Zoeas of Calappa Species with Special Reference to Larval Characters of the Family Calappidae (Crustacea, Brachyura)

Authors: Taishaku, Hajime, and Konishi, Kooichi

Source: Zoological Science, 12(5) : 649-654

Published By: Zoological Society of Japan

URL: https://doi.org/10.2108/zsj.12.649

ZOOLOGICAL SCIENCE 12: 649–654 (1995)

Zoeas of *Calappa* Species with Special Reference to Larval Characters of the Family Calappidae (Crustacea, Brachyura)

HAJIME TAISHAKU[1] and KOOICHI KONISHI[2]

[1]*Toba Aquarium, Toba, Mie 517 and* [2]*National Research Institute of Aquaculture, Nansei, Mie 516-01, Japan*

ABSTRACT—The first stage zoeas of two box crabs, *Calappa japonica* Ortmann, 1892 and *Calappa gallus* (Herbst, 1803), are described and illustrated from laboratory-hatched material. The main morphological characters are compared with those of previously described species within the Calappidae. The first stage zoeas of all *Calappa* species so far described are very similar except in overall size and the number of spinules on rostral spine. However, there are conspicuous differences among the early zoeal stages of the calappid genera.

INTRODUCTION

Box crabs of the genus *Calappa* of the family Calappidae are remarkable because of their unique cheliped shape and their predatory behavior against gastropods and hermit crabs [18, 20, 22]. It is of interest as to at which point in their life history the calappid crabs attain their specialized form and behavior. Knowledge of larvae of the box crab larvae is, however, fragmentary [15]. The first larval description in the family was made by Smith [19] for *Calappa flammea* (Herbst), under the name of *C. marmorata*, but no figures were given. Gurney [7] provided a complete morphological description for *C. lophos* (Herbst) larva, while Lebour [12] described the planktonic megalopa stages of *C. flammea* and *Cycloes bairdii* Stimpson from Bermuda. Several authors have studied calappid zoeas: *C. lophos* [1, 14, 22], *C. philargius* (L.) [21], *Hepatus chilensis* (H.Milne Edwards) [3], *Matuta lunaris* (Forskål) [8, 14, 21], and *Orithya sinica* (L.) [9]. Recently, Seridji [17] gave a description of planktonic zoeas which were assigned to this family from the western Mediterranean. The complete larval development within the Calappidae is known only for *Hepatus epheliticus* (L.) of the subfamily Matutinae [2].

The larval morphology has been documented in 3 species found in Japanese water [1, 21]. Nevertheless, information on calappid larvae is still poor since this family includes 22 species [13], and it is difficult to identify calappid larvae in plankton samples.

In this paper we describe the first stage zoeas of *C. japonica* Ortmann and *C. gallus* (Herbst), compare larval characters within the Calappidae, and provide a tentative key to zoeas of the calappid subfamilies.

Accepted July 13, 1995
Received April 24, 1995

MATERIALS AND METHODS

Ovigerous females of *C japonica* and *C. gallus* were obtained from Shima, Mie Prefecture in April and October 1993, respectively. Collected females were kept in aquaria at 17–21°C. A female of *C. japonica* laid eggs on September 1 and released the first stage zoeas on September 25. In *C. gallus*, the crab also carried eggs on October 25 and shed the first stage zoeas on November 23. Newly hatched zoeas were fixed in 5% formalin and preserved in 70% ethanol for morphological observation. The larvae were fed with *Brachionus plicatilis* Müller, but all of them died. Total carapace length (TL) was measured between the tips of rostral and dorsal spines. Total width of zoea (TW) was indicated as the distance between the tips of lateral spines. Most of the terminology for setae follows that of Ingle [10]. Setation counts are from proximal to distal. Techniques for dissection, observation and drawings were almost the same as previous work [11]. Differences of size and spinule number of the zoeas were analyzed statistically using Duncan's multiple range test. The specimens used in this study have been deposited at the Zoological Institute, Faculty of Science, Hokkaido University under accession numbers ZIHU 1000 and 1001.

DESCRIPTION OF FIRST ZOEAS

Calappa japonica Ortmann, 1892

Dimensions: TL and TW range 1.48–1.78 mm (mean 1.68 mm) and 1.02–1.18 mm (mean 1.11 mm), respectively.

Carapace (Fig. 1A): A ventrally-curved rostral spine, dorsal spine, and a pair of short lateral spines. Rostral spine with 4–6 pointed spinules along its anterior half.

Antennule (Fig. 2A): Conical with 3 aesthetascs and a short simple seta.

Antenna (Fig. 2B): Biramous, spinous process. Exopod pointed.

Mandible (Fig. 2C): Stout incisor process, molar processes developed.

Maxillule (Fig. 2D): Coxal endite with 6 serrated setae and a simple seta. Basial endite with 2 cuspidate setae, 2

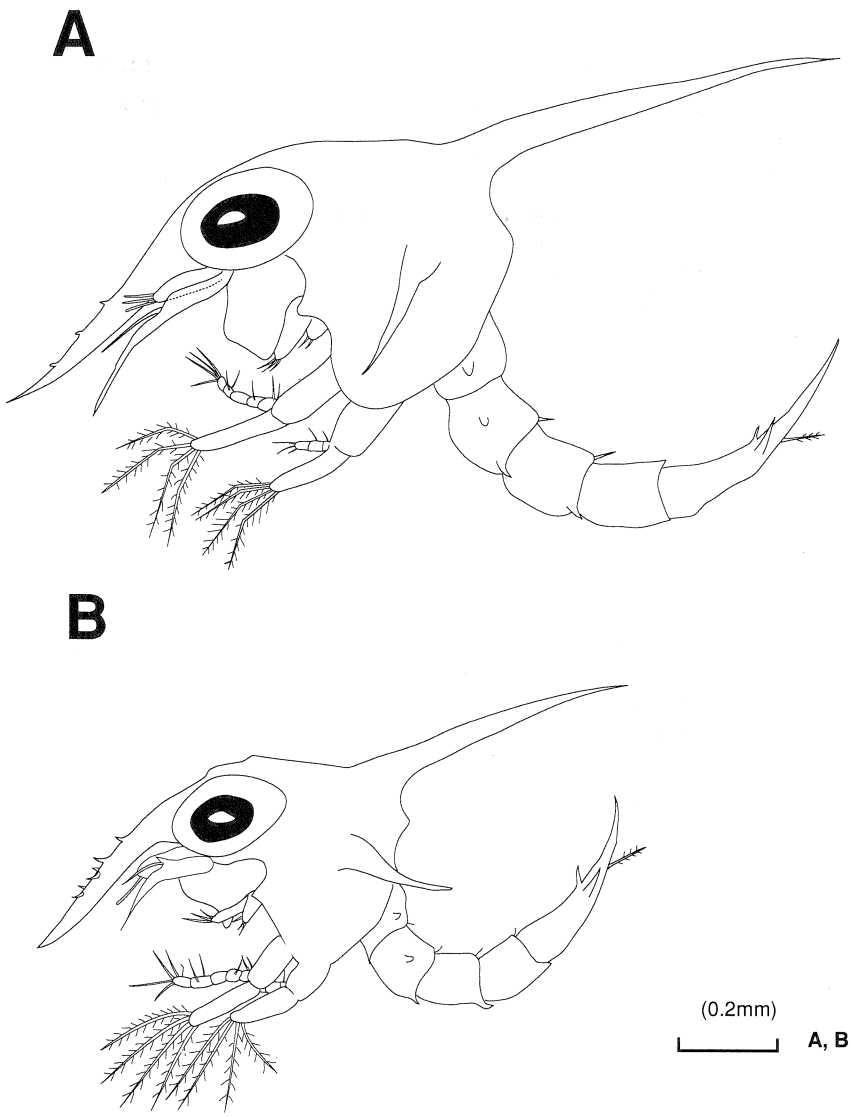

FIG. 1. Whole animals of two *Calappa* zoeas in lateral view. A: *Calappa japonica* Ortmann, 1892, B: *Calappa gallus* (Herbst, 1803). Scale bar=0.2 mm.

plumodenticulate setae, and a short serrated seta. Two-segmented endopod, with 2+4 setae on the distal segment.

Maxilla (Fig. 2E): Coxal and basial endites bilobed, with 5+3 and 4+4 plumodenticulate setae, respectively. Unsegmented endopod with 2+5 setae. Scaphognathite with 4 marginal setulate plumose setae and a long plumose projection.

Maxilliped 1 (Fig. 2F): Coxa with a short seta. Basis with 2+2+2+2 simple setae. Endopod five-segmented, with 2,1,0,2,4+I setae (Roman numeral indicates a dorsal seta). Exopod unsegmented, with 4 long plumose natatory setae distally.

Maxilliped 2 (Fig. 2G): No coxal seta. Basis with 1+1+1+1 setae. Three-segmented endopod with 1,1,3 setae. Exopod as in maxilliped 1.

Maxilliped 3 and pereiopods: Rudimentary bud.

Abdomen: Five somites plus a forked telson. Abdominal somites 2–5 each with a pair of dorsoposterior setules, and somites 2 and 3 with lateral knobs. No pleopods on abdominal somites.

Telson (Fig. 2H): Forked, each furca with 2 outer spines and a dorsal spine, and 3 long posterior setae: posterior outer spine thin and short.

Calappa gallus (Herbst, 1803)

The morphology of this congener species is almost identical with that of *C. japonica* except for its overall size and the morphology of the rostral spine (cf. Fig. 1). TL and TW range 1.28–1.46 mm (mean 1.35 mm) and 0.84–0.98 mm (mean 0.88 mm), respectively. The number of spinules on the anterior half of the rostral spine is 5–10, and these are longer than those of *C. japonica*. In one specimen, the

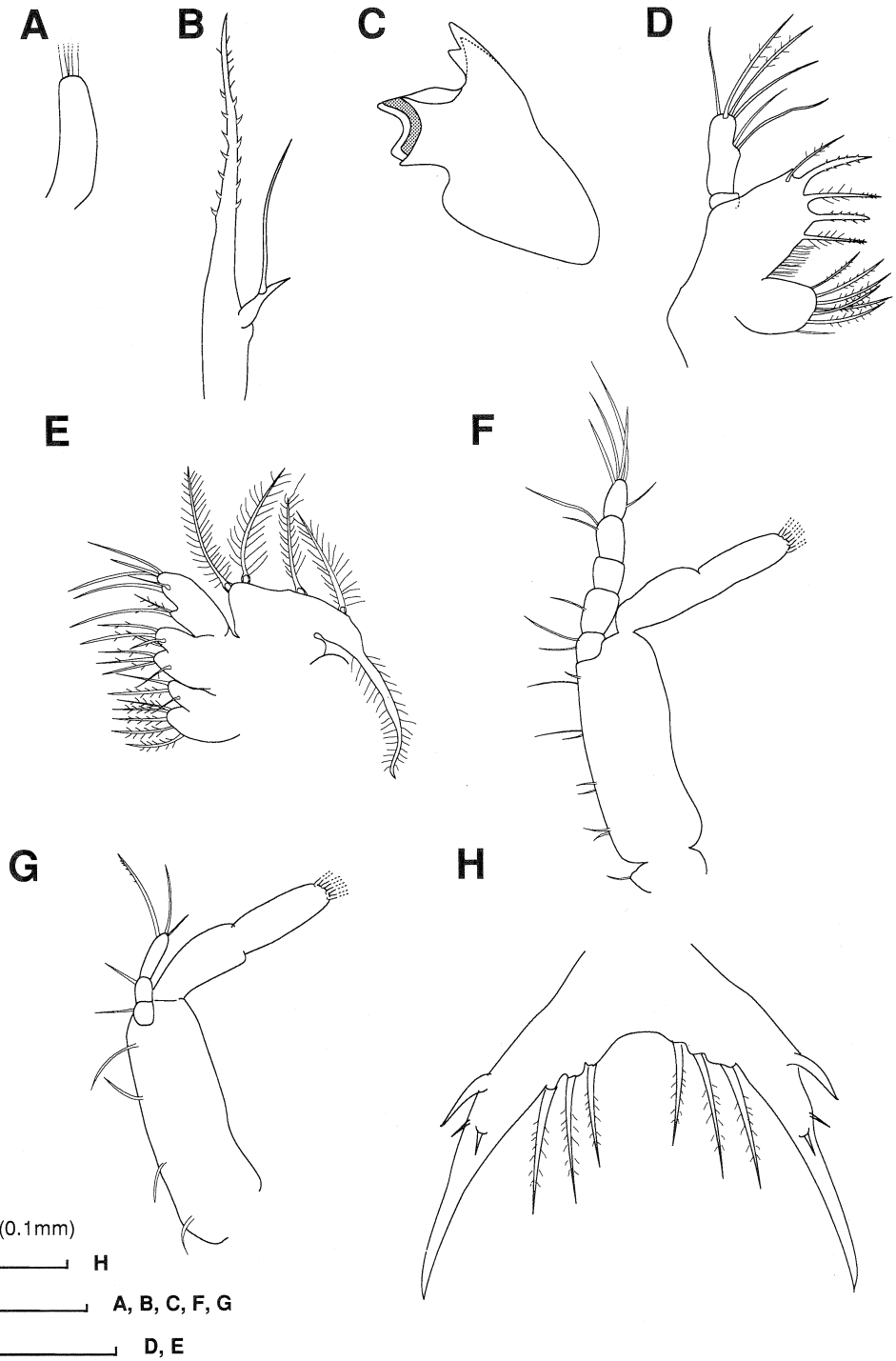

FIG. 2. Appendages and telson of zoea 1 of *Calappa japonica* Ortmann, 1892. A: antennule, B: antenna, C: mandible, D: maxillule, E: maxilla, F: maxilliped 1, G: maxilliped 2, H: telson. Whole aesthetascs or exopod setae are not shown in A, F, and G. Scale bars=0.1 mm.

basial endite of the maxillule had a short distal spinule instead of a seta (Fig. 3D'). The whole animal and the appendages are illustrated in Figure 1B and Figure 3, respectively.

DISCUSSION

Table 1 summarizes the morphology of the known zoeas of the Calappidae. All Indo-Pacific *Calappa* species are almost identical except for the overall size of *C. japonica* and the rostral spines. The TL and the number of spinules on the rostral spine are significantly different between the two species described here ($p<0.01$), and the larvae of both species are larger than those of *C. lophos* and *C. philargius*. *Calappa japonica* and *C. gallus* also appear to differ from *C.*

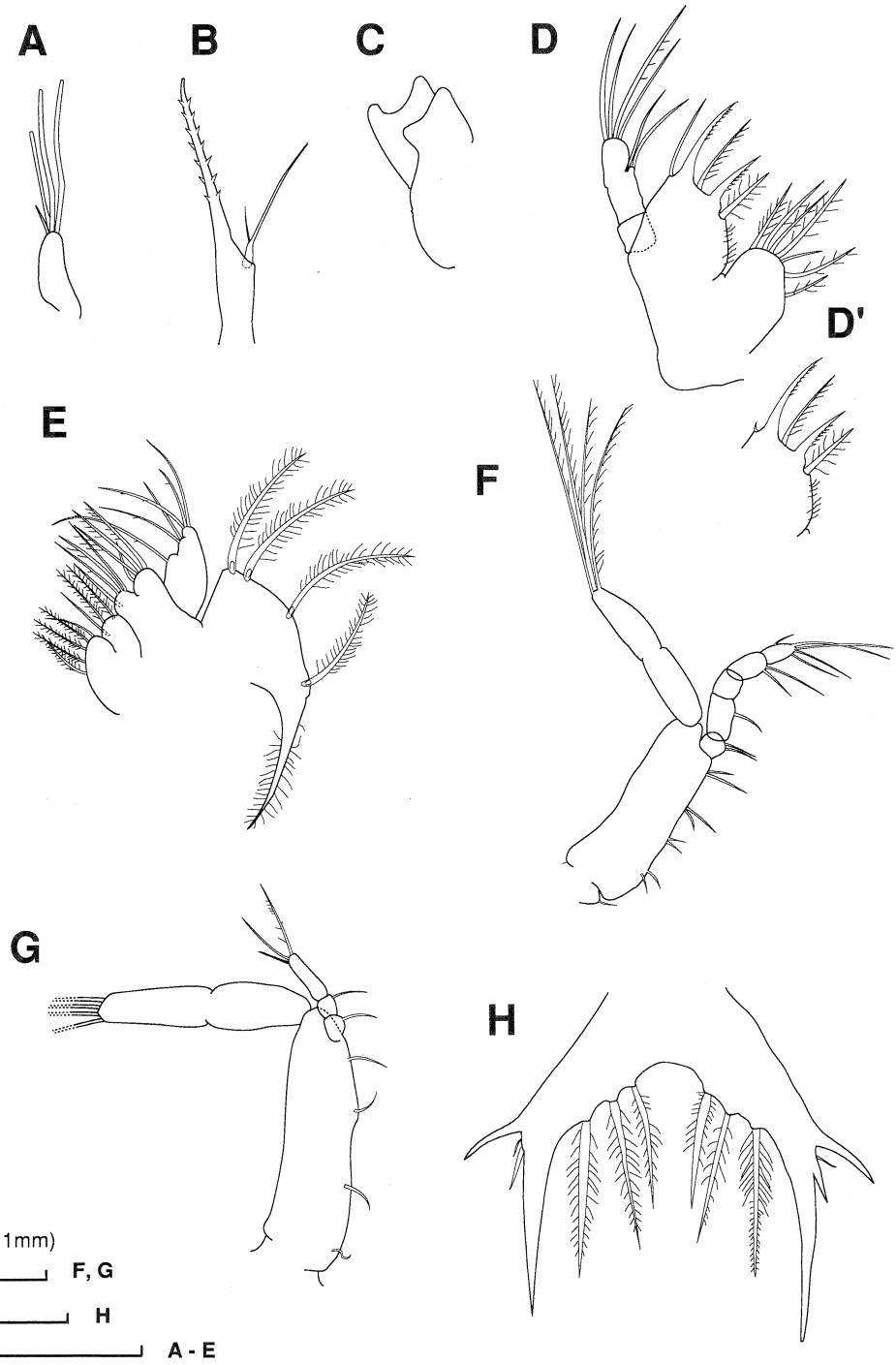

FIG. 3. Appendages and telson of zoea 1 of *Calappa gallus* (Herbst, 1803). A: antennule, B: antenna, C: mandible, D: maxillule, D': maxillular basial endite with short distal seta, E: maxilla, F: maxilliped 1, G: maxilliped 2, H: telson. Whole exopod setae are not shown in G. Scale bars=0.1 mm.

lophos and *C. philargius* in possessing a third outer spine on the telsonal furca, though it is possible that earlier authors overlooked this minute spine. The first zoea of *C. granulata* (L.), which was described from planktonic material from the western Mediterranean, is considerably different from the other known *Calappa* species both in its remarkable body size and the setation of the maxillule and maxillipeds.

On the other hand, there are remarkable differences between the zoeas of different subfamilies within the Calappidae. We herewith give a tentative key to the early zoeas of the calappid subfamilies based on laboratory-reared materials.

1. Rostral and dorsal spines of carapace remarkably longer

TABLE 1. Comparison of main larval characters of the first stage zoeas of Calappidae

Subfamily	Calappinae					Matutinae				Orithyiinae
Species	*C. japonica*	*C. gallus*	*C. lophos*	*C. granulata*	*C. philargius*	*M. lunaris*	*M. planipes*	*H. epheliticus*	*H. chilensis*	*O. sinica*
References	This study	This study	[21]	[17]	[21]	[21]	[8]	[2]	[3]	[9]
CARAPACE										
TL(mm)	1.68	1.35	0.95	2.2	0.93	0.66	0.76*	0.95*	1.5	8.50(1.28)**
rostral spine	+	+	+	+	+	+	+	+	+	+
dorsal spine	+	+	+	+	+	+	+	+	+	+
lateral spine	+	+	+	+	+	+	+	+	+	+
ANTENNULE										
aesthetascs	3	3	3	?	3(?)	3	3	4	(2)	3
ANTENNA										
endopod	—	—	—	—	—	—	—	—	—	+
exopod	+(r)	+(r)	+	+	+	—	—	+	+	+
MAXILLULE										
coxal endite	7	7	7	7	7	6	6	7	7	5
basial endite	5	5	5	5	5	5	5	5	5	5
endopod	0,2+4	0,2+4	0,2+4	1,2+4	0,2+4	1,4	1,3	1,6	1,6	1,5
MAXILLA										
coxal endite	5+3	5+3	5+3	5+4	5+3	4+3	4+2	6+4	3+4	6+3
basial endite	4+4	4+4	4+4	4+4	4+4	4+4	2+2	5+4	5+4	8+8
endopod	2+5	2+5	2+5	2+5	2+5	2+2	2+2	3+5	3+5	3+5
scaphognathite	4+a	4+a	4+a	?	4+a	4+a	4+a	4+a	4+a	8+a
MASILLIPED 1										
basis	2+2+2+2	2+2+2+2	2+2+2+2	1+1+2+3	2+2+2+2	2+2+3+3	?	2+2+3+2	2+2+3+2	2+2+3+3
endopod	2,1,0,2,4+I	2,1,0,2,4+I	2,1,0,2,4+I	3,2,1,2,4+I	2,1,0,2,4+I	3,2,1,2,4+I	3,2,1,2,4+I	3,2,1,2,4+I	3,2,1,2,4+I	2,2,1,2,4+I
MASILLIPED 2										
basis	1+1+1+1	1+1+1+1	1+1+1+1	1+1+1+1	1+1+1+1	1+1+1+1	?	1+1+1	1+1+1+1	1+1+1
endopod	1,1,3	1,1,3	1,1,3	1,1,5	1,1,3	1,1,6	1,1,5	1,1,5	1,1,4	0,1,4
ABDOMEN										
lateral expansion in somite 4	—	—	—	—	—	+	+	—	—	—
TELSON										
outer spine	2+r	2+r	2	2(r)	2	3	3	?	3	2(1+r)
inner spine	3+3	3+3	3+3	3+3	3+3	3+3	3+3	3+3	3+3	4+4

* measured from figure, ** number in parenthesis shows carapace length (CL), r: reduced or vestigial form, TL: total carapace length.
C.: Calappa, H.: Hepatus, M.: Matuta, O.: Orithyia

than lateral spines; maxillular scaphognathite with 8 plumose setae in the first stage.
.....Orithyiinae

— Rostral, dorsal and lateral spines of carapace approximately equal length; scaphognathite with 4 plumose setae and a plumose apical projection at the first stage.
..... 2

2. Proximal segment of maxillular endopod without seta; endopod of maxilliped 1 with setation of 2,1,0,2,4+I.
.....Calappinae

— Proximal segment of maxillular endopod with a seta; endopod of maxilliped 1 with setation of 3,2,1,2,4+I.
..... 3

3. Carapace without lateral spines; abdominal somite 4 with prominent lateral expansion.
..... Matutinae (*Matuta*)

— Carapace with lateral spines; abdominal somite 4 without lateral expansion.
..... Matutinae (*Hepatus*)

The matutinid genera, *Hepatus* and *Matuta*, differ from each other in the main larval characters. This supports Guinot's conclusion [4, 5] which united the genera *Hepatus*, *Aethra*, *Osachila*, *Hepatella* and *Actaeomorpha* in Hepatinae, distinguishing it from the Matuninae.

The zoeas of the subfamily Calappinae closely resemble those of the families Portunidae and Xanthidae in general morphology, having telsonal furca with outer spines, the antenna with an exopod, and lateral knobs on abdominal somites 2 and 3. The *Calappa* zoeas are distinguished from the xanthid zoeas by setal number of proximal endopod

segment in maxilliped 1:2 in the former and 3 in the latter. The portunid zoeas also differ from *Calappa* zoeas in having a single seta on the proximal segment of the maxillular endopod and only a seta on the second endopod segment of maxilliped 1. The Calappidae, Leucosiidae, Dorippidae, and Raninidae have been grouped into the higher taxon Oxystomata in the classification of adult crabs, whereas their larvae show great morphological diversity. In recent trends in adult brachyuran taxonomy, however, this taxon is no longer valid [6]. On the basis of larval morphology, a similar conclusion was proposed by Rice [16]. Seridji [17] also adopted it from the view point of larval morphology, suggesting that the Oxystomata seemed more likely to be an assemblage of diverse taxa adapted to a similar mode of life.

All zoeas of the present two species died without feeding on the marine rotifers provided. Terada [21, 22] had the same experience with *C. lophos* and *C. philargius*. It is not clear at present whether calappid zoeas feed on zooplankton or not, although Terada [*op. cit.*] suggested that they might feed on phytoplankton. Yatsuzuka and Iwasaki [23] succeeded in rearing small pinnotherid larvae with specialized morphology using a combination of *Chlorella* and bivalve trochophore larvae as diets. Further calappid larval nutritional studies are required, since no complete larval development has been described in the subfamily Calappinae.

ACKNOWLEDGMENTS

We are grateful to Dr. S.F. Mawatari of Hokkaido University for his support in this study. Special thanks are also due to Ms. M. Kurihara for her help during the preparation of the figures.

REFERENCES

1 Aikawa H (1937) Further notes on brachyuran larvae. Rec Oceanogr Wks Japan 9: 87–162

2 Costlow, JD, Bookhout CG (1962) The larval development of the *Hepatus epheliticus* (L.) under laboratory conditions. J Elisha Mitchell Sci Soc 78: 113–125

3 Fagetti GE (1960) Primera estadio larval de cuatro Crustaceos Brachiros de la Bahia de Valparaiso. Rev Biol Mar 10: 143–154

4 Guinot D (1966) Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. I. Les affinités des genres *Aethra, Osachila, Hepatus, Hepatella* et *Actaemorpha*. Bull Mus natn Hist nat 38(5): 744–762

5 Guinot D (1967) Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. I. Les affinités des genres *Aethra, Osachila, Hepatus, Hepatella* et *Actaemorpha* (suite et fin). Bull Mus natn Hist nat 38(6)1966(1967): 828–845

6 Guinot D (1978) Principes d'une classification évolutive des Crustacés Décapodes Brachyoures. Bull biol Fra Belg 112: 211–292

7 Gurney R (1924) Decapod larvae. Natural History Report British antarctic. Terra Nova Exped 8: 37–202

8 Hashmi SS (1969) The brachyuran larvae of the West Pakistan hatched in the laboratory. Part I. Oxystomata Calappidae (Decapod: Crustacea). Pakistan J Sci & Indust Res 12: 272–278

9 Hong SY (1976) Zoeal stages of *Orithyia sinica* (Linnaeus) (Decapoda, Calappidae) reared in the laboratory. Publ Inst Mar Sci, Natl Fish Univ Busan 9: 17–23

10 Ingle RW (1992) Larval stages of northeastern Atlantic crabs: An illustrated key. Chapman and Hall, 363 pp.

11 Konishi K, Taishaku H (1994) Larval development of *Paralomis hystrix* (De Haan, 1846) (Crustacea, Anomura, Lithodidae) under laboratory conditions. Bull Natl Res Inst Aquacult 23: 43–54

12 Lebour MV (1944) Larval crabs from Bermuda. Zoologica New York 29: 113–128

13 Miyake S (1983) Japanese crustacean decapods and stomatopods in color. Vol. II. Brachyura. Hoikusha, Osaka. 261 pp. 56 pls (in Japanese)

14 Raja Bai KG (1959) Studies on the larval development of Brachyura III. Development of *Calappa lophos* (Herbst) and *Matuta lunaris* Forskål (Crustacea: Brachyura). J Zool Soc India 11: 65–72

15 Rice AL (1980) Crab zoeal morphology and its bearing on the classification of the Brachyura. Trans Zool Soc London 35: 271–424

16 Rice AL (1981) Crab zoeae and brachyuran classification: a re-appraisal. Bull Br Mus nat Hist (Zool.) 40: 287–296

17 Seridji, R. (1993) Descriptions of some planktonic larvae of the Calappidae (Crustacea, Decapoda, Brachyura). J. Plankton Res., 15, 437–453

18 Shoup JB (1968) Shell opening by crabs of the genus *Calappa*. Science 160: 887–888

19 Smith SI (1880) Occasional occurrence of tropical and subtropical species of decapod Crustacea on the coast of New England. Trans Connecticut Acad Arts & Sci 4: 254–267

20 Takeda M, Suga H. (1979) Feeding habits of box crabs, Calappa. Res Crust 9: 43–46 (in Japanese with English abstract)

21 Terada M (1987) Zoeal forms of 14 species of crabs from the Enshunada. Res Crust 16: 93–120 (In Japanese with English abstract)

22 Vermeij GJ (1982) Gastropod shell form, breakage, and repair in relation to predation by the crab *Calappa*. Malacologia 23: 1–12

23 Yatsuzuka K, Iwasaki N (1979) On the larval development of *Pinnotheres* aff. *sinensis* Shen. Rep Usa Mar Biol Inst 1: 79–96 (in Japanese with English abstract)