Bull. Natn. Sci. Mus., Tokyo, Ser. A, **29**(4), pp. 197–203, December 22, 2003

First Zoea of the Deep-Water Spider Crab, *Rochinia debilis* Rathbun, 1932 (Crustacea, Decapoda, Majidae), from Sagami Bay, Central Japan

Hironori Komatsu and Masatsune Takeda

Department of Zoology, National Science Museum, 3–23–1 Hyakunin-cho, Shinjuku-ku, Tokyo, 169–0073 Japan
e-mail: h-komatu@kahaku.go.jp (HK) and takeda@kahaku.go.jp (MT)

Abstract First zoea of the deep-water spider crab, *Rochinia debilis* Rathbun (subfamily Pisinae) collected from Sagami Bay, central Japan, is described based on laboratory-reared material. The larva has several advanced or reduced characters which suggest abbreviated or recithotrophic development. Morphological characters of first zoea of *R. debilis* are compared with those of the other Pisinae, and it is noted that they are quite different from those of *R. carpenteri* (Thomson) in the absence of lateral spine of carapace and the setation of each appendage, and similar to those of *Goniopugettia sagamiensis* (Gordon) in the presence of mandibular palp and the setation of maxillule and *Scyra compressipes* Stimpson in the setation of maxilla and first maxilliped.
Key words: Crustacea, Decapoda, Majidae, first zoea, *Rochinia debilis*, Sagami Bay.

Introduction

Rochinia debilis Rathbun, 1932, characterized by the long branchial tubercles and villiform setae covering the whole body, is a small majid crab mainly inhabiting the edge of continental shelf. The distribution is restricted to Sagami Bay, central Japan, at the depths of 85–300 m (Sakai, 1976). Its ecological feature is little known.

The majid subfamily Pisinae Alcock, 1895 hitherto comprised 29 species belonging to 15 genera in Japan (Miyake, 1983), but the larval development of only seven species was described (Aikawa, 1937; Kurata, 1969; Terada, 1983; Ko, 1997; Kim & Hong, 1999; Taishaku & Konishi, 2001): *Doclea ovis* (Herbst, 1788), *Goniopugettia sagamiensis* (Gordon, 1931) (recently transferred to Pisinae by Ng *et al.*, 2001), *Hyastenus diacanthus* (de Haan, 1837), *H. elongatus* Ortmann, 1894, *Phalangipus hystrix* (Miers, 1886), *Pisoides ortmanni* (Balss, 1924), and *Scyra compressipes* Stimpson, 1857.

The genus *Rochinia* A. Milne-Edwards, 1875 hitherto consists of 33 species from the world, but the larval development of only one species, *R. carpenteri* (Thomson, 1873), was described by Ingle (1979) from northeast Atlantic. Although many authors revised this genus and its congeners, there still may be some problems concerning the systematic status of *Rochinia* as briefly mentioned in the following lines. Griffin and Tranter (1986a, b) synonymized the genus *Sphenocarcinus* A. Milne-Edwards, 1878 with *Rochinia*, but Guinot & Richer de Forges (1985, 1986a, b) considered them as two valid genera in accordance with the precedents. Both authors described several new species in *Rochinia* and *Sphenocarcinus*, respectively. Later, in the description of a new species of *Sphenocarcinus*, Richer de Forges (1992) discussed the generic characters of both genera and concluded that *Sphenocarcinus* is heterogeneous and should be divided into two or three taxonomic categories. Almost simultaneously with his paper, Tavares (1991) revised the genus *Rochinia* s.l. and resurrected the amphi-American genus *Sphenocarcinus* for two species and the Indo-West Pacific genus *Oxypleurodon* Miers, 1886 for six species, and established a new genus *Nasutocarcinus* for four Indo-West Pacific species having the long rostrum. In this important contribution, unfortunately, Sakai (1986) has been overlooked. This paper written in Japanese with English title is partly based on an incoherent explanation, but even if so, in that paper, a new genus *Goniopugettia* was established to accommodate two species endemic to Japan, *Pugettia sagamiensis* Gordon which has been transferred to *Rochinia* by Griffin and Tranter (1986a) and a new species *G. tanakae*. If this new genus is valid as Ng *et al.* (2001) followed, *P. brevirostris* Doflein, 1904 which is generally close to *P. sagamiensis* and been transferred to *Rochinia* by Griffin and Tranter (1986a) may be treated as a species of *Goniopugettia*. Richer de Forges (1995) restated the morphological characters of *Oxypleurodon* and clarified the relation to *Rochinia* and *Sphenocarcinus*. Recently, Williams and Eldredge (1994) and Takeda (2001) described *R. decipiata* from Guam and *R. kotakae* from Japan, respectively.

In this paper, we describe the first zoea of *R. debilis* and compare it with known larvae of the Pisinae. This study was conducted as a part of the project to elucidate environmental change through an ongoing comparison of flora and fauna of the Sagami-nada Sea and surrounding shore regions by the National Science Museum, Tokyo.

Materials and Methods

An ovigerous female of *Rochinia debilis* was collected by commercial fishing traps for scampi, *Metanephrops japonicus* Tapparone-Canefri, from Sagami Bay, 35°04.67′N, 139°44.60′E, at the depth of 250–300 m, on 26 March 2003. The crab was maintained in an aquarium at constant water temperature of 13°C without feeding. Larvae hatched in the aquarium about one month later, and were fixed in 10% formalin and then transferred to 70% ethanol for preservation. Dissected appendages were examined using LEICA MZ8 stereomicroscope and Olympus BH microscope, and drawing was made with the aid of camera lucida. Carapace length was measured from the anterior border of the eye to the posterior border of the cephalothorax. This value is shown as mean$\pm$SD, and the range is given in parenthesis in the text. Setal counts on appendages and measurements were based on the mean of 5 specimens. The sequence of the description is based on the malacostracan somite plan, and zoeae are described from anterior to posterior; setal armature on appendages is described from proximal to distal segments and in order of endopod to exopod (Clark *et al.*, 1998). Specimens examined in the present study are deposited in the Showa Memorial Institute, National Science Museum, Tokyo, under accession numbers NSMT-Cr S101 (ovigerous female) and NSMT-Cr S102 (first zoeae).

Results

Twelve larvae hatched on 20 April, 2003. Eight larvae of them were fixed, and the rest were reared in an aquarium. Most of them were lost within a week, and seven days later only one of them molted to the second zoeal stage without feeding. Two days later after molting, it was also lost.

Description of zoea I

Size: carapace length (from front of eye to posterior margin of carapace) 1.22$\pm$0.04 mm (range 1.14–1.24 mm).

Carapace (Fig. 1a, b): dorsal spine long, curved distally, without spinulation; rostral spine much shorter than dorsal spine, slightly shorter than antennal exopod, without spinulation; lateral spines absent; pair of anterodorsal setae; lateral lobe expanded; ventral margin (Fig. 1c) with 1 anterior seta and 4 posterior setae derived internally and submarginally; eyes sessile; large amount of yolk visible through carapace.

Antennule (Fig. 2a): uniramous, endopod absent; exopod unsegmented, with 2 long, broad and 2 shorter, slender aesthetascs and 1 short

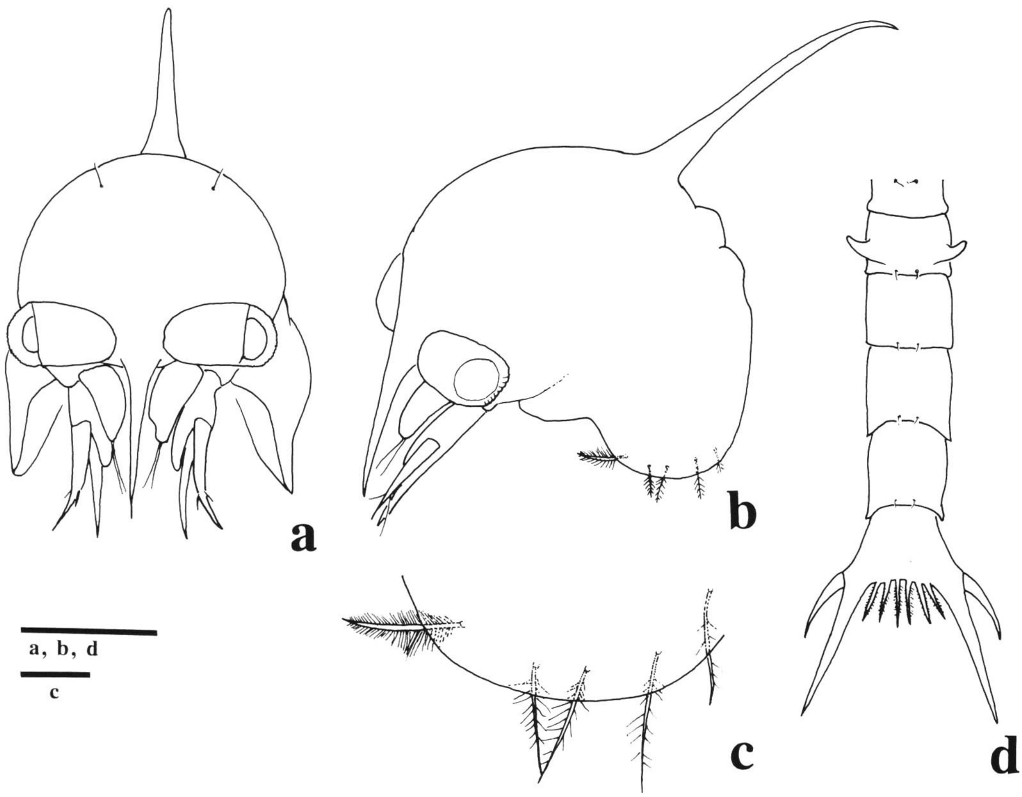

Fig. 1. *Rochinia debilis* Rathbun, 1932, zoea 1. a, b, carapace, frontal and lateral views, respectively; c, lateral lobe of carapace, lateral view; d, abdomen, dorsal view. Scale for a, b, d=0.5 mm; scale for c=0.1 mm.

seta.

Antenna (Fig. 2b): protopodal process as long as exopod, with 2 rows of spinules; endopod present, about 0.4 times as long as exopod; exopod with 2 unequal subterminal setae, with 2 rows of spinules on distal part and thicker setae, respectively.

Mandible (Fig. 2c): not fully calcareous, translucent; molar and incisor processes developed, but scarcely dentate; rudiment of palp near basal part.

Maxillule (Fig. 2d): coxal endite with 6 setae; basial endite with 3 thick and 4 thin setae; endopod unsegmented, with 2 terminal setae.

Maxilla (Fig. 2e): coxal endite bilobed, with 4+4 setae; basial endite indistinctly bilobed, with 5+4 setae; endopod simple, with 2 subterminal and 1 terminal setae; exopod (scaphognathite) margin with 17 or 18 setae and 1 distal stout process.

First maxilliped (Fig. 2f): coxa without setae; basis with 9 setae arranged 2, 2, 2, 3; endopod 5-segmented, with 3, 2, 1, 2, 1 subterminal and 4 terminal setae, respectively; exopod 2-segmented, with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 2g): coxa without setae; basis with one seta at base; endopod 3-segmented, with 0, 1, 1 subterminal and 3 terminal setae, respectively; exopod 2-segmented, with 4 long terminal plumose natatory setae.

Third maxilliped (Fig. 2h): present, biramous; endopod longer than exopod; epipod present.

Pereiopods (Fig. 2i): cheliped biramous; pereiopods 2–5 uniramous.

Abdomen (Fig. 1d): five somites; somite 2 with pair of dorsolateral processes directed anteriorly; somites 4 and 5 with posterolateral spinuous processes; somite 1 with pair of dorsomedial

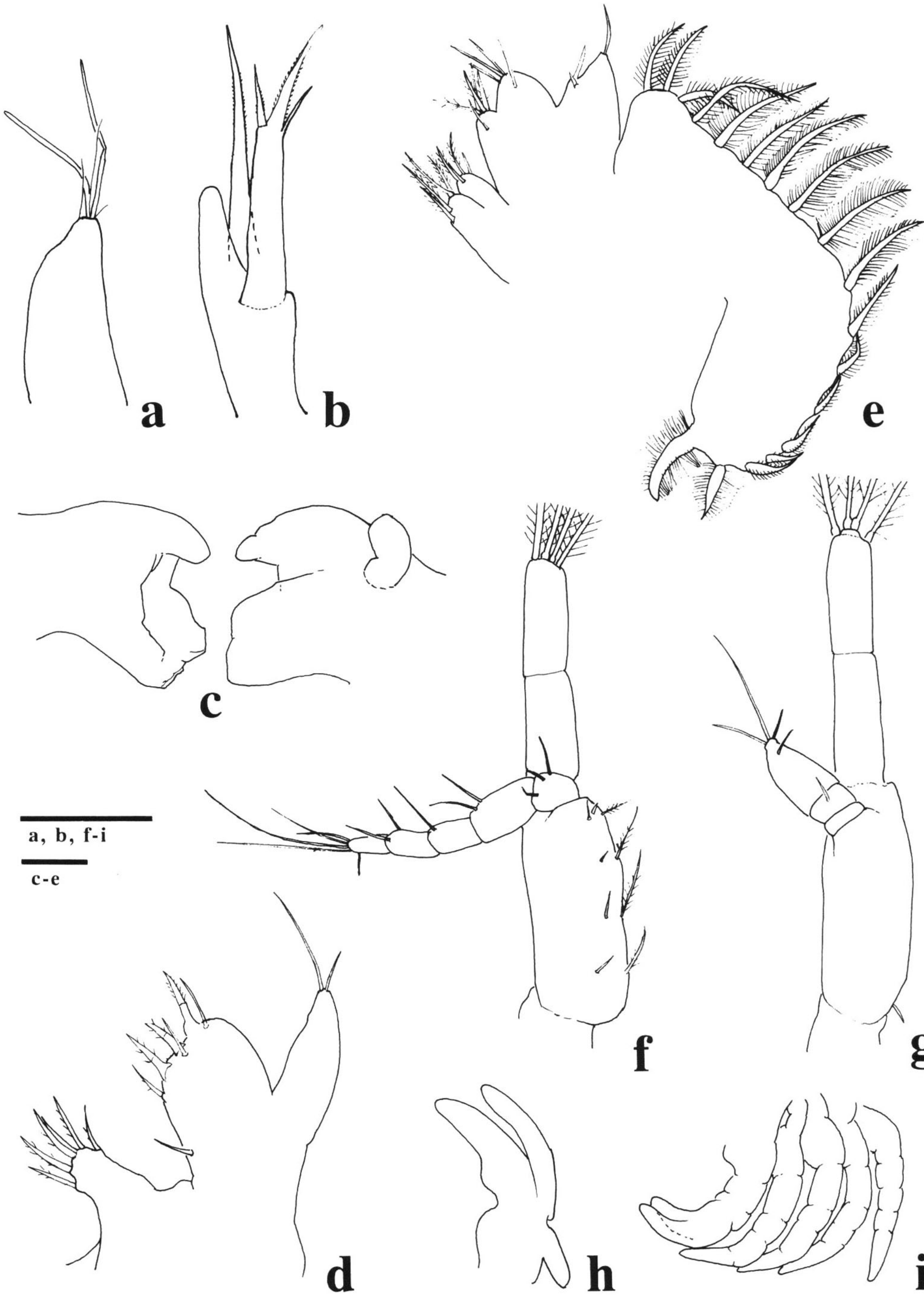

Fig. 2. *Rochinia debilis* Rathbun, 1932, zoea 1, left appendages in external view except mandible. a, antennule; b, antenna; c, right mandible in external and internal views; d, maxillule; e, maxilla; f, first maxilliped; g, second maxilliped; h, third maxilliped; i, pereiopods 1–5. Scales=0.1 mm.

setae; somites 2–5 each with pair of posterodorsal setae; pleopods buds on somites 2–5.

Telson (Fig. 1d): each fork long, spinulated; one large lateral spine; dorsal medial spine absent; posterior margin with 3 pairs of stout spinulate setae.

Chromatophores: dominantly bright orange, occurring on antero-dorsal, ventro-lateral and posterior parts of carapace, ventral margin of eye, base of antenna, ventral surfaces and posterior ends of abdominal somites, and telson except folk and spines. Cornea light brown.

Discussion

The present first zoea of *Rochinia debilis* Rathbun, 1932 has some advanced characters: the carapace size is relatively large (carapace length 1.22±0.04 mm), the antennal endopod is budded, the palp of mandible is budded, the scaphognathite of maxilla is fringed with 17–18+1 setae, the exopod of third maxilliped is developed, all pereiopods are developed, and the abdominal somites 2–5 have pleopods buds. On the contrary, the present zoea shows some reduced characters: the molar process of mandible is less dentate, the endopod of maxillule is unsegmented, and the coxal and basal endites of maxillule have 6 and 7 setae, respectively. These characters and a large amount of yolk suggest its abbreviated or lecithotrophic development (Rabalais & Gore, 1985; Taishaku & Konishi, 2001), although the laboratory rearing was unsucceeded.

The present zoea agrees well with eight diagnostic characters of the subfamily Pisinae mentioned by Ingle (1979). That is, the carapace has no lateral spine, the dorsal spine is of moderate length, the rostral spine is moderate in length, the antennal exopod has two short setae, the basal segment of second maxilliped has less than three setae, the second abdominal somite has dorsolateral process, the third to fifth abdominal somite have short posterolateral processes, and each telson folk has only one spine.

The first zoea of *R. debilis* is compared with those of *R. carpenteri* (Thomson, 1873) described by Ingle (1979) from northeast Atlantic, *Goniopugettia sagamiensis* (Gordon, 1931) described by Taishaku and Konishi (2001) from Japan, and *Scyra compressipes* Stimpson, 1857

Table 1. Comparison of first zoeal characters for four species of Pisinae. + = present, − = absent, ? = unknown.

Characters	*Rochinia debilis* (present study)	*R. carpenteri* (Ingle, 1979)	*Goniopugettia sagamiensis* (Taishaku & Konishi, 2001)	*Scyra compressipes* (Kim & Hong, 1999)
Carapace				
Lateral spine	−	+	−	−
ventral margin	1 spine+4 setae	?	1 spine+5 setae	1 spine+5 setae
Mandiblar endopod palp	+	−	+	−
Maxillule				
Coxal endite setation	6	7	6	7
Basal endite setation	7	9	7	7
Endopod	0+2	1, 2+4	0+2	1, 0+4
Maxilla				
Coxal endite setation	4+4	5+4	5+3	4+4
Basal endite setation	5+4	5+4	5+3	5+4
Endopod	3	6	4	4
Scaphognathite setae	17–18	11	14	10
First maxilliped				
Setal formula of basis	2, 2, 2, 3	2, 2, 3, 3	2, 2, 3, 3	2, 2, 2, 3
Second maxilliped				
Setal formula of basis	1	1, 1, 1	1, 1, 1	1, 1, 1
Setal formula of endopod	0, 1, 4	0, 1, 5	0, 1, 4	0, 1, 4
Telson lateral spine	+	+	+	+

described by Kim and Hong (1999) from Korea. The comparison is summarized in Table 1.

The first zoea of *R. debilis* is quite different from that of *R. carpenteri* in most of characters. It is particular that the first zoea of *R. carpenteri* has lateral spines that are usually absent in the Pisinae including *R. debilis*. The differences of the first zoeae between *R. debilis* and *R. carpenteri* suggest that the genus *Rochinia* may be still heterogeneous, although many authors have revised this genus.

As known from Table 1, the first zoea of *R. debilis* is similar to that of *Goniopugettia sagamiensis* in the presence of mandiblar palp, 6 setae on the coxal endite of maxillule, 7 setae on the basal endite of maxillule, and 0+2 setae on the endopod of maxillule. But these characters may be the outcomes of convergence for abbreviated or recithotrophic development. The first zoea of *R. debilis* is also similar to that of *Scyra compressipes* in the absence of subterminal setae on the endopod of maxillule, 5+4 setae on the basal endite of maxilla, and 2, 2, 2, 3 setae on the basis of first maxilliped. The similarities with *G. sagamiensis* and *S. compressipes* are indicative of their close relatives reasonably considered from the morphological similarities in the adults.

Acknowledgements

We express cordial thanks to the Nagai Fishermen's Cooperative Association for kind arrangements for carrying out the survey and the staff of the fishery boat *Ido-Inkyo-maru No. 3* for generous help in making collection of the material. Thanks are also due to the Misaki Marine Biological Station, The University of Tokyo for providing us the laboratory.

References

Aikawa, H., 1937. Further notes on brachyuran larvae. *Rec. Oceanogr. Wks Japan*, **9**: 87–162.

Clark, P. F., D. K. Calazans, & G. W. Pohle, 1998. Accuracy and standardization of brachyuran larval descriptions. *Invert. Reprod. Develop.*, **33**: 127–144.

Griffin, D. J. G. & H. A. Tranter, 1986a. The Decapoda Brachyura of the Siboga Expedition. Part VIII. Majidae. *Siboga Exped.*, **39**(C4): 1–335.

Griffin, D. J. G. & H. A. Tranter, 1986b. Some majid spider crabs from the deep Indo-West Pacific. *Rec. Austr. Mus.*, **38**: 351–371.

Guinot, D. & B. Richer de Forges, 1985. Revision of the Indo-Pacific *Sphenocarcinus* with a single rostrum and description of two new species (Crustacea, Decapoda, Brachyura, Majidae). *Mar. Res. Indonesia*, **24**: 49–71.

Guinot, D. & B. Richer de Forges, 1986a. Crustacés décapodes: Majidae (genres *Platymaia*, *Cyrtomaia*, *Pleistacantha*, *Sphenocarcinus* et *Naxioides*). Résultats des campagnes MUSORSTOM. I et II. Philippines, 2. *Mém. Mus. Natn. Hist. Nat., Paris*, (A), **133**: 83–177.

Guinot, D. & B. Richer de Forges, 1986b. Découverte d'une nouvelle espèce de *Sphenocarcinus* en Nouvelle-Calédonie, *S. mammatus* sp.nov. (Crustacea, Decapoda, Brachyura). *Indo-Malayan Zool.*, **3**: 27–37.

Ingle, R. W., 1979. The larval development of the spider crab *Rochinia carpenteri* (Thomson) [Oxyryncha: Majidae] with a review of majid subfamilial larval features. *Bull. Br. Mus. Nat. Hist.* (Zool.), **37**: 47–66.

Kim, D. N. & S. Y. Hong, 1999. Larval development of *Scyra compressipes* (Decapoda: Brachyura: Majidae: Pisinae) reared in the laboratory. *J. Crust. Biol.*, **19**: 782-791.

Ko, H. S., 1997. The first zoeal stage of *Hyastenus elongatus* (Ortmann, 1893) (Decapoda, Brachyura, Majidae). *Kor. J. Syst. Zool.*, **13**: 1–8.

Kurata, H., 1969. Larvae of Decapoda Brachyura of Arasaki, Sagami Bay—IV. Majidae. *Bull. Tokai Reg. Fish. Res. Lab.*, **57**: 81–127. (In Japanese with English summary.)

Miyake, S., 1983. *Japanese Crustacean Decapods and Stomatopods in color.* Vol. II. Hoikusha, Osaka, 227 pp. (In Japanese.)

Ng, P. K. L., C.-H. Wang, P.-H. Ho, & H.-T. Shih, 2001. An annotated checklist of brachyuran crabs from Taiwan (Crustacea: Decapoda). *Natn. Taiwan Mus. Spec. Publ. Ser.*, **11**: I–IV, 1–86.

Rabalais, N. N. & R. H. Gore, 1985. Abbreviated development in decapods. *In* A. M. Wenner (ed.), Crustacean Issues 2: Larval Growth, pp. 67–126. A. A. Balkema, Rotterdam.

Rathbun, M. J., 1932. Preliminary descriptions of new species of Japanese crabs. *Proc. Biol. Soc. Wash.*, **45**: 29–38.

Richer de Forges, B., 1992. A new species of *Sphenocarcinus* A. Milne Edwards, 1875 from Tasmantid Guyots, *S. lowryi* n. sp. (Crustacea: Decapoda: Bracyura) with notes on the taxonomic status of the genus. *Rec. Austr. Mus.*, **44**: 1–5.

Richer de Forges, B., 1995. Nouvelles récoltes et nouvelles espèces de Majidae de profondeur du genre *Oxy-*

pleurodon Miers, 1886. *Crustaceana*, **68**: 43–60.

Sakai, T., 1976. *Crabs of Japan and the Adjacent Seas.* I–XXIX+773 pp. (in English); 461 pp. (in Japanese); 151 pls. Kodansha, Tokyo.

Sakai, T., 1986. Rare species and their genus of crabs in Japan. *Res. Crust.*, **15**: 1–4, pls. 1–3, frontispiece. (In Japanese.)

Taishaku, H. & K. Konishi, 2001. Lecithotrophic larval development of the spider crab *Goniopugettia sagamiensis* (Gordon, 1931) (Decapoda, Brachyura, Majidae) collected from the continental shelf break. *J. Crust. Biol.*, **21**: 748–759.

Takeda, M., 2001. Annotated list of crabs from Tosa Bay, southwest Japan, collected by the R/V *Kotaka Maru* during the years 1997–2000. *Natn. Sci. Mus. Monogr., Tokyo*, **20**: 217–262.

Tavares, M. S., 1991. Redéfinition des genres *Rochinia* A. Milne Edwards, *Sphenocarcinus* A. Milne Edwards et *Oxypleurodon* Miers, et établissement du genre *Nasutocarcinus* gen. nov. (Crustacea, Brachyura, Majidae). *Bull. Mus. Natn. Hist. Nat., Paris* (4) (A), **13**: 159–179.

Terada, M., 1983. Larval development of four Japanese spider crabs (Brachyura, Majidae, Pisinae). *Proc. Jpn. Soc. Syst. Zool.*, **25**: 17–28. (In Japanese with English summary.)

Williams, A. B. & L. G. Eldredge, 1994. A new species of spider crab from Guam, *Rochinia decipiata* (Brachyura: Majidae). *Crust. Res.*, **23**: 1–4.