Larval Development of the Stone Crab, *Hapalogaster dentata* (De Haan, 1844) (Crustacea: Anomura: Lithodidae) Reared in the Laboratory

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(*With 11 Text-figures and 3 Tables*)

Despite the commercial importance to the crabs of the family Lithodidae, the detailed life history of these crab-shaped anomurans, especially in their larval phase, has been poorly documented. Furthermore, we have little knowledge of the larvae of the small lithodid species belonging to the subfamily Hapalogastrinae. On the other hand, 4 species belonging to 3 genera of the Hapalogastrinae have been recorded from Japan along the coasts of Hokkaido (Miyake, 1982): *Hapalogaster dentata* (De Haan), *H. grebnitzkii* Schalfeew, *Dermaturus mandtii* Brandt and *Oedignathus inermis* (Stimpson). Kurata (1964) described the larvae of *D. mandtii* mainly based on planktonic materials, and nothing of the larval stages of Japanese hapalogastrinid crabs of known parentage has yet been reported.

The present paper describes and illustrates the complete larval development of the stone crab *H. dentata* under laboratory conditions, while comparisons of its larval characteristics are also made with previously reported descriptions of the larval development of the family Lithodidae.

Materials and Methods

One ovigerous female of *Hapalogaster dentata* was obtained from the intertidal zone at Kamekawa, southern Hokkaido, on 1st May 1984, and placed in a laboratory aquarium. Hatching took place on the next day. Fifty freshly-hatched first zoeas were placed in 5 glass vessels, each containing 10 zoeas in 200 ml of artificial sea water (JAMARIN®: Jamarin Laboratory, Osaka, Japan) at 15°C temperature and 35 ppt salinity. Newly-hatched *Artemia* nauplii were

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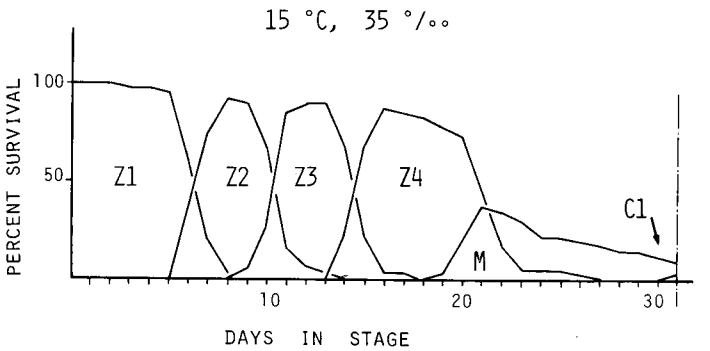

Fig. 1. Percentage and duration of survival in larvae of *Hapalogaster denta* (De Haan), reared under laboratory conditions.

given as food every other day. The sea water was changed every day. Observations for stage changes, numbers, dead larvae were made daily. Exuviae and a number of larvae were fixed in 5% formaldehyde solution for about 2 hours. Fixed materials were washed with distilled water and then preserved in 70% ethanol until dissection. The specimens to be dissected were stained with methylene blue. A minimum of 5 specimens for each stage, except the megalopa, was examined to verify setation and segmentation. Drawings and measurements were prepared with a stereomicroscope or a microscope with drawing attachment. The carapace length was measured from the tip of the rostrum to the mid-posterior end of the carapace. Setal arrangement is listed from proximal to distal. In the following description, the term *megalopa* is used instead of the term *glaucothoe*, according to the opinion by Pike and Williamson (1960).

Under laboratory conditions, zoeas of *H. dentata* passed through 4 zoeal stages and reached the megalopa 19 to 23 days after hatching. The zoeas showed relatively low mortality in early stage, while most of the fourth zoeas died during moulting to megalopa stage: thus finally only one specimen of the first crab was obtained in the present case. Fig. 1 indicates percentage and duration of the larvae reared in the laboratory conditions.

Description of Larval Stages

First zoea

The carapace has a rostrum which curved somewhat ventrally and a pair of postero-lateral short spines projecting slightly downward (Fig. 2-I). The length of the carapace ranges 1.73–1.89 mm: mean 1.80 mm (11 specimens). The eyes are sessile at this stage. The abdomen consists of 5 somites and a long tapered telson (Fig. 4-I). The second through fifth abdominal somite have 2 or 3 pairs of

short dorsal spines and one pair of lateral spines on their posterior margin. The posterior margin of the telson is cleft medially to form a pair of slight lobes. Each lobe of the telson bears 6 pairs of long serrated posterior processes and a pair of small hair-like ones. The outermost process is naked (Fig. 4-I). This feature of telsonal processes is herein expressed as 7+7. There is no anal spine on ventral surface of the telson.

Antennule (Fig. 5-I): Uniramous and unsegmented process, with 4 long, terminal and 2 shorter subterminal aesthetascs. Two short simple setae on its distal end. Subterminally, a large plumose seta is found: throughout zoeal stages, this seta is always situated on the base of the endopod bud.

Antenna (Fig. 5-I'): The antenna is composed of a scale (=exopod), endopod and a basal segment with a stout serrated spine and a short one. The endopod with a minute subterminal spine. The scale is longer than the endopod; 6 plumose setae and a simple seta on the inner margin.

Mandible (Fig. 6-I): A series of small teeth dorsally and larger teeth on the molar process: they are asymmetrical and have different denticulation on both sides of body.

Maxillule (Fig. 7-I): The endopod is provided with 2 short setae on the proximal, one long seta on the middle and 3 long setae on the distal segment; the setation of the endopod is unchanged in this and all subsequent zoeal stages. The basal endite has 2 stout denticulate spines and 2 setae, while the coxal endite bears

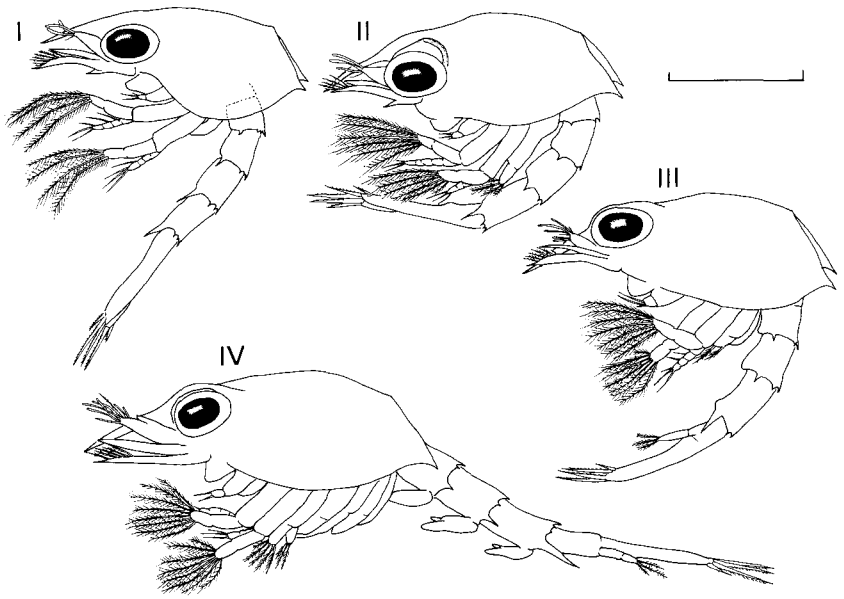

Fig. 2. *Hapalogaster dentata* (De Haan). Zoeal stages I-IV, lateral view. Scale line equals 1.0 mm.

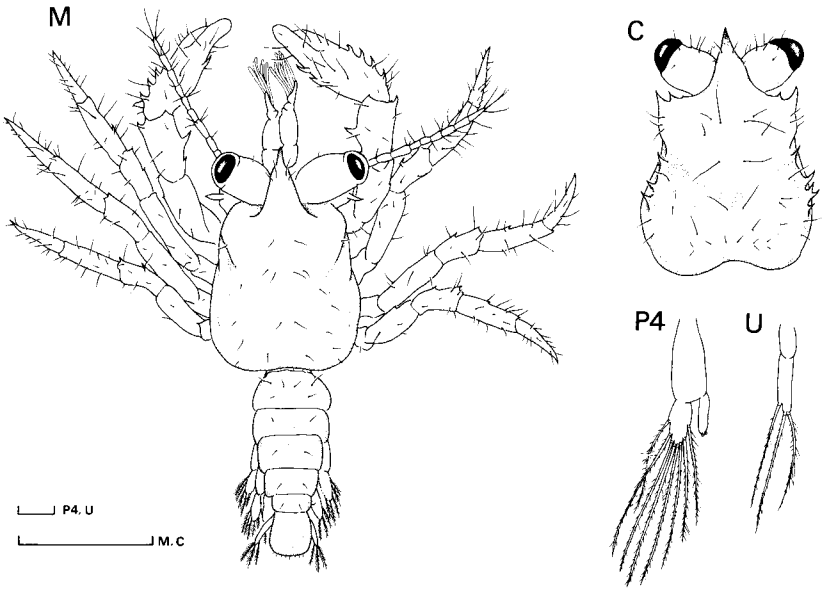

Fig. 3. *Hapalogaster dentata* (De Haan). Megalopa (M) and the carapace of first crab stage (C), dorsal view. P4 : fourth pleopod of megalopa, U : uropod of the same. Scale lines equal 1.0 mm for M and C, 0.1 mm for P4 and U, respectively.

6 denticulate spines and one seta.

Maxilla (Fig. 8-I): The endopod is slightly bilobed and 3 setae on the proximal, 4 setae on distal lobe. The setation of the endopod is constant throughout zoeal stages. The bilobed basal endite has 5 and 4 setae on the proximal and distal lobe, respectively, while the coxal endite bears and 8 ones on the proximal 3 setae on the distal lobe. The scaphognathite bears 5 soft plumose setae on its marginal border.

Maxilliped 1 (Fig. 9-I): The five-segmented endopod equal in length to the exopod; the setation is 3, 2, 1, 2, 5, and there are many fine hairs on the outer side of second through penultimate segment. The exopod, slightly constricted at middle portion, has 4 long, natatory plumose setae. The basis carries 10 (occasionally 11) simple setae on its ventral surface. Two simple setae are found on the ventral side of the coxa. The setal number and distribution of the basis and coxa is constant in all zoeal stages.

Maxilliped 2 (Fig. 10-I): The exopod bears 4 long, natatory plumose setae as in the first maxilliped. The endopod is four-segmented, and has a setation of 2, 2, 2, 5; the second and penultimate segment carries numerous fine hairs on its outer surface. The basis has 3 simple setae on its ventral surface; this feature is unchanged throughout zoeal stages.

Maxilliped 3 (Fig. 11-I): Presents as a biramous bud at this stage, but no

setal armature.

Second zoea

The carapace length ranges 1.74–1.93 mm; mean 1.84 mm (5 specimens). The eyes now are stalked in this and subsequent stages (Fig. 2-II). The number of paired serrated posterior processes of the telson has increased to 7 (Fig. 4-II), and this number is constant through the fourth zoea.

Antennule (Fig. 5-II): The distal portion of the antennule has 3 or 4 aesthetascs and 3 simple setae, while 4 aesthetascs and one plumose seta on the subterminal portion. A small endopod bud is observed.

Antenna (Fig. 5-II'): The inner margin of the scale is fringed with 7 plumose setae. The subterminal small spine of the endopod is reduced.

Mandible (Fig. 6-II): As in the previous stage.

Maxillule (Fig. 7-II): The basal endite bears 4 stout, denticulate spines and 2 setae, while the coxal endite has 5 denticulate spines and 3 setae. Others as in the first zoea.

Maxilla (Fig. 8-II): The setal arrangement of bilobed basal endite is unchanged, and the coxal endite bears 8 setae on the proximal, 4 setae on the distal lobe. The scaphognathite carries 8 soft plumose setae.

Maxilliped 1 (Fig. 9-II): On the outer side of the first through third endopodial segments, there is a long sparsely plumose seta on each one. The number of terminal, long natatory setae on the exopod has increased to 7.

Maxilliped 2 (Fig. 10-II): The second and third segment of the endopod bears a long sparsely plumose seta on its outer side. Others as in the first maxilliped.

Maxilliped 3 (Fig. 11-II): The endopod bears 2 terminal plumose setae and one simple seta. The exopod has 6 long plumose setae distally.

Third zoea

The carapace length ranges 1.98–2.13 mm; mean 2.07 mm (5 specimens) (Fig. 2-III). Small tubercles representing the rudiment of pleopods are found on the postero-ventral side of each abdominal somite. The sixth abdominal somite is indistinctly separated from the telson, and a pair of uropods, having 3 plumose setae on the distal end, is now recognized (Fig. 4-III).

Antennule (Fig. 5-III): The terminal portion bears 3 aesthetascs and 4 simple setae, while the subterminal portion has 5 aesthetascs, one plumose and one simple seta.

Antenna (Fig. 5-III'): The endopod becomes more elongated, and is nearly the same length of the scale. The subterminal small spine of the endopod has disappeared at this stage. Others unchanged.

Mandible (Fig. 6-III): A small tubercle, suggesting emergence of a bud of palp, is observed on the outer side.

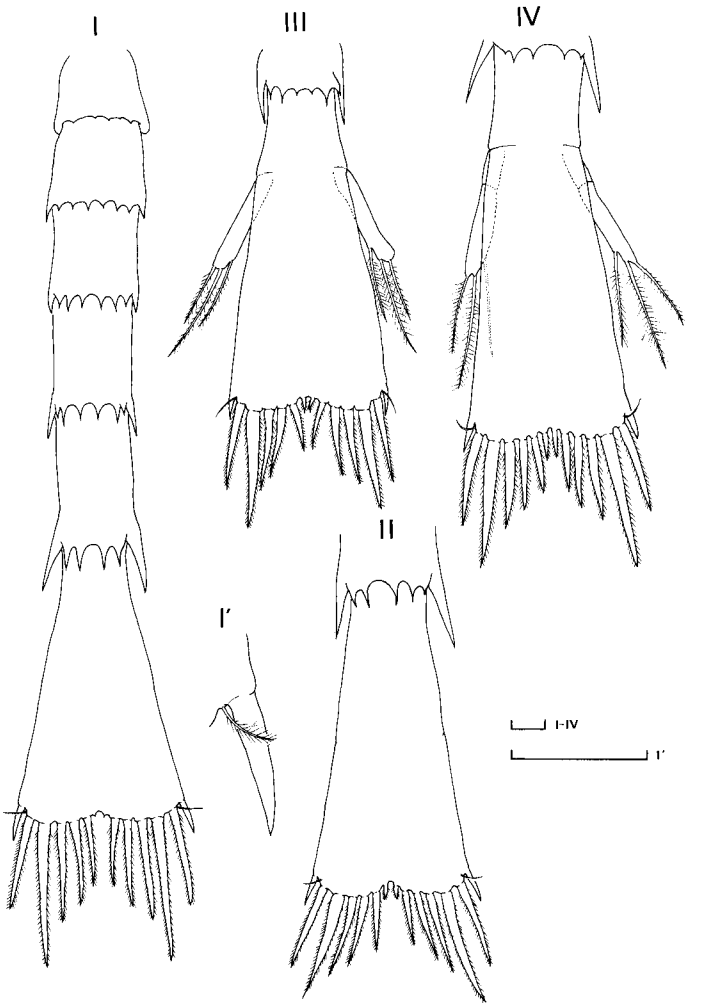

Fig. 4. *Hapalogaster dentata* (De Haan). Abdomen and telson of zoeal stage I, and telson of zoeal stages II-IV, dorsal view. I' : the outermost telsonal process, enlarged. Scale lines equal 0.1 mm.

Maxillule (Fig. 7-III): The spines on the basal endite are unchanged, but occasionally the number of denticulate spines of the coxal one is reduced to 7.

Maxilla (Fig. 8-III): The setal arrangement of endopod, basal and coxal endites is similar as in the second zoea. The scaphognathite bears 11 soft plumose setae.

Maxilliped 1 (Fig. 9-III): The exopod bears 8 long, natatory plumose setae. Others unchanged.

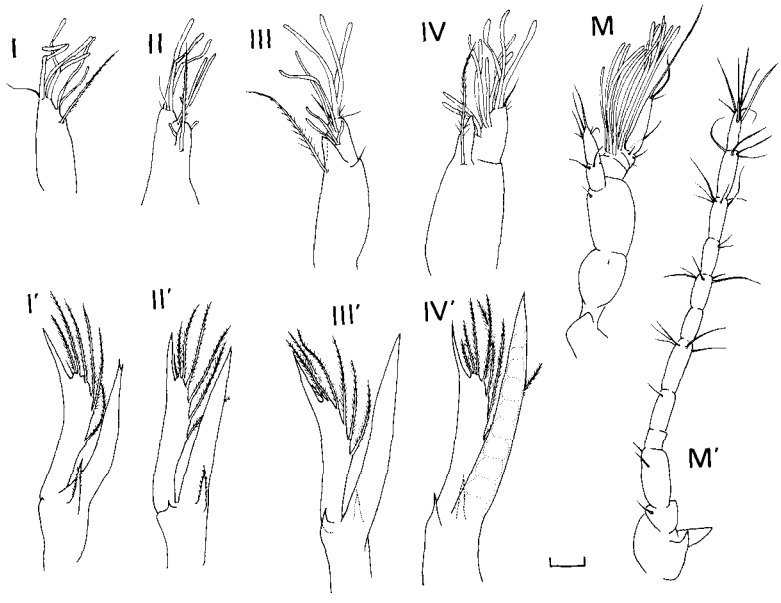

Fig. 5. *Hapalogaster dentata* (De Haan). Antennules and antennae of zoeal stages I-IV and of megalopa. Scale line equals 0.1 mm.

Maxilliped 2 (Fig. 10-III): The number of natatory plumose setae on the tip of exopod has increased to 8. Others as in the previous stage.

Maxilliped 3 (Fig. 11-III): The number of plumose setae on the exopod is 8, and the endopod bears 3 plumose setae.

Fourth zoea

The carapace length ranges 2.09-2.37 mm; 2.20 mm (11 specimens). The size of pereiopods has increased so that they project beyond the margin of the carapace. The second through fifth abdominal somite project a pair of biramous buds of pleopods (Fig. 2-IV). The uropods on the sixth abdominal somite are two-segmented now, but no endopod is found (Fig. 4-IV).

Antennule (Fig. 5-IV): The outer ramus of the antennule carries 10 aesthetascs and 3 setae; the endopod bud, providing with one proximal plumose seta, more elongated.

Antenna (Fig. 5-IV'): The tip of the endopod now exceeds that of the scale. The endopod also with indication of segmentation. Others as in the previous stage.

Mandible (Fig. 6-IV): The bud of palp is now conspicuous.

Maxillule (Fig. 7-IV): The basal endite has 6 stout, denticulate spines, while the coxal endite carries 7 denticulate spines and one seta.

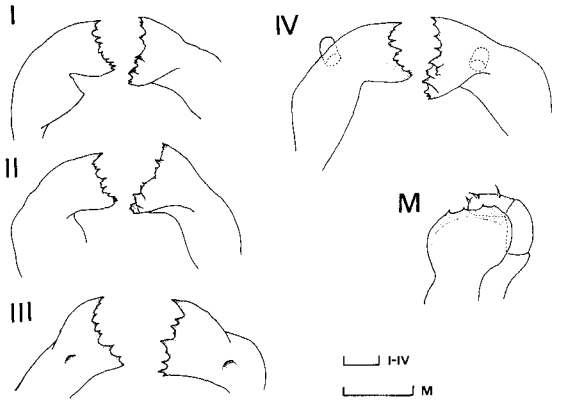

Fig. 6. *Hapalogaster dentata* (De Haan). Mandibles of zoeal stages I–IV and of megalopa. Scale lines equal 0.1 mm.

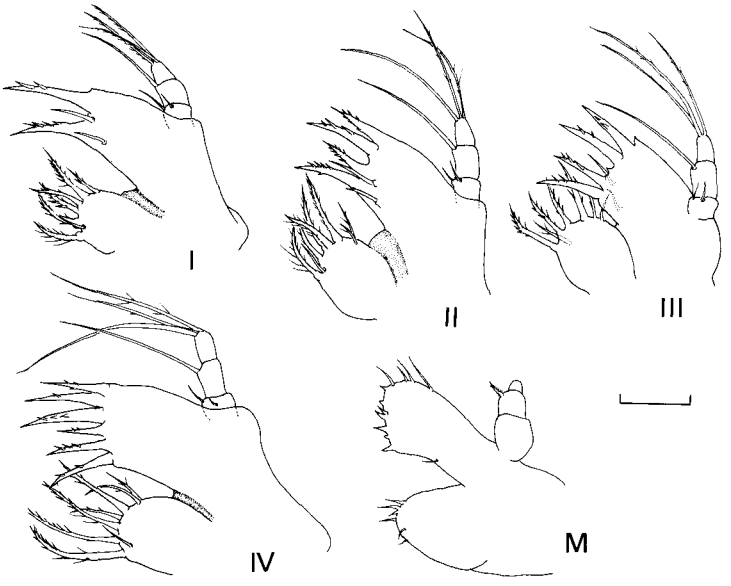

Fig. 7. *Hapalogaster dentata* (De Haan). Maxillules of zoeal stages I–IV and of megalopa. Scale line equals 0.1 mm.

Maxilla (Fig. 8-IV): In some specimens, the proximal lobe of the basal endite has 4 setae. The scaphognathite carries 12 or 13 soft plumose setae. Others unchanged.

Maxilliped 1 (Fig. 9-IV): As in the previous stage.

Maxilliped 2 (Fig. 10-IV): As in the previous stage.

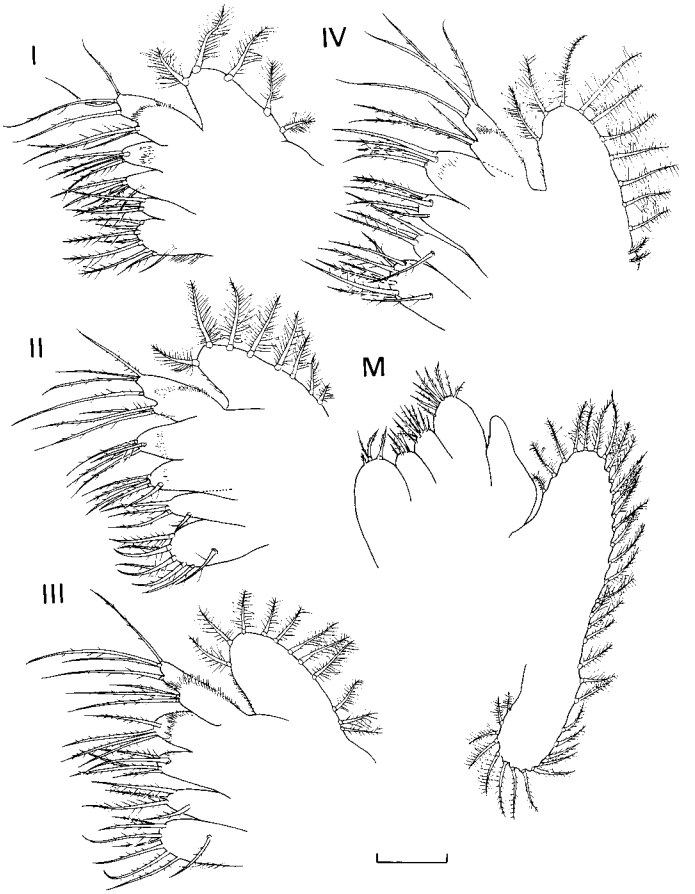

Fig. 8. *Hapalogaster dentata* (De Haan). Maxillae of zoeal stages I-IV and of megalopa. Scale line equals 0.1 mm.

Maxilliped 3 (Fig. 11-IV): The endopod is slightly elongated, but others as in the previous stage.

Megalopa

The carapace length ranges 1.53-1.64 mm; mean 1.60 mm, while width 1.07-1.12 mm (3 specimens). Generally, the external morphology resembles that of adult crabs. The rostrum is reduced in size, and the postero-lateral spines have disappeared. The pereiopods are now functional; the fifth pereiopod is concealed under the carapace (Fig. 3-M). The exopod of the first through third pleopod carries 9 long plumose setae, and the fourth has 8 ones (Fig. 3-P4). The uropods is as in the previous stage (Fig. 3-U).

Antennule (Fig. 5-M): The antennule consists of a three-segmented peduncle which distally has a pair of segmented rami. The larger ramus is four-segmented; the basal has neither setae nor aesthetascs; the next bears 6 aesthetascs, the third has 5 (occasionlly 6) aesthetascs and 3 setae, and the distal segment carries 3 terminal setae and one subterminal seta. The smaller ramus is two-segmented; the distal segment has 3 large terminal setae and 3 small setae, and the proximal segment bears 2 setae. The proximal segment of the peduncle without seta, while the second and third one carries small, non-plumose seta on each.

Antenna (Fig. 5-M'): The endopod is transformed into an elongate, eleven-segmented process; all segments except the third and sixth from the basis carry simple setae. The exopod now is reduced to a small digitiform prominence.

Mandible (Fig. 6-M): General feature of the mandible is transformed into a spoon-shape; the palp is three-segmented, providing with 3 short setae on the distal segment.

Maxillule (Fig. 7-M): The endopod now is three-segmented and the second segment has one plumose seta. The basal endite bears 5 or 6 simple setae and several small spines, and the coxal endite carries 6 setae.

Maxilla (Fig. 8-M): The endopod is transformed into a single-lobed projection without setal armature. The basal endite carries 9 setae on each lobe, but occasionally the proximal lobe with 8 setae. The bilobed coxal endite has 5 setae

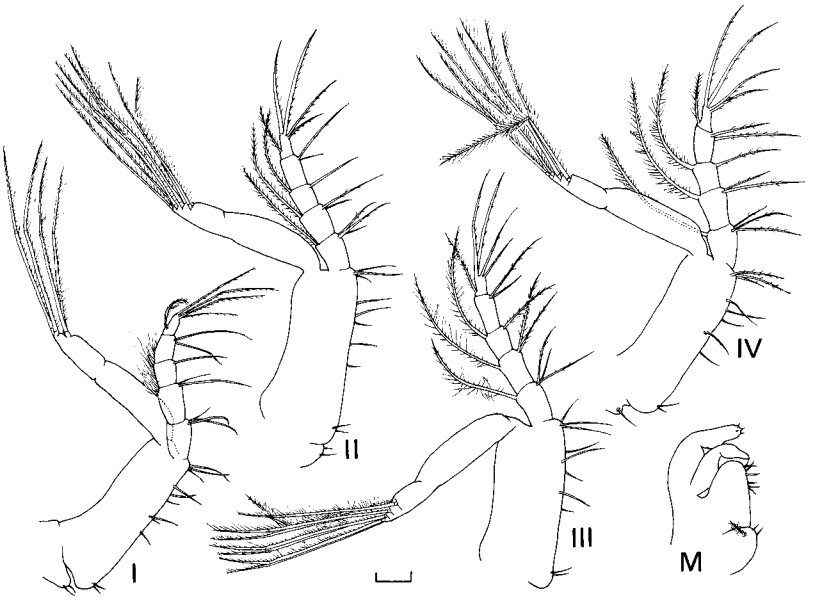

Fig. 9. *Hapalogaster dentata* (De Haan). First maxillipeds of zoeal stages I-IV and of megalopa. Scale line equals 0.1 mm.

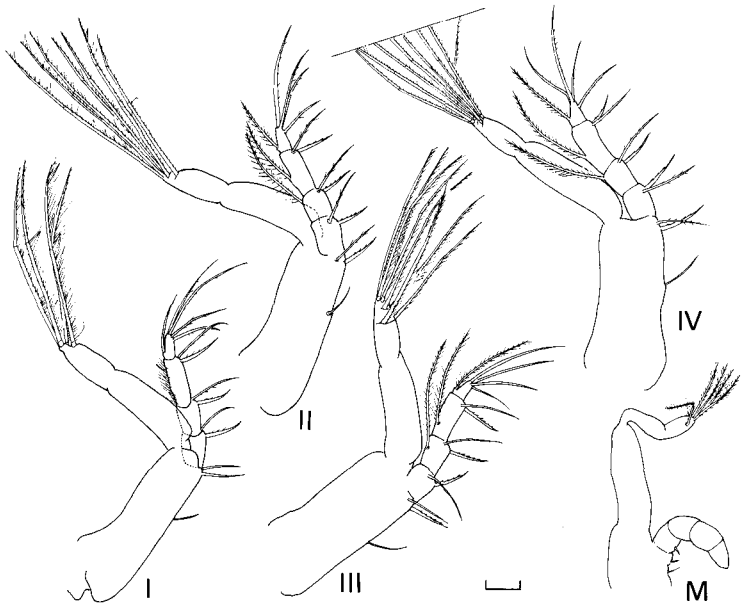

Fig. 10. *Hapalogaster dentata* (De Haan). Second maxillipeds of zoeal stages I–IV and of megalopa. Scale line equals 0.1 mm.

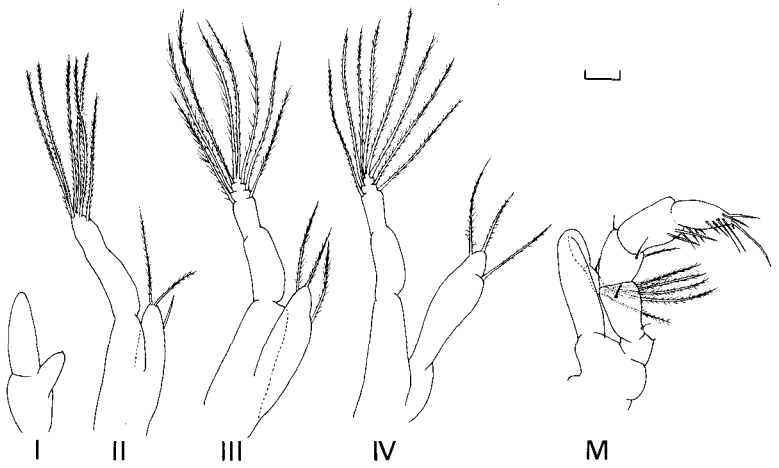

Fig. 11. *Hapalogaster dentata* (De Haan). Third maxillipeds of zoeal stages I–IV and of megalopa. Scale line equals 0.1 mm.

on the proximal and 4 (occasionally 5) ones on the distal lobe. The number, of marginal, soft plumose setae of the scaphognathite ranges from 31 to 36.

Maxilliped 1 (Fig. 9-M): The first maxilliped is reduced, smaller than in the zoeal stages. The endopod with unarmed. The two-segmented exopod has 4 terminal short spines. The innerdistal margin of the basal endite bears 7 simple setae, while the coxal endite carries 2 simple and one plumose setae.

Maxilliped 2 (Fig. 10-M): The second maxilliped is also reduced in size as in the first maxilliped. The exopod has 5 long plumose setae distally. The endopod four-segmented and the first segment has one short simple seta. The basis bears 2 simple setae.

Maxilliped 3 (Fig. 11-M): The third maxilliped is slightly larger than in the zoeal stages. The two-segmented exopod carries 5 long plumose setae distally. The endopod is five-segmented and armed with setae as in the crab stages.

First carb

The general appearance is very similar to that of the megalopa, but the abdomen is now folded ventrally. The carapace length is 1.71 mm, and width 1.21 mm. Several spines fringe the antero-lateral borders of the carapace (Fig.

Table 1. Larval descriptions within the family Lithodidae

Species	Stage (s)	Source of materials	Author (s)
(Hapalogastrinae)			
Dermaturus mandtii	Z1-4, M, C1-2	P+L	Kurata, 1964
Hapalogaster dentata	Z1-4, M, C1	L	present study
Hapalogaster mertensii	PZ, Z1-4, M, C1	L	Miller & Coffin, 1961
(Lithodinae)			
Paralithodes camtschaticus	Z1	L	Nakazawa, 1912
Paralithodes camtschaticus	Z1	P	Marukawa, 1933
Paralithodes camtschaticus	PZ, Z1-4, M	P	Sato, 1958
Paralithodes camtschaticus	Z1-4, M, C1	P+L	Kurata, 1964
Paralithodes brevipes	Z1, LZ, M	P+L	Marukawa, 1933
Paralithodes brevipes	PZ, Z1-4, M, C1	L	Kurata, 1956
Paralithodes platypus	Z1	(L)	Marukawa, 1933
Paralithodes platypus	Z2-4	(P)	Sato, 1958
Paralithodes platypus	Z1	P	Kurata, 1964
Paralithodes platypus	Z1-4, M	L	Hoffman, 1968
Lithodes maja	PZ, Z1, LZ	P+L	Sars, 1890
Lithodes maja	Z1-2, M	L	MacDonald, *et al.*, 1957
Lithodes aequispina	Z1-4, M	L	Haynes, 1982
Lithodes antarctica	Z1-3, M	L	Campodónico, 1971
Paralomis granulosa	Z1-2, M	L	Campodónico & Guzmán, 1981
Cryptolithodes typicus	Z1-4, M, C1	L	Hart, 1965

L: laboratory-reared, P: plankton, C: crab stages, M: megalopa, Z: zoeal stages.

3-C).

Discussion

Since Sars (1890) described the prezoea, the first and last zoeas of *Lithodes maja* (L.), the larval development of the family Lithodidae has been studied in 5 genera, 10 species (Table 1). In Japan, Nakazawa (1912), who was the first author write about Japanese anomuran larvae, described the first zoea of *Paralithodes camtschatica* (= *P. camtschaticus*). After this pioneer work, several studies have been made in Japanese lithodid crabs, but most of them dealt with such large and commercially important species as *Paralithodes*. Studies of larvae of the subfamily Hapalogastrinae, which is not important commercially, are also scarce both in Japan and in other countries. At present, only 2 reports about them are known: *Hapalogaster mertensii* (Brandt) by Miller and Coffin (1961), and *Dermaturus mandtii* by Kurata (1964). The larval description and illustration of *H. mertensii*, however, are inadequate for making a detaild comparison of the larval characteristics. Kurata (*o.c.*) gave a description of the larval stages of the Lithodidae from Hokkaido, including 6 unidentified zoeas and magalopas found in plankton.

A synopsis of the main larval characteristics of the present species is shown in Table 2. The setation of the maxillular and maxillar endopods, as well as the maxillipedal basis, are constant throughout the zoeal stages; these characteristics also shown little individual variation. Four zoeal instars were observed in *H. dentata*, this being consistent with those found in *H. mertensii* and *D. mandtii*. The larvae of the *Lithodes* species, *Paralomis granulosa* (Campodónico and Guzmán, 1981) and of *Paralithodes brevipes* (Kurata, 1956) have fewer zoeal instars than those of typical paguroids: i.e. 4 zoeal stages. They also have many marginal setae on the maxillar scaphognathite even in the first zoeal stage: e.g. 12-15 setae in the first zoea of *Paralomis granulosa*. The larval development of the Lithodinae frequently shows an abbreviated character, whereas that of the Hapalogastrinae has a constant instar number of paguroid (= Paguridae + Lithodidae) species, so far as is known. In this respect, it is suggested that the Hapalogastrinae has more primitive or typical paguroid features than the Lithodidae. The megalopas of the Lithodidae, except for *Cryptolithodes typicus* Brandt, usually carry many spines on the carapace as do adult crabs, whereas those of the Hapalogastrinae have none.

The zoea of *H. dentata* closely resembles that of *D. mandtii*, but the zoeas of these two species are distinguished by the setation of the antennal scale and endopod during the first stage, and by the setal number of uropods in the later stages. The megalopas of both species also differ in the setal number of the uropodal exopods: 3 in *H. dentata* and 4 in *D. mandtii*.

The zoeas of the *H. dentata* have several characteristics in common with Kurata's "Species C" (Table 3): 1) size of body, 2) setal arrangement of the

Table 2. A synopsis of main larval characteristics of *Hapalogaster dentata* (De Haan)

Characteristics	Larval stages				
	Z1	Z2	Z3	Z4	M
CARAPACE:					
length (range, mm)	1.73-1.89	1.74-1.93	1.98-2.13	2.09-2.37	1.53-1.64
ANTENNULE:					
aesthetascs	6	7-8	8	10	11-12
setae	2	4	5	4	7
endopod	—	bud	bud	bud	2, 8
ANTENNA:					
endopod	+	+	+	+	5p+10f
exopod	7	7	7	7	r
MANDIBLE:					
palp	—	—	bud	bud	+
MAXILLULE:					
endopod	2, 1, 3	2, 1, 3	2, 1, 3	2, 1, 3	r
basal endite	4	6	6	6	12 (15), 1
coxal endite	7	8	7	8	4+2
MAXILLA:					
endopod	3+4	3+4	3+4	3+4	r
basal endite	5+4	5+4	5+4	5 (4)+4	9 (8)+9
coxal endite	8+3	8+4	8+4	8+4	5 (4)+4
scaphognathite	5	8	11	12-13	31-36
MAXILLIPED 1:					
basis (protopod)	10	10	10	10	r
endopod seg. 1	3+n	3+1	3+1	3+1	—
seg. 2	2+n	2+1	2+1	2+1	—
seg. 3	1+n	1+1	1+1	1+1	—
seg. 4	2+0	2+0	2+0	2+0	—
seg. 5	4+1	4+1	4+1	4+1	—
exopod	4	7	8	8	r
MAXILLIPED 2:					
basis (protopod)	3	3	3	3	r
endopod seg. 1	2+0	2+0	2+0	2+0	1
seg. 2	2+n	2+1	2+1	2+1	1
seg. 3	2+n	2+1	2+1	2+1	0
seg. 4	4+1	4+1	4+1	4+1	0
exopod	4	7	8	8	5
MAXILLPED 3:					
setae of endopod	(bud)	2 (3)	3	3	0, 5, 6, 8, 8
exopod	(bud)	6	8	8	5
ABDOMEN:					
pleopod	—	—	—	bud	9
No. of somites	5	5	(6)	6	6
TELSON:					
uropod (exopod)	—	—	+	+	+
(exopod, setae)	—	—	3	3	3
No. of processes	7+7	8+8	8+8	8+8	—

[—: absent, +: present, f: flagellum, n: numerous fine setae, p: peduncular, r: reduced; setation = from proximal to distal]

Table 3. Comparison of main larval characteristics within the family Lithodidae

SPECIES	INSTAR	CARAP.	ANTENNA		MAXILLULE	MAXILLA		UROPOD[1]	TELSON
		PLS	exo.	end.	end.	end.	sca.	exo.	proc.
Hapalogaster									
dentata	4	+	7	s	2, 1, 3	3+4	5-6	3	7+7
mertensii[2]	4	+	6	s	(1, 1, 3)	(3+3)	?	4	7+7 (?)
Dermaturus									
mandtii	4	+	10	—	2, 1, 3	3+4	5	4	7+7
Paralithodes									
camtschaticus	4	+	6	—	2, 1, 3	3+4	5	3	8+8
brevipes	3	+	9	s	2, 1, 3	3+4	5	3	7+7
platypus[3]	4	+	9	—	2, 1, 3	3+4	5	4	9+9
platypus[4]	4	+	8	s	0, 1, 3	3+3	5	3	9+9
Lithodes									
maja	2	+	8-9	—	2, 1, 3	3+4	10	(+)	10+10
aequispina	4	+	10	—	0, 1, 3	3+4	11	2-3	12+12
antractica	3	+	9	—	0, 4	3+3	15	(+)	10+10
Paralomis									
granulosa	2	+	9	—	0, 3	3+4	12-15	—	10+10
Crypotolithodes									
typicus	4	—	8	s	0, 1, 3	3+4	11	—	7+7
unidentified[5]									
Species A.	?	+	9	s	?	?	?	?	7+7
Species B.	4	+	8	s	?	?	?	3	7+7
Species C.	4	+	7	s	?	?	?	3	7+7

PLS: postero-lateral spines, s: subterminal spine, sca.: scaphognathite, +: present, —: absent
[1] last zoeal stage, [2] data shown in parentheses are judged from text figures, [3] after Kurata, 1964, [4] after Hoffman, 1968, [5] after Kurata, 1964.

antennal scale, 3) presence of a minute subterminal spine on the antennal endopod, and 4) setation of the uropod in the later zoeal stage. As Kurata stated, ".. probably, the adult crabs of this larva will be commonly found in this area (Ishikari Bay, the Sea of Japan)". In fact, adult crabs of *H. dentata* are distributed along the coast of the Sea of Japan, including Ishikari Bay. It now seems most probable that the "Species C" can be ascribed to the zoeas of the present species. Among 3 of Kurata's unidentified magalopas of "Species G-1, G-2, and G-3", "Species G-2" is very similar to the megalopa of *H. dentata* in having 3 terminal setae on the uropod, and in the shape of the carapace. The "Species G-2" were collected from the coast of the Sea of Japan, while those of the "Species G-3" were obtained both from Ishikari Bay and Akkeshi Bay located on the Pacific side of Hokkaido. The adult crabs of *H. dentata*, however, have not been recorded in that area. These facts suggest that the "Species G-2" is likely to correspond to the megalopa of *H. dentata*.

It has been said that the zoeas of Lithodidae have a close affinity to those of the Paguridae, whereas the megalopas are quite different because of their adult-like form; consequently, it is difficult to distinguish the zoeas of the two families. Some authors have tried to generalize the larval characteristics of the Lithodidae, although information about the larvae of this family was limited. Gurney (1942) pointed out that there were no definable differences between the larvae of the Lithodidae and those of the Paguridae apart from the reduction or disappearance of the uropods. MacDonald *et al.* (1957) stated that the diagnostic feature of lithodid larvae revealed that there were no medio-dorsal on the abdominal somites and that the appendages of the sixth abdominal somite were reduced and did not take the form of an uropod. Pike and Williamson (1960) also stressed that the number of zoeal stages tended to be reduced and that pleopod buds were present from first stage. In his description of the lithodid larvae found in Hokkaido, Kurata (1964) listed the general larval features of the Lithodidae, and pointed out that the lithodid zoeas bear lateral carinae on the carapace and an endopod of the third maxilliped in the first stage. Later, negative evidence against these generalized larval features was offered for *Cryptolithodes typicus* (Hart, 1965). For example, the zoeas of *C. typicus* have a carapace like that of some Diogenidae and the Coenobitidae species. She stated, ".. I feel it unwise to attempt to generalize at present time". Since then, however, the problem does seem to be diminishing gradually, as larval information increases, especially of the pagurid species (see also Gore and Scotto, 1983). The pagurid zoeas are clearly different from lithodid ones in 2 respects: possession of an uropodal endopod and the absence of the third maxillipedal endopod during the late stages. Lack of medio-dorsal spines on the abdominal somites serves available to separate the lithodids from the coenobitids and some of the diogenids. There is also a noticeable absence of the anal spine on the ventral surface of the telson in the Lithodidae, although few of the authors mention this feature. Recent larval evidence, therefore, mainly supports the conclusion of Kurata. Considering previous larval data and the results of the

present study, we select the zoeal characteristics and suggest the following diagnosis of lithodid zoeas:

1) Uropods, if present, lack an endopod, even in the final zoeal stage.
2) The third maxilliped has an endopod in the first zoeal stage.
3) Abdominal somites lack medio-dorsal spines.
4) The telson without an anal spine.

Summary

The complete larval development of the stone crab, *Hapalogaster dentata* (De Haan), with occurs on the southwest coast of Hokkaido, is described, based on larvae reared in the laboratory. This species passes through 4 zoeal stages and one megalopa. At a temperature of 15℃ and a salinity of 35 ppt., the development through the 4 zoeal stages to the emergence of the first crab at least 30 days. The zoeal and megalopal stages of *H. dentata* are compared with previously reported species of the Lithodidae and morphological differences between 2 subfamilies are noted in zoeal instars and carapace armatures of megalopas. The larvae of the present species resemble those of *Dermaturus mandtii* Brandt, but they are distinguished by setation of the antennal scale and the uropods in the zoeal stages, and by the uropod in the megalopa. Main larval characteristics of the present zoeas and megalopa are compared with unidentified planktonic lithodid larvae described by Kurata (1964), and it is proposed that Kurata's zoea "Species C" and megalopa "Species G-2" correspond to the zoea and megalopa of *H. dentata*, respectively. A diagnosis of the lithodid zoeas is also suggested.

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Addendum: Larval description has been reported for the zoeas of lithodid crabs (*cf*. Haynes, 1984, Fish. Bull. 82: 315-324).