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THE DEEP-SEA SHRIMPS OF THE FAMILY OPLOPHORIDAE (CRUSTACEA: DECAPODA) FROM TAIWAN*

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Abstract

This paper reports upon four species of deep-sea oplophorid shrimps collected off north-east and southern Taiwan at depths of about 100–450 m. All are new to the marine fauna list of Taiwan. *Oplophorus gracilirostris* and *Oplophorus typus* are found to have the ability to lock the laterally extended scaphocerites. A key is given for their identification and their colours are fully illustrated. Sexual differences are also discussed.

Introduction

Most oplophorids are well-known bathypelagic shrimps that have the ability to luminesce and exhibit vertical migration. Interestingly, a number of specimens belonging to this family have been obtained from the coastal shrimp fishery and are used by local fishermen as part of the natural food in the fish and prawn culture industry. In the present paper, four oplophorid species are described from our collections, namely: *Oplophorus typus* H. Milne Edwards, 1837, *Oplophorus gracilirostris* A. Milne Edwards, 1881, *Oplophorus spinicauda* A. Milne Edwards, 1883 and *Systellaspis pellucida* (Filhol, 1885). All have the same local name "spiny shrimp" and are new to the fauna list of Taiwan. The first two species have the ability to lock their laterally extended scaphocerite by unique structures on the scaphocerite and the basicerite. This report includes descriptions of the external characteristics and the sexual differences of these shrimps, together with keys and colour illustrations. Restricted synonymies are also provided.

Materials and Methods

All the specimens were obtained from local fish markets at fishing harbours and were said to be caught at about 100–450 m depth off north-east and southern Taiwan. Reference specimens are deposited in the Fisheries Department of the National Taiwan College of Marine Science and Technology. The stated measurement is body length which was measured from the postorbital margin to the posterior margin of the telson with the specimen outstretched.

Key to the genera of Oplophoridae from Taiwan:

- A. Exopods of all thoracic appendages conventionally slender; outer margin of scaphocerite smooth; abdominal somite VI never dorsally carinate *Systellaspis* Bate, 1888
- B. Exopods of maxilliped III and pereopod I foliaceous; outer margin of scaphocerite usually spinous (all Taiwan species with outer margin of scaphocerite spinous)
. *Oplophorus* H. Milne Edwards, 1837

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Genus *Systellaspis* Bate, 1888
Systellaspis pellucida (Filhol, 1885)
(Plate IA; Figure 1)

Acanthephyra pellucida -- Filhol, 1885: 144, 162.

Systellaspis affinis -- Des Man, 1920: 43; Chace, 1936: 29; Calman, 1939: 190; Dennell, 1940: 345; Chace, 1947: 39, fig. 3; Crosnier and Forest, 1968: 1133.

? not *Systellaspis lanceocaudata* Bate, 1888 -- Bals, 1925: 243, figs. 12, 13.

Systellaspis pellucida -- Crosnier and Forest, 1973: 92, figs. 26c, 27c.

• 'Material Examined': Ta-Chi, I-Lan County;

Chan leg.: 14 October 1984; 1 ♂ 54 mm, 4 ovigerous ♀♀ 57–62 mm. 31 December 1984; 1 ovigerous ♀ 59 mm, 1 ♀ 60 mm. 26 March 1985; 4 ovigerous ♀♀ 54–56 mm, 25 ♀♀ 52–57 mm. 8 May 1985; 1 ♂ 52 mm, 5 ovigerous ♀♀ 50–53 mm, 5 ♀♀ 48–52 mm. 14 July 1985; 3 ♂♂ 41–44 mm, 4 ♀♀ 47–50 mm. Tong-Kang, Ping-Tong County; Chan leg.: 31 October 1984; 2 ovigerous ♀♀ 56 and 62 mm. 2 December 1984; 2 ovigerous ♀♀ 56 and 62 mm. 2 December 1984; 3 ♀♀ 51–58 mm. Su-Ao, I-Lan County; Chan leg.: 3 May 1985; 2 ovigerous ♀♀ 51 and 52 mm, 2 ♀♀ 52 and 53 mm.

Body slender and shell flexible. Rostrum

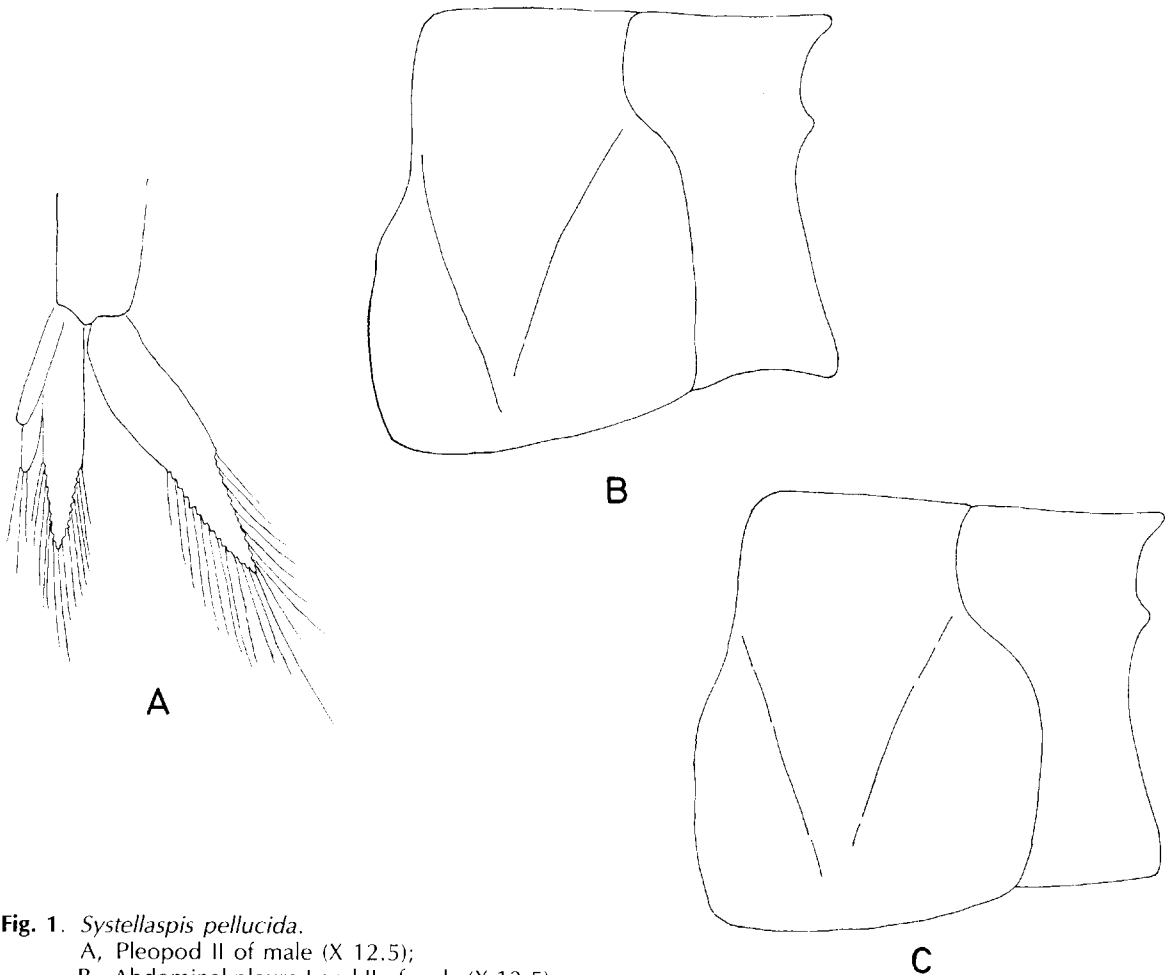


Fig. 1. *Systellaspis pellucida*.
A, Pleopod II of male (X 12.5);
B, Abdominal pleura I and II of male (X 12.5);
C, Abdominal pleura I and II of female (X 12.5).

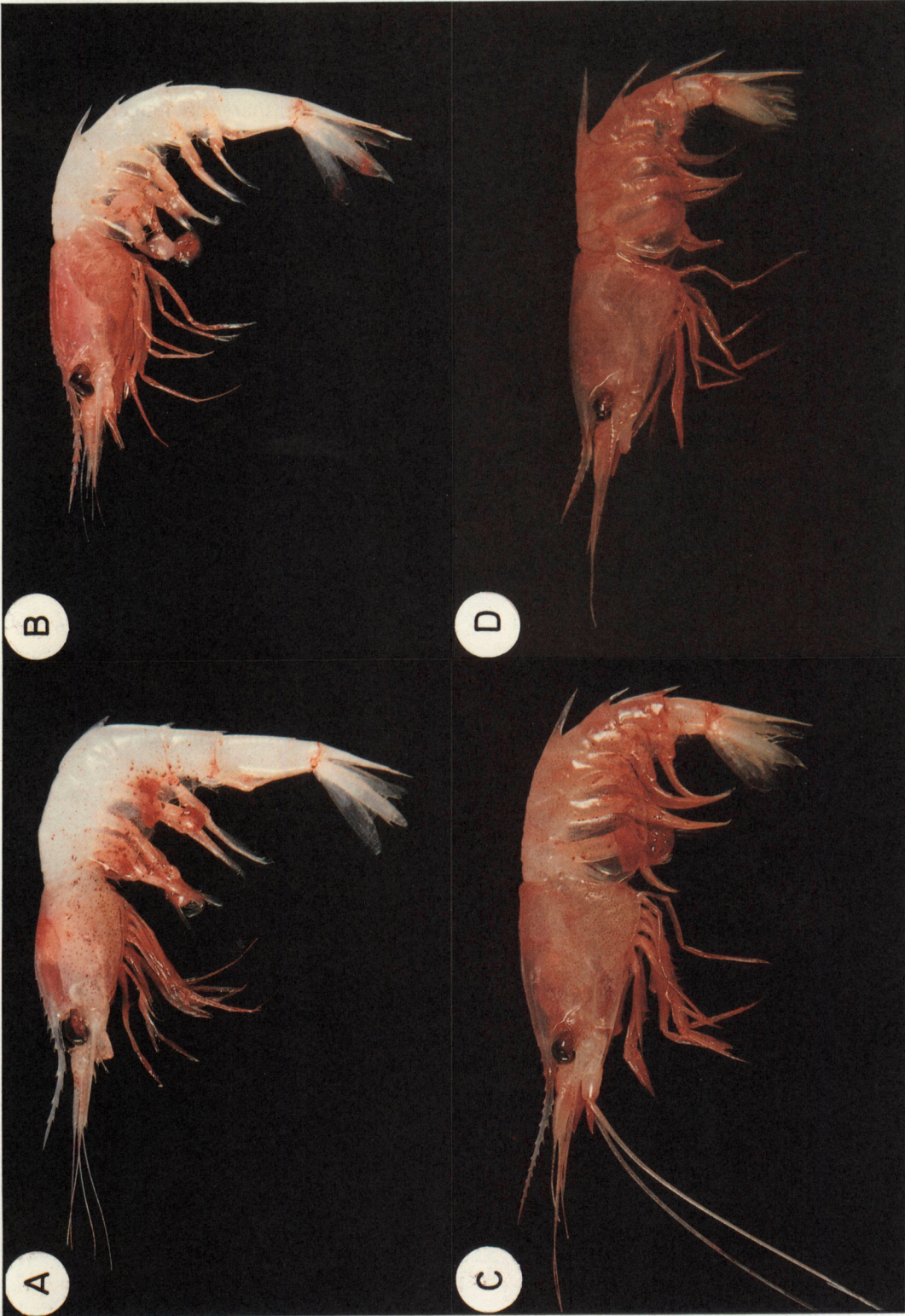


Plate I. A, Lateral view of a 53 mm ovigerous female of *Systellaspis pellucida*, showing partly scarlet and partly white eggs; B, Lateral view of a 47 mm ovigerous female of *Oplophorus spinicauda*, showing near hatching white eggs; C, Lateral view of a 56 mm ovigerous female of *Oplophorus gracilirostris*, showing scarlet eggs; D, Lateral view of a 39 mm female of *Oplophorus typus*.

armed dorsally with 4–6 (usually 6) teeth and ventrally with 4–6 (usually 5) teeth. Usually 3–4 post-rostral teeth present. Rostrum generally slightly longer than scaphocerite. No lateral carinae on carapace. Exopods of all pereopods slender. Abdominal tergites III, IV and V produced into short but acute spine posteriorly. Hind margins of abdominal tergites IV and V not serrated laterally. Dorsal midline of abdominal tergite VI and anterior telson rounded or flattened, not sulcate. Telson more or less as long as uropods (slightly shorter in some specimens). Eggs few, ranging from 6–18 per ovigerous female, large and beanshaped, about 2 × 3 mm.

- **Colour:** Generally transparent but covered with scattered scarlet spots. Eye brown-red. Internal organs inside carapace and eggs scarlet. Carapace with violet-blue longitudinal bars (photophores) near ventral margin. Thoracic appendages, bases of pleopods and posterior margins of posterior three abdominal segments vermilion. Photophores of deep purple colour.
- **Distribution:** World wide tropical seas: Philippines, Malay Archipelago, West Africa, Bahamas, West Indies, China Sea and Zanzibar.
- **Remarks:** Detailed morphological figures have been given by Crosnier and Forest (1973). The distribution and structure of the photophores have been extensively studied by Calman (1939) and Dennell (1940). The male specimens investigated in this study possess an appendix masculina on the endopod of the pleopod II and both appendix interna and appendix masculina are translucent and slender. The sex of the species can be somewhat determined from the outline of the abdominal pleuron I, where the lower margin is concave in the male but is nearly straight in the female. Moreover, in males, a median blunt protuberance is present on the abdominal sternites I and II, the pleopods of the abdominal segment III are very close to each other and the coxae of the anterior three pleopods are relatively short, about half the length of the basis. However, in females only a

rudimentary median elevation is visible on the abdominal sternites I and II, the pleopods of the abdominal segment III are widely separated and the coxae of the anterior three pleopods are long, markedly longer than half the length of the basis. *S. pellucida* is relatively larger than other local oplophorids and more numerous off north-eastern Taiwan.

Genus *Oplophorus* H. Milne Edwards, 1837

Key to the species of Oplophorus from Taiwan:

1. Abdominal somites II, III and IV produced into overhanging spine posteriorly
..... *Oplophorus spinicauda*
A Milne Edwards, 1883
- Abdominal somites III, IV and V produced into overhanging spine posteriorly 2
2. Rostrum provided with teeth near tip of scaphocerite; posterior spine of abdominal somite V shorter than IV
..... *Oplophorus gracilirostris*
A. Milne Edwards, 1881
- Rostrum devoid of teeth near tip of scaphocerite; posterior spine of abdominal somite V longer than IV
..... *Oplophorus typus*
H. Milne Edwards, 1837

Oplophorus spinicauda A. Milne Edwards, 1883
(Plate IB; Figure 2)

Oplophorus spinicauda -- A. Milne Edwards, 1883: pl. 30; Chace, 1936: 30; Chace, 1940: 184, fig. 54; Chace, 1947: 42; Hayashi and Miyake, 1969: 68; Crosnier and Forest, 1973: 24; Hanamura, 1979: 171; Miyake, 1982: 174.

Oplophorus foliaceus -- Rathbun, 1906: 922, pl. 20 fig. 8.

Hoplophorous spinicauda -- De Man, 1920: 42.

Hoplophorous foliaceus -- Balss, 1925: 249.

- **Material Examined:** Tong-Kang, Ping-Tong County: 27 January 1983; 1 ♀ 43.5 mm. Yu leg. 31 October 1984; 4 ovigerous ♀♀ 43–47 mm. 2 December 1984; 1 ♂ 32 mm, 17 ovigerous ♂♂ 42–54 mm. 26 March 1985; 1

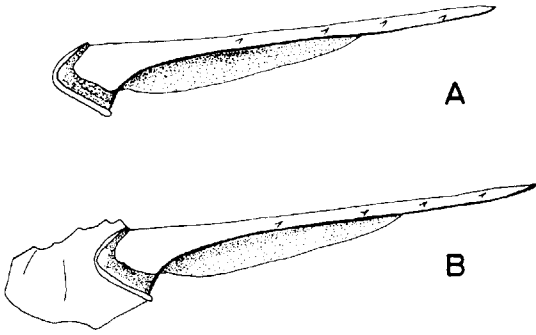


Fig. 2. *Oplophorus spinicauda*.

- A, Scaphocerite, latero-ventral view (X 12.5);
 B, Lateral view of scaphocerite and basicerite (X 12.5);

♂ 26 mm, 2 ovigerous ♀♀ 44 and 45 mm. 28 July 1985; 3 ovigerous ♀♀ 45–47 mm. Chan leg.

Body slender and shell flexible. Rostrum always with 8 teeth above and 7 teeth below, extending slightly beyond scaphocerite. Post-rostral carina usually provided with 4 teeth. Outer margin of scaphocerite armed with 4–5 large acute spines. Exopods of all pereopods foliaceous. Conspicuous overhanging median posterior spine present on abdominal tergites II, III and IV. Telson more or less longer than uropods. Eggs large, few (about 10 in one ovigerous female) and bean-shaped, about 2×2.5 mm.

- **Colour:** Similar to *S. pellucida* but with scattered red dots and no violet longitudinal bars (photophores) on ventral carapace. Lateral surfaces of abdomen with transparent, yellow-green, patches and tips of uropods reddish. Eggs scarlet, becoming white and with blackish eye spot when close to time of hatching.
- **Distribution:** World wide tropical seas: Belize, Morocco, northern Madagascar, southern India, Hawaiian Islands, Florida, West Indies, Philippines, E. Indian Ocean and Japan.
- **Remarks:** As pointed out by Chace (1940) and Hayashi and Miyake (1969), there is no appendix masculina on the endopod of the pleopod II in males. The sex of the species can, however, be determined by the shape of

the lower margin of the abdominal pleuron I, which is concave and rough in males whereas it is horizontally straight and smooth in females. No median protuberance is present on the abdominal sternites I and II of either sex but the appearance of the coxae of the anterior three pleopods are similar to those of *S. pellucida*. This species closely resembles *S. pellucida* and is very different from other *Oplophorus* species in the general body shape, soft integument, non-rigid exopods of the pereopods, shape of the rostrum and telson, and the outline of the abdominal pleuron I in each sex. Moreover, the appearance of the appendix interna is also thin and slender. Additional to lacking the ability to lock the scaphocerite as in other *Oplophorus* species reported upon in this paper, it appears rather unsuitable to place this species in the genus *Oplophorus* only on account of the characteristic foliaceous exopods of the pereopods, as this character is somewhat vague. This species is mainly found off southern Taiwan and is smaller than other local oplophorids.

Oplophorus gracilirostris A. Milne
 Edwards, 1881

(Plates IC and IIA, B; Figures 3, 4)

Oplophorus gracilirostris -- A. Milne Edwards, 1881: 6; Rathbun, 1906: 921; Yokoya, 1933: 29, fig. 12; Chace, 1936: 30; Chace, 1947: 44, figs. 4–7; George and Rao, 1966: 329; Kensley, 1972: 38, fig. 17F; Hanamura, 1979: 171; Miyake, 1982: 174.

Oplophorus longirostris -- Bate, 1888: 765, pl. 127 fig. 2.

Hoplophorus Smithii -- Wood-Mason and Alcock, 1891: 194.

Hoplophorus gracilirostris -- Alcock, 1901: 73; Kemp and Sewell, 1912: 20; De Man, 1920: 42.

? not *Hoplophorus typus* (H. Milne Edwards, 1837) -- Blass, 1925: 248, figs. 21–23 (in part); Calman, 1939: 188 (in part).

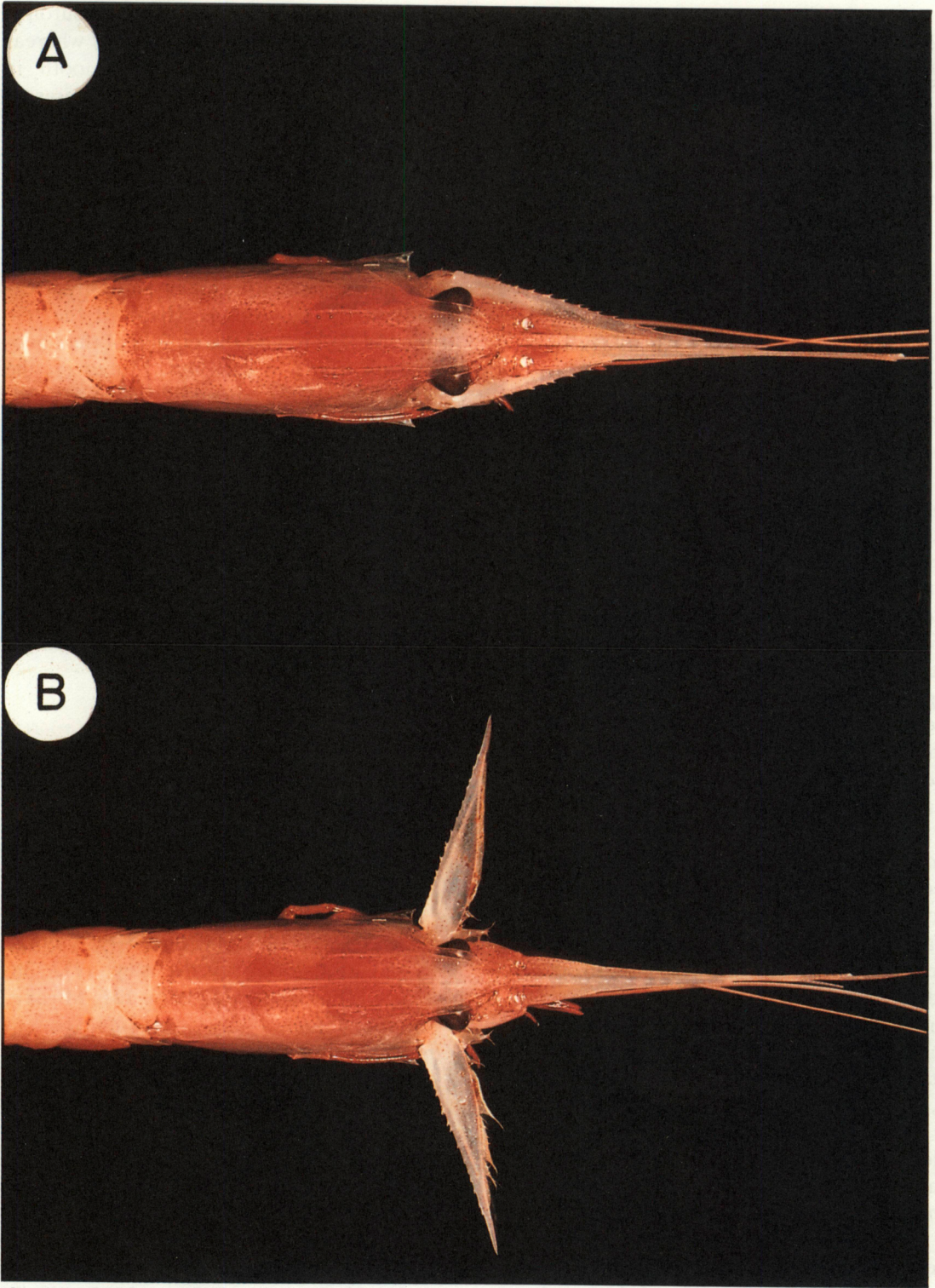


Plate II. Dorsal view of the cephalothorax of *Oplophorus gracilirostris* (58 mm ovigerous female).
A, Scaphocerite in normal position; B, Scaphocerite in locked position.

- **Material Examined:** Tong-Kang, Ping-Tong County; Chan leg.: 2 December 1984; 9 ovigerous ♀♀ 47–54 mm, 4 ♀♀ 38–55 mm. 28 July 1985; 29 ovigerous ♀♀ 46–58 mm. Ta-Chi, I-Lan County; Chan leg.: 31 December 1984; 8 ♂♂ 36–44 mm, 1 37 mm.

Body robust and shell hard. Rostrum extending beyond scaphocerite, armed with 12–14 teeth dorsally and 9–11 teeth ventrally. Outer margin of scaphocerite provided with about 18 small spines and with rather inconspicuous barb near distal end. Lateral carinae at base of rostrum subparallel to dorsal midline of carapace. Postero-lateral angle of carapace armed with a spine, which is not so remarkable as in *O. typus*. Only exopods of maxilliped III and pereopod I foliaceous. Abdominal tergites III, IV and V produced into overhanging spines posteriorly, with length progressively shorter from III to V. Telson somewhat longer than uropods. Eggs large, 20–30 in one ovigerous female, bean-shaped and about 2.5×3 mm (size rather irregular).

- **Colour:** Eye deep vermilion. Body transparent but covered with dense scarlet spots, especially in mid-lateral region of each abdominal somite and posterior margins of posterior three abdominal segments, sometimes as scarlet stripes. Lateral surfaces of abdomen with transparent yellow-green patches. Interlateral organs inside carapace and thoracic appendages scarlet. Branchial chamber grey-green and with some silver reflections. Anterior dorsum of carapace near base of rostrum sometimes brilliant vermilion. Photophores purple-red. Eggs scarlet or partly white and partly scarlet to nearly white when there is a blackish eye spot.
- **Distribution:** World wide. Pacific and Indian Oceans and Japan.
- **Remarks:** This species is sometimes numerous off the north-east and southern coasts of Taiwan. As noticed by Chace (1947), the sex of the species can be determined by the shape of the lower margin of the abdominal pleuron I, which is concave and spinous in males whereas it is convex and rather smooth in ovigerous females. However, in immature

females the outline of the abdominal pleuron I is similar to that of the males except that only the spinous protuberance is slightly behind the midline of the pleuron and obtuse whereas it is somewhat anterior to the midline and well-developed in males. More apparent features that can be used to separate immature females from males are at the abdominal pleuron II, the abdominal sternite I and the length of the coxae in the anterior three pleopods. The antero-lateral angle of the abdominal pleuron II is smooth in females but is distinct in males. The abdominal sternite I in males is provided with a V-shape carina and bears a blunt protuberance medially whereas this carina and the median protuberance are absent in females. The length of the coxae of the anterior three pleopods is short, less than half the length of the basis in males, but long, markedly longer than half the length of the basis in females. The appendix masculina is long and well-developed on the endopod of the pleopod II in males. The short appendix interna on the endopods of the pleopods is broad and rigid. The species closely resembles *O. typus*. Besides the comparative features that separate *O. gracilirostris* from *O. typus*, the most diagnostic characteristic of *O. gracilirostris* is the anterior section of the rostrum near the tip of scaphocerite which is armed with teeth.

A peculiar phenomenon is observed on the scaphocerite in *O. gracilirostris* and *O. typus*. When the scaphocerite is fully abducted, it is firmly locked by the basicerite. The scaphocerite fixed in this position can not be pulled forward to the original position. Only when the scaphocerite is lifted and separated from the basicerite can it be released and moved freely. The locking mechanism is by the complementary structures of the scaphocerite and the basicerite. The scaphocerite is thick at the outer margin, especially near the base and with a well-developed knob present at its proximal end on the ventral surface. This knob is provided with a rough surface and a sharp edge on the inner surface. A deep transverse groove is

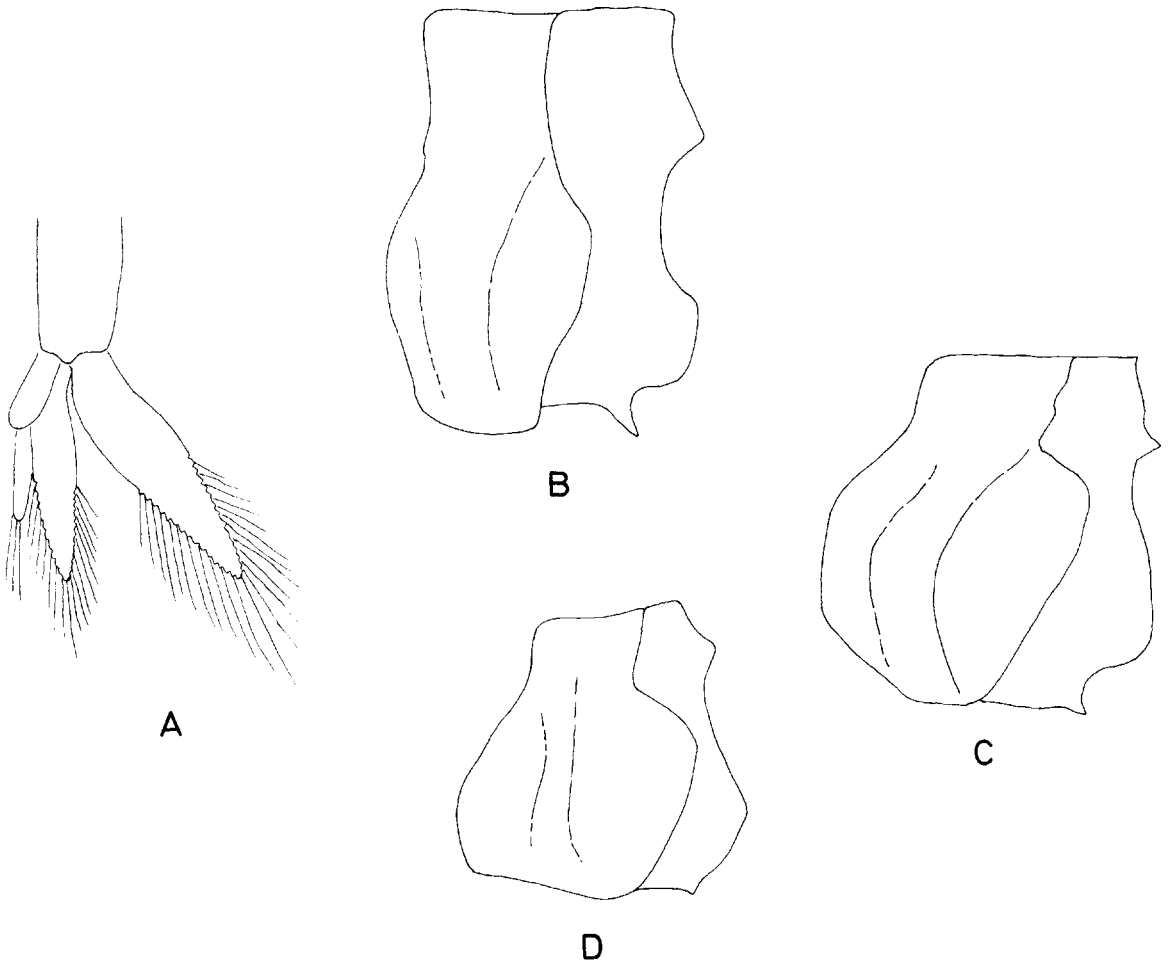
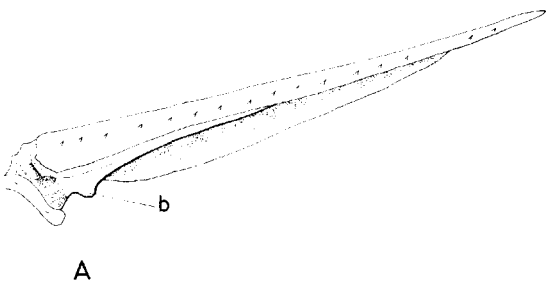
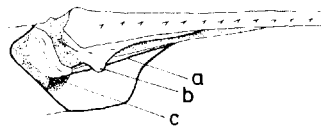


Fig. 3. *Oplophorus gracilirostris*.
 A, Pleopod II of male (X 12.5);
 B, Abdominal pleura I and II of male (X 12.5);
 C, Abdominal pleura I and II of ovigerous female (X 5);
 D, Abdominal pleura I and II of non-ovigerous female (X 12.5).



A



B

Fig. 4. *Oplophorus gracilirostris*.
 A, Scaphocerite, latero-ventral view (X 12.5). (b=ventral knob);
 B, Lateral view of scaphocerite and basicerite (X 12.5). (a=upper sharp edge of basicerite; b=ventral knob of scaphocerite; c=concavity of basicerite).

present posterior to the knob. On the basicerite, the outer surface is flat and with the upper and lower edges sharp. The sharp upper edge of the basicerite is straight on the anterior two-thirds but abruptly depressed near the base, where it forms a concavity and with a sharp angle at the juncture. In the normal position, the knob at the ventral scaphocerite is higher than the upper sharp edge of the basicerite. When the scaphocerite is fully extended posteriorly, the knob falls into the concavity of the basicerite and becomes lower than the upper sharp edge, thus locking the scaphocerite in place. The upper sharp edge near the concavity of the basicerite prevents the knob, lower in at this position, from moving forward. As the scaphocerite is elevated and the knob leaves the concavity, the knob is higher than the upper sharp edge of the basicerite and can pass it to move forward. *O. spinosus* and *O. novaezeelandiae* appear also to have a similar arrangement of scaphocerite and basicerite (Chace 1940, fig. 55; Crosnier and Forest 1973, fig. 5). This locking phenomenon is somewhat similar to the locking of the dorsal spine in the trigger fishes (Balistidae). Together with the hard integument and spinous outline, the firmly extended spinous scaphocerite could act as a defense mechanism by increasing the required gape of the predator's mouth to ingest its prey. On the other hand, the increased surface area may also enhance the buoyancy of these bathypelagic *Oplophorus* species floating in the deep-sea. In any event, the discovery of this locking phenomenon on the scaphocerite provides more insight into its function.

Oplophorus typus H. Milne Edwards, 1837
(Plate ID)

Oplophorus typus -- H. Milne Edwards, 1837: 424, pl. 25 figs. 6–7; Bate, 1888: 762, pl. 127 fig. 1; Chace, 1936: 30; Chace, 1947: 46, figs. 8–11; Hayashi and Miyake, 1969: 71.

Oplophorus brevirostris -- Bate, 1888: 766, pl. 127 fig. 3.

Hoplophorus typus -- De Man, 1920: 48; Dennel, 1940: 328.

? *Hoplophorus typus* -- Balss, 1925: 248, figs. 21–23 (in part); Calman, 1939: 188 (in part).

- *Material Examined*: Tong-Kang, Ping-Tong County; Chan leg.: 2 December 1984; 2 ♂♂ both 32 mm, 2 ♀♀ 34 and 35 mm. Ta-Chi, I-Lan County, Chan leg.: 8 May 1985; 1 ovigerous ♀, 1 ♀ both 39 mm.

Body robust and shell hard. Rostrum short, with 7–9 dorsal and 4–7 ventral teeth, reaching near to tip of scaphocerite. Outer margin of scaphocerite also provided with about 16 small spines but no barb near distal inner margin of scaphocerite. Lateral carinae at base of rostrum converging posteriorly toward dorsal midline of carapace. Postero-lateral angle of carapace armed with prominent sharp-hooked spine. Only exopods of maxilliped III and pereopod I foliaceous. Abdominal tergites III, IV and V terminated with long spine posteriorly, that of V much longer than IV and nearly as long as III. Telson slightly longer than uropods. Ovigerous female with 8 eggs, large and bean-shaped, 3.5 × 2.25 mm.

- *Colour*: Body colour as in *O. gracilirostris*.
- *Distribution*: Indo-West-Pacific: Fiji Islands, New Guinea, Philippines, Bali Sea, Timor, E. Saleyer, Andaman Islands, Maldives, Gulf of Aden, Arabian Sea, E. Africa and E. Indian Ocean. Reports from Hawaii and Atlantic Ocean may refer to related but not identical species.
- *Remarks*: De Man (1920) and Chace (1947) have extensively described the characteristics of *O. typus*. Dennel (1940) has described the distribution and structure of the photophores. The appendix masculina and appendix interna are similar to those of *O. gracilirostris*. The sex of the species can also be determined by the length of the rostrum, the outline of the antero-lateral margin of the abdominal pleuron I, the structure of the abdominal sternite I and the coxae of the anterior three pleopods. In males, the rostrum may reach or slightly extend beyond

the tip of the scaphocerite and the antero-lateral margin of the abdominal pleuron I is concave whereas in females the rostrum does not reach the tip of the scaphocerite and the antero-lateral margin of the abdominal pleuron I is convex. The appearance of the abdominal sternite I and the coxae of the anterior three pleopods in different sexes are similar to those of *O. gracilirostris*. Thus, the figure by Bate (1888) of *O. brevirostris* was actually a male of *O. typus* while his figure of *O. typus* was a female. The present species also has the ability to lock the laterally extended scaphocerites. The structure of the scaphocerite and the basicerite is similar to that of *O. gracilirostris* except the concavity of the basicerite is more well-marked in the present species. The long overhanging post-

erior spines of abdominal tergites III and V have a tendency to curve slightly upwards unlike the outer convex margin of those of *O. gracilirostris*. *O. typus* can be easily distinguished from *O. gracilirostris* by the rostrum near the tip of the scaphocerite being devoid of teeth and the much longer overhanging spine on the abdominal tergite V. This species is uncommon and was always accompanied by the much larger *O. gracilirostris*.

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