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Larval Development of *Chasmagnathus convexus* De Haan (Crustacea, Brachyura) Reared under Laboratory Conditions

By

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Relationships. This species is closely related to *Galathea formosa* De MAN, 1902, which has only originally been known from Ternate, Malay Archipelago. De MAN's specimen is ovigerous and has the same condition to the present holotype as in sex and size. The differences between these are given below.

	G. formosa	*G. maculiabdominalis*
Colour	carapace and abdomen reddish above, with a longitudinal stripe of white dorsally	carapace and abdomen purplish; abdomen with 4 pairs of brownish purple spots
Rostrum	broader than long	longer than broad
Cervical groove	distinct	indistinct
Third maxilliped	ischium without inner distal marginal spine	ishium with two spinules on inner distal margin
Walking leg	carpus with a row of 2 or 3 small spines on dorsal surface	carpus without spines on dorsal surface

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Larval Development of *Chasmagnathus convexus* De HAAN (Crustacea, Brachyura) Reared under Laboratory Conditions*

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Larvae of the marsh crab, *Chasmagnathus convexus* De HAAN, were reared in the laboratory and their developments were traced. The larvae passed through 4 zoeal and one megalopa stages before they molted to the first crab stage. Major characteristics of each larval stage and of the first crab are described.

Post-larval development of the Japanese estuarine crabs have been reported of several species of the genera *Sesarma* and *Helice* (YATSUZUKA, 1957; BABA & MIYATA, 1971; BABA & MORIYAMA, 1972). However no information of any stage of the larvae and larval development has so far been given to *Chasmagnathus convexus* De HAAN, which is together with those of the above-mentioned two genera one of the commonest species in Japan, with the range from Sagami Bay southwards to Okinawa and Formosa (SAKAI, 1965). According to our observations made in the estuary of the river Shirakawa, Kumamoto, this species copulates near the entrance of its nest burrows built in the reed marsh, in the middle of November, especially under the condition of the sunlight. And subsequently they spawn in the following January. Hatching occurs in April and early in May. Under laboratory conditions the larvae were reared and examined. This paper provides a morphological description of the complete larval development of *Chasmagnathus convexus*.

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Methods and material

Females of *Chasmagnathus convexus* with eyed-eggs migrate to under stones in small tidal pools among reed marshes or near the shore in April, waiting to shed their eggs freely to the sea around new or full moon night. Such egg-bearing females were collected from the mouth of the river Shirakawa, Kumamoto. Hatched larvae were reared in plastic jars (38 cm in diameter, 30 cm in depth) containing sea water of about 25‰ salinity which was artificially made, and newly hatched *Artemia* nauplii were fed to the larvae. The water was aerated and renewed in part per day. The water temperature ranged from 18.5 to 23.6°C with a mean of 21.2°C.

Results

The larvae of *Chasmagnathus convexus* hatched out at night on 13rd April 1972 and reached the megalopa stage on 4th May, passing through 4 zoeal stages, and subsequently first crabs appeared in June 2. Prior to this rearing preliminary observations were also made in the spring of 1970, which showed that the zoeae of this species hatched out on

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4th May 1970 and molted three times, but all died while they were molting to the megalopa stage. Major characteristics of each larval stage and change of the morphology were noted below.

General morphology of zoeal stages

First zoea.

Age: 1–5 days. Length (a distance between tips of rostral and dorsal spines):

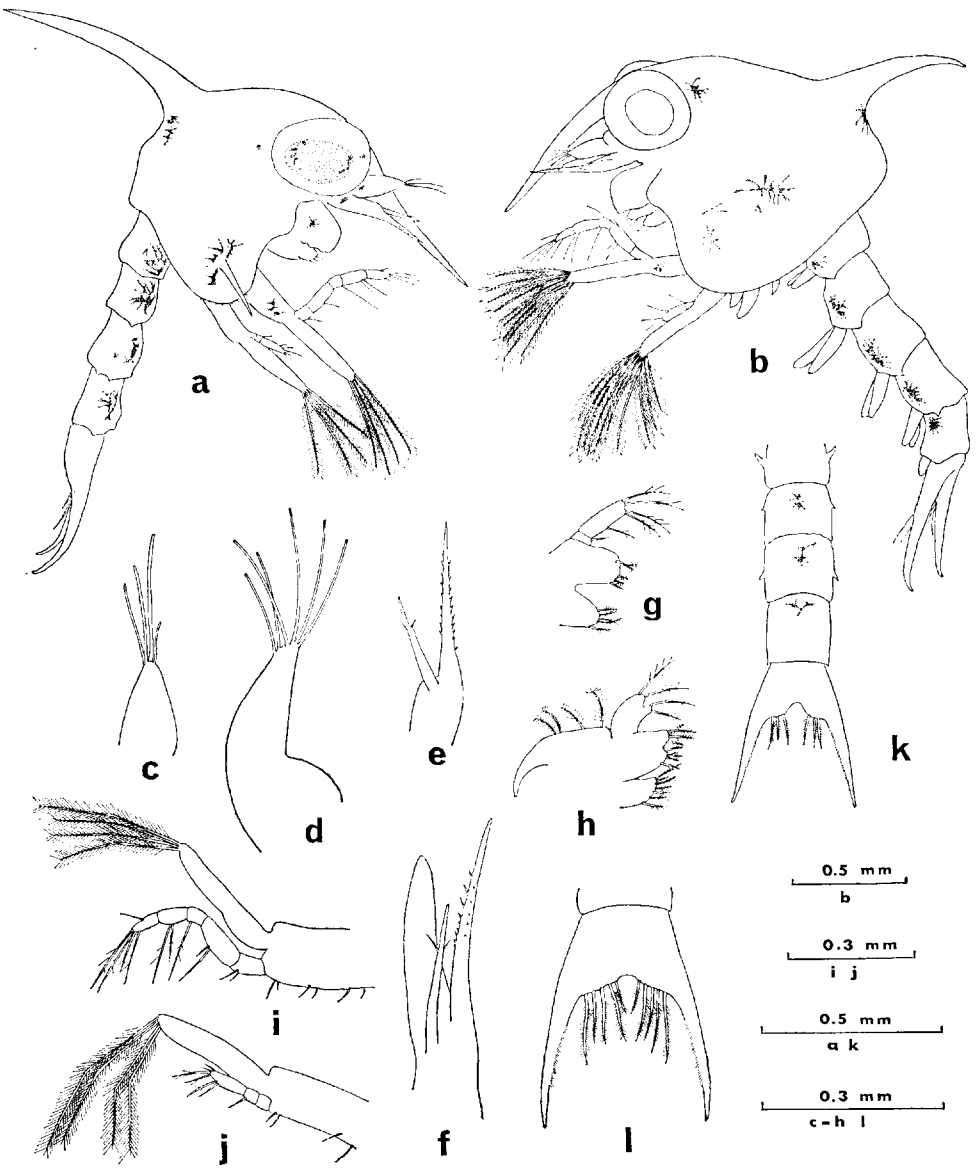

Fig. 1. *Chasmagnathus convexus* De Haan, a, first zoea, lateral view; b, fourth zoea, lateral view; c, antennule, first zoea; d, antennule, fourth zoea; e, antenna, first zoea; f, antenna, fourth zoea; g, maxillule, first zoea; h, maxilla, first zoea; i, first maxilliped, first zoea; j, second maxilliped, first zoea; k, abdominal segments, first zoea; l, telson, fourth zoea.

1.50 mm.

Cephalothorax with a rostral spine and a stout dorsal spine. Lateral spines present, shorter and more slender than preceding two spines. Posterolateral margin with about 7 minute denticles. Eyes not stalked. Abdomen consists of five segments and telson; first segment covered by carapace; second segment with a lateral spine anteriorly directed; a small lateral spine present on each side of third segment; fourth segment with a lateral spine directed posteriorly, which is larger than that of third segment; posterolateral margin of fifth segment feebly produced to form a minute spine. Telson bifurcated to make a fork; fork curving dorsally. Posterior margin embayed deeply; three well-developed plumose setae present outside of the embayment; inner margin of fork fringed with very fine setae.

Chromatophores located on near base of antennule, labrum, mandible, protopod of first maxilliped, base of lateral spine (carapacial center), behind dorsal spine, corneal region, behind eye and each abdominal segment.

SECOND ZOEA.

Age: 5–12 days. Length: 1.56 mm. Eye stalked and mobile. Telson setae increase to 4–4; inner pair short. Chromatophore pattern as in preceding stage.

THIRD ZOEA.

Age: 12–18 days. Length: 1.90 mm. Lateral spine becomes smaller. Abdominal segments increase to six. Pleopods appeared as small buds. Telson setae represented as complete 4–4, or sometimes 4–5. Chromatophore pattern similar to that of preceding stage; sixth abdominal segment lacking chromatophores.

FOURTH ZOEA.

Age: 18–26 days. Length: 2.05 mm. Lateral spine of carapace remains small. Third maxilliped and following thoracic appendages appear as simple forms; most of them concealed beneath carapace. Pleopods rather developed, with small endopods. Telson setae as a formula of 5–5; innermost pair of setae rather developed. Chromatophore pattern remains unchanged.

Cephalothoracic appendages of zoeal stages

ANTENNULE.

Antennule unsegmented and conical, with a group of terminal aesthetascs. From first to fourth zoea number of aesthetascs changes in order of 4, 5, 6, 6. Basal portion inflated in fourth stage.

ANTENNA.

Antenna of first zoea bears a cylindrical protopod with prolonged spinous process and exopod; spinous process terminates at middle of rostrum, with two rows of denticles internally and externally; external row of 8 to 10 denticles and internal of 5 to 8; exopod measuring about 2/3 of spinous process; a pair of short setae placed at distal third. Number of denticles on spinous process widely variable within 10 in subsequent stages. Unsegmented endopod appears in second stage as a small rounded protrusion; that of third stage reaches the site of exopod setae; in fourth stage developed endopod terminates between tips of spinous process and exopod.

MANDIBLE.

Mandible of first zoea consists of incisor and molar processes; incisor process with 3 large teeth; molar process cylindrical; its masticatory surface slightly hollowed. Until

fourth stage these fundamental forms unchanged; palp appears as a rudimentary bud in fourth stage.

MAXILLULE.

Maxillule with two-segmented endopod and basal and coxal endites; this feature remains constant throughout all zoeal stages; distal segment of endopod with two terminal and two subterminal setae, and also with a single lateral marginal seta medially placed; proximal segment short, with a single seta; these setations remain unchanged throughout zoeal stages. Basal endite bears 5 short plumose setae in first, 7 in second, 9 to 11 in third and 14 to 16 in fourth zoea. Setae on coxal endites numbering 5 in first, 5 or 6 in second, 6 in third and 7 or 8 in terminal zoea. A developed plumose seta appears on opposite side of basal endite in second and subsequent zoeal stages.

MAXILLA.

Through zoeal stages maxilla consists of unsegmented endopod, basal and coxal endites and a scaphognathite; endopod slightly bifurcated, with two terminal and two subterminal plumose setae. Basal endite bilobed, with 9 marginal setae in first, 9 in second, 10 in third and 14 in fourth zoea. Scaphognathite of first zoea terminates in a sharp point, with 4 plumose setae marginally; apical portion rounded in second stage; fringing setae numbering 6, 16 17, 24 29 in second, third and fourth zoea respectively.

FIRST MAXILLIPED.

First maxilliped is made of protopod, five-segmented endopod and exopod in all stages of zoeae; in first and second zoeal stages setation of endopod represents a formula, 2, 2, 2, 2, 5; in third stage a short seta is added to outer margin of proximal third segment; another short seta appears on outer margin of proximal second segment in fourth zoea. Natatory setae are 4 in first zoea, and successively increase to 6, 8, 10 as the stages are advanced.

SECOND MAXILLIPED.

Second maxilliped consists of protopod, three-segmented endopod and exopod quite similar to that of first maxilliped; endopod with setation of 0, 1, 6, constant throughout all zoeal stages.

THIRD MAXILLIPED.

Third maxilliped poorly developed in first two stages. A small biramous bud appears in third and fourth stages; it is concealed beneath carapace, without any setae.

General morphology of magalopa

Age: 26–36 days. Carapace length: 1.5 mm.

Carapace longer than broad, posteriorly broadened, without any setae dorsally; ordinary sites of lateral and dorsal spines slightly elevated and each with a minute spine. Rostrum slightly produced forwards and curving downwards; rostral region between eyes slightly hollowed. Pereiopods well developed and functional; last pereiopod small, its distal segment with three long feelers. Eyes large, placed in a distinct orbit.

Abdomen consists of six segments and telson; fourth segment bears two minute spines on posterior lateral margin; fifth segment with a strong posterolateral spine on either side, which terminates in the middle of sixth segment; second to sixth segments with well-developed pleopods; pleopod consists of simple endopod and exopod with a fringe of swimming setae; the setation in five pairs of plopods is 18–18, 18–18, 17–17, 17–17, 11–11;

endopods with three terminal hooks present on second to fifth abdominal segments.

Chromatophores distributed on eyestalks, mid-lateral and posterolateral portions of carapace, gastric region, ordinary site of dorsal spine, bases of second and third maxillipeds, and each abdominal segment.

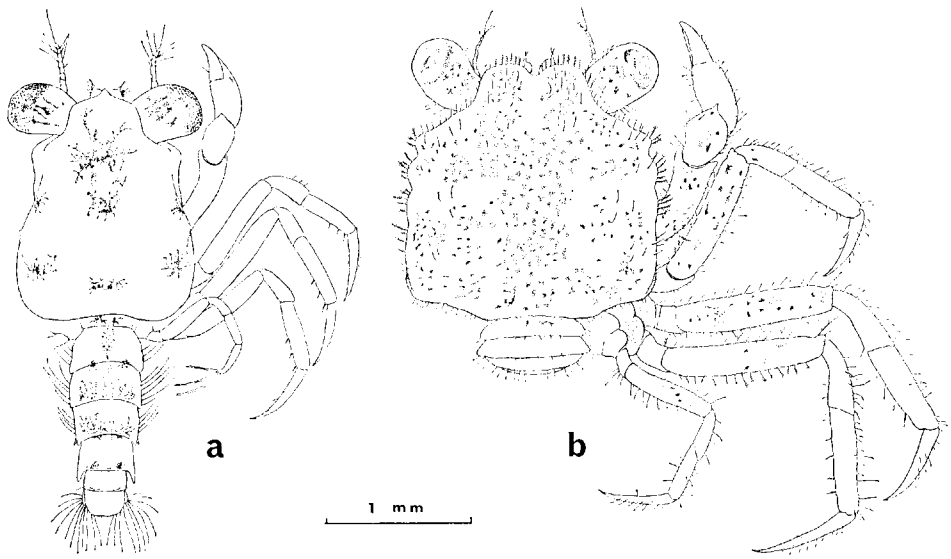

Fig. 2. *Chasmagnathus convexus* De HAAN, a, megalopa, dorsal view; b, first crab, dorsal view.

Cephalothoracic appendages of megalopa

Antennule consists of enlarged base and three-segmented peduncle; intermediate segment of peduncle has unsegmented flagellum with three short setae; distal segment with about 13 aesthetascs. Antenna ten-segmented; its setation is 0, 0, 0, 0, 0, 3, 2, 3, 2, 1; distal four segments with long setae. Mandible has body with sharp cutting edge and two-segmented palp; distal segment of palp with about 9 short plumose setae; masticatory surface of molar process disappears. Maxillule consists of unsegmented endopod and basal and coxal endites; endopod constricted at middle and with 4 terminal setae; both endites with many bristles and plumose setae. Maxilla made up of simple endopod, bilobed basal and coxal endites, both with fringing setae, and well-developed scaphognathite; basal endite with 9 setae on distal lobe, 8 on proximal lobe; coxal endite with 3 setae on distal lobe and 10 on proximal lobe; about 55 setae fringing a broad scaphognathite.

First maxilliped consists of unsegmented endopod with 3 terminal plumose setae, exopod and two endites; exopod constricted at middle, distally having three long plumose setae; proximal half with two similar setae; epipod with long coarse setae terminally and marginally; both endites not bilobed, with many fringing setae. Second maxilliped has four-segmented endopod; exopod constricted at middle, having distal half with 5 long plumose setae terminally, and proximal half with only a single plumose seta; long epipod with 4 coarse setae; distal two segments of endopod setose. Third maxilliped well developed; endopod five-segmented, all setose internally; exopod constricted at distal third, with 5 terminal plumose setae; epipod well developed; short plumose setae distributed proximally and long non-plumose coarse setae distally.

General morphology of first crab

Age: more than 36 days. Carapace, 1.7 mm broad, 1.7 mm long.

Carapace quadrangular; dorsal surface coarse, sparsely furnished with short setae, chiefly on lateral and frontal regions; lateral margin with three protrusions; anterior two moderately developed but hindmost weak; all provided with short plumose setae. Frontal region medially hollowed. Posterolateral margin with a weak ridge. Eyes large, laterally expanded at the level of lateral margin of carapace; orbit distinct; its inferior margin minutely tuberculate.

Chela rather stout; each cutting edge almost straight, not curved, with about 4 small tubercular teeth; tips of fingers end each in end acute point, slightly curving inwards each other. First three walking legs subequal, furnished with short setae; dactylus subequal to propodus in length; fourth walking leg smaller; dactylus longer than propodus.

Chromatophores distributed on whole surface of carapace, eyestalks and meral and sometimes carpal segments of pereiopods.

Discussion

No information has been procured of the larval development and larval forms of *Chasmagnathus convexus*. In comparison with other species of the esturine Sesarminae this species has no peculiarity in the larval development. Among Sesarminae found in Kumamoto all the members of the genera *Sesarma* and *Helice* have a breeding season between May and August, whereas in *Chasmagnathus convexus* hatching occurs only before April or early in May. The first zoea of this species has larger size than those of the other estuarine Sesarminae: *Chasmagnathus convexus*, 1.50 mm; *Helice tridens tridens*, 1.16 mm; *H. tridens wuana*, 1.14 mm; *Sesarma dehaani*, 0.85 mm; *S. haematocheir*, 0.70 mm; *S. intermedium*, 0.73 mm; *S. pictum*, 0.73 mm; *S. erythrodactylum*, 0.74 mm; *S. plicatum*, 0.70 mm (BABA & MIYATA, 1971; BABA & MORIYAMA, 1972; and unpublished data.)

The zoeae of this species are distinguished from those of *Sesarma* species by having lateral spines. In comparison with larvae of two subspecies of *Helice*, which are the most related, the fourth abdominal segment has a lateral spine in *Ch. convexus* and *H. tridens tridens*, but it is lacking in *H. tridens wuana*. In other respects common characteristics to *Helice tridens tridens* and *Chasmagnathus convexus* appear in the hair formulae of maxillipeds 1–3, endopods of maxillules and maxillae. Only a distinct character between zoeae of this species and the two subspecies of *Helice* is the presence of a paired or single setae near the distal portion of the exopod of the antenna; the setae are single in the two subspecies but paired in *Ch. convexus*. In the setation of the telson the first and final zoeae of both *Ch. convexus* and the two subspecies of *Helice* show the same formulae, 3–3 and 5–5 respectively; but in the second zoea the setation remains as 3 3 in *Helice* subspecies whereas it advances to be 4–4 in *Ch. convexus*.

In the megalopa stage no distinct differences are noted in the member of *Helice*, *Sesarma* and *Chasmagnathus*. The setation of pleopods of *Ch. convexus* is near to that of *H. tridens wuana*, as represented by 18, 18, 17, 17, 11 in the former, and 18, 19 or 20, 17 or 18, 16 or 17, 11 or 12 in the latter. Hooks on the endopod are three in number in *Helice* and *Chasmagnathus* species, which fact separates them from the known *Sesarma* species with two hooks.

The telson quadrangular in shape is common to *Chasmagnathus convexus* and *Helice tridens wuana*, both of which possess 4 posterior marginal plumose setae. A slight difference is also found in furnishment of setae on the exopods of the first to third maxillipeds; in

H. tridens wuana the maxillipeds 1–3 have the setation, 4–5–4, the setation in *H. tridens tridens* is represented by 4–4–5, and 5–5–5 in *Ch. convexus*, although these setations may be variable.

The first crab of *Chasmagnathus convexus* is the most setose, separated from *Sesarma dehaani* by the form of the lateral margin of the carapace. In *Helice tridens wuana* the cardiac groove is distinct whereas it is absent in *Ch. convexus*, and further the lateral margin of the carapace has 4 distinct teeth with small tubercular teeth in *H. tridens wuana* but in *Ch. convexus* it bears 3 rounded projections only with short plumose setae instead of tubercular teeth.

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