

淡水産 새우 *Macrobrachium japonicum* (De Haan)의
Zoea 幼生기에 出現하는 同一令期群 속의
個體變異체에 대한 形態學的 考察

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MORPHOLOGICAL VIEW ON BIG INDIVIDUALS APPEARED IN
THE SAME AGE GROUP OF ZOEAL LARVA, *MACROBRACHIUM*
JAPONICUM (DE HAAN)

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Adult female prawn, *Macrobrachium japonicum*, which used for this work were collected at the river Simanto, Shikoku in Japan, and removed in the laboratory.

Newly hatched larvae from an adult reared in circulation-filtered aquaria, which is controlled under the conditions of water temperature $26 \pm 0.3^\circ\text{C}$, chlorinity 6.21—6.45‰ Cl, pH 8.0—8.1, Illumination 3000 lux, and fed on *Artemia salina* nauplius sufficiently.

For a period of rearing of zoea larvae, big individuals—individual varying bodies, comparing with standard bodies in the same aged individual group, are occasionally appeared from fifth zoea larva stage, and occurrence of it be tempted to relate with the factor of trophic condition.

This paper was dealt with a comparative morphological view on big individuals, comparing with standard type in the same aged group, to solve the problem on (1). the existence or nonexistence of stages which it is easier to occurrence of big individuals, (2). the rate of development in several appendages of an individual, and (3). a happening of skipping whether it certainly occur or not, during newly hatched zoea larvae develop to post larva stage.

The results of the above are as follow: (1). the stages which is easier to occur of big individuals are fifth and seventh stage in this species, (2). even same individual, development of several appendages differs more or less on the rate of growth in accordance with its parts, (3). Evidence which skipping phenomenon is occurred, during development through zoea larvae to post larvae, couldn't confirm.

緒 言

淡水産 새우인 *Macrobrachium japonicum*의 初期 zoea 幼生을 飼育하는 동안 同一令期群에서 出現하는 “속성이”를 종래 魚類飼育時에 생기는 個體처럼 外型的인 形態만으로 比較 觀察하지 않고 各 器官의 分化, 發生面에서 比較하여 個體變異체인 “속성이”의 生物學的 意義를 究明코저 하며 특히 部位別 器官의 分化 및 發生 速度의

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異時性, 個體變異체가 出現하기 쉬운 令期の 存在와 種에 甲殼類의 初期幼生期の 環境要因의 變化로 誘發된다는 어느 中間令期の skipping 現象——發生 令期の 一部를 飛躍, 省略하는 現象——을 再確認하기 위하여 同一令期群의 個體變異체와 標準型個體의 各 器官을 形態學的인 面에서 比較 觀察하여 완전한 어느 令期の 省略 有無를 究明코져 한다.

從來 魚類의 숙성이의 生長에 關係서는 많은 報告가 있었고, 숙성이의 出現率과 攝餌關係, 個體群의 體長組成 關係 및 棲息空間關係 등에 대한 生態的인 研究와 이것을 養殖面에 活用하고자 많은 實驗이 이루어졌다. 그러나 어느것이나 個體群內의 外樣上의 成長變異체를 主体로 하여 숙성이를 規定지어 놓고 이 活用度를 論하고 있었 으며(Yamagishi, 1964, 1969) 숙성이 自體의 形態學的 意義는 言及되어 있지 않다. 더우기 甲殼類에 있어서는 숙성이의 出現에 대해서 前述한 Broad(1957 a, b)의 *Palaemonetes*에 關한 報告뿐인 것 같다.

이 實驗을 하기 위해 日本 Sikoku의 Simanto에서 採集된 親蝦를 東京水產大學 資源研究所로 옮겨 屋內의 水槽中에서 交尾, 抱卵 孵化된 幼生을 使用하였다.

材料 및 方法

한 親蝦의 孵化槽에서 얻은 zoea 幼生을 28ℓ들이의 循環式 二重水槽內에 設置된 Bolting-silk pouch 속에 500尾씩 投入하여, 水溫 26±0.3℃, Chlorinity 6.21~6.45‰, Cl, pH 8.0~8.1, 照度 3000 lux 條件 下에 갖 孵化된 *Artemia salina* nauplius를 먹이로 充分量을 給與하여 飼育했으며 本 飼育水槽의 詳細한 構造는 이미 보 고된 바 있다(Kwon and Uno 1968, Kwon 1974).

한편 本種의 各 zoea 令期를 規定하기 위하여 26℃ 恒溫室內에서 30ml들이 bowl-finger속에 各 令期別로 10尾 씩 投入하여 脫皮를 確認한 후 다음 令期를 定하고 飼育水槽內의 幼生과 比較 觀察하였으며, 그 때의 環境條件 은 Chlorinity 6.18~6.26‰, Cl, pH 8.0~8.1, 照度 3000 lux로써 米리 充分한 aeration 下에 준비해 둔 用 水를 每日 한번씩 換水하였다.

同一令期の 標準型 個體와 個體變異체와의 形態的인 差異를 比較 檢計하기 위하여 30% alcohol glycerin 溶液 으으로써 固定시킨 후 stereo-microscope 下에서 各 令期別로 附屬肢를 dissection하여 camera lucida를 통하여 發生, 分化의 差異點을 스캐치 하였으며 micrometer를 사용하여 體長 및 附屬肢의 長이를 測定하였다.

結 果

本種은 室內에서 水溫 26±0.3℃, Chloinity 6.21~6.45‰, Cl, pH 8.0~8.1, 照度 3,000 lux의 條件上에서 *Artemia salina* nauplius를 먹이로 給與하여 飼育하는데 所要되는 期間은 29~38日이었다. 各 令期別의 特徵은 Table 1, 2에 표시되어 있다.

Table 1. Growth of zoea larva, *Macrobrachium japonicum* (De Haan) reared in the laboratory

| No. of zoea stages | Intermolt period (days) | Body length (mm) | | No. of specimen |
|--------------------|-------------------------|------------------|--------------------|-----------------|
| | | Mean | standard deviation | |
| 1 | 0—2 | 3.20 | 0.01 | 40 |
| 2 | 2—4 | 3.31 | 0.03 | 30 |
| 3 | 5—8 | 3.45 | 0.07 | 30 |
| 4 | 7—10 | 3.73 | 0.08 | 30 |
| 5 | 9—12 | 4.01 | 0.20 | 30 |
| 6 | 11—15 | 4.37 | 0.18 | 30 |
| 7 | 14—18 | 4.51 | 0.22 | 30 |
| 8 | 17—22 | 4.86 | 0.15 | 30 |
| 9 | 21—25 | 5.14 | 0.21 | 30 |
| 10 | 23—28 | 5.35 | 0.18 | 30 |
| 11 | 26—33 | 5.68 | 0.21 | 30 |
| P. L | 29—38 | 5.46 | 0.27 | 30 |

* Water temperature 26±0.3℃, Chlorinity 6.21~6.45‰, pH 8.0~8.1, Illumination 3000 lux and fed on *Artemia salina* nauplius; s. d. : standard deviation.

Table 2. Recognized characters of each zoea stage larva, *Macrobrachium japonicum*
(De Haan) reared in the laboratory

| The stage number of zoea | Body length (mm) | Recognized characters |
|--------------------------|------------------|---|
| 1 | 3.20 | Sessile eyed, and cephalothorax in covered with unarmed carapace, and rostrum projects horizontally. |
| 2 | 3.31 | Stalked eyed, articulation of uropod appears, and carapace armes with a pair of supra-orbital and branchiostegal spines. |
| 3 | 3.45 | One rostral tooth, and uropod is biramous with rudimental endopod. |
| 4 | 3.73 | Two dorsal rostrum-teeth, oblonged telson in almost recutangular and biramous uropod with setae. Rudimental fourth and fifth pereopods appear. Antennule with a stout spine in mid-portion. |
| 5 | 4.01 | Oblonged and more rectangular telson and it is concaved apparently on terminal portion. Fourth pereopod appears in the rudimentary biramous, |
| 6 | 4.37 | Elongated and rectangular telson with three pair of spines laterally and five pair posteriorly. Antennal flagellum with 4 segments and almost same as scale in length. Outer peduncular flagellum of antennule with 4 aesthetes terminally and 2 ones on the folded appendices. |
| 7 | 4.51 | Antennal flagellum with 5 segments and more or less larger than the scale. Telson is more elongaed, narrower and almost horizontally on distal portion. Buds of pleopods appear on ventral portion of fifth somite. |
| 8 | 4.86 | 5 rudimental pleopods appear on ventral portion of somites. Telson is more elongated, narrower posteriorly and more or less extended back from the mid-portion than former stage. Posterior outer large spines of the terminal of telson are pointed more or less outward at the distal end. |
| 9 | 5.14 | Segments of antennal flagellum are increased in their base part, held 6 segments and more longer than scale. Pleopods are biramous and bare. Propodi of first and second pereopods are more or less protuberant at inner distal portion. Telson Uropod is more extended posteriorly from mid-portion on the distal. Uropod is more or less larger than telson. |
| 10 | 5.35 | Antennal flagellum longer than the scale with 7 to 8 segments. Inner flagellum of antennule is two segmented and outer flagellum with 3 folded appendices. Pleopods are more developed with setae on outer ramus. Propodi of first and second pereopods are protuberant at inner distal portion, forming chelae with dactylus. Rudimetal statocyst apeared. Mid-portion at the distal of telson is more protuberent pesterioli and a pair of small spines of inner distal portion of it are disappeared occasionally. |
| 11 | 5.68 | Pleopods developed fully, bearing with internal appendices. Antennal flagellum is longer than former stage with 12 to 14 segments, and inner flagellum of antennule is 4 or 5 segmented and outer flagellum bears with 3 to 4 folded appendices. Propodi of first and second pereopods are fully developed to chelae. Mid-portion at the distal of telson is more advanced posteriorly, more elongated and narrower than the former and its lateral spines disappeared. 3 to 4 rostrum toothed appear on its dorsal margin, |

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Length of antennal scale is larger than width of it in 3 or 4 times. Antennal flagellum is over half of total length. Mandible is strong and incisor process is stouter than that of zoea larval mandible. First pereiopod is chelated and shorter than second pereiopod, chela. Expods of pereiopods are reduced or occasionally remained rudimentary. Rostrum is more or less shorter than antennal scale. Carapace is armed with a pair of antennal spines and two pair of branchiostegal spines. Posterior margin of fifth abdominal pleurae is rounded and anal spine absent. Distal portion of telson is armed with a pair of large spines, a pair of small spines and another pair of spines with plumose setae. Behaviors of swimming and locomotion are as adult.

* Water temperature $26 \pm 0.3^\circ\text{C}$, Chlorinity 6.21~6.45‰ Cl, pH 8.0~8.1, Illumination 3000 lux and fed on *Artemia salina* nauplius; s. d. : standard deviation

本種도 이미 報告된 *Macrobrachium rosenbergi* 및 *Macrobrachium nipponense* (Kwon and Uno 1968, 1969)과 같이 最終 zoea期에서 第 1 post-larva로 變態할 때 體長이 줄어지는 경향을 나타내며 (Fig. 1 및 Table 1,2), 各 zoea 幼生の 令期別의 形態的인 發生, 分化는 이미 日本水産學會大會에서 報告한 바 있다 (Kwon, 1970). 本 報告에서는 個體變異體 (big individual)와 同一令期の 標準型인 個體와의 形態的인 變化를 區別하기 위하여 서로 관련성이 큰 令期만을 詳細히 圖示하고 說明하였다 (Plate I~III, Table 3).

各 飼育槽에서 飼育하는 令期別 幼生에 있어서 第5令期和 第7令期에 있는 同一個體群 中에서 뛰어나게 큰 個體가 가끔 出現하며 標準型인 第5令期の 平均體長이 4.01mm인 때 比해 個體變異體인 속성이는 4.22mm였고, 第7令期の 平均値는 4.51mm로써 어느 것이나 體長을 기준으로 할 때 各各 한 令期를 skipping한 다음 令期の 標準型인 個體群의 平均體長에 가깝게 된다.

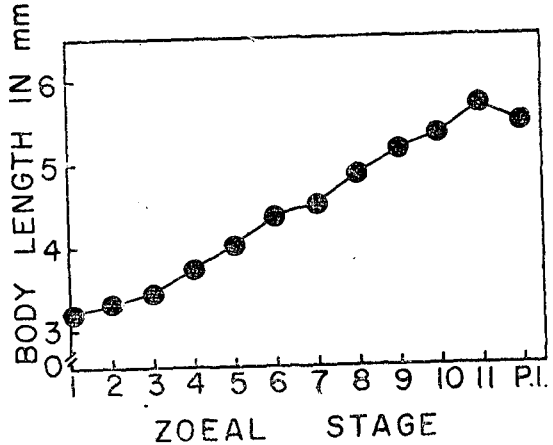


Fig. 1. The growth of zoea larva, *Macrobrachium japonicum*.

Table 3. Morphological comparison between big individual and common individual which are appeared in the same age group of zoea larva, *Macrobrachium japonicum* (De Haan) reared in the laboratory

| The stage number of zoea | Body length (mm) | | No. of specimens | Characters |
|--------------------------|------------------|-------|------------------|---|
| | Mean | s. d. | | |
| 5th stage | 4.01 | 0.20 | 30 | Carapace with 2 dorsal rostrum teeth. Telson (Fig. N) more elongated and almost rectangular, with 5 pair posteriorly and 3 pair spines laterally. Uropod (Fig. N) biramous; outer ramus with about 14 plumosed setae and a tiny spine; inner ramus with about 10 setae. Antennal scale (Fig. A) not segmented; disto-lateral tip pointed spine, somewhat concaved at distal edge; blade with 16 plumosed and a single small setae. Antennule (Fig. B) with 2 segmented peduncle; terminal peduncle with 4 large plumosed setae; 2 flagella, inner small one with a stout seta at the distal and outer large one with 4 aesthetes and a slender seta at the distal; terminally near the prominence with a minute and 4 short |

setae on opposite side; proximal peduncle with about 5 plumosed setae and a stout spine on inner side; protuberance stylocelite with about 7 small setae; on articulation of both segments with a stout and 6 short setae; proximal peduncle with 8 small setae sub-terminally. Mandible(Fig. C) without palp; incisor process with 3 teeth at tip; molar process with fine toothed cutting edge, 3 movable teeth in angle between molar and incisor processes. First maxilla (Fig. D) uniramous, consisting of 3 lobes; coxa with 5 inwardly directed spines, basis with 3 spines and 4 teeth; exopod simple, palp-like, with 2 terminal small setae. Second maxilla(Fig. E) biramous, plate-like; propod three-lobed, armed with 4, 3, and 3 plumosed setae; endopod unsegmented, with 2 setae on a lobe near the proximal portion and a seta terminally; exopod flattened gill bailer with 4 anteriorly, 4 laterally and 1 plumosed setae posteriorly. First maxilliped (Fig. F) biramous and with a rudimental epipod; protopod rudimentary segmented, coxa 2 minute and basis with 6 medially directed setae on inner margin; endopod unsegmented, with 3 plumosed setae on terminal extremity, with 1 small seta sub-terminally in outer side and with 2 small setae in mid-portion inner side; exopod with 4 apical and 2 sub-apical setae, longer endopod. Second maxilliped(Fig. G) biramous; coxa reduced; than protopod with 1 seta on inner margin; endopod 4 segmented, on the jointment of ultimate and penultimate segments with 2 setae and 1 stout small seta; ultimate segment with 2 slender setae and 1 stout claw terminally, with 1 stout small seta sub-terminally inner side; exopod longer than endopod, with 4 apical and 2 sub-apical setae. Third maxilliped(Fig. H) biramous, coxa reduced, basis with 2 setae, larger than second maxilliped, and almost similar to second maxilliped in shape, but the followings are only different: endopod with four-segmented, merus with 2 setae on inner side, 3 stout spines at junction of propodus and ductylus, and ductylus with 1 stout claw at the terminal and 3 slender setae near the proximal part; exopod with 4 apical and 2 sub-apical setae. First pereopod (Fig. I) biramous, coxa reduced; basis with 2 setae; endopod with four-segmented, merus with 2 setae on inner side, 3 stout spines at junction of propodus and ductylus, 1 seta at junction of propodus and carpus in outer side, and 1 strong claw at the terminal and slender seta near the terminal of ductylus; exopod with 4 apical and 2 sub-apical setae. Second pereopod (Fig. J) biramous, coxa reduced; shape is almost similar to first pereopod but only somewhat smaller than it in size. Third pereopod (Fig. K) biramous, incomplete, similar to second pereopod in shape, but smaller than it; exopod with 4 apical and 2 sub-apical setae, but smaller than endopod in length. Fourth pereopod (Fig. L) rudimentary biramous as bud. Fifth pereopod(Fig. M) uniramous and incomplete in shape, and five-segmented; dactylus with 1 seta near the distal and terminal claw, propodus with 2 setae near the proximal part, a seta at junction between propodus and carpus in outer side, merus with 2 setae on inner side, and at junction between merus and ischium bears a seta.

| | | | | |
|-----------------------------|------|------|----|--|
| Big individual of 5th stage | 4.22 | 0.12 | 6 | <p>Antenna, antennule, mandible, first maxilla, and uropod and telson (Fig. A-D, N) are almost similar to common individuals in the same age in shape and size (5). Differences from common fifth zoea larva are in the followings: Second maxilla (Fig. E) flattened gill bailer with 6 anteriorly, 4 laterally and 3 setae posteriorly (6). First maxilliped (Fig. F) biramous epipod; protopod two-segmented, coxa with 2 minute and basis with 7 medially directed setae on inner margin; exopod with 4 apical and 2 sub-apical setae, base with 1 seta, and longer than endopod (6). Second and Third maxilliped (Fig. G-H), First, Second and Third pereopod (Fig. I-K) are almost similar to common individuals in the same age in shape, excepting of size (5). Fourth pereopod (Fig. L) biramous and incomplete in the shape and size, coxa reduced; basis with 2 setae; endopod with four-segmented, merus with 2 setae on inner side, 2 to 3 stout spines at junction of propodus and ductylus, and 1 strong claw at the terminal and a slender seta near the terminal of ductylus, occasionally absent; exopod with 4 apical and 2 sub-apical setae (6). Fifth pereopod (Fig. M) uniramous and five-segmented; ductylus with 1 seta near the distal in outer side, a strong terminal claw, and with 1 stout spine near the base on inner side; propodus with 3 setae near the proximal portion, and 2 setae bears at the junction between carpus and propodus (6).</p> |
| 7th stage | 4.51 | 0.22 | 30 | <p>Rudimentary buds of pleopod appear on the ventral portions of third and fourth abdominal somite. Telson is more elongated, narrower posteriorly than base, with 3 pairs spines laterally and with 5 pairs spines posteriorly; It is narrower in the posterior part than the former stage, distal portion is almost horizontally. Uropod (Fig. N) is also elongated; outer ramus is more or less longer than the terminal of telson, outer ramus with about 21 setae and 1 tiny spine at margin, inner ramus with about 17 setae. Disto-lateral tip of antennal scale (Fig. A) pointed with spine, somewhat concaved at distal edge; blade with 22 plumosed with three-segmented and with 2 segments on base. Antennule (Fig. B) with 2 segmented peduncle; terminal peduncle with 5 large plumosed setae; 2 flagella, inner small one with 2 stout setae at the distal, and outer large one with 4 aesthetes, and terminally near the prominence with a minute and 4 short setae on the opposite side; proximal peduncle with about 8 plumosed setae and a stout spine on inner side, on articulation of segments with a stout and about 10 short setae around, and with about 13 small setae around sub-terminally; protuberance stylocerite with about 9 small setae. Mandible (Fig. C) with 5 movable teeth in angle between molar and incisor processes. First maxilla (Fig. D) with consisting of 3 lobes; coxa with 6 inwardly directed spine, basis with 3 spines and 5 teeth; endopod with 2 terminal small setae. protopod of second maxilla (Fig. E) three-lobed, armed with 4, 3 and 3 plumosed setae; exopod flattened gill bailer with 17 plumosed setae</p> |

| | | | | |
|-----------------------------|-------|-------|---|---|
| | | | | <p>at margin, First maxilliped(Fig. F) biramous, with a rudimentary biramous epipod; coxa with 2 minute and basis with 7 medially directed setae on inner margin; exopod with 4 apical and 2 sub-apical setae, and base with 2 setae. Second maxilliped (Fig. G) biramous; coxa reduced, protopod with 1 seta; endopod 4 segmented, 2 stout and 1 tiny seta at the jointment of ductylus and propodus, ductylus with 2 slender and 1 stout seta near the terminal, and 1 terminal claw; exopod longer than endopod, with 4 apical and 2 sub-apical setae. Third maxilliped (Fig. H) reduced coxa; basis with 2 setae, larger than second maxilliped, and almost similar to second maxilliped in shape; endopod with four-segmented, merus with 2 setae, 3stout spines at the junction of propodus and ductylus, and ductylus with 3 slender setae near the terminal and 1 stout terminal claw, and merus with 2 setae on inner side, 1 seta at junction of carpus and propodus in outer side; Exopod with 4 apical and 4sub-apical setae. First pereopod(Fig. I). biramous, coxa reduced; basis with 2 setae; endopod with four-segmented, the shape is almost similar to third maxilliped, excepting of ductylus with 3 stout spines at the junction of ductylus and propodus, 2 slender setae near the terminal, and 1 stout claw; 2 setae at junction of carpus and propodus on both side; Exopod with 4 apical and 6 sub-apical setae. Second pereopod (Fig. J) is similar to first pereopod in shape. Third and fourth pereopod (Fig. K-L) is almost similar to first pereopod in shape, excepting of size and axopod with 4 apical and 4 subapical setae. Fifth pereopod (Fig. M) uniramous, five-segmented; ductylus with 1 tiny seta near the distal and 1 stout terminal claw, and with a stout spine near the base on inner side; Propodus with about 6 spines inner side and 1 tiny seta near the terminal in outer side; 2 setae at junction of carpus and propodus, setae near junction of merus and carpus in outer side, merus with 2 setae inner side, and 1 seta at junction of merus and ischium.</p> |
| Big individual of 7th stage | 4. 82 | 0. 16 | 9 | <p>Pleopod (Fig. P) rudimentary biramous and bare (9). Distal portion of telson (Fig. Q) is almost horizontally (7). Uropod (Fig. N) more elongated, outer ramus with about 21 plumosed setae at margin and 1 tiny spine at the disto-lateral corner, inner ramus with about 17 setae at margin (7). Blade of antennal scale(Fig. A) with about 22 plumosed setae and a single small setae; antennal flagellum with three segmented and with 2 segments on base (7). Antennule (Fig. B) with 2 segmented peduncle, on articulation of segments with a stout and about 9 to 10 setae around, Proximal peduncle with about 14 small setae around sub-terminally, portuberance stylocerite with about 10 small setae (7). Mandible (Fig. C) with 5 movable teeth (7). First maxilla (Fig. D) with consisting of 3 lobes; coxa with 7 inwardly directed spine, basis with 3 spines and 5 teeth (9). Exopode of second maxilla (Fig. E) flattened gill bailer with 20 to 21 setae in margin (8). Epipod of first maxilliped (fig. F) biramous; coxa with 2 minute and basis with 8 medially directed setae inner margin; exopod with 4 apical and 2 sub-apical setae, and base</p> |

with 4 setae (9). Second maxilliped (Fig. G) is similar to common 7 zoea stage in shape, excepting of size (9). Third maxilliped (Fig. H) is almost similar to common 7 zoea stage in shape; excepting of size; endopod with four segmented, merus with 2 setae, 3 stout spines at the junction of propodus and dactylus with 3 slender setae near the terminal and 1 stout terminal claw; and 2 to 3 setae at junction of carpus and propodus; exopod with 4 apical and 4 sub-apical setae (9). First and second pereopod (Fig. I--J) biramous; and more advance in shape and size; indopod with 3 setae at junction of carpus and propodus, proximal portion of propodus, with 4 stout spines, inner distal portion of propodus is protuberant, forming rudimentary chelae with ductylus; exopod with 4 apical and 6 sub-apical setae (10). Third and fourth pereopod (Fig. K--L) is more advanced than common 7 zoea stage in shape and size, endopod with 4 stout setae at junction of propodus and ductylus, 2 setae at junction of carpus and propodus; exopod third with 4 apical and 6 sub-apical setae and fourth pereopod with 4 apical and 4 sub-apical setae (8). Fifth pereopod (Fig. M) is more advanced in shape and size; propodus with about 7 spines inner side and 1 tiny seta near the terminal in outer side; merus with 2 setae inner side and also with 2 setae outer side (9).

* Water temperature $26 \pm 0.3^{\circ}\text{C}$, Chlorinity 6.21—6.45‰, pH 8.0—8.1, Illumination 3000 lux, Fed on *Artemia salina* nauplius; s. d. : standard deviation and arabic number in parenthesis are shown comparative stage, excepting of (Fig.).

한편, 이 同令期群 중에서 出現하는 個體變異體(숙성이)와 標準型인 個體간의 各 附屬肢의 形態의 差異點을 比較한 結果 plate II 및 plate III, plate V 및 plate VI에서 처럼 어느것이나 部分的인 附屬肢는 標準型인 同一令期의 幼生과는 전혀 다른 1~令期를 省略하고 分化된 附屬肢의 形態를 나타내지만 또 다른 일부 附屬肢는 원래의 同一令期의 標準型인 形態를 그대로 지니고 있다(Table 3). 따라서, big individuals를 단지 外形의 個體長만으로 고려했을 때는 全 發生令期中 어느 한 令期를 省略飛躍하여 分化된 것처럼 보이나 실제 附屬器官의 分化發達 정도로 볼 때에는 省略分化된 것은 아닌것 같다.

Table 3은 第5 및 第7의 同一令期에서 出現하는 숙성이(big individuals)와 標準個體의 各附屬肢의 形態의 差異點을 서로 比較한 것이다.

第5令期에 出現하는 숙성이에 대한 附屬肢의 發生, 分化 程度를 보면 antenna, antennule, mandible, 第1 maxilla, uropod, telson, 第2 maxilliped, 第3 maxilliped, 第1, 第2 및 第3 pereipod는 標準型인 第5令期의 特徵을 그대로 保存하고 있으며 第2 maxilla, 第1 maxilliped, 第4 및 第5 pereipod는 1令期를 飛躍省略된게 같은 第6令期의 特徵을 나타낸다(plate III).

한편, 發生過程이 더욱 進展되어 第7令期에 出現하는 숙성이의 附屬肢의 發生分化를 同一令期의 標準型인 個體群과 比較하면 變化의 幅이 第5令期の 그것보다 훨씬 크고, antenna, telson, uropod 및 antennule의 形態는 標準型인 7令期の 特徵을 가지고 있고, 그 外 附屬肢는 8.9 및 10令期の 特徵을 保存하므로(plate VI), 個體의 體長 또는 部分的인 特徵으로써 令期를 定할 수 없으며, 종래 甲殼類의 初期幼生の 發生過程에서 어느 令期가 省略되어 다음 令期로 飛躍分化된다는 現象은 이 實驗 結果로는 肯定할 수 없을듯 하다.

숙성이의 形態의 分化를 比較 觀察하면 同一幼生の 個體일지라도 各附屬器의 分化速度가 一律의으로 한 令期에 따라 分化, 發生되는 것이 아니고 서로 어떤 連關下에서 獨立된 分化速度를 나타내는 것 같다.

한편, 第7令期에 出現하는 숙성이의 各 附屬器의 分化速度를 보면, uropod, telson, antenna, antennule 및 mandible 및 mandible은 同一令期群의 標準型인 特徵을 保有하고 있으나 第2 mandible, 第3 및 第4 pereipod

는 8令期, 第1 maxilla, 第1, 第2 및 第3 maxilliped, 第5 pereiopod 및 pleopod는 9令期の 特徵을 第1 및 第2 pereiopod는 10令期の 特徵을 나타내고 있어 各 附屬器官에 따라 分化速度가 一律的인 等時性을 띠는 것이 아니고 環境要因의 變動에 대해서 極히 安定性이 강한 部位와 이에 反해서 環境要因의 變化에 對한 變異의 感受性이 敏感한 部位가 있으므로 各 附屬器의 分化發生에 異時性을 나타내는 것 같다.

또, 飼育水槽中에서 幼生의 個體密度를 크게 했을 때 가끔 共喰現象이 일어나고 이와 같은 條件下에서 同一 個體群 사이에 體長變動幅이 넓어지며 따라서 本實驗에 있어서도 第5令期 以後부터 共喰現象이 가끔 생김을 觀察할 수 있었다.

考 察

初期幼生의 飼育途中 同一令期の 個體群에서 뒤어나게 體長이 큰 숙성(個體變異體)가 간혹 出現함은 *Macrobrachium rosenbergi*에서도 報告하였으며 특히 숙성이기 쉬운 令期가 第6令期和 第10令期였으나(權, 1974) 本種에서는 第5令期和 第7令期가 보다 出現可能性이 큰 令期로서 zoea幼生의 全令期를 통하여 體長의 變動分布值의 幅이 큰 것과 관련성이 있음을 알 수 있고 이같은 現象이 일어나는 主原因은 飼育時의 環境要因中 個體의 空間密度 및 攝餌要因과 관련이 큰 것 같으며 이 時期에 個體群間에 共喰現象이 빈번하다. 이같은 現象은 Broad(1957 b)도 *Palaemonetes pugio*의 實驗에서 zoea幼生의 個體, 成長에 대한 變異가 第6令期부터 생기며, 이 原因은 水溫, 鹽分, 攝餌要因에 의해서 誘發되며 이 中 특히 攝餌要因이 가장 큰 役割을 한다고 報告하고 있다.

한편 Broad(1957 a, b)는 *Palaemonetes pugio*와 *P. vulgaris*에서 各種의 먹이를 주어 飼育한 結果 個體成長의 變異에 의한 skipping 現象이 있다고 報告하였으나 本實驗에서도 個體密度를 크게한 飼育槽에서 흔히 共喰現象이 일어나며 第5令期 以後부터 현저하게 되므로 이때 숙성의 出現이 빈번하여지는 것 같다.

또, 本種의 同一令期群에 있어서의 標準型和 숙성의 各 附屬器官의 分化發生의 差異를 形態學的 面으로 比較한 結果 部分的으로는 보다 分化發生의 進展된 令期の 特徵을 나타내고 있으나 또 다른 한 部分의 附屬器官은 個體成長의 變異에 관계없이 있으며 外觀上으로 본 숙성이라고 해서 크기에 해당하는 令期の 特徵을 모두 갖추고 있는 것은 아니며 또한 部分的인 附屬器官의 分化, 發生程度로 보아 skipping 現象이 일어난 것 같이 보이지만 엄밀한 形態的인 面으로 보아서는 완전히 한 令期를 飛躍, 省略하여 그 다음 令期로 移行한다고 하는 Broad의 報告는 認定될 수 없을 것 같다.

Broad(1957 a)가 *Palaemonetes pugio*와 *P. vulgaris*의 實驗報告에서 “같은 크기의 幼生은 그 令期 및 完全脫皮의 回数에 관계없이 形態가 닮는다”는 것은 前述한 바와 같이 部分的인 附屬器官의 構造만을 觀察한 것으로 추측되며 本實驗結果 Table 3에서 나타난 바와 같이 同一令期群의 標準型和 숙성의 사이에는 幼生의 크기에는 관계없이 所定令期の 特徵은 部分的이나마 뚜렷이 保有하고 있다는 것을 再確認할 수 있었다(Uno and Kwon, 1969).

또 個體變異體의 各 附屬器官의 分化, 發生 樣狀을 調査한 結果, 同一令期群의 個體일찌라도 附屬器官의 分化速度가 一律적으로 그 令期에 따라 同時에 分化되는 것이 아니고 어떤 市體的인 調節下에서도 어느程度 獨自的인 分化過程을 밟고 있는 것 같다. 그 理由는 同一令期群에서 出現하는 個體變異體의 附屬器官의 分化樣狀을 標準型和 比較하면 uropod, telson antenna 및 antennule 처럼 環境要因의 變化에 대해서 極히 安定性을 가지고 있는 器官이 있는 反面에 pleopod, pereiopod 및 maxilliped 처럼 發生分化가 環境要因의 變化에 대한 感受性이 대단히 敏感한 部分이 있어서 주어진 環境要因의 變動에 따라 同一令期の 個體群일찌라도 各 器官의 分化速度에 差異를 나타내므로 發生過程에 있어 各 器官마다 오히려 어느 程度의 獨自的인 分化速度——異時性——을 가지고 있는 것 같다. 따라서 종래 甲殼類의 初期幼生의 令期를 規定함에 있어 同一令期群에 있어서 各 附屬器官의 分化, 發生速度는 一律적으로 令期에 따라 變化된다는 等時性으로서 脫皮後의 各 附屬器官에 대한 共通된 特徵에 의해 區分하였으나 엄밀하게 생각하면 各 附屬器官의 分化, 發生速度가 部位別로 異時性인 것 같이 나타남으로今後 各 令期를 規定함에 있어서는 全 附屬器官의 分化로써 결정할 것이 아니라 前述한 바와 같이 環境要因의 變動에도 보다 安定性을 띠는 附屬器官을 指標로 하여 脫皮後의 令期를 規定하는 것이 타당할 것 같다.

要 約

1. 飼育水槽에서 交尾, 抱卵시킨 親蝦로부터 孵化된 幼生을 循環式 二重水槽內에서 水溫 $26 \pm 0.3^{\circ}\text{C}$, Chlorinity 6.21~6.45 ‰, pH 8.~8.1, 照度 3,000 lux의 條件下에서 *Artemia salina* nauplius를 먹이로 給與하여 飼育했다.

2. 同一令期群에서 出現하는 個體變異體(숙성어)와 標準型個體 사이의 形態的 差異를 比較하여 숙성어의 出現令期와 관련이 있는 第4令期로부터 第9令期の 各 附屬肢의 發生過程을 관찰한 結果, 本種에 있어서도 個體成長의 變異에 의한 숙성어가 出現하기 쉬운 令期(第5令期和 第7令期)가 存在하며 이 現象이 일어나게 되는 原因은 攝餌要因과 관련이 큰 것으로 보인다.

3. 同一令期群의 숙성어를 外形의인 形態學的 面으로 器官의 分化정도로써 標準型的 個體와 比較 調査한 結果 同一令期群에서 出現하는 숙성어의 各 附屬器官은 部分的으로는 令期가 發展된 個體의 特徵도 具備하지만 또 다른 面으로는 그 令期の 標準型的 特徵도 具備하고 있다. 그래서, 各 令期の 特徵은 個體의 크기에 관계없이 同一令期の 特徵을 部分的으로나마 明確히 保有하고 있었다. 한편 本種에 있어서의 個體變異體는 한 令期를 完全히 飛躍省略하여 그 다음 令期로 이행하는 것이 아니고 附屬器官의 分化速度가 部分的으로 異時性을 나타낼 따름이므로 完全한 skipping現象은 관찰할 수 없었다.

4. 幼生の 附屬器의 發生分化는 一過的으로 個體變異가 크지만 環境要因의 變動에 따라 安定性을 가지는 部分과 이와 反對로 變異의 感受性이 큰 두 部分으로 나눌 수 있으며 따라서 한 個體內의 各 附屬器의 分化, 發生은 部位에 따라 異時性을 가지고 있는 것 같다.

5. 各 令期の 規定은 종래와 같이 脫皮後의 1個體의 全体 附屬器의 變化된 共通의인 程度에 따라 定할 것이 아니라 前述한 環境要因의 變動에 대해서 極히 安定性을 띠는 附屬器官을 指標로 하여 定하는 것이 타당할 것 같다.

文 獻

Broad. A. C. (1957 a): Larval development of *Palaemonetes pugio* Holthuis. Biol. Bull., 112(2): 144—161.

—— (1957 b): The relationship between diet and larval development of *Palaemonetes*. Biol. Bull., 112(2): 162—170.

Kwon, C. S. and Y. Uno (1968): The larval development of *Macrobrachium modestus* (Heller) in the laboratory. Lamer, 6(4), 263—278. and (1969): The larval development of *Macrobrachium nipponense* (De Maan) reared in the laboratory. La mer, 7(4), 278—294.

—— and —— (1969): The larval development of *macrobrachium nipponense* (De Maan) reared in the laboratory. La mer, 7(4), 278—294.

—— (1970): Larval development of *Macrobrachium japonicum* (De Haan) reared in the laboratory. 70年度 秋期日本水産學會大會發表.

權晉洙 (1974): *Macrobrachium rosenbergi* (De Maan)의 初期幼生の 成長 및 水溫과 交態와의 관계. 韓水誌 7(2), 12—22

Uno, Y. and C. S. Kwon (1969): Larval development of *Macrobrachium rosenbergi* (De Maan) reared in the laboratory. Jour. Toko Univ. Fish., 55(2), 179—190.

山岸宏(1964): 魚類の生長の個體變異について. 生物科學, 16(3), 98~104.

Yamagisi. H. (1969): Postembryonal Growth and its variability of the three marine fishes with special reference to the mechanism of growth variation in Fishes. Res. Popul. Ecol., 14—33.

Explanation of Plates

Plate I. Fourth zoea

A, antenna; B, antennule; C, mandible; D—E, first and second maxillae; F—H, first, second and third maxillipeds; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod

Plate II. Fifth zoea

A, antenna; B, antennule; C, mandible; D—E, first and second maxillae; F—H, first, second and third maxilliped; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod

Plate III. Big individual of fifth zoea

A, antenna; B, antennule; C, mandible; D—E, first and second maxillae; F—H, first, second and maxillipeds; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod.

Plate IV. Sixth zoea

A, antenna; B, antennule; C, mandible; D—E, first and second maxillae; F—H, first, second and third maxillipeds; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod; O, telson.

Plate V. Seventh zoea

A, antenna; B, antennule; C, mandible; D—E, first and second maxillae; F—H, first, second and third maxillipeds; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod; O, telson.

Plate VI. Big individual of seventh zoea

A, antenna; B, antennule; C, mandible; D—F, first and second maxillae; F—H, first, second and third maxillipeds; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod; O, telson; P(1—5), first, second, third, fourth and fifth pleopods; Q, abdominal view.

Plate VII. Eighth zoea

A, antenna; B, antennule; D—E, first and second maxillae; F—H, first, second and third maxillipeds; I—M, first, second, third, fourth and fifth pereopods; N, telson and uropod; O, abdominal view.

Plate VIII. Ninth zoea

A, antenna; B, antennule; C, mandible; D—E, first and second maxillae; F—H, first, second and third maxillipeds; I—M, second, third, fourth and fifth pereopods; N—O, telson; P(1—5), first, second, third, fourth and fifth pleopods; Q, abdominal view.

PLATE I

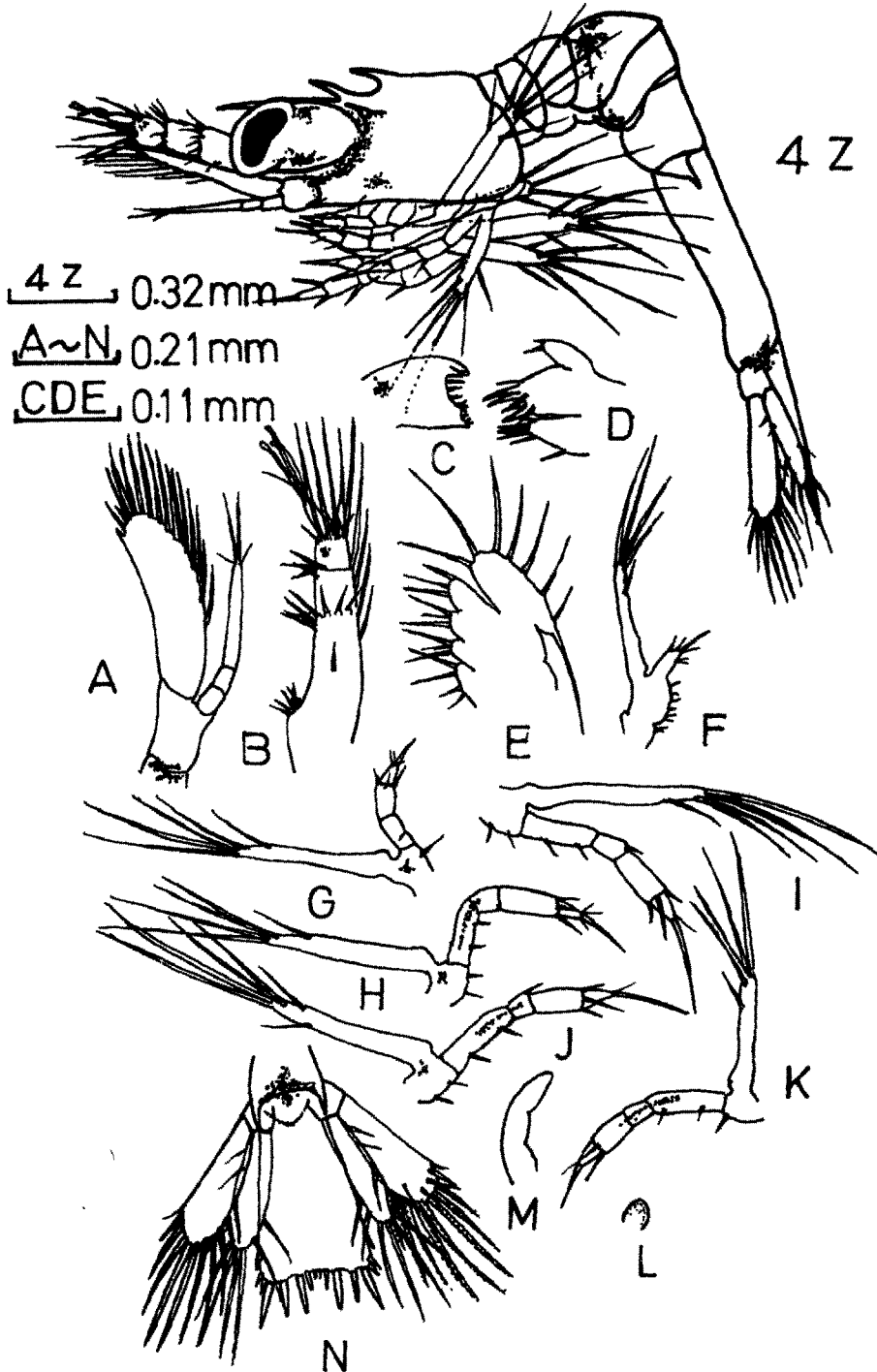


PLATE II

5 Z

5 Z 0.32 mm

A~N 0.21 mm

CDE 0.11 mm

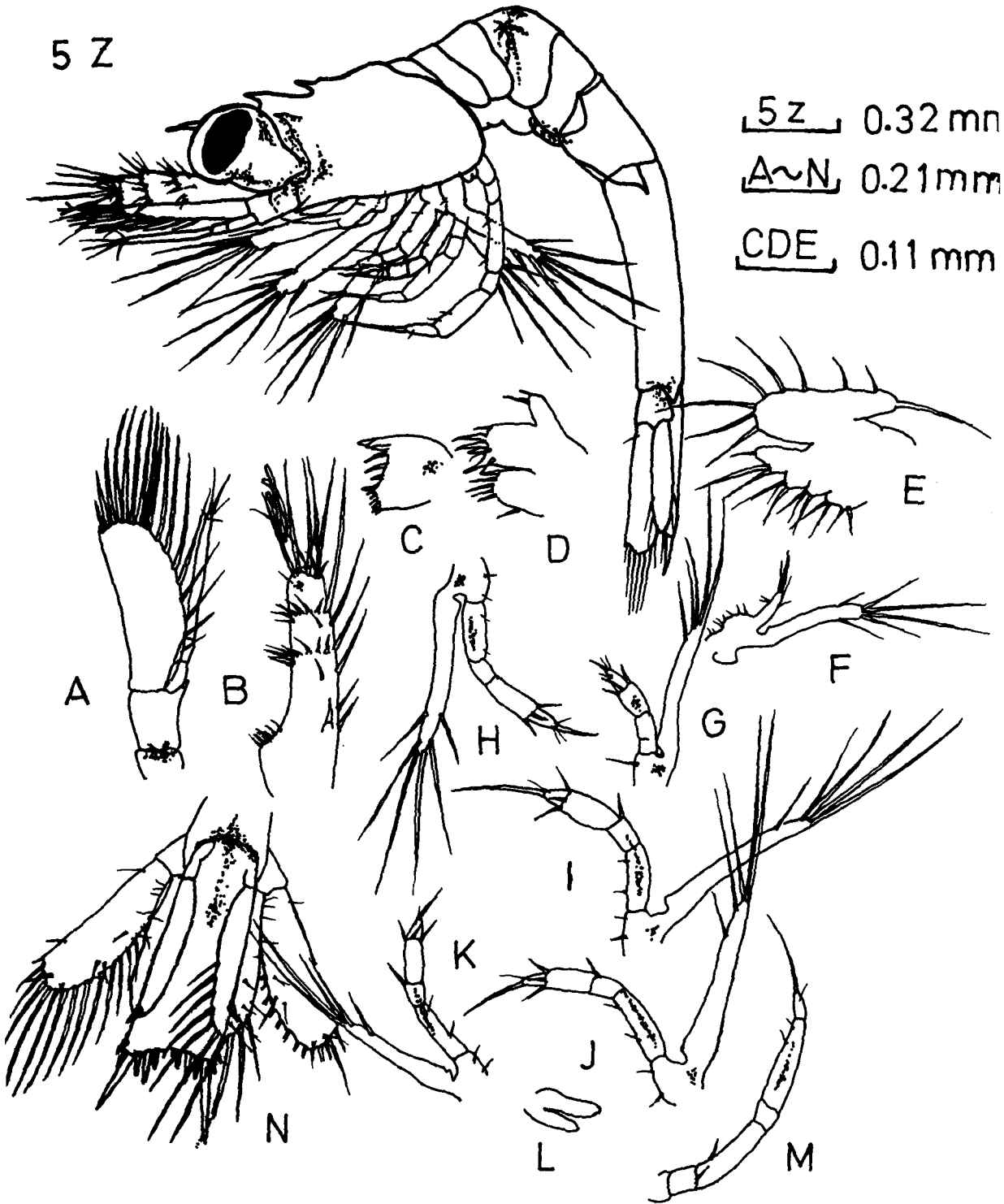


PLATE III

A5-Z

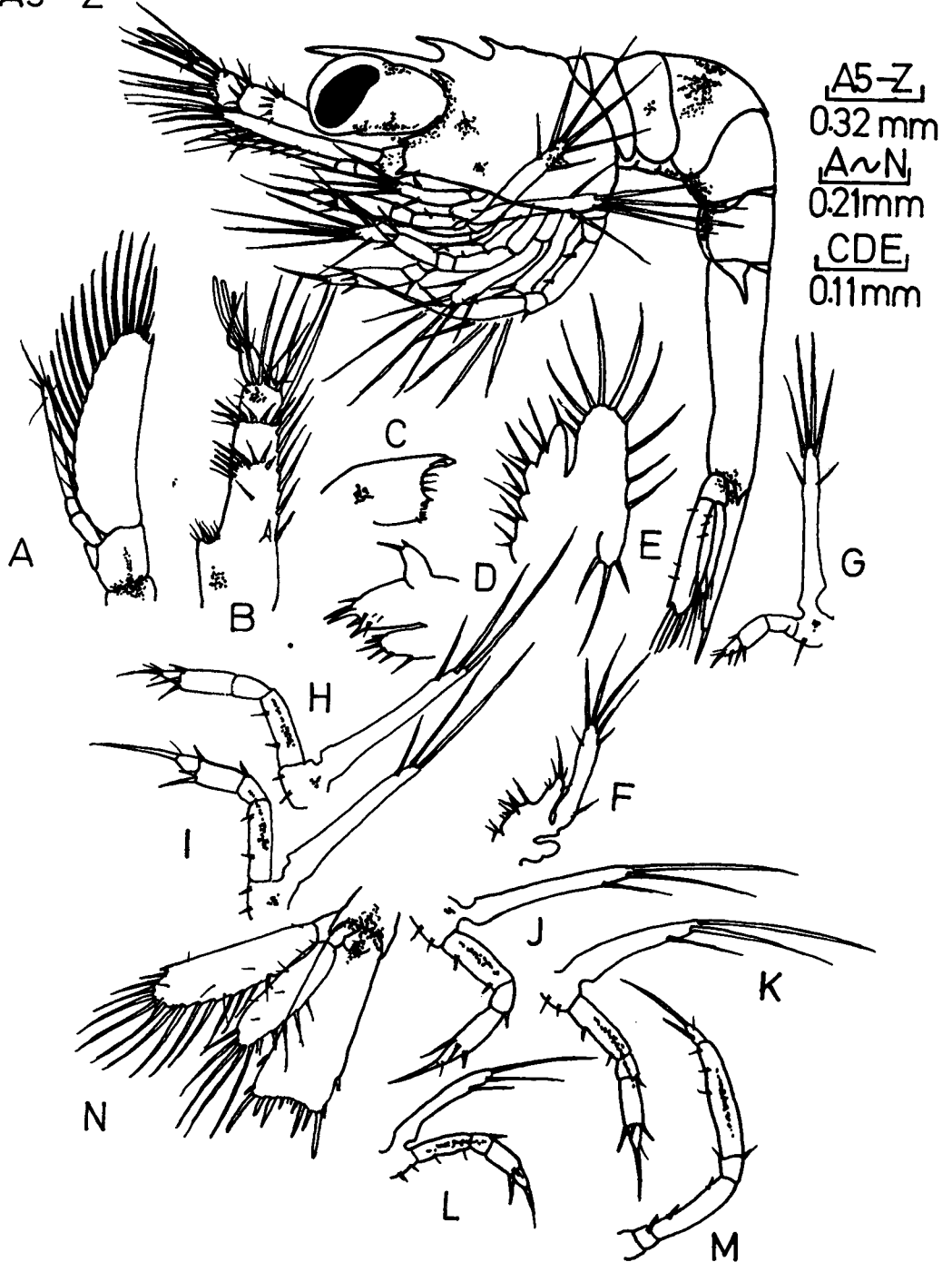


PLATE IV

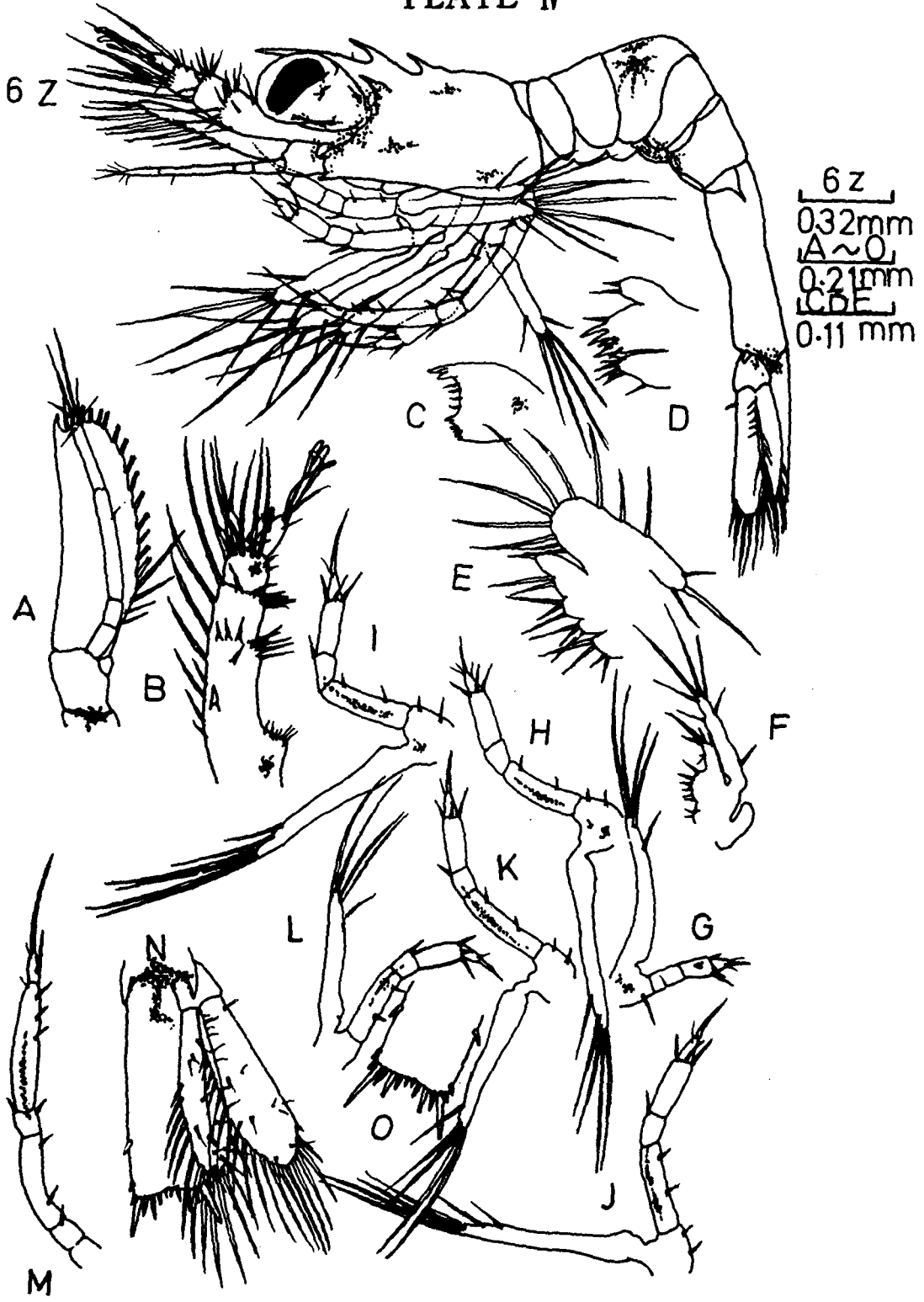


PLATE V

[F]
0.30mm
7z
[]
0.75mm
[CDE]
0.15mm
[A ~ O] A
0.45mm

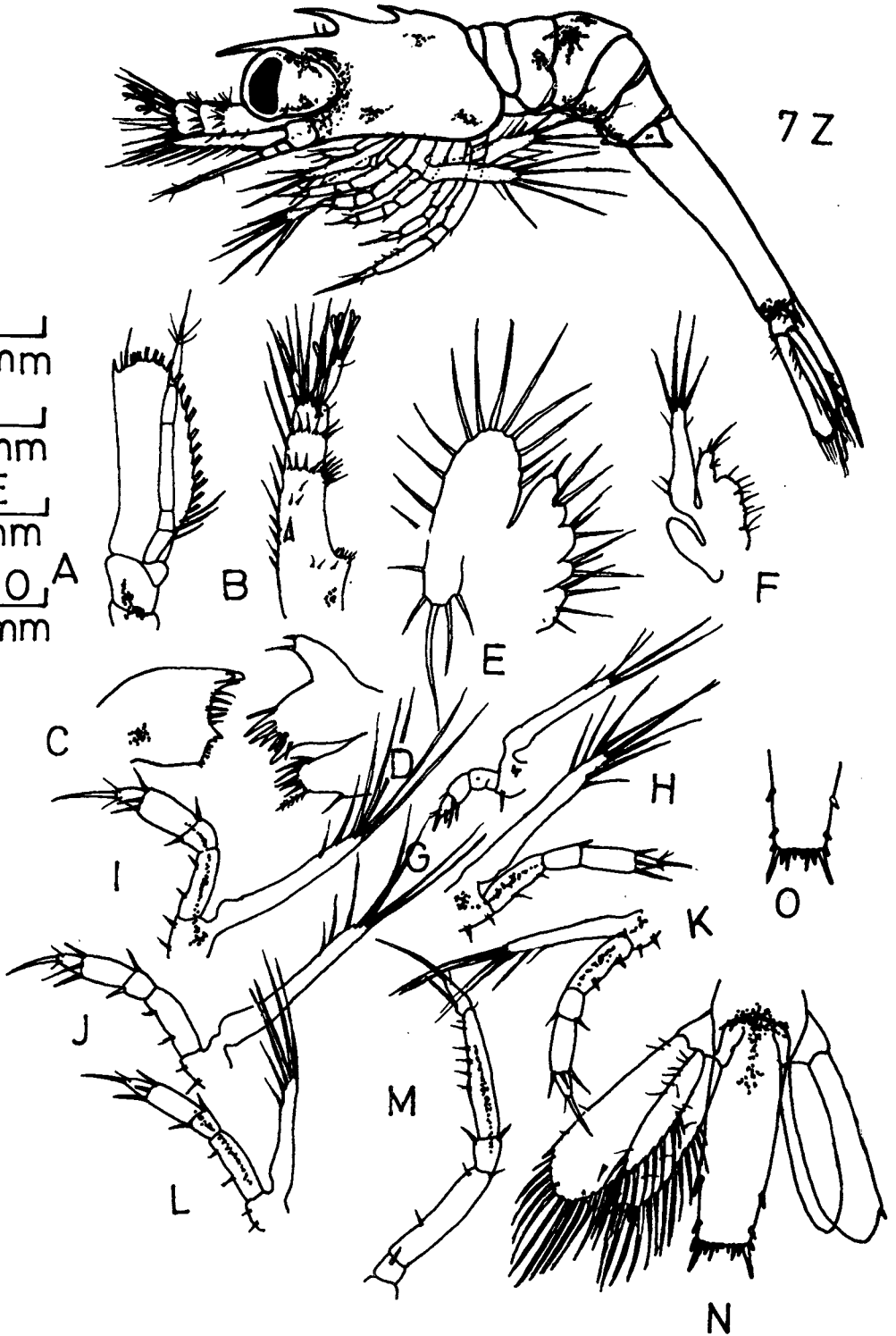


PLATE VI

F~M
0.30mm
CDEOR
0.15mm
ABNQ
0.45mm

A7-Z

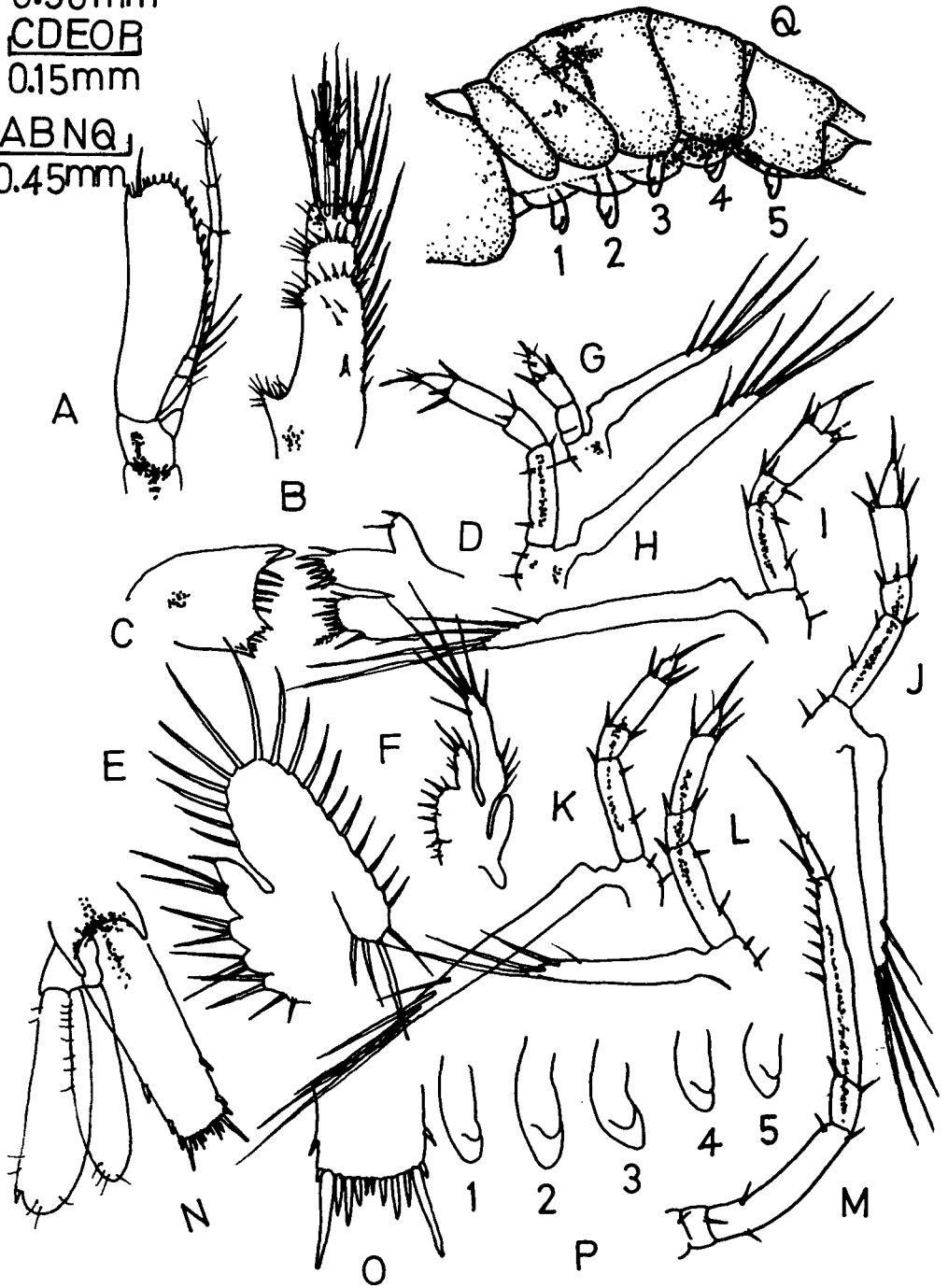


PLATE VII

[F]
0.30 mm
[CDE]
0.15 mm
[A~O]
0.45 mm

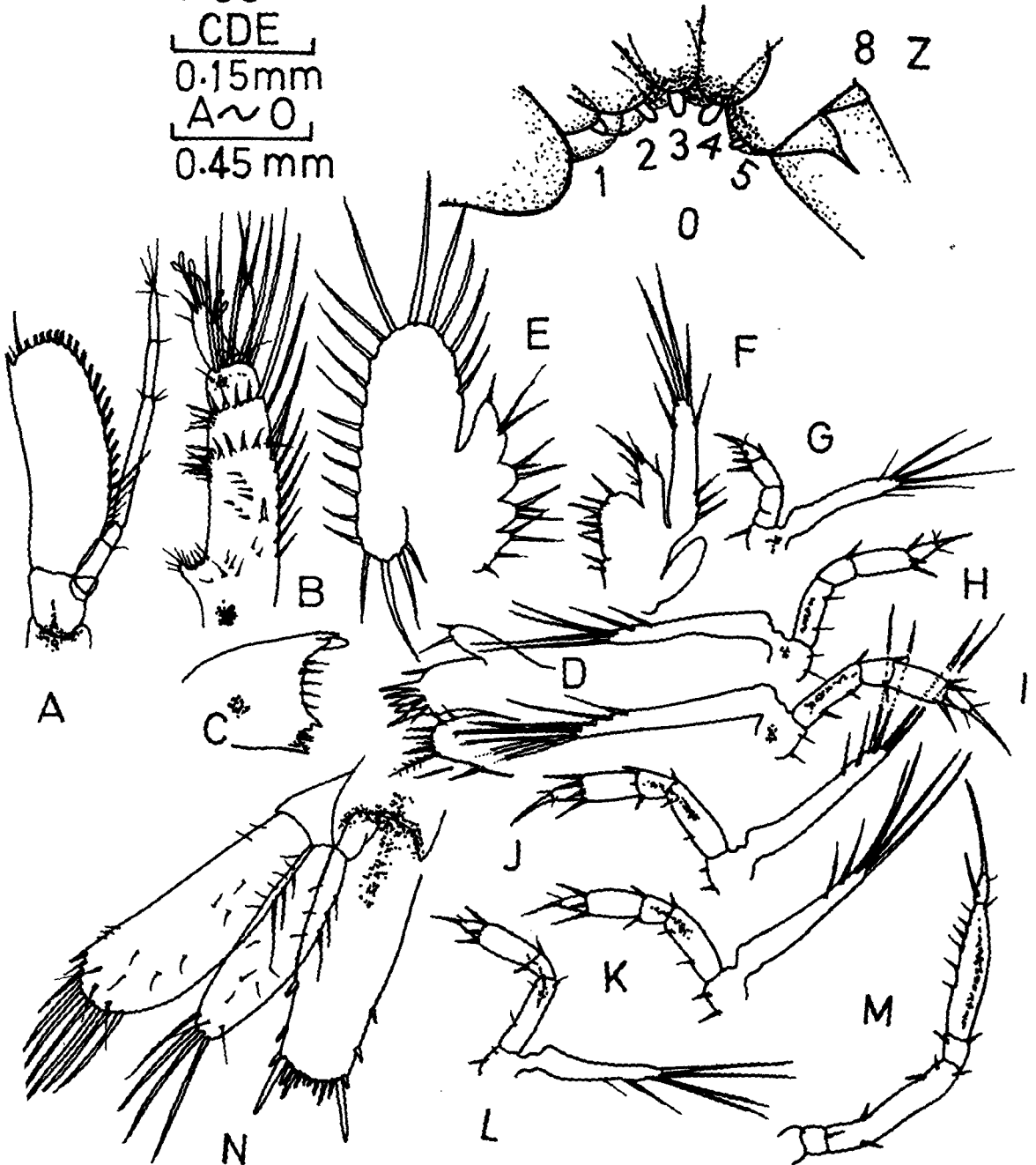


PLATE VIII

