

The Larval Development of *Pagurus lanuginosus* de Haan(Crustacea, Anomura) Reared in the Laboratory

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PAGURUS LANUGINOSUS DE HAAN의 유생 발생에 관한 연구

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Pagurus lanuginosus de Haan의 유생을 실험실에서 사육하여 glaucothoe기까지의 발생을 관찰 연구하였다.

- 1) *P. lanuginosus*는 4기의 Zoea기와 1기의 glaucothoe기의 유생기를 가졌다.
- 2) 평균 수온 13.6°C와 평균 염분농도 33.67%의 사육조건에서 알에서 부화한 zoea-유생은 31—32일 후에 glaucothoe 유생으로 변태 발생했다.
- 3) 각 zoea기의 평균기간은 7—9일이었다.
- 4) zoea 유생의 가장 독특한 형태적 특징의 하나로 미선(telson)의 말단에 3쌍의 돌기(1쌍의 털과 6쌍의 칩)를 가지며 그 돌기의 수와 모양은 전 zoea기 동안에 변함이 없다.
- 5) zoea 유생의 제2 측각의 외지의 내면에는 5개의 우상모가 나 있다.
- 6) glaucothoe 유생의 telson 말단에는 3쌍의 우상모가 나 있다.
- 7) glaucothoe 유생은 안병극을 갖지 않는다.

1. Introduction

Since the early work of Hart (1937), describing the larval stages of *Pagurus beringanus* (Benedict) from laboratory-reared materials, only limited number of papers have been published dealing with the larvae of *Pagurus* species.

The *Pagurus* larvae of the West Pacific regions are poorly known. Kurata (1964) described 18 *Pagurus* species mainly based on the plankton samples collected in the Hokkaido waters. Among the 18 species of Kurata the first zoea of *Pagurus middendorffi* Brandt was obtained both from eggs and plankton materials. The larval development of *Pagurus samuelis* has been studied in detail by Kurata(1968).

Considerable numbers of studies on *Pagurus* larvae were conducted in the British waters and

in the Mediterranean. MacDonald, Pike and Williamson (1957) described in detail the larvae of ten species of Paguridae with morphological keys for identification. The larvae of Diogenidae and Paguridae from the Bay of Naples were studied by Pike and Williamson (1960).

Coffin (1958, 1960) studied the early development of *Pagurus samuelis* (Stimpson), but descriptions of all the appendages of the larvae were limited. The larva of *Pagurus marshi* Benedict was described in great detail by Provenzano and Rice (1964).

The purpose of the present study is mainly to illustrate and to describe the zoeal stages and the glaucothoe of *Pagurus lanuginosus* de Haan based on the larval materials reared in the laboratory. Some informations on the time required for the larval development were given. Larval characters were discussed with those of British species chosen by MacDonald, Pike and Williamson (1957). Comparisons were made with *P. samuelis* and *P. marshi*.

2. Methods and Materials

An ovigerous female of *Pagurus lanuginosus* was collected on 5 January 1969, under the rocks of tide pool in the vicinity of Haewundae Marine Laboratory, Haewundae, Pusan. The specimen was kept in a glass bath containing filtered sea water. The water was changed with filtered seawater everyday.

In the morning of 10 January 1969, a total of 55 larvae was obtained. The larvae were separated into groups of 20 zoeal forms per bowl with approximately 90cc of filtered sea water in clean bowls. Newly hatched *Artemia* nauplii were added as food. Everyday the larvae were moved to freshly filtered sea water in clean bowls to remove exuviae and the dead larvae.

The larvae were reared under the mean temperature of 13.6°C with range of 9–15.5°C. The salinity varied from 33.35 to 33.99‰. The rearing animals were illuminated in the room by natural daylight but were shaded from direct sunlight

Exuviae and the dead specimens were preserved in 70% ethyl alcohol or in 5% formalin buffered with sodium borate. Mallory's acid fuchsin red was used for staining the casts and dead specimens. Permanent preparates were made by using Brandt's glycerin jelly as the mounting medium.

Specimens were dissected in 80% lactic acid under a binocular stereomicroscope. All the drawings were prepared with the aid of a camera lucida. For measurements and observing the color patterns of live specimens, the larvae were anaesthetized with a drop of 0.3% urethane. Measurements were made with an ocular micrometer. Total length was measured from the tip of the rostrum to the median posterior margin of the telson excluding telson spines. Carapace length was measured from the tip of rostrum to the last postero-lateral margin of the carapace, not to the dorsal posterior margin.

The term stage is used herein in sense of instar or intermoult.

I am indebted to Dr. Byung Don Lee, Director of Haewundae Marine Laboratory. He suggested this study and gave me constructive advice during the course of the study, and kindly reviewed the manuscript. I would like to thank Dr. Hoon Soo Kim, Seoul National University, for identifying the adult specimen.

3. General Rearing Data

The larvae of *Pagurus lanuginosus* de Haan reached the glaucothoe after passing through four successive zoeal stages. Table 1 presents a summary of survival to various instars and durations in days of the instars. The first zoea moulted to the glaucothoe 31-32 days after hatching. As shown in Table 1 the durations of each zoeal stage were approximately 7-9 days respectively. All the glaucothoe died after two days from moulting, and no descriptions of the crab instar were possible for the present study.

Table 1. Number of Larvae and Duration in Days of Developmental Stages of *Pagurus lanuginosus* de Haan Based on Specimens Surviving to the Succeeding Instar at Mean Temperature of 13.6°C and Mean Salinity of 33.67‰

	Zoea I	Zoea II	Zoea III	Zoea IV	Glaucothoe
Series I					
No. specimens	20	14	9	5	1
Range	8-10	7-8	8-9	7-8	—
Mean	8.3	7.6	8.0	9	—
Series II					
No. specimens	20	15	6	4	2
Range	8-9	8-9	7-8	8-9	—
Mean	8.3	8.2	7.3	9.5	—

4. Description of the Larval Stages

General Features of the Zoeal Stages

The rostrum does not exceed the cephalic appendages. The postero-lateral margin of the carapace forms a sharp angle. In the first zoeal stage the eyes are fused to the carapace, becoming free from the second stage. The scale-shaped exopodite of antenna bears five pulmose setae, while the endopodite is naked. The rudimentary third maxilliped of the first zoeal stage becomes biramous and setose in the second zoeal stage, and the endopodite has one terminal spine. Abdominal somites 2-5 have two pairs of dorsal spines on the posterior margin. The paired dorsal spines are progressively longer on the more posterior somites. The fifth abdominal somite carries a pair of strong postero-lateral spines. Telson bears 6+1 pairs of processes of which the number is consistent throughout all the zoeal stages. In the first and second zoeal stages the sixth abdominal somite is fused to the telson. In the third zoeal stage the telson becomes free from the sixth abdominal somite for the first time, and the exopodite of uropod appears. No mid-dorsal spines are developed on the posterior margin of the 6th abdominal segment. The basipodites of uropod is naked. In the fourth stage the pleopods are developed as unarmed buds on the abdominal somites 2-5.

The colour pattern is simple persisting through the zoeal stages. A pair of red chromatophores is placed on each basipodite of the third maxillipeds and at the base of the mandible.

There are two pairs of yellowish chromatophores on the carapace; a pair is on the mid-dorsal surface of the cephalothorax, and the other is on the ventro-lateral margin of cephalothorax.

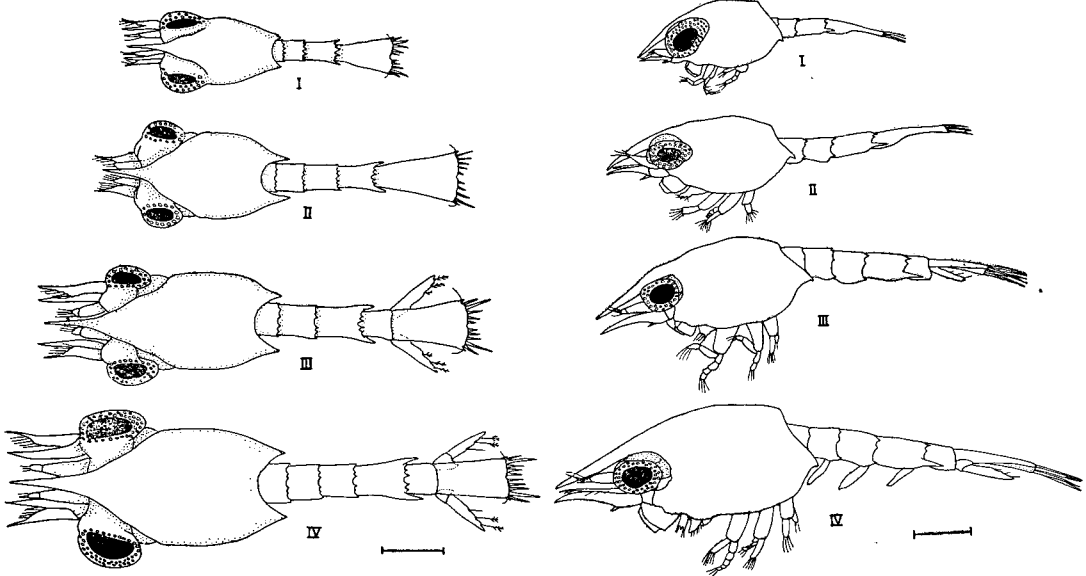


Fig. 1. *Pagurus lanuginosus*.

Dorsal view of zoeal stages. Scale is 0.5mm.

Fig. 2. *Pagurus lanuginosus*.

Lateral view of zoeal stages. Scale is 0.5mm.

First Zoea

Carapace Length : 1.34-1.47mm (3 preserved specimens)

Total Length : 2.19-2.38mm (3 preserved specimens)

Carapace (Figs. 1,2)___ The carapace has a pointed rostrum curved slightly downward distally. The postero-lateral corner of the carapace terminates as the sharp angle. The eyes are sessile.

Abdomen (Figs. 1,2)___ The abdomen is composed of five somites plus a telson. The 6th abdominal somite is fused to the telson. The postero-lateral process of the somites 1-4 is a small acute point, and the one on the 5th somite forms a strong posterior spine. All the abdominal somites bear two pairs of dorsal spines. The posterior margin of the telson (Fig. 3 C-I) is slightly convex with a median notch. There are 6+1 pairs of terminal processes. The outermost one is a fixed spine, the second are fine hairs, and processes 3-7 are strong spines fringed with setules.

Antennule (Fig. 3 A-I)___ Antennule bears two terminal aesthetacs and a subterminal pulmose seta.

Antenna (Fig. 3 B-I)___ The antenna has its exopodite fused to the basipodite. The endopodite terminates as a stout naked process. At the base of the endopodite there is a strong serrated ventral spine. The exopodite is scale-like with five long pulmose setae. The outer-distal corner is elongate and terminates as an acute distal spine.

Mandible (Fig. 4-I)___ The mandibles are stout and well armed with median teeth.

Maxillure (Fig. 3 D-I) ___ The three-segmented endopodite has three long setae on the terminal segment, one on the middle segment, and a short one distally on the proximal segment. The basal endite bears two strong spines with several spinules along the distal half of the spines respectively. There are two simple spines at the base of the strong spines. The coxal endite bears five serrated and two simple setae.

Maxilla (Fig. 5 A-I) ___ The coxal and basal endites are bifurcated. The proximal lobe of the coxal endite bears one terminal and four subterminal setae. On the distal lobe there are three terminal and one subterminal setae. The proximal lobe of the basal endite bears four terminal and one subterminal setae, and there are three terminal and one subterminal setae on the distal lobe. The endopodite has three terminal and 1+2 subterminal setae. The scaphognathite bears five bushy pulmose setae.

The First Maxilliped (Fig. 5 B-I) ___ The exopodite bears four natatory setae. The five-segmented endopodite has a serrated seta arrangement of 3-2-1-2-5 progressing distally. The basipodite carries a total of eight setae in groups of 1-1-2-1-3 progressing distally.

The Second Maxilliped (Fig. 5 C-I) ___ The exopodite has four natatory setae. The four-segmented endopodite has four terminal and one subterminal serrated setae on the distal segment. The three proximal segments bear one finely serrated and one simple spine on the distal corners respectively.

The Third Maxilliped (Fig. 5 D-I) ___ The third maxilliped is a non functional uniramous rudiment.

Second Zoea

Carapace Length : 1.60 - 1.72mm (2 preserved specimens)

Total Length : 3.00 - 3.25mm (2 preserved specimens)

Carapace (Figs. 1-II, 2-II) ___ The carapace is relatively unchanged except that the eyes are no longer immobile.

Abdomen (Figs. 1-II, 2-II) ___ The median notch of the telson (Fig. 3 C-II) has become less distinct.

Antennule (Fig. 3 A-II) ___ The antennule has three additional short setae distally.

Antenna (Fig. 3 B-II) ___ Similar to that of the preceding stage, but the endopodite is jointed to the basipodite.

Mandible (Fig. 4-II) ___ The mandible added two rows of minute corneous teeth.

Maxillule (Fig. 3 D-II) ___ The endopodite is unchanged. The basal endite now has four strong spines and two short spines. The setation of the coxal endite is unchanged.

Maxilla (Fig. 5 A-II) ___ Setation on the both endites is unchanged except that there is an additional seta added to the proximal lobe of the coxal endite. The scaphognathite has seven setae.

The First Maxilliped (Fig. 5 B-II) ___ The exopodite bears five natatory setae. The three proximal segments of the endopodite added each one lateral pulmose seta distally. Pairs of medial setae of the basipodite are not changed.

The Second Maxilliped (Fig. 5 C-II) ___ The penultimate and the antipenultimate segments of

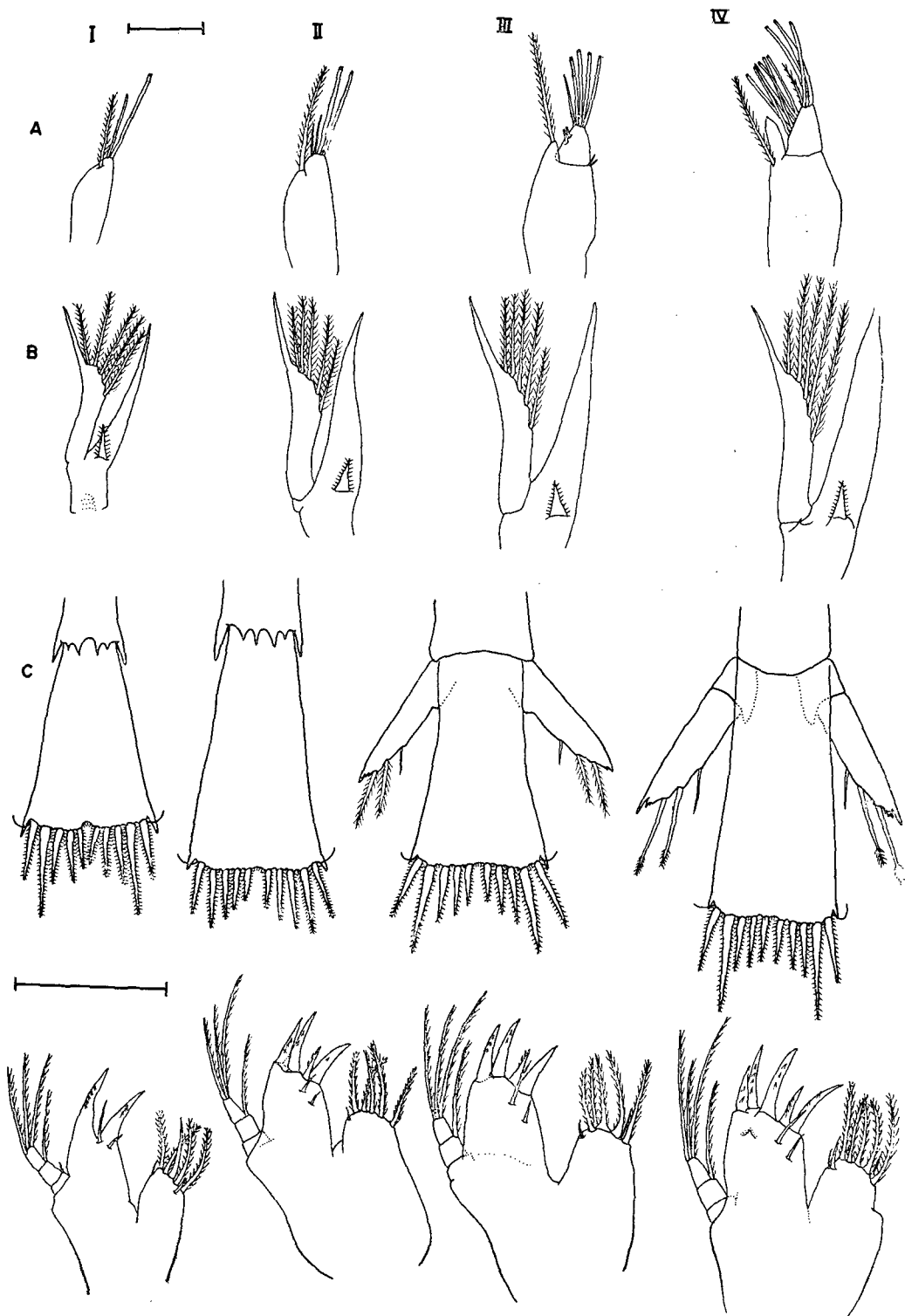


Fig. 3. *Pagurus lanuginosus*. Appendages of zoeal stages. A, antennule; B, antenna; C, telson; D, maxillure. Scales are 0.5mm respectively.

the endopodite added one lateral pulmose seta respectively. The exopodite has seven terminal natatory setae.

The Third Maxilliped (Fig. 5 D-II) ___ The third maxilliped became biramous. The exopodite has six terminal natatory setae, while the unsegmented endopodite bears one pulmose seta distally.

Third Zoea

Carapace Length : 1.95-2.09 mm (2 preserved specimens)

Total Length : 3.45-3.50 mm (2 preserved specimens)

Carapace (Figs. 1-III, 2-III) is relatively unchanged. The eyes are mobile, and the eye stalk is more elongated.

Abdomen (Figs. 1-III, 2-III) ___ The sixth abdominal somite is distinct from the telson (Fig. 3 C-III). The exopodites of the uropod are developed. The inner margin of the exopodite has two long and one short pulmose setae.

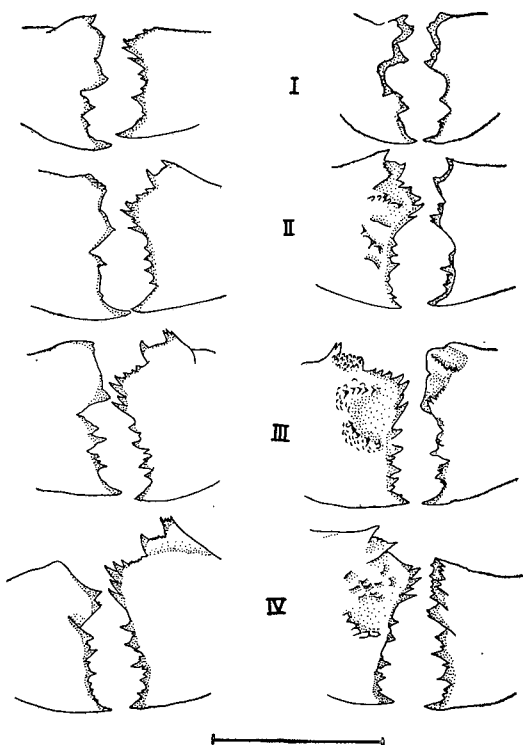
Antennule (Fig. 3 B-III) ___ The antennule has two segments. There is a small lobe bearing one terminal pulmose seta at the distal end of the basal segment with two small setae on the opposing side. The distal segment has five terminal aesthetacs and two short subterminal ones.

Antenna (Fig. 3 B-III) ___ The antenna is essentially unchanged.

Mandible (Fig. 4-III) ___ Several horny ridges and corneous teeth are added.

Maxillure (Fig. 3 D-III) ___ The maxillure differs only in size from that of the second zoea.

Maxilla (Fig. 5 A-III) ___ The proximal lobe of the coxal endite bears two terminal and two subterminal setae. The scaphognathite has 11 bushy hairs. Other setations are not changed.



The First Maxilliped (Fig. 5 B-III) ___ The maxilliped is not changed except for adding of two natatory setae to the exopodite.

The Second Maxilliped (Fig. 5 C-III) ___ The second maxilliped is relatively unchanged except that the exopodite has eight natatory setae.

The Third Maxilliped (Fig. 5 D-III) ___ The third maxilliped has one additional natatory seta to the exopodite.

Fig. 4. *Pagurus lanuginosus*. paired mandibles of zoeal stages in (left column) anterior view, and (right column) posterior view. Scale is 0.5mm.

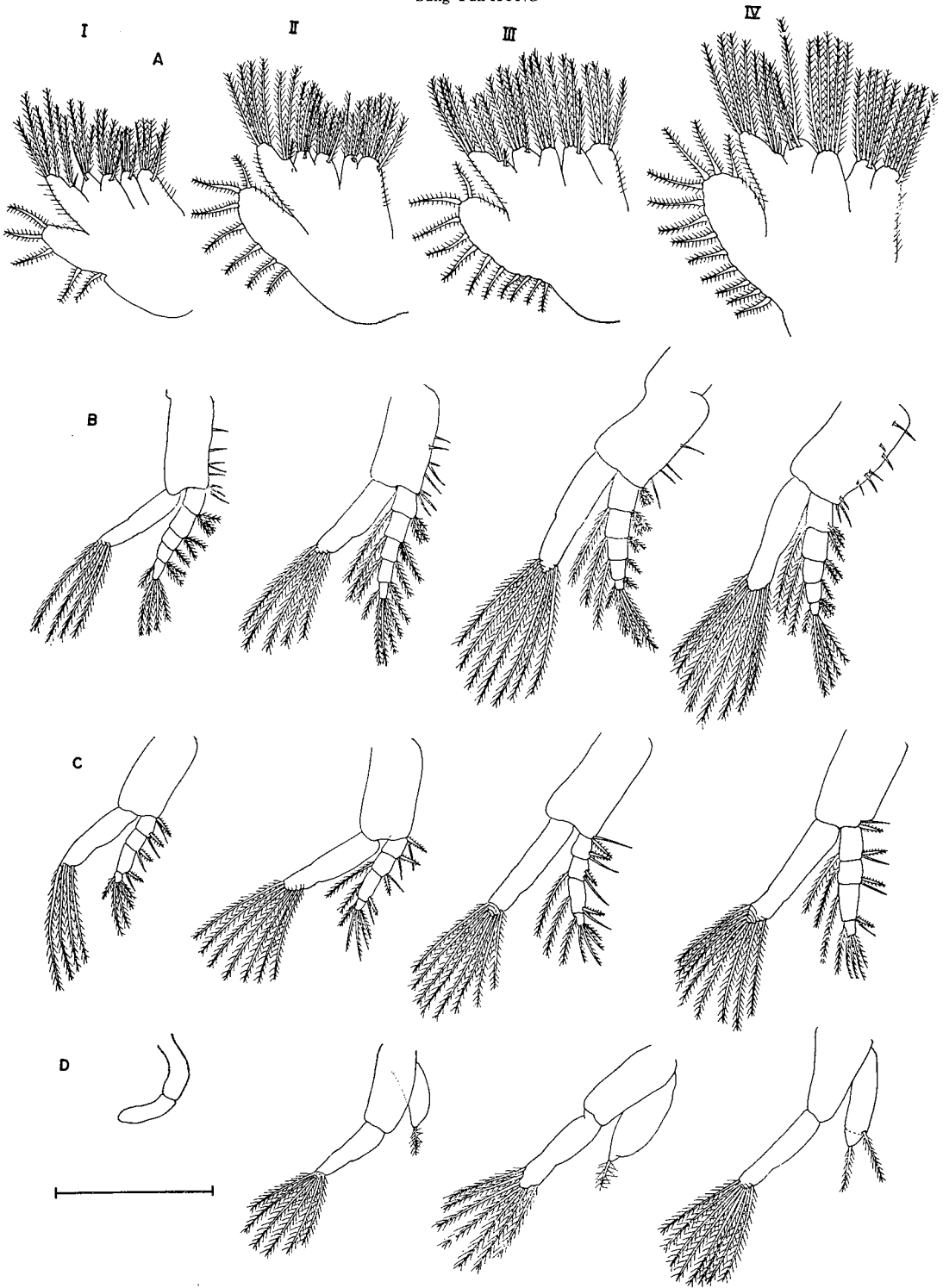


Fig. 5. *Pagurus lanuginosus*. Appendages of zoeal stages. A, maxilla; B, first maxilliped; C, second maxilliped; D, third maxilliped. Scale is 0.5mm.

Fourth Zoea

Carapace Length : 2.15-2.20 mm (2 preserved specimens)

Total Length : 4.01-4.15 mm (2 preserved specimens)

Carapace (Figs. 1-IV, 2-IV)___ The carapace is little changed.

Abdomen (Figs. 1-IV, 2-IV)___ The pleopods are represented by four pairs of unarmed buds on the abdominal somites 2-5. Two pulmose setae on the inner margin of the exopodite of the uropod were replaced by two spines fringed with spinules distally (Fig. 3 C-IV). The exopodite of the uropod terminates as an acute tip with three dentate teeth.

Antennule (Fig. 3 A-IV)___ The terminal pulmose seta on a small lobe is replaced by a subterminal one. The distal segment has three aesthetacs and one pulmose seta distally with six subterminal aesthetacs.

Antenna (Fig. 3 B-IV)___ The endopodite is more thick and strong, and has a minute tooth at the base of the scale-like exopodite.

Mandible (Fig. 4-IV)___ The mandible is basically unchanged.

Maxillure (Fig. 3 D-IV)___ The basal endite has added one strong terminal spine bearing two or three spinules. An additional spine has been added distally to the coxal endite.

Maxilla (Fig. 5 A-IV)___ The maxilla is relatively unchanged except that there is one pulmose spine added to the distal lobe of the coxal endite. The scaphognathite has 12 setae.

The First Maxilliped (Fig. 5 B-IV)___ The first maxilliped is basically unchanged but a seta has been added to the penultimate segment of the endopodite.

The Second Maxilliped (Fig. 5 C-IV)___ The second maxilliped is essentially unchanged except the proximal segment has added one pulmose seta laterally.

The Third Maxilliped (Fig. 5 D-IV)___ The exopodite has added one natatory seta distally. The endopodite has one subterminal pulmose seta additionally.

Glaucothoe

Carapace Length : 2.01 - 2.05mm (2 preserved specimens)

Total Length : 3.09 - 3.10mm (2 preserved specimens)

Carapace (Fig. 6 A,B)___ The carapace is almost equal in length to the abdomen including telson. The prominent rounded rostrum extends well beyond the front. The cornea of the eye is not wider than the eye stalk. The latter is almost two times longer than its width and bears two small setae on the dorsal surface. The eye reaches to the middle of the propodus of the right cheliped. The chromatophore pattern of the glaucothoe is similar to that of the zoeal stages. But the whole surface of the carapace is tinged with reddish colouration.

Abdomen and telson (Fig. 7 R)___ Abdomen has six abdominal somites and a telson. Four pairs of pleopods are on the abdominal somites 2-5. No dorsal spines are found on the distal margin of the somites. The uropods are asymmetrical; the left uropod is slightly larger than the right. The telson is almost round in shape, and has a pair of lateral notch on the lateral margin. The distal margin of the telson bears 3+3 pulmose setae with a median notch. There are pairs of short simple setae of various sizes distributed on the dorsal surface of the telson. The exopodite of the uropod has 10 or 11 pulmose setae with three additional short setae on the postero-lateral margin. There are eight or nine corneous processes on the postero-lateral margin of the

exopodite. The endopodite is much smaller than the exopodite, and bears four corneous processes on the inner margin with a simple short seta distally. The propodite of the uropod has a single short seta dorsally. The sixth abdominal somite bears three pairs of setae at each postero-lateral corner, and four other pairs on the dorsal surface.

Antennule (Fig. 7 A)___ The segmented antennule reaches to the middle of the antenna. The penultimate segment bears a small seta, and distally there is a small two-segmented lobe, representing the inner flagellum, which bears five distal setae. The ultimate four-segmented lobe, representing the fused external flagellum, bears a total of 11 or 15 aesthetacs in three groups on the three distal lobe. The penultimate lobe has a short seta, and the ultimate lobe bears three setae of various sizes

Antenna (Fig. 7 B)___ The antenna reaches far beyond the right cheliped. The oblong antennal scale bears three short spines, and there are flagellated segments bearing a few distal setae except the third segment.

Maxillure (Fig. 7 I)___ The endopodite is unsegmented, recurving at the tip and bearing four simple setae distally. The basal endite carries a group of nine or ten acute teeth, two sub-terminal pulvose setae and three simple setae. The coxal endite has four simple terminal setae.

Maxilla (Fig. 7 J)___ The endopodite is slender and naked. Distal and proximal lobes of the basal endite bear five and six spines respectively. The coxal endite has two and four spines on its distal and proximal lobes respectively.

The First Maxilliped (Fig. 7 K)___ The first maxilliped is much smaller than those of the zoeal stages. The exopodite and the endopodite are not segmented, and have two short spines respectively. The basis has two pulvose setae and nine or ten processes.

The Second Maxilliped (Fig. 7 L)___ The two-segmented exopodite has six terminal pulvose setae and one subterminal spine on the distal segment. The unsegmented endopodite bears four terminal spines.

The Third Maxilliped (Fig. 7 M)___ The two-segmented exopodite has six terminal setae on the distal segment. The five segmented endopodite has a spine arrangement of 2-3-7-10-6 progressing distally.

Pereiopods. (Fig. 7 C-H)___ The first pair of pereiopods is chelated. The right cheliped is larger than the left. The pereiopods 4-5 are much smaller than the three preceding ones.

Pleopods (Fig. 7 N-Q)___ There are four pairs of pleopods on the abdominal somites 2-5. Pleopods decreased in size from anterior to posterior. The setation of the exopodites of pleopod varies from eight to nine. The small endopodites have small hooks distally.

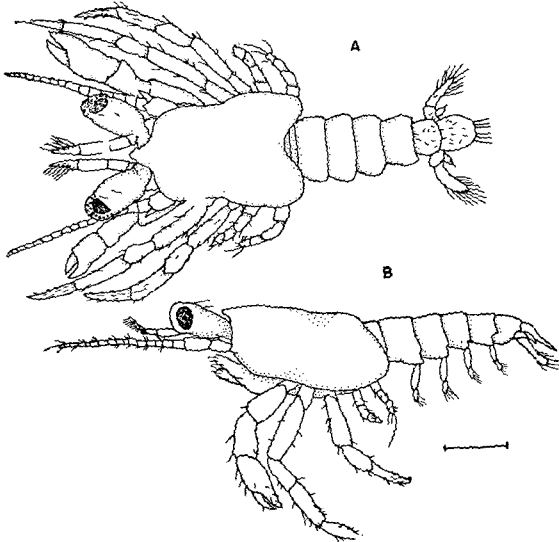
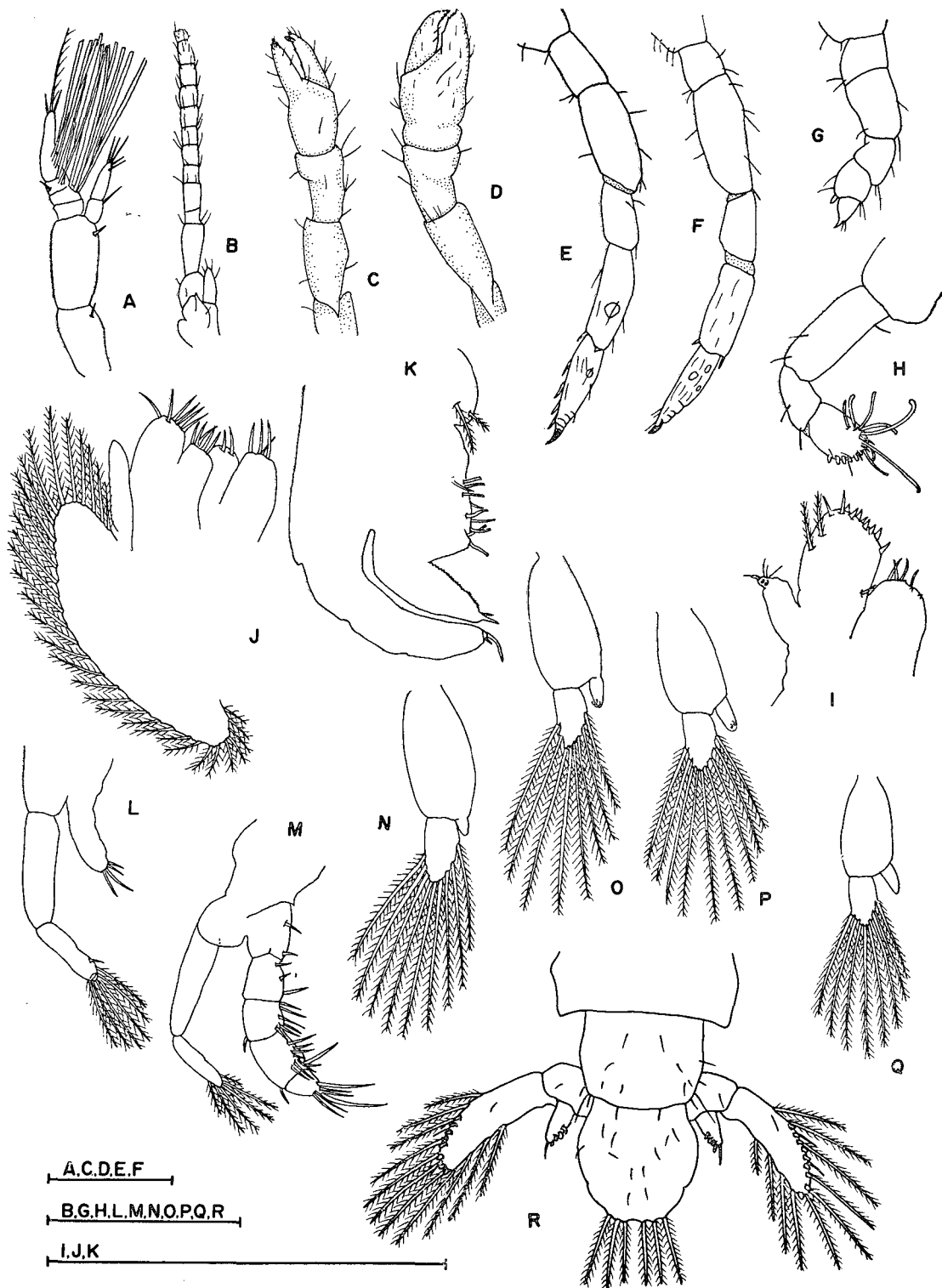


Fig. 6. *Pagurus lanuginosus*. The glaucothoe.

A, dorsal view; B, lateral view. Scale is 0.5mm.



A.C.D.E.F
 B.G.H.L.M.N.O.P.Q.R
 I.J.K

Fig. 7. *Pagurus lanuginosus*. Appendages of glaucothoe. A, antennule; B, antenna; C, left cheliped dorsal view; D, right cheliped, dorsal view; E, second pereopod; F, third pereopod; G, fourth pereopod; H, fifth pereopod; I, maxilla; K, first maxilliped; L, second maxilliped; M, third maxilliped; N-Q, pleopods of the second to fifth abdominal somite respectively; R, telson. Scales are 0.5mm respectively.

5. Discussion

MacDonald, Pike and Williamson (1957) divided the larvae of the genus *Pagurus* from British waters into A and B groups. They were grouped by 11 larval characters. One of the larval characters chosen by them was the number of paired telson spines of the pre-zoea. In the present study, however, no pre-zoea was found. Provenzano and Rice (1964) also reported no pre-zoea from the larvae of *Pagurus marshi* Benedict collected from the Bay of Biscayne. All the other larval characters, except the presence of mandibular palp in the 4th zoeal stages, make it possible to place *Pagurus lanuginosus* in the A group which includes *Pagurus bernhardus* and *P. pubescens*. But *P. lanuginosus* bears seven pairs of telson processes while *P. pubescens* and *P. bernhardus* have eight pairs respectively.

No mandibular palp found in the zoeal stages of *P. lanuginosus* while the species of group A formed the mandibular palp at the 4th zoeal stage. The appearance of the mandibular palp in the 4th zoeal stage was found in *P. middendorffi* (Kurata, 1964) and in *P. samuelis* (Kurata, 1968).

Among the zoeal larvae of *Pagurus* species, *P. lanuginosus* seems to be the only species that bears 6+1 pairs of telson processes which are consistent throughout the zoeal stages. Also no developmental changes were found in the shape of the 3rd telson spine. In the zoeal larvae of Paguridae, not only the number but also the shape of the telson process varies from species to species. The first zoea of *Pagurus scultimanus* obtained in the plankton samples had seven pairs of telson process including a pair of a delicate hairs (Macdonald, Pike and Williamson, 1957). Because no larvae of the further stages were obtainable by them, it can not be ascertained whether the seven pairs of telson processes were consistent or not. The seven pairs of telson process were also observed in the first zoea of *Pagurus samuelis* by Coffin (1960). However, he presented no descriptions on those of the late zoeal stages; nevertheless his drawings of the late zoea showed that the number of the telson process increased to seven excluding a pair of hairs. *P. samuelis* has seven pairs of telson processes in the first zoeal stage, but eight pairs was found in the second zoeal stage (Kurata, 1968). Kurata (1964) reported the presence of seven pairs of telson processes in the first zoeal stages of two *Pagurus* species, but no further stages were studied.

With regard to the shape of the 3rd telson spine at the 3rd zoeal stage, *P. lanuginosus* is very similar to that of the *Pagurus* species studied by Kurata (1964, 1968). The 3rd telson spines of *P. samuelis* and the 18 species including *P. middendorffi* are never fused to the telson during the zoeal stages as that of *P. lanuginosus* did. Except the zoeal larvae of only a single species, *P. pubescens*, all those of *Pagurus* species from the British waters were found to have the 3rd telson spine broadened and shortened in the 3rd zoeal stage (MacDonald, Pike and Williamson, 1957). Pike and Williamson (1960) also reported that such a morphological change is one of the larval characters of Paguridae from the Bay of Naples, with an exception of *P. anachoretus*.

Larval Development of *Pagurus lanuginosus*

P. lanuginosus has no setae at the end of the basipodite of uropod in the 4th zoeal stages. All the Kurata's (1964, 1968) zoeal larvae and, those of *P. beringanus* (Hart, 1937) and *P. samuelis* (Coffin, 1960) revealed that the basipodites of uropod were naked. In the case of *P. marshi* (Provenzano, 1964), *P. anachoretus* (Pike and Williamson, 1960) and all the species of the B group (MacDonald, Pike and Williamson, 1957), the basipodite of uropods bear one or two setae.

Table 2 summarizes the setation of several appendages of the three *Pagurus* species.

Table 2. Comparison of Setation of Appendages and Telson Processes During the Development in Three *Pagurus* Species

	<i>Pagurus lanuginosus</i> de Haan				<i>Pagurus samuelis</i> (Stimpson) Kurata (1968)			
Antenna	I	II	III	IV	I	II	III	IV
endopodite	0	0	0	0	1 spine	1 spine	1 spine	1 spine
exopodite	5	5	5	5	6	6	6	6
Maxillure								
endopodite	1+1+3	1+1+3	1+1+3	1+1+3	0+1+3	0+1+3	0+1+3	0+1+3
Maxilla								
endopodite	7	7	7	7	3+4-6	3+4-6	3+4-6	3+4-6
Third Maxilliped								
endopodite	0	1	1	3	—	—	—	—
Telson Process	7+7	7+7	7+7	7+7	7+7	8+8	8+8	8+8
Uropod								
basipodite			0	0			0	0
	<i>Pagurus marshi</i> (Stimpson) Provenzano (1964)							
Antenna	I	II	III	IV				
endopodite	2	2	1	1				
exopodite	9-11	10	10	10				
Maxilla								
endopodite	1+1+2	1+1+2	1+1+2	1+1+2				
Maxilla								
endopodite	5	5	5	6				
Third Maxilliped								
endopodite	0	0	2	1+3				
Telson Process	7+7	8+8	8+8	8+8				
Uropod								
basipodite			0	2				

MacDonald, Pike and Williamson (1957) illustrated eight telson processes in the glaucothoes of *Pagurus* species from British waters. Provenzano (1964) described eight telson setae in the glaucothoe of *P. marshi*. *P. beringanus* was found to have eight telson processes (Hart, 1937). Kurata (1968) also described eight telson processes in the glaucothoe of *P. samuelis*. But the glaucothoe of *P. lanuginosus* have six telson processes. Provenzano (1968) pointed out that all

the *Pagurus* species for which glaucothoe descriptions have been made have eight large setae on the posterior margin of the telson. It has been one of the essential differences between the glaucothoes of Paguridae and coenobitidean hermit crabs.

As in the case of the zoeal stages, the number of telson processes of glaucothoe of *P. lanuginosus* is different from those of other species for which glaucothoe descriptions have been made up to the present time.

6. Summary

A study on the complete zoeal development and the glaucothoe of *Pagurus lanuginosus* de Haan was conducted in the laboratory.

- 1) *P. lanuginosus* had four zoeal stages and a single glaucothoe stage.
- 2) At mean temperature 13.6°C and mean salinity 33.67‰, total duration of the zoeal stages was approximately 31-32 days.
- 3) The zoeal larvae of *P. lanuginosus* can be easily distinguished from those of other *Pagurus* species in having 7+7 telson processes of which number as well as shape is consistent throughout all the zoeal stages.
- 4) The antennal exopodite bears five pulmose setae, and the endopodite is naked throughout the zoeal stages.
- 5) The 6th abdominal segment has no mid-dorsal spine on its posterior margin during the 3rd and 4th stages.
- 6) The basipodites of uropod are naked on the distal margin.
- 7) Mandibular palp is absent in the 4th stage.
- 8) Antenna of glaucothoe is long extending far beyond the chelipeds.
- 9) Ocular scale is absent in the glaucothoe.
- 10) Glaucothoe has 3+3 telson processes on the distal margin of the telson.

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