridge well marked, corneous crest on dactylus (in tl. > 30 mm), setae moderately dense.	Setae very dense especially on "stout type", large prox. tooth on dactylus, stridulating ridge on most specimens.
Overall appearance		Very similar in the two types.	Very different in the two types.

morphology however, these first pereopods have an overall similar appearance. Furthermore, in both types, the stridulating ridge and the longitudinal mesio-dorsal corneous crest on the dactylus are well defined in specimens exceeding 30 mm in total length.

3. Figs. 3H, 3I represent the first pereopod in the smallest late stage males of the “stout type” (tl. 50.5 mm) and “slender type” (tl. 48 mm) respectively. As the largest young male captured measures 58.5 mm in total length, it is apparent that, at least in the population of *U. edulis* of Luk-Kong, Taiwan, a moult marking the transition into one or other of the adult forms occurs between about 48-58.5 mm in size (c. 50-60 mm).

In the “stout type”, the first pereopod is now distinctly stouter and more spinose than in the young; the fixed finger has lengthened, moved towards the middle of the ventral border of the palm and the tip is widely separated from it. As size increases (fig. 1D), the fixed finger moves further backwards and its gap with the palm widens still more.

In the “slender type”, the first pereopod now has a propodus narrowing distally; it is less spinose and has a faint stridulating ridge on its mesio-distal surface. The fixed finger is considerably smaller than it was during the young stage and placed distally, while the dactylus has lost the longitudinal corneous crest on its mesial surface. In specimens of larger size (fig. 2B), the slenderness of the propodus is more pronounced while the stridulating ridge fades away.

In both types of pereopods, but especially in the “stout” form, setae are now very dense on the carpus, propodus and dactylus, on mesial as well as on external surfaces, and typically have food particles attached to them. These appendages probably now take on the role of filtering food and in the “stout type”, they may be used for agonistic behaviour.

4. Males in late mature phase of “stout type” and “slender type” are found all year round in Luk-Kong waters although those of the “stout type” are more numerous and larger.

In decapods, the polymorphism of the male second pereopod has been reported in many species of *Macrobrachium* (Holthuis, 1950) and especially in the well-known giant prawn *M. rosenbergii* (de Man). Development of its adult male morphotypes is considered as an environment consequence (Ra'anani and Cohen, 1985) and its morphotypic differentiation has been studied (Kuris et al., 1985).

The polymorphism of the male first pereopod has been reported in the crab *Macropodia rostrata* L. (see Teissier, 1933), in the pagurid *Diogenes pugilator* Roux (see Forest & Guinot, 1956); it occurs in the terminal sexually mature phase, as observed in *U. edulis*, in certain spider crabs, *Pisa tetraodon* (Pennant) (see Vernet-Cornubert, 1958) and *Pisa armata* (Latreille) (see Hartnoll, 1978). This polymorphism of the final instar, as Hartnoll noted (1978), has several parallels in the insects. It is worth further investigation in *Upogebia*. Charniaux-Cotton (1962), studying the action of the androgenic gland and its hormone in crustaceans, reported the constant presence of ovocytes in male gonads of *Upogebia major* de Haan; the same may happen in *Upogebia edulis*. In this latter species and concerning the occurrence of ovocytes, it is therefore questionable whether the structure of male gonads differs between the early and late mature phase as well as between the “stout” and the “slender” type.

The underlying mechanisms which control absolute and relative growth in Crustacea are not known but Hartnoll (1982) assumed that growth patterns are adaptive. As for *U. edulis* whose complete biology is still to be investigated, it is a mystery as to what adaptive pressure would

favour the development of a "stout" type of first pereiopod in only a portion of the male population and yet leave the rest with an appendage nearly identical to that of the female. One possibility is that males of this species could have discrete alternative reproductive life histories as shown in certain fishes (Chan & Ribbink, 1990).

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