

Larval Development of *Sesarma (Holometopus) dehaani*
H. MILNE EDWARDS (Crustacea, Brachyura)
Reared in the Laboratory

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Sesarma (Holometopus) dehaani lives in brackish water in Japan from Bosô Province to Kyushu and Okinawa, and in Formosa, Korea, North and South China (SAKAI, 1965). Six species of the genus *Sesarma*, together with other grapsids, are known to us to occur around the mouth of the Shirakawa River which runs through Kumamoto City, situated at the middle part of Kyushu. It is our main purpose to study the biology of these estuarial crabs, and as a first step it was aimed in this study to rear the larvae of *S. dehaani* in the laboratory, from hatching to the first crab stage, and to provide a description of all larval stages.

On the larval forms of the Japanese *Sesarma* species there are reports by AIKAWA (1929, 1937) and YATSUZUKA (1957). The former has described first zoeae of *Sesarma* sp. and *S. pictum*, and the latter has reared *S. haematocheir* and *S. dehaani* from first zoeae to megalops. However, no detailed description of *S. dehaani* has been given to all stages of the larvae. Two species of *Sesarma* from North Carolina have been brought up to megalops by COSTLOW & BOOKHOUT (1960, 1962), and two Venezuelan species of *Metasesarma* and *Sesarma* by DIAZ and EWALD (1968). Those seem to be the only papers that furnish details of zoeal characters of all stages of sesarmids living in brackish water.

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Methods and material

Ovigerous females of *Sesarma dehaani* were collected from the estuary of the Shirakawa River, Kumamoto, on 2nd June 1970, and were maintained in each a compartment surrounded with net of small meshes which was emerged in an air lift filter aquarium containing 60 per cent of artificially made sea water (For sale: Fresh Marine). When hatched, the larvae were removed to an aquarium of 40 × 20 × 20 cm in size that was exposed to the air by the throw of air stone. Rotifers, *Brachionus plicatilis*, and *Artemia* nauplii were fed to zoeae, and pieces of bivalve, *Tapes philippinarum*, and fish, *Spratelloides gracilis*, to megalops. The water was renewed once in part a day. Temperature was not controlled, the aquarium being left in the room so that water temperature is about 23.8°C in mean, ranging from 22.9°C to 24.6°C. Larvae and exuviae

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in each stage were fixed in 50 per cent of ethylene glycol. After 5 minutes preservation in ethylene glycol, the larvae were dissected under stereo-microscope and observed under monocular microscope. Drawings were made on graph paper with the aid of a sectioned ocular micrometer.

Results

The zoeae of *Sesarma dehaani* have 4 stages and reached the first crab stage passing through a megalopa stage during 22 days in the shortest period. Major characteristics of larval stages are as follows:

FIRST ZOEAE (Fig. 1).

A distance between tips of the rostral and the dorsal spines measures 0.85 mm. The carapace has a short dorsal spine equal to the rostral spine in length. The rostral spine exceeds the antenna and is twice the length of the antennule. The eyes are not

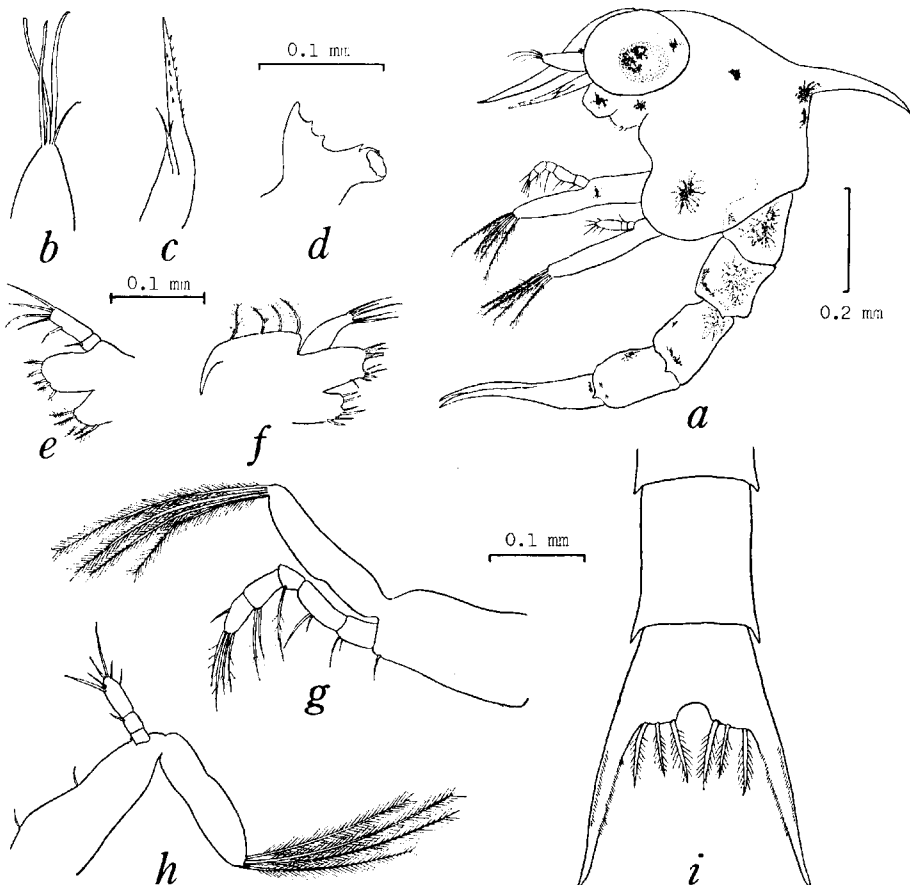


Fig. 1. *Sesarma dehaani*, first zoeal stage, *a*, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, maxilla; *g*, first maxilliped; *h*, second maxilliped; *i*, terminal segments of abdomen.

stalked. The abdomen consists of 5 segments and the telson. The second abdominal segment bears on either side a short spine which is directed anterolaterally. A minute spine is located on the mid-lateral line of the third segment. The abdominal segments 3-5 bear each a pair of spines on the mid-lateral line of the posterior margin, the hindmost (5th) pair is the strongest. The second segment ends in a rounded posterior margin. The telson is directed slightly dorsally, and has 3-3 plumose setae on the inner surface, its folk bearing rows of fine setae both on the inner and the outer surfaces.

The chromatophores are located on the following points: 1, the base of the rostrum (near the base of the antennule); 2, between the eyes; 3, mandible; 4, carapacial center; 5, behind the cornea; 6, behind the dorsal spine; 7, each abdominal segment; 8, protopod of first maxilliped.

The antennule is with three aesthetes of equal size and one short seta. The spinous process of the protopod of the antenna fails to reach the rostral spine, bearing two rows of denticles along its whole length. The exopod of the antenna is one-fourth the length of the process, terminating in two setae of unequal size.

The mandible has the well-developed molar process and the incisor process, the latter of which is furnished with three teeth (Fig. 1, d). The endopod of the maxillule is two-segmented; the distal bears four long setae of equal length at the terminal end and a somewhat shorter one at the mid-inner margin; the proximal with a short non-plumose seta inner-distally. Both the coxal and the basal endites bear 5 plumose setae. The endopod of the maxilla is unsegmented, and slightly bifurcated, having three terminal and two subterminal spines. The coxal endite is slightly bifurcated, and has two distal and four proximal setae. The basal endite is bilobed; the distal and the proximal lobes bear 4 and 5 plumose setae, respectively. Four plumose setae fringe the margin of the scaphognathite. The setation of the 5-segmented endopod of the first maxilliped is 2, 2, 1, 2, 5 (Fig. 1, g), and the exopod has four plumose natatory setae. The endopod of the second maxilliped is three-segmented, its setation being 0, 1, 6. Four plumose swimming setae are from the tip of the exopod.

SECOND ZOEAE (Fig. 2).

A distance between the tips of the rostral and the dorsal spines is 1.05 mm. The eyes are stalked. The setation of the telson remains as in the preceding stage. The antennule bears 5 setae distally, the three long, one short and the remaining moderate. The antenna is essentially the same to the first zoea; the exopod small, terminating in two short setae. A plumose seta is present on the opposite side of the basal endite of the maxillule; seven spines or setae (plumose) are from the basal endite, and 5 from the coxal. The setation of the endopod of the maxilla is 3, 2 (3, terminal and 2, subterminal); the basal endite is bilobed, the distal lobe having 4 plumose setae and the proximal 5; the coxal endite has 7 setae. The scaphognathite has 4 soft plumose hairs on the distal margin and also three on the apical tip. The endopods of the first and second maxillipeds are equal to those of the first zoea in setation. The exopods of both maxillipeds have 6 swimming setae.

Chromatophore pattern is as in the first zoea.

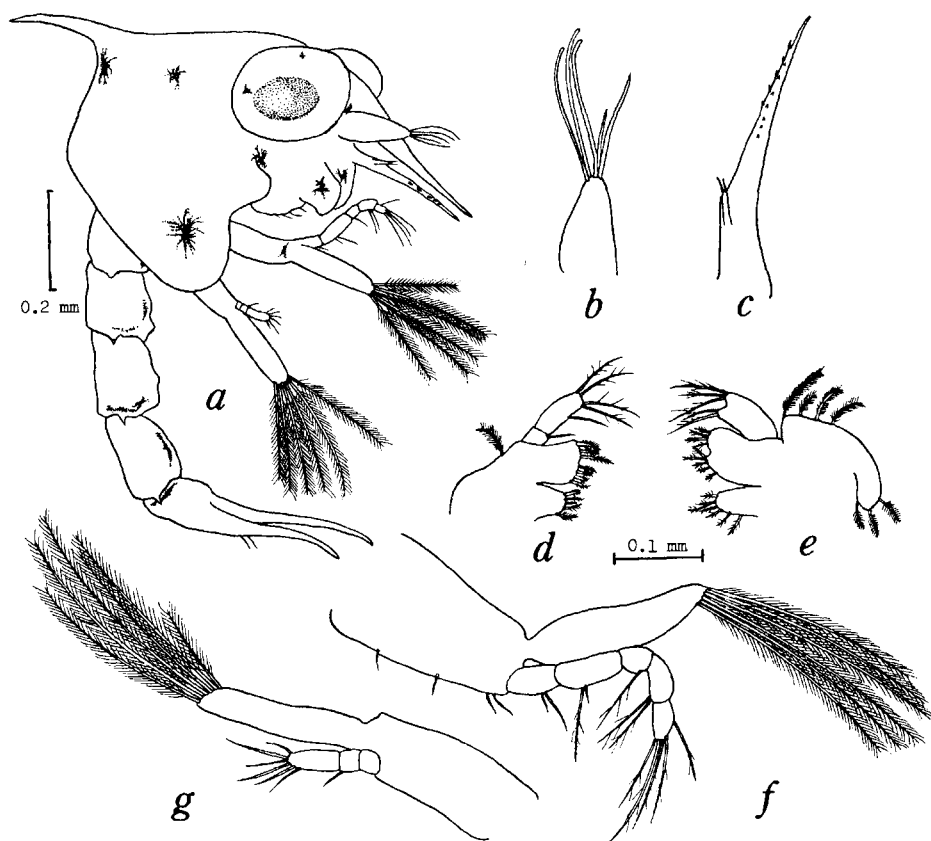


Fig. 2. *Sesarma dehaani*, second zoeal stage, *a*, lateral view; *b*, antennule; *c*, antenna; *d*, maxillule; *e*, maxilla; *f*, first maxilliped; *g*, second maxilliped.

THIRD ZOEAL STAGE (Fig. 3).

A distance between the dorsal and rostral spines measures 1.28 mm. The endopod of the antenna develops and exceeds beyond the exopod. The posterolateral margin of the carapace bears three plumose setae. The maxillule is the same to that of the second zoea, with a plumose seta growing up behind the endopod. The setation of the endites of the maxilla remains as in the preceding stage. Six soft plumose setae fringe the distal margin of the scaphognathite and four similar hairs are from the apical tip. The exopods of the first and second maxillipeds bear each 8 plumose swimming setae. In the setation of the endopod of the first maxilliped short setae increase on the outer margins of the merus and carpus, and one seta of moderate length on the inner margin of the dactylus. The third maxilliped, cheliped and walking legs are visible as small buds.

Abdominal segments increase to 6. The setation of the telson is 3-3. Dorsally the first segment has a single long seta.

Excepting the 6th abdominal segment which contains no chromatophores, the distributional pattern of the chromatophores is the same to that of the preceding stage.

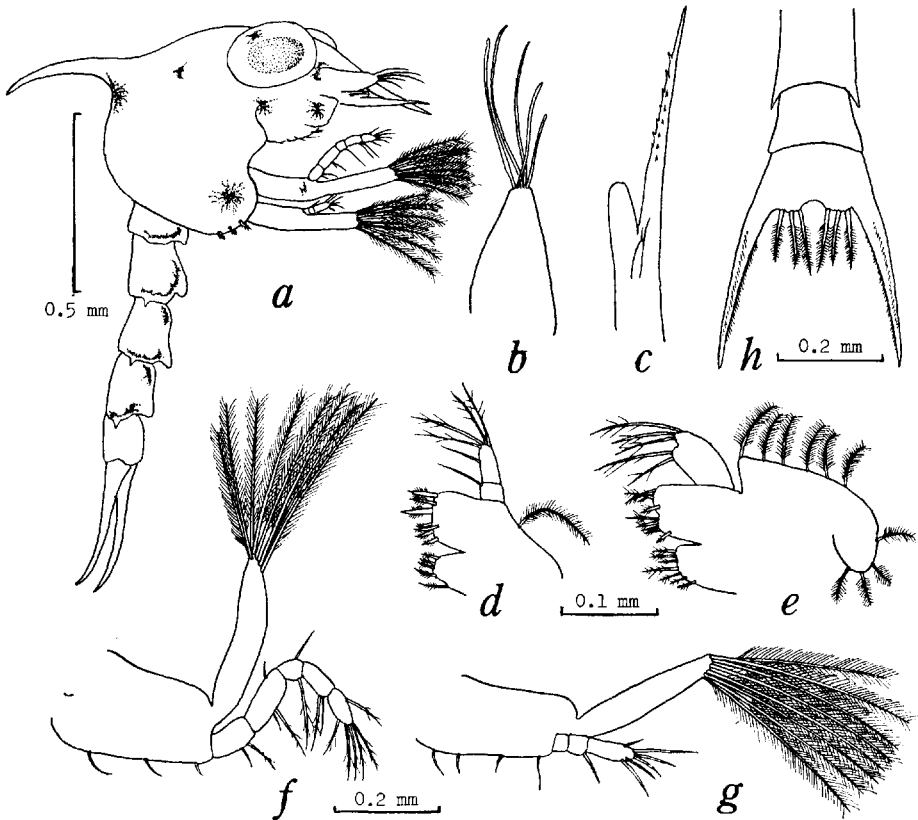


Fig. 3. *Sesarma dehaani*, third zoeal stage, *a*, lateral view; *b*, antennule; *c*, antenna; *d*, maxillule; *e*, maxilla; *f*, first maxilliped; *g*, second maxilliped; *h*, terminal segments of abdomen.

FOURTH STAGE (Fig. 4).

From the tip of the rostral spine to that of the dorsal it measures 1.58 mm. Four spines fringe the posterolateral margin of the carapace. The antennule is inflated at the base, having distally 6 aesthetes. The unsegmented endopod of the antenna reaches the middle of the spinous process of the protopod. The basal and coxal endites of the maxillule bear 10 and 9 setae, respectively. Five setae are on the distal lobe of the maxillar distal endite and 6 on the proximal; the coxal endite bears 11 setae. The scaphognathite is well developed, having marginally 19 soft plumose setae. Natatory setae on the exopods of the first and second maxillipeds increase to 10. The third maxilliped and the following pereopods still remain undeveloped and do not project from beneath the carapace. Pleopods become large buds, with rudimentary endopods. The first abdominal segment bears 3 or 4 setae dorsally which are arranged in a transverse row. The setation of the telson remains unchanged.

MEGALOPA (Fig. 5).

The carapace is 1.00 mm long and 0.68 mm wide. The rostral and dorsal spines disappear. The interorbital region of the carapace is deeply hollowed. The antennule

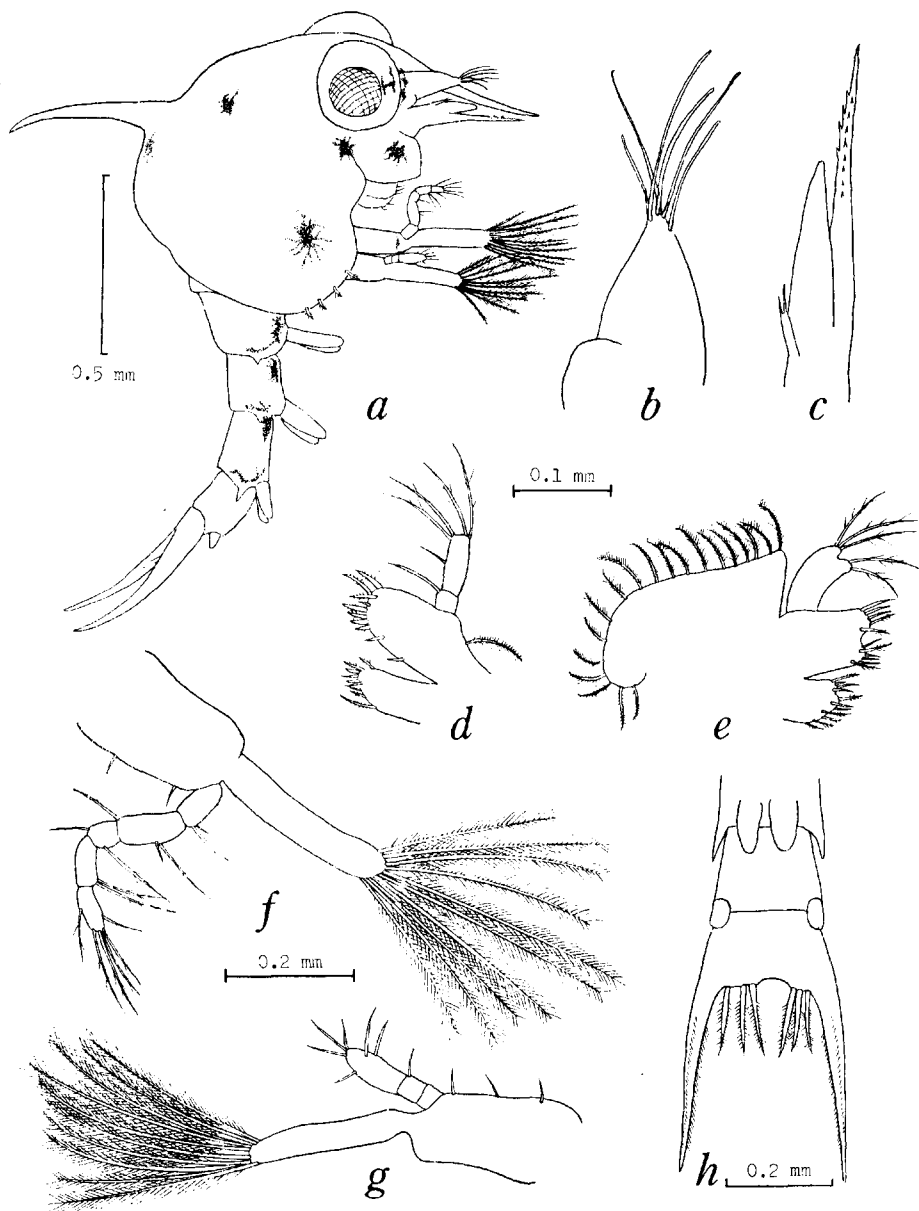


Fig. 4. *Sesarma dehaani*, fourth zoeal stage, *a*, lateral view; *b*, antennule; *c*, antenna; *d*, maxillule; *e*, maxilla; *f*, first maxilliped; *g*, second maxilliped; *h*, terminal segments of abdomen.

has an enlarged base bearing two setae and the peduncle of 3 segments; the distal segment bears 8 aesthetes, and the median two setae distally. The antenna of 9 segments has setae chiefly distally. The mandible has the body with a smooth cutting edge, bearing two segmented palp which has four setae distally; the molar process in the former stage disappears in this stage. The maxillule bears three terminal setae on the endopod. The basal and coxal endites have 14 and 8 plumose setae, respectively. The

maxilla has a simple, non-haired endopod; the basal endite is bilobed, the distal lobe bearing 5 plumose setae and the proximal 8; the coxal endite is likewise bifurcated, 4 plumose setae springing from the distal lobe and 9 from the proximal. The margin of the scaphognathite is furnished with about 34 plumose setae. The endopod of the first maxilliped is unsegmented, with two terminal and two subterminal setae. The exopod is two-segmented, the proximal segment has three setae of moderate length, and the distal is furnished with three or four plumose setae of long size. The epipod is broad with three non-plumose setae distally. The basal endite has 11 non-plumose setae and the coxal endite 5 plumose setae. The second maxilliped has no epipod; the endopod is 4-segmented, having one seta on the proximal second segment, three on the third, and 6 on the terminal segment. The exopod is two-segmented, and has 5 setae distally. The endopod of the third maxilliped is well developed, consisting of 5 segments. The

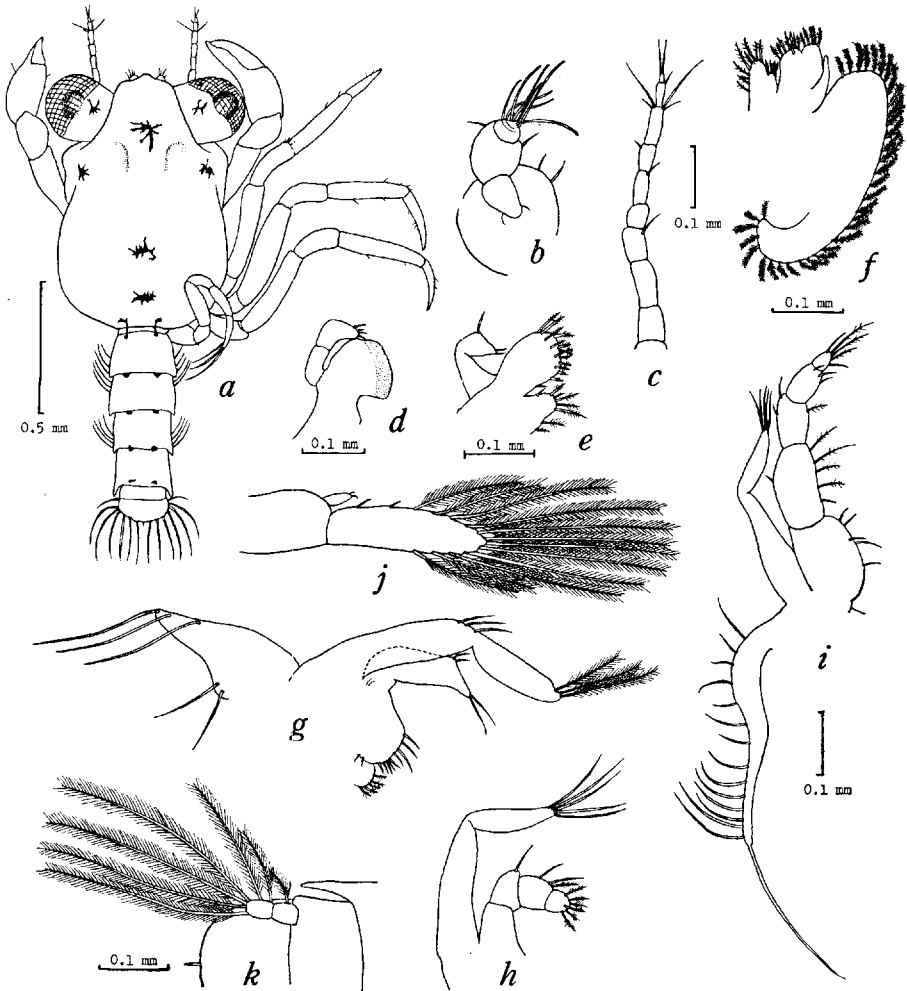


Fig. 5. *Sesarma dehaani*, megalopa stage, a, dorsal view; b, antennule; c, antenna; d, mandible; e, maxillule; f, maxilla; g, first maxilliped; h, second maxilliped; i, third maxilliped; j, second pleopod; k, right half of terminal segments of abdomen.

setation is as represented in Fig. 5, *i*; the exopod is two-segmented, distally bearing 5 setae. The epipod is also well developed, externally and distally fringed with long plumose and non-plumose setae.

Chelipeds and walking legs are as shown in Fig. 5, *a*. The fifth pereopod (4th walking leg) has three long setae distally.

The abdomen is 7-segmented; the segments 2-5 have each a spine on either side of the posterior margin, that of the 5th segment is the strongest, reaching the posterior margin of the 6th segment. The 6th segment is about half the length of the telson which terminally has a central spine only. The setation of the second to 6th pleopods is 14, 14, 14, 11, 7. Two small hooks are present on each of the distal margins of the endopods of the pleopods 2-5.

The chromatophores are located on: 1, one on the dorsal surface of the rostrum; 2, behind the eyestalk on the carapace; 3, two on the center and posterior portions of the carapace; 4, on the eyestalk; 5, base of each pereopod; 6, bases of antennule and antenna; 7, bases of second and third maxillipeds; 8, dorso-lateral surfaces of abdominal segments 1-5.

FIRST CRAB STAGE (Fig. 6).

The carapace is 1.13 mm long and 0.95 mm wide. The rostrum is quadrate, with the anterior margin smoothed. The outer orbital angle is a rather developed spine, behind this is a distinct projection, followed by a weak eminence behind.

The abdominal segments are folded beneath the cephalothorax. The posterior marginal spines in the preceding stage disappear. The telson bears four posterior marginal setae of small size and another one on either side. All pleopods have no setae. The eye is large. The antennular basal segment is inflated without any setae; the peduncle consists of three segments, the distal bearing three setae terminally. The 8-segmented antenna bears setae distally (detailed description: two terminal setae on the distal segment, and one long and three short setae on the penultimate). The maxillule is as represented in Fig. 6, *e*; the endopod is two-segmented, the distal segment being quadrate with a short seta on either terminal edge. The basal endite has 15 setae and the coxal 8. The endopod of the maxilla is simple and unsegmented without any setae. In the basal endite the distal lobe has 5 plumose setae and the proximal 6. The coxal endite is also bilobed, 4 setae projecting from the distal lobe and 5 from the proximal.

The endopod of the first maxilliped is unsegmented, with 6 terminal short setae; the exopod is furnished distally with 4 plumose setae; the epipod is wide at base and becomes narrow distally, bearing long non-plumose setae marginally. The basal endite has 11 plumose short setae and the coxal 8. The second maxilliped has the exopod which is furnished with four terminal plumose setae, and one short non-plumose and one plumose setae on the inner margin of the proximal half; the 5-segmented endopod is with following setation: one plumose seta on the inner margin of the merus; one on the distal margin of the carpus, three on the propodus, and 8 on the terminal margin of the dactylus. The epipod is absent. The third maxilliped is stout; the endopod is flattened, and is setose on the inner margins of the proximal two segments and on the terminal margins of the distal three segments. The exopod is folded in two segments,

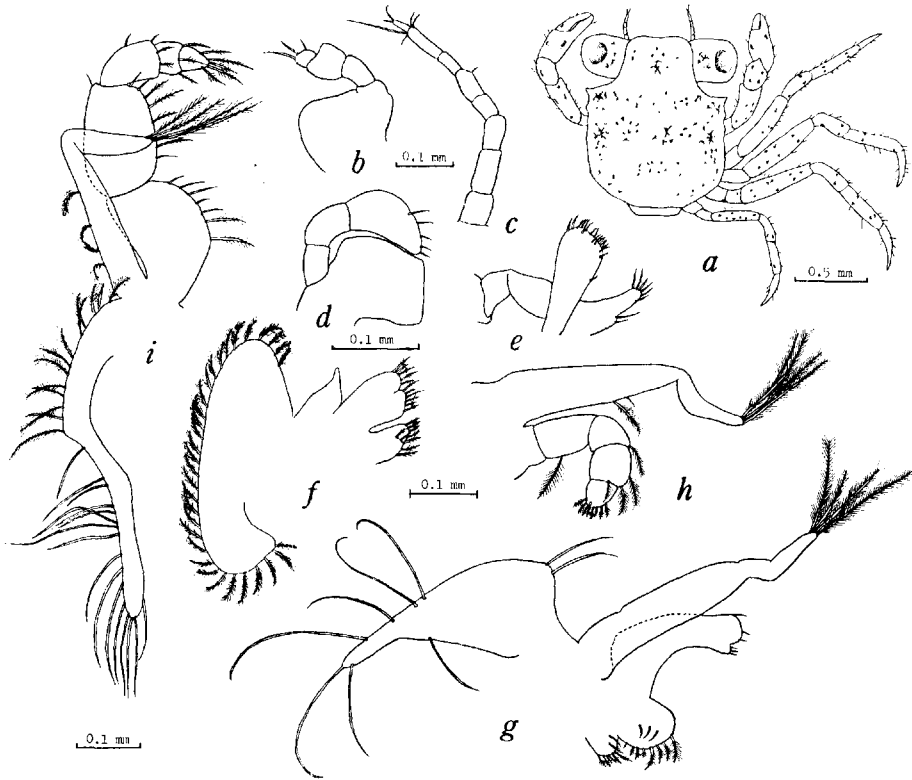


Fig. 6. *Sesarma dehaani*, first crab stage, *a*, dorsal view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, maxilla; *g*, first maxilliped; *h*, second maxilliped; *i*, third maxilliped.

the distal having four long plumose setae terminally and the proximal four short plumose ones externally. The epipod is strongly developed, and is thickly furnished with setae along its whole length, those on the proximal half are plumose and the remainders non-plumose. The chelipeds and walking legs are as represented in Fig. 6, *a*. The fifth pereopod is of normal shape, losing the terminal setae in the preceding stage.

Brownish chromatophores are distributed on the whole body (Fig. 6, *a*).

Discussion

Few have been reported on the complete development of *Sesarma* (YATSUZUKA, 1957; COSTLOW & BOOKHOUT, 1960, 1962; DIAZ & EWALD, 1968; LAM, 1969). According to COSTLOW & BOOKHOUT who reared larvae of *Sesarma cinereum* and *S. reticulatum* from North Carolina, there are three zoeal stages in *S. reticulatum* and four in *S. cinereum*. DIAZ & EWALD described *Sesarma ricordi* with four zoeal stages from Venezuela. It was already mentioned that *Sesarma dehaani* had 4 zoeal stages in normal condition but rarely 5 stages were observed when the zoeae were late in development, and further the 5th zoeal stage usually occurs in *S. haematocheir* (YATSUZUKA, l.c.). The result of the present study agrees with YATSUZUKA's, but the 5th zoea did not appear.

LAM (l.c.) discussed the abbreviated development of *Sesarma* (*Geosesarma*) *perracae* from Singapore, which species has large eggs containing much yolk, and therefore has a more advanced first larval stage of sedentary habit. It is beyond the scope of our study to compare with LAM's account in number of larval stages and the morphology. From the larvae of North Carolina species those of *Sesarma dehaani* differs, when compared in the first stage, in having 6 setae on the terminal segment of the endopod of the second maxilliped. According to HYMAN (1925), the first zoeae of *S. cinereum* and *S. reticulatum* bear each two rows of fine setae on the folk of the telson, which also appear in *S. dehaani*. The presence or absence of such setae seems to be a useful character in classifying *Sesarma* larvae as it proved valid in our unpublished work on *Sesarma* larvae of Kumamoto. *Sesarma dehaani* is most allied to Venezuelan *S. ricordi*, but slightly differs in number of setae on the antennule and on the coxal endite of the maxilla.

YATSUZUKA (l.c.) noted and illustrated that the antenna of *S. dehaani* belongs to B₁-type of AIKAWA (1933). But the specimens before us show that the exopod of the antenna ends in two setae, which fact leads B₄-type. AIKAWA (1929) gave a short description to *Sesarma* sp., which was said to possess a lateral spine on the carapace. As has been pointed out by COSTLOW & BOOKHOUT (1960), however, AIKAWA's account must have been from the improper identification of the adult crab.

Aside from *S. reticulatum* which has three zoeal stages, there is no marked difference between *S. cinereum* and *S. dehaani* in the second and third stages. In the fourth stage they differ each other in the following respects: (1) The antennal endopod is segmented in *S. cinereum* while unsegmented in *S. dehaani*. (2) The mandible has an unsegmented palp in *S. cinereum* instead of none in *S. dehaani*. (3) The endopod of the third maxilliped is segmented in *S. cinereum* but that of *S. dehaani* is still a bud. (4) All the pereopods are considerably developed and are seen outside of the carapace in *S. cinereum*, whereas those of *S. dehaani* are beneath the carapace and not fully differentiated. In all larval stages *Sesarma dehaani* is not markedly separable from the Venezuelan species.

In the megalopa stage the distal segments of the abdomen in *Sesarma cinereum* and *S. reticulatum* are considerably different from those of *S. dehaani*. The sixth segments of the North Carolina species are rather long and the telsons bear distinct postero-marginal setae or spines. Contrary to these the terminal segments of *S. dehaani* are similar to those of *Metasesarma rubripes* reported by DIAZ & EWALD (1968) and *Hemigrapsus sanguineus* by KURATA (1969), both of the Grapsidae. The fifth segment of the abdomen in *S. dehaani* bears on either side a strong spine which reaches the posterior margin of the 6th segment. The telson has the rounded posterior margin, a short seta being located on its center. From a dorsal aspect the telson appears to have 7 long setae, but such setae originate from the 6th pleopod, one from the protopod and the other 6 from the exopod.

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