

## Phyllosoma and Nisto Stage Larvae of Slipper Lobster, *Parribacus*, from the Izu-Kazan Islands, Southern Japan

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**Abstract** Eight giant phyllosomae, one smaller phyllosoma, and two nistos referable to slipper lobster, *Parribacus*, obtained from the Izu, Ogasawara and Kazan Islands (34°45'N, 139°25'E–25°25'N, 141°17'E) are described and illustrated. A 19.1 mm phyllosoma from O-shima and six giant phyllosomae obtained from stomach contents of a yellow fin albacore from Kita-Iwo-jima are not identified specifically. A 60.8 mm phyllosoma from Miyake-jima and a 80.0 mm gilled phyllosoma from O-shima are possibly identifiable to *P. japonicus* Holthuis. Two nistos from Hachijo-jima and Miyake-jima are referred to *P. japonicus* due to the shape of the lateral margin of second antenna.

**Key words:** Phyllosoma, Nisto, *Parribacus*, Izu Islands, Ogasawara Islands, Kazan Islands.

### Introduction

Giant phyllosomae having the remarkable size and scythe-shaped dactyli of pereopods have been recorded from various areas in the Micronesian and Melanesian waters in the Pacific (Richters, 1873; Johnson, 1951, 1971; Robertson, 1968; Michel, 1971; Sekiguchi, 1990; *etc.*), from the Indian Ocean (Prasad & Tampi, 1965; Saisho, 1966; Berry, 1974; Prasad *et al.*, 1975) and also from the Atlantic Ocean (Sims & Brown, 1968; Robertson 1968). Among the giant phyllosomae, a 75 mm specimen (Richters, 1873), a 80 mm specimen (Prasad *et al.*, 1975) and a 83 mm specimen (Michel, 1971) were at the gilled stage.

As to the generic identification of giant phyllosomae, Robertson (1968) pointed out that “in Richters’ 75 mm specimen the distal margins of the second antennae are distinctly incised, suggesting the adult condition found both in *Parribacus* and *Arctides*,” and supposed that the giant phyllosomae and smaller phyllosomae collected from the Indian Ocean were referred to *Parribacus*, in view of the relative abundance of the larvae and the scarcity of adults of *Arctides* in the region. Johnson (1971) assigned a series of phyllosoma stages including two giant phyllosomae from Hawaiian waters to *P. antarcticus* (Lund), based on the supposition that “larvae found in local waters are most likely produced by local species.”

Giant phyllosomae including final stage obtained by the senior author from the Izu-Kazan Islands (34°45'N, 139°25'E–25°25'N, 141°17'E) are recorded here for the first time from Japanese waters, and the specific identity is discussed in detail.

Nisto stage of *Parribacus* was first reported from the Caribbean Sea by Guilding (1925) as *Scyllarus carinatus* Guilding. Holthuis (1985) considered, however, that the specimen really belonged to *Parribacus* and the species was synonymous with *P. antarcticus*. Boas (1880) recorded a transparent natant stage *Parribacus*, 50 mm in total length, from off Oahu, Hawaii. Rathbun (1906) described two specimens of thin papyraceous texture from Hawaiian waters under the name of *Parribacus papyraceus*, and Johnson (1971) mentioned a nisto stage of *Parribacus* also from Hawaii. In Japan, Balss (1914) recorded a juvenile specimen from Misaki, Sagami Bay, which agreed with Rathbun's description, and Parisi (1917) assigned three nistos obtained from Sagami Bay to *Paribacus [sic] ursus major* (Herbst) which is at present generally considered to be synonymous with *P. antarcticus*.

Two nisto specimens from Hachijo-jima and Miyake-jima are described, and specific identities are discussed in the present paper.

### Material and Methods

The specimens recorded here were collected during the years between 1975 and 1992 by various methods. The collection data for these specimens are given in Table 1. The smallest phyllosoma, 19.1 mm in total length, was collected off the coast of Oshima (Fig. 1) in August 1985 by R/V *Kamome* of the Tokyo Metropolitan Fisheries Experiment Station using a pair of surface nets. The nets with a diameter of 1 m at the mouth, 3.3 m long, 2.5 mm square mesh, were towed horizontally at surface in night. A giant phyllosoma, 60.8 mm long, was caught off Miyake-jima in April 1992 by R/V *Miyako* of the same Experiment Station. It was enmeshed on the drift-net with 57 mm stretched mesh which targeted flying fishes. Six giant phyllosomae were obtained from the stomach contents of a yellow fin albacore caught with bottom fishing by R/V *Miyako* in June 1988 at a fishing ground near Kita-Iwo-jima. A gilled stage phyllosoma stranded on a Kobohama beach, Oshima was found by an islander at dawn in August 1987. Stages of these phyllosomae obtained were determined following Johnson (1971) and by the characteristics of appendages.

A nisto specimen found in the collections of the Hachijo Branch, Tokyo Metropolitan Fisheries Experiment Station, was collected at Okago, Hachijo-jima in January 1975, though the method of collection is unknown. Another nisto, attracted to light of the R/V *Miyako* anchoring off Ako, Miyake-jima, was dipped up with a net at night in October 1983.

All the specimens examined are deposited at the National Science Museum, Tokyo (NSMT).

Table 1. Collection data of phyllosomae and nistos recorded in the present report.

	Number of specimens	Total length (mm)	Date	Time	Location	Position		Depth	Method of collection
						Latitude	Longitude		
Phyllosoma (NSMT-Cr 12162)	1	19.1	23 Aug. 1985	20:00–20:15	Oshima	34°37'	139°19'	Surface	3.3 m plankton net
Phyllosoma (NSMT-Cr 12163)	1	60.8	24 Apr. 1992	00:40	Miyakejima	34°07'	139°34'	Surface	Gill net
Phyllosoma (NSMT-Cr 12164)	6	66–73.0	29 Jun. 1988	13:53–14:14	Kitaiwojima	25°24'	141°11'	—	Stomach contents
Phyllosoma (NSMT-Cr 12165)	1	80.0	3 Aug. 1987	05:30	Oshima	34°44'	139°22'	—	Stranded
Nisto (NSMT-Cr 12166)	1	48.0	7 Jan. 1975	—	Hachijojima	33°06'	139°46'	—	—
Nisto (NSMT-Cr 12167)	1	48.9	7 Oct. 1983	Night	Miyakejima	34°04'	139°28'	Surface	Dip net

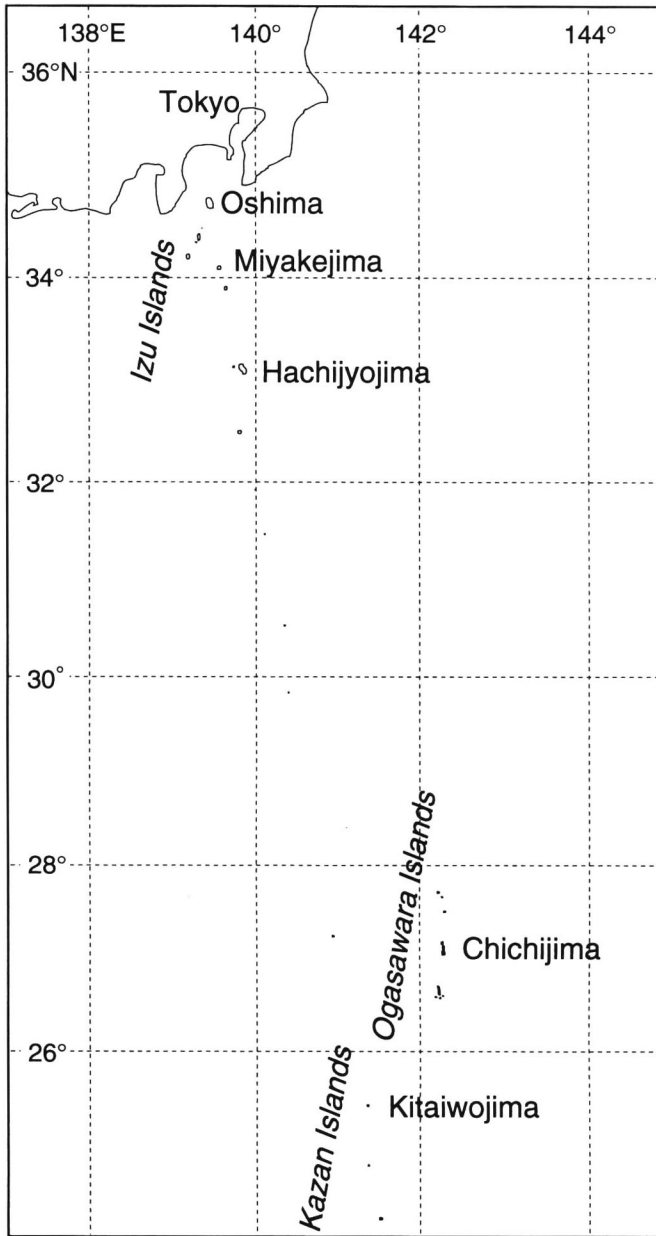


Fig. 1. Location of collecting areas.

### Description

#### Phyllosoma, Stage VIII

(Fig. 2)

One specimen from O-shima (NSMT-Cr 12162). Body length from tip of fore-body to tip of telson, 19.1 mm. Cephalic shield oval, 15.8 mm long, 12.2 mm wide; posterolateral margins not overlapped coxae of third maxillipeds. Thorax 10.6 mm

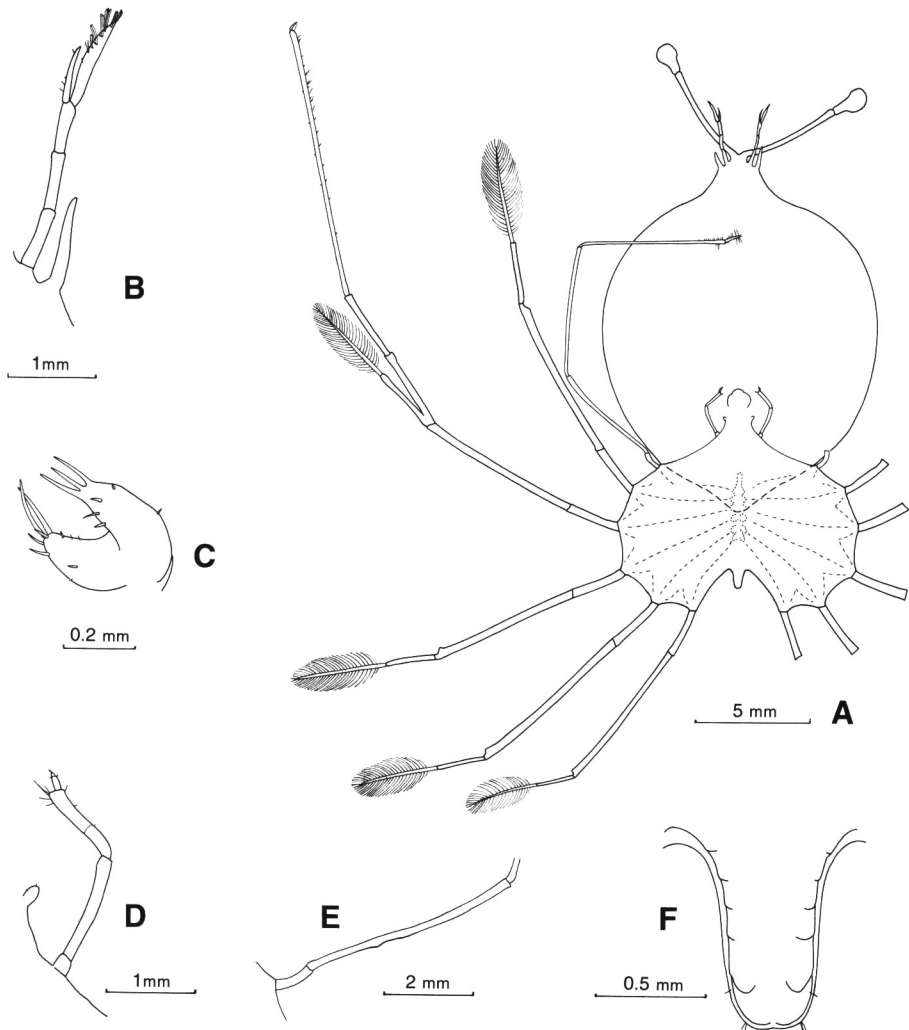


Fig. 2. Phyllosoma (NSMT-Cr 12162) of *Parribacus* sp. in ventral view. — A, Stage VIII (19.1 mm); B, first and second antennae; C, first maxilla; D, second maxilla and second maxilliped; E, third maxilliped; F, abdomen.

wide, deeply concave behind. Abdomen unsegmented, with two or three setae on both sides of tip of telson. First antenna with three-segmented peduncle; inner flagellum shorter than outer flagellum. Second antenna uniramous, without external segmentation. First maxilla biramous; coxal endite bearing two long slender setae at its tip; basal endite terminating in three strong setae. Second maxilla small, lobe-like with two short setae. First maxilliped not indicated. Second and third maxillipeds consisting of five segments, and third maxilliped with exopod bud indicated as a slight elevation. Pereiopods 1 to 5 without coxal spine; each exopod with 25, 27, 24, 23, and 17 pairs of plumose setae, respectively; fifth pereiopod well developed. Four pairs of pleopod buds indicated beneath cuticle.

This specimen is quite similar to a 19.0 mm specimen from Hawaiian waters assigned to *Parribacus antarcticus* by Johnson (1971). However, it is not clear whether the present specimen is really referable to *P. antarcticus* or not, since the larval characters of the other species known from the northern Pacific have not been revealed.

### **Phyllosoma, Stage XI**

(Fig. 3)

One specimen from Miyake-jima (NSMT-Cr 12163). Body length, 60.8 mm. Cephalic shield leaf-like, 47.5 mm long, 44.4 mm wide, entirely overlapping coxae of third maxillipeds. Thorax 31.0 mm wide, deeply concave behind. Abdomen with 5 segments, clearly marked off both on lateral sides. Telson trapezoidal. First antenna longer than second antenna; inner and outer flagella nearly equal in length. Second antenna broadened at base, not segmented; short lateral process now existed. Coxal endite of first maxilla with a row of 7 small setae on anterior margin; terminal setae both at coxal and basal endites little changed from stage VIII. Second maxilla as in Fig. 3 D, without setae. First maxilliped now indicated as a small bud. Second maxilliped with slight exopod bud. Third maxilliped little changed. Pereiopods 1–5 without coxal spine, each exopod with 56, 57, 56, 55, and 54 pairs of plumose setae, respectively. Pereiopods 3 and 4 terminating each in a long scythe-shaped dactylus. Pleopods present on both sides of abdominal segments 1–4, biramous without appendix interna. Uropod developed; posterior margin not beyond tip of telson.

This specimen is similar in size to a 57.2 mm specimen from Hawaii (Johnson, 1971), a 64 mm specimen from the Indian Ocean (Saisho, 1966) and a 65 mm specimen from the Caribbean Sea (Robertson, 1968). However, the anterior margin of the cephalic disc is a little more concave in the present specimen than the others, and the second antenna has no segmentation unlike Johnson's and Robertson's specimens (no description was given in Saisho's specimen).

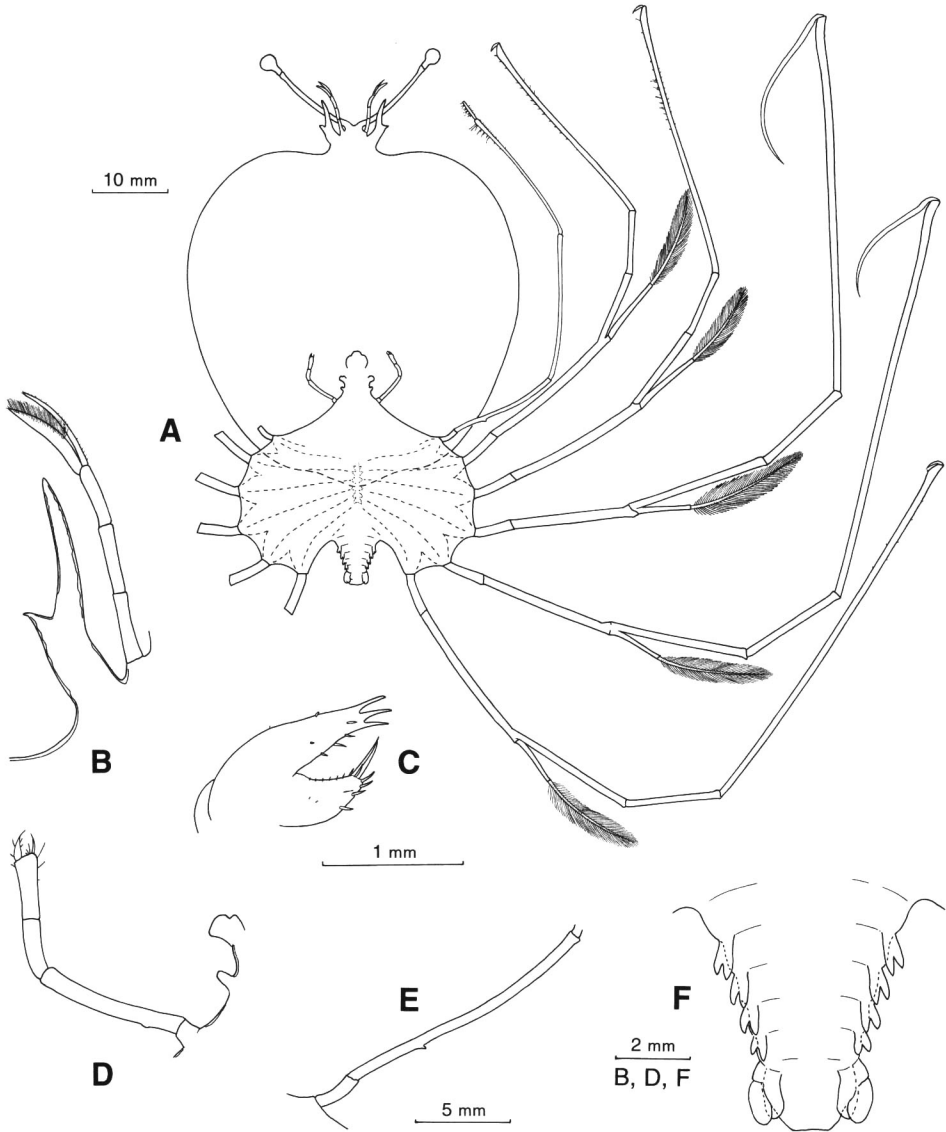


Fig. 3. Phyllosoma (NSMT-Cr 12163) of *Parribacis japonicus* Holthuis in ventral view. — A, Stage XI (60.8 mm); B, first and second antennae; C, first maxilla; D, second maxilla, first and second maxillipeds; E, third maxilliped; F, abdomen.

**Phyllosoma, Subfinal Stage**

(Fig. 4)

Six specimens from Kita-Iwo-jima (NSMT-Cr 12164). Body length of the largest specimen, 73.0 mm. Cephalic shield 55.4 mm long, 51.2 mm wide; outline apple-shaped, with projected posterior margin, anterior margin slightly concave; its

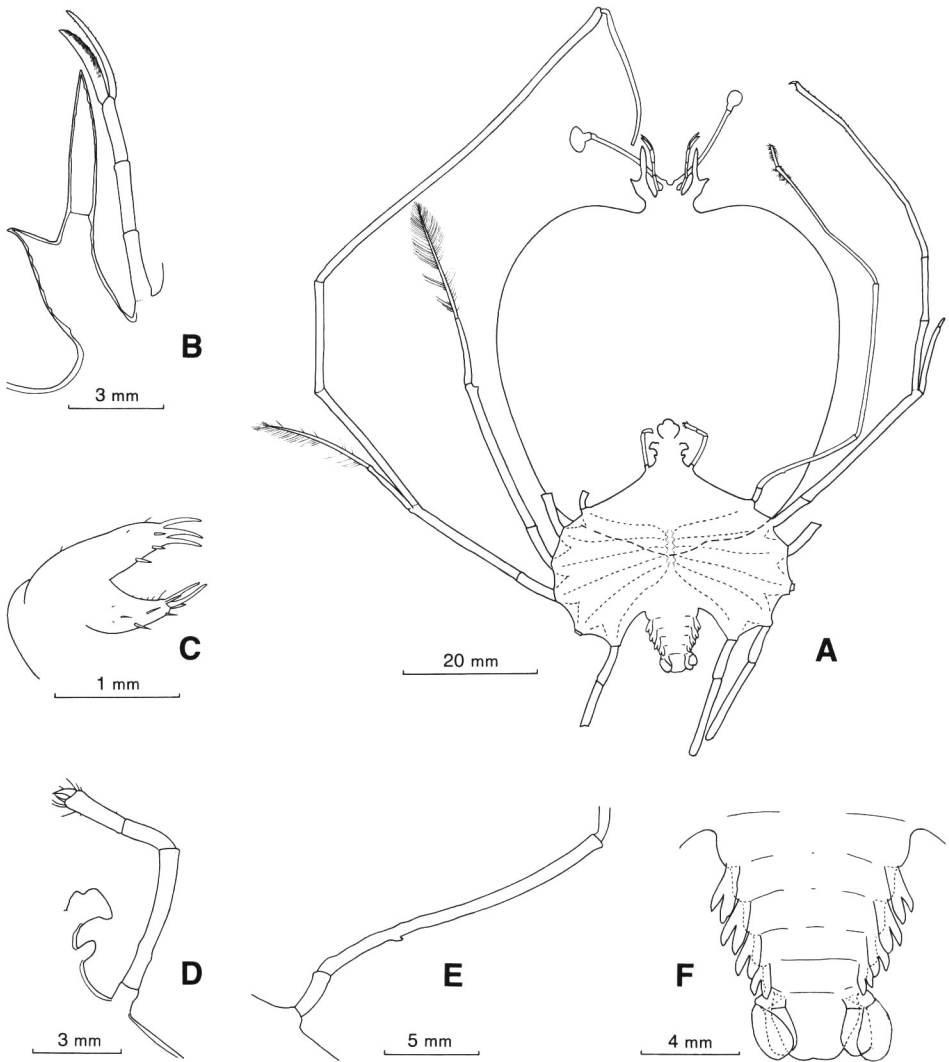


Fig. 4. Phyllosoma (NSMT-Cr 12164) of *Parribacus* sp. in ventral view. — A, Subfinal stage (73.0 mm); B, first and second antennae; C, first maxilla; D, second maxilla, first and second maxillipeds; E, third maxilliped; F, abdomen.



greatest width more anterior than stage XI, at anterior 1/3 of length of cephalic shield. Thorax 35.0 mm wide, deeply concave behind. Abdomen with 5 segments, unarmed at lateral-ventral margins. Telson trapezoidal, shallowly indented at posterior margin. First antenna longer than second antenna; inner flagellum slightly longer than outer flagellum. Second antenna broadened, segmented under cuticle; lateral process elongated. Coxal endite of first maxilla bearing a row of 5 small setae on anterior margin; terminal setae as in previous stage. Second maxilla and first maxilliped almost equal to those of previous stage in shape, but a little larger in size. Second and third maxillipeds little changed. Pereiopods 1–3 without coxal spine; each exopod with 56, 57, and 56 pairs of plumose setae, respectively. Pereiopods 4 and 5 almost missing. Pleopods biramous, elongated; appendix interna not evident. Uropod biramous, articulated at base; outer ramus reaching posterior margin of telson.

Two giant phyllosomae collected so far have nearly the same body length as the present specimen. Of the two, the specimen from Mariana waters (Sekiguchi, 1990) is similar to the present specimen, but the specimen from Marshall waters (Johnson, 1951) differs in having the cephalic shield conspicuously narrowed posteriorly with short blunt spines both on the lateral sides of abdomen.

Of the six specimens obtained from the stomach contents of an albacore, the largest one is described above; the second largest is 71.6 mm in total length, and one other specimen is wanting in posterior half of abdomen; the remaining three specimens are digested to a certain extent, with ca. 72, 70, and 66 mm in total length.

### **Phyllosoma, Final stage**

(Fig. 5)

One specimen from O-shima (NSMT-Cr 12165). Body length, 80.0 mm. Cephalic shield 57.0 mm long, ca. 48 mm wide; anterior margin a little concave; greatest width at anterior 1/3 length of cephalic shield; posterolateral margin somewhat linear. Thorax 39.2 mm wide, bearing gill buds. Abdomen well developed, with 6 segments. A small blunt spine present at lateral-ventral margin on each side of second to fifth segments. Telson trapezoidal, shallowly indented at posterior margin. Inner flagellum of first antenna slightly longer than outer flagellum. Second antenna significantly broadened, with 2 segments, slightly longer than first antenna, large lateral process on first segment. Outer margin of lateral process crenurated with 6 small risings, except distal angle, under cuticle. Coxal endite of first maxilla bears a row of 6 small setae on anterior margin. Second maxilla ear-shaped, without setae, consisting of a single segment. First maxilliped finger-like process with lateral lobe as in Fig. 5D, consisting of a single segment, extending to lateral projection of second maxilla. Second maxilliped with a clearly projected exopod and provided with a gill bud on proximal segment. Third maxilliped consisting of 6 segments with a small exopod. Exopods of pereiopods 1–5 with 58, 60, 59, 59, and 52 pairs of plumose setae, respectively.

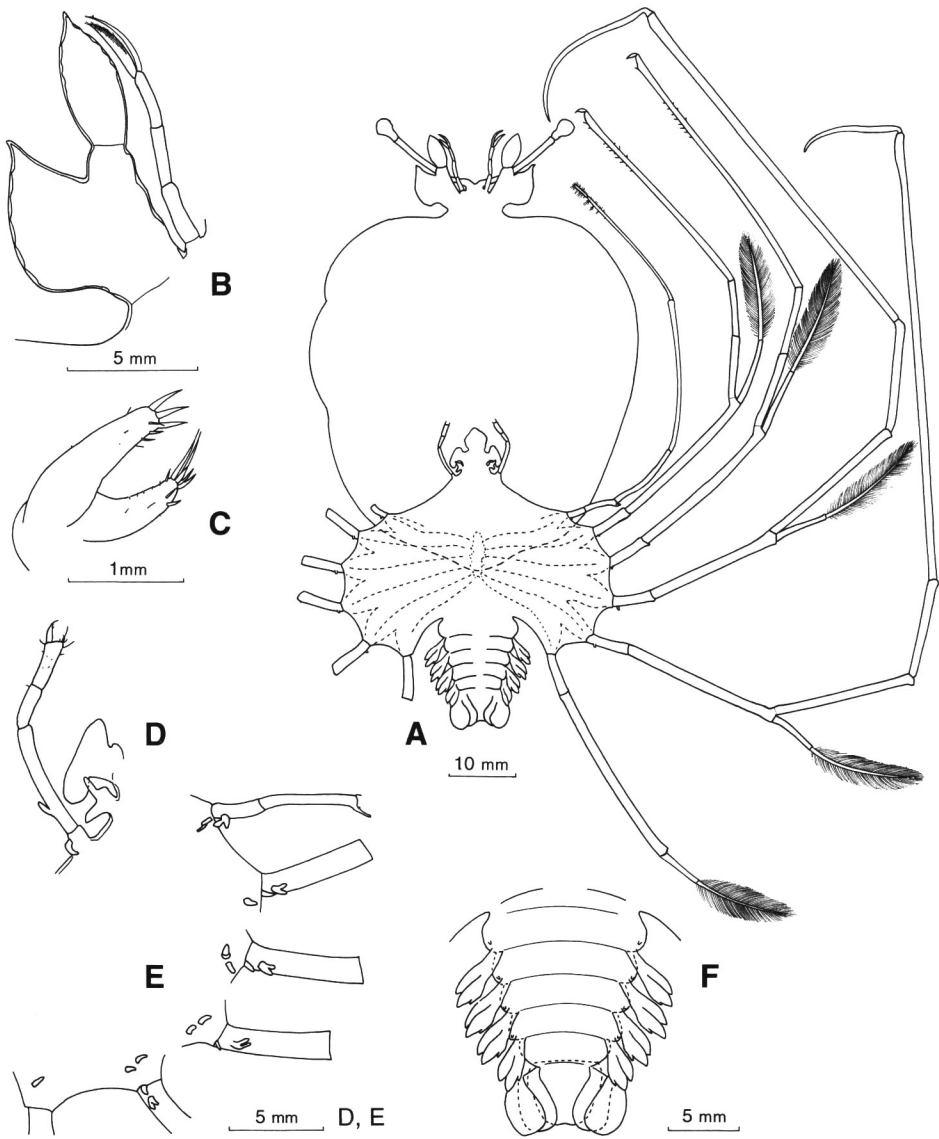


Fig. 5. Phyllosoma (NSMT-Cr 12165) of *Parribacus japonicus* Holthuis in ventral view except for E. — A, Final stage (80.0 mm), with right margin of cephalic shield distorted after fixation; B, first and second antennae; C, first maxilla; D, second maxilla, first and second maxillipeds; E, gill buds, dorsal view of thorax and base of maxilliped 3 and pereopods 1–5; F, abdomen.

Pereiopods 3 and 4 each terminating in a long scythe-shaped dactylus. Pleopods biramous, with an appendix interna on each inner ramus. Uropod well developed, posterior margin extends beyond tip of telson. Gill buds present on thorax at dorsolateral margin where the third maxilliped and pereiopods 1 to 5 join to the thorax. A bifurcate gill bud also occurred on coxae of third maxilliped and pereiopods 1–4.

Three gilled stage phyllosomae which seem to belong to *Parribacus* have been reported so far. Those three larvae are all distinguished from the present specimen by the following features. In the specimen from the South Pacific (Richters, 1873), the first maxilliped does not extend to the leaf-like lateral projection of the second maxilla. In the specimen from the Indian Ocean (Prasad *et al.*, 1975), the posterolateral margin of the cephalic shield is round, and in the specimen from the South Pacific (Michel, 1971), the cephalic shield has its greatest width at anterior 2/5 length of the cephalic shield.

### Nisto

(Fig. 6)

Two specimens from the Izu Is. (NSMT-Cr 12167). Total length of the larger specimen from Miyake-jima, 48.9 mm, carapace 22.3 mm long, 34.4 mm wide. Outline of second antenna and carapace oval. Body transparent before fixation. Anterior margin of second antenna slightly emarginated; 11 obvious and 2 inconspicuous teeth

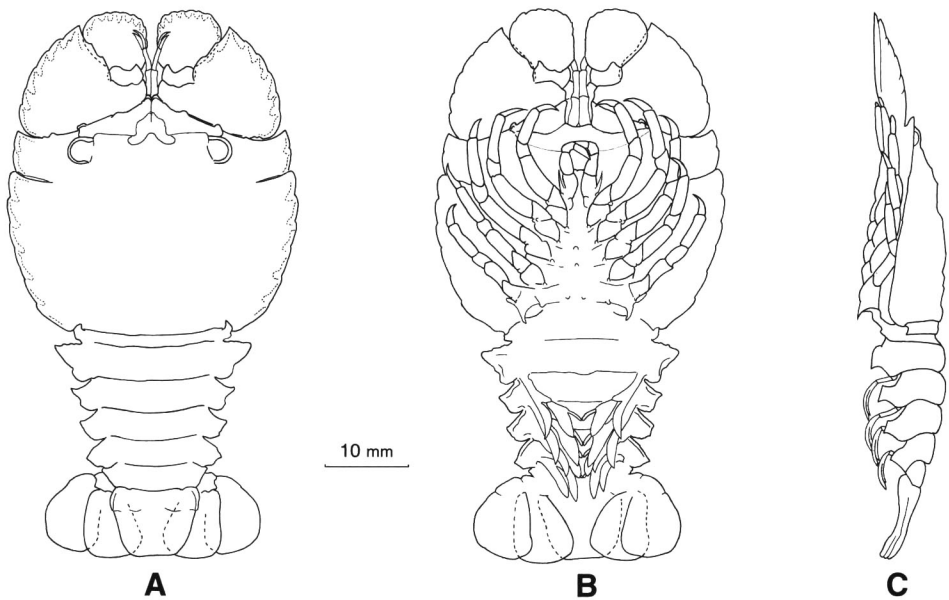


Fig. 6. Nisto (NSMT-Cr 12167) of *Parribacus japonicus* Holthuis (48.9 mm) in dorsal (A), ventral (B) and lateral (C) views.

beneath cuticle. Inner margin of fourth segment bearing 2 teeth, outer margin bearing 5 teeth except anterolateral angle, beneath cuticle. Carapace with a low ridge at midline and with a deep cervical incision at lateral margin. Third maxilliped with an exopod. A bifurcate stout spine situated at coxa of fifth pereopod, their tips projecting posteriorly and anterolaterally. A tubercle on sternum close to articulation with each pereopod, and at midline between base of second and third and third and fourth pereopods. Two tubercles situated on posterior margin of sternum. A low abdominal carina present. Pleopods well developed, each bearing an exopod and a long endopod with an appendix interna.

Of two specimens from the Izu Islands, a specimen from Miyake-jima is described above. Another individual taken at Hachijo-jima is 48.0 mm in total length, 22.1 and 34.0 mm in carapace length and width, respectively.

### Discussion

Two *Parribacus* species, *P. antarcticus* (Lund) and *P. japonicus* Holthuis, are recorded from Japanese and Taiwanese waters as revised by Chan and Yu (1989) and also by Nomura and Sekiguchi (1995). The distributions of the *Parribacus* species have not been revealed enough in Izu-Ogasawara-Kazan waters, although all the specimens collected during the years between 1990 and 1996, 25 specimens from Oshima, 84 specimens from Hachijo-jima and 7 specimens from Chichi-jima were referred to *Parribacus japonicus*. In the North Pacific another *Parribacus* species, *P. scarlatinus* Holthuis, is known from the Marshall Islands which are located in the North Equatorial current. The phyllosoma larvae have very long developmental period as noted on the Japanese spiny lobster *Panulirus japonicus* (Von Siebold) by Yamakawa *et al.* (1989), and therefore it is possible that the larvae of *P. scarlatinus* are carried to Japanese waters by the North Equatorial Current and the Kuroshio Current and collected in the sea off the Izu-Ogasawara-Kazan Islands together with the larvae of *Parribacus japonicus* and *P. antarcticus*.

The specific identity of giant phyllosomae has not been clear except for *P. antarcticus* identified by Johnson (1971) and Prasad *et al.* (1975). However, all the giant phyllosomae collected from the Atlantic and Indian Oceans are considered to be the larvae of *P. antarcticus*, since according to Holthuis (1985), the only *Parribacus* species distributed in those waters is *P. antarcticus*. As to the giant phyllosomae reported so far, the ratio of cephalic shield width/thorax width (CW/TW) was plotted against total length (Fig. 7), where the width and length were estimated by measuring the figures if numerical data were not mentioned in the text. The plotted dots of the specimens that are referable to *P. antarcticus* lie almost in a straight line except Berry's specimen from off South Africa.

Final stage phyllosoma from Oshima has markedly lower CW/TW compared to *P. antarcticus*, and it differs from the final stage *P. antarcticus* reported by Prasad

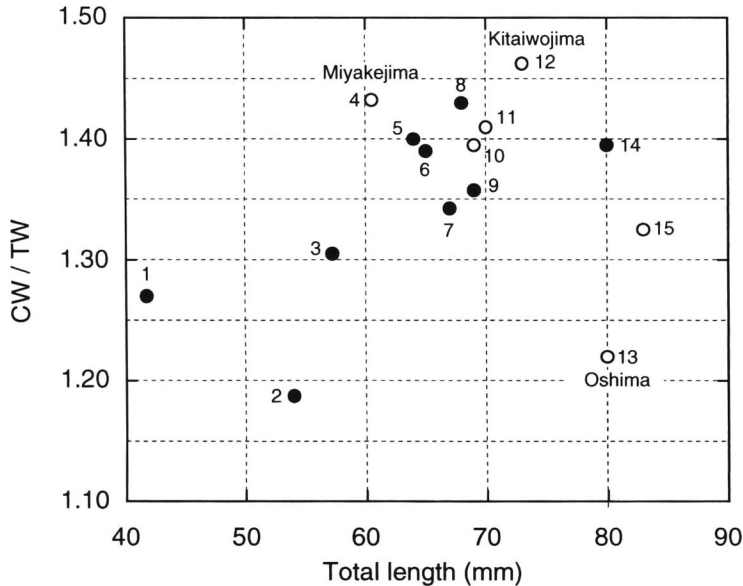


Fig. 7. Ratio of cephalic shield width/thorax width of the known giant phyllosomae. Solid circles show the specimens referred definitely to *Parribacus antarcticus*. 1, 3, Hawaiian Is. (Johnson, 1971); 2, Indian Ocean (Berry, 1974); 4, 12, 13, present specimens; 5, Indian Ocean (Saisho, 1966); 6, Caribbean Sea (Robertson, 1968); 7, 14, Indian Ocean (Prasad, 1975); 8, Mariana Is. (Sekiguchi, 1990); 9, Bermuda (Simus & Brown, 1968); 10, One of five specimens from Kita-Iwo-jima other than the specimen showed as no. 12; 11, Marshall Is. (Johnson, 1951); 15, Pacific Ocean (Michel, 1971).

(1975) in having more linear outline of posterolateral margin of cephalic shield. The 60.3 mm specimen from Miyake-jima also appears not to be *P. antarcticus*, since 1) the specimen has higher CW/TW, and 2) the anterior margin of cephalic shield is distinctly concave compared to a 64 mm specimen from the Indian Ocean (Saisho, 1966) and a 57.2 mm specimen from Hawaiian waters (Johnson, 1971) both of which were referred to *P. antarcticus*. Although there is a little possibility that the giant phyllosomae from O-shima and Miyake-jima recorded in the present report are the larvae of *P. scarlatinus*, the two phyllosomae are most likely *P. japonicus*, since the habitat of adult *P. scarlatinus* is in the sea as far as 4000 km apart from the Izu Islands and also the giant phyllosoma from the Marshall Islands (Johnson, 1951) differs significantly from the present two phyllosomae in the outline of cephalic shield.

In the giant phyllosomae from Kita-Iwo-jima the anterior margin of cephalic shield is a little more concave compared to the giant larvae referred to *P. antarcticus*, *i.e.*, the specimens from the Caribbean sea (Robertson, 1968), Bermuda waters (Sims & Brown, 1968), and the Indian Ocean (Saisho, 1966). As it is not clear whether this is due to the specific difference or intraspecific variation, the specific identity of the

Kita-Iwo-jima specimens is still obscure. We have little information with respect to the distribution of adult *Parribacus* around Kita-Iwo-jima, although seven specimens collected off Chichi-jima Island (200 km NNE of Kita-Iwo-jima) in March 1990 were identified with *P. japonicus*. It is necessary to collect the adults and giant phyllosomae of various stages in the waters off the Ogasawara-Kazan Islands in order to identify the present phyllosomae from Kita-Iwo-jima.

Although the specimen illustrated in Fig. 4 is the least injured one of the six specimens obtained from the stomach contents of a yellow fin albacore, the remaining five specimens are not entirely digested, suggesting that all six phyllosomae were preyed in a short time. Also in these specimens the range of total length is restricted (66–73.0 mm) and the outlines of their cephalic shields were quite similar to each other. These facts show that the six giant phyllosomae of nearly same stages existed in a narrow area, in spite of the final stage of long planktonic life.

The nisto from Hawaiian waters recorded by Rathbun (1906) appears to be referable to *P. antarcticus*, since it is the only *Parribacus* species in the area. In addition, the presence of six teeth on the lateral margin of second antenna in the nisto agrees with adult *P. antarcticus*. In two nistos from Hachijo-jima and Miyake-jima the lateral margin of second antenna is cut into five teeth, except the anterolateral angle. Among three *Parribacus* species distributed in the North Pacific, *P. japonicus* is the only species in which the second antenna bears five teeth on the lateral margin of fourth segment. Based on these facts the nistos from Hachijo-jima and Miyake-jima are attributable to *P. japonicus*. Likewise, three nistos reported from Sagami Bay as *P. ursus major* by Parisi (1917) are probably *P. japonicus* because of the presence of five teeth on the lateral margins of second antenna.

### Acknowledgments

We should like to express our cordial thanks to the following colleagues and friends for collection and provision of phyllosomae, nistos and adults of *Parribacus*: Ms. Yoshimi Tsuchiya of a tourist house "Yoshimi" in O-shima Island, Mr. Mitsuaki Ishii of the Chiba Prefectural Fisheries Experiment Station, Messrs. Moriyoshi Saito and Masayuki Yamada of the Tokyo Metropolitan Fisheries Experiment Station, Dr. Megumi Minagawa of the Seikai National Fisheries Research Institute, and Mr. Johnson Kimura of the Ogasawara Fisheries Center. We are also grateful to the crews of the R/Vs *Miyako* and *Kamome* of the Tokyo Metropolitan Fisheries Experiment Station for their kind assistance in collecting the samples on board.

### Literature

- Balss, H., 1914. Ostasiatische Decapoden II. Die Natantia und Reptantia. *Abh. B. Akad. Wiss.*, Suppl. 2 (10): 1–101.

- Berry, P. F., 1974. Palinurid and scyllarid lobster larvae of the Natal coast, South Africa. *Investl. Rep. Oceanogr. Res. Inst. Durban*, (34): 1–44.
- Boas, J. E. V., 1880. Studier over Decapodernes Slaegtskabsforhold. (Recherches sur les affinités des Crustacés Décapodes). *K. dansk. Vidensk. Selsk. Skr.*, (6), 1: 26–210.
- Chan, T. Y. & H. P. Yu, 1989. On the *Parribacus* lobsters (Crustacea: Decapoda: Scyllaridae) of Taiwan. *J. Taiwan Mus.*, 42: 1–7.
- Guilding, L., 1925. An account of some rare West Indian Crustacea. *Trans. Linn. Soc., Lond.*, 14: 334–338.
- Holthuis, L. B., 1985. A revision of the family Scyllaridae (Crustacea: Decapoda: Macrura). I. Subfamily Ibacinae. *Zool. Verh., Leiden*, (218): 1–130.
- Johnson, M. W., 1951. A giant phyllosoma larva of a loricate crustacean from the tropical Pacific. *Trans. Am. Microsc. Soc.*, 70: 274–278.
- Johnson, M. W., 1971. The phyllosoma larvae of slipper lobsters from the Hawaiian Islands and adjacent areas (Decapoda, Scyllaridae). *Crustaceana*, 20: 77–103.
- Michel, A., 1971. Note sur les puerulus de Palinuridae et les larves phyllosomes de *Panulirus homarus* (L). *Cah. O. R. S. T. O. M.*, (Oceanogr.), 9: 459–473.
- Nomura, K. & H. Sekiguchi, 1995. The geographical distribution of the genus *Parribacus* (Decapoda, Scyllaridae) in Japan. *Nanki Seibutsu*, 37: 47–51. (In Japanese with English summary.)
- Parisi, B., 1917. I Decapodi Giapponesi del Museo di Milano. V. Galatheidea e Reptantia. *Atti. Soc. ital. Sci. nat.*, 56: 1–24.
- Prasad, R. R. & P. R. S. Tampi, 1965. A preliminary report on the phyllosomas of the Indian Ocean collected by the Dana Expedition 1928–30. *J. mar. biol. Ass. India*, 7: 277–283
- Prasad, R. R., P. R. S. Tampi & M. J. George, 1975. Phyllosoma larvae from the Indian Ocean collected by the Dana Expedition 1928–1930. *J. Mar. biol. Ass. India*, 17: 56–107.
- Rathbun, M. J., 1906. The Brachyura and Macrura of the Hawaiian Islands. *Bull. U. S. Fish. Comm.*, 23: 827–930.
- Richters, F., 1873. Die Phyllosomen. Ein Beitrag zur Entwicklungsgeschichte der Loricaten. *Z. wiss. Zool.*, 23: 623–646.
- Robertson, P. B., 1968. A giant scyllarid phyllosoma larva from the Caribbean Sea, with notes on smaller specimens (Palinuridea). *Crustaceana*, Suppl. 2: 83–97.
- Saisho, T., 1966. Studies on the phyllosoma larvae with reference to the oceanographical conditions. *Mem. Fac. Fish., Kagoshima Univ.*, 15: 177–239.
- Sekiguchi, H., 1990. Four species of phyllosoma larvae from the Mariana waters. *Bull. Jap. Soc. Fish. Oceanogr.*, 54: 242–248.
- Sims, H. W. Jr. & C. L. Brown, Jr., 1968. A giant scyllarid phyllosoma larva taken north of Bermuda (Palinuridea). *Crustaceana*, Suppl. 2: 80–82.
- Yamakawa, T., M. Nishimura, H. Matsuda, A. Yujigado & N. Kamiya, 1989. Complete larval rearing of the Japanese spiny lobster *Panulirus japonicus*. *Nippon Suisan Gakkaishi*, 55: 745.

