

TRANSACTIONS
OF THE
ROYAL SOCIETY OF NEW ZEALAND

ZOOLOGY

VOL. 5

No. 2

AUGUST 14, 1964

**Larvae of *Petrolisthes elongatus* (Milne Edwards, 1837).
(Crustacea, Decapoda, Anomura)**

By ROBERT G. WEAR,
Victoria University of Wellington

Abstract

THE zoea and megalopa larvae of *Petrolisthes elongatus* from Wellington Harbour, New Zealand, are described and a key to the zoea larval stages is given.

INTRODUCTION

Petrolisthes elongatus has a New Zealand-wide distribution on rocky or stony beaches. In the Wellington area this species is extremely abundant between the tide marks, especially among rocks and loose stones near low water.

First stage zoea larvae were obtained by moult from pre-zoea larvae hatched from ovigerous female crabs in the laboratory. As in the life history of *P. novaezelandiae* described by Wear (1964) there are two main zoeal stages including the sub-stages 1a, 1b, 2a, 2b and 2c. The megalopa larva, not found in the plankton, was reared from late stage zoea larvae in the laboratory.

Notes on the determination of larval stages, nomenclature, measurements, and diagrammatic representation of coloured chromatophores are given by Wear (1964).

LIST OF ABBREVIATIONS

Abd. = Abdomen.
Abd. Seg. 1 = Abdominal Segment 1.
An. = Anus.
An. Sp. = Anal Spine.
Arth. Br = Arthrobranch.
Basip. = Basipodite.
Carp. = Carpopodite.
Cox. = Coxopodite.
Cpce. = Carapace.
Dact. = Dactylopodite.
Dist. End. = Distal Endite.
End. 1-4 = Endites 1 to 4.
Endop. = Endopodite.
Epip. = Epipodite.
Ex. = Exite.
Exop. = Exopodite.
Gill B. = Gill Buds.
Inc. Pr. = Incisor Process.
I.R. = Inner Ramus.
Isch. = Ischiopodite.

Lat. Sp. = Lateral Spine.
Mer. = Meropodite.
Mol. S. = Molar Surface.
Mxpd. 3 = Maxilliped 3.
O.R. = Outer Ramus.
Ped. = Peduncle.
Per. 1-5 = Pereiopods 1 to 5.
Pleur. Br. = Pleurobranch.
Plp. = Palp.
Plpds. = Pleopods.
Post. Sp. = Posterior Spine.
Pr. End. = Proximal Endite.
Prop. = Propodite.
Prot. = Protopodite.
Rost. = Rostrum.
Scaph. = Scaphognathite.
Seg. 1-5 = Abdominal Segments 1 to 5.
Tel. = Telson.
Urop. = Uropod.

*Published by the Royal Society of New Zealand, c/o Victoria University of
Wellington, P.O. Box 196, Wellington.*

THE ZOEAL LARVAE

Zoea larvae first appear in the Wellington Harbour plankton in September, but until November they are rare. They are most abundant from December to February, but are not recorded from April through to August. Zoeal stages 1a and 2b are essential in the planktonic life history, differing from *P. novaezealandiae*, in which stages 1a and 2a are essential. In *P. elongatus* stage 1b was often bypassed when stage 1a larvae moulted to stage 2a. Also stage 1b larvae may moult to stage 2b, thus bypassing stage 2a. Stage 2c was frequently bypassed and is rare in the plankton. The majority of stage 2b larvae moulted to the megalopa in the laboratory.

Hence the sequence of zoeal stages is probably either 1a → 2a → 2b → megalopa, or 1a → 1b → 2b → megalopa. Stage 2c may occasionally be included. This pattern is similar to that of *Porcellana platycheles* and *P. longicornis* described by Lebour (1943) and *Petrolisthes novaezealandiae* described by Wear (1964). *P. elongatus* larvae probably pass through three and occasionally four of the five possible zoeal stages, and, as in *P. novaezealandiae*, it is doubtful if any larva moults through all five stages in reaching the megalopa stage.

A KEY TO THE ZOEAL LARVAE OF *Petrolisthes elongatus*

- | | |
|--|-------------------|
| 1 (4) Total carapace length less than 16mm; eyes sessile and immovable; 1st antennae uniramous; exopodite of 1st and 2nd maxillipeds with 4 natatory setae; pleopod buds absent; 7 + 7 posterior telson setae; gill buds absent | STAGE ONE |
| 2 (3) Endopodite of 2nd antennae shorter than exopodite; 3rd maxillipeds and pereopods as very short buds; 7th pair of telson setae on central prominence shorter than 5th or 6th pairs | Stage 1a (Fig. 1) |
| 3 (2) Endopodite and exopodite of 2nd antennae equal in length; 3rd maxillipeds and pereopods as long, unjointed rods; 7th pair of telson setae as long as 5th and 6th pairs | Stage 1b (Fig. 1) |
| 4 (1) Total carapace length greater than 16mm; eyes stalked and movable; 1st antennae biramous; exopodite of 1st and 2nd maxillipeds with 14 or more natatory setae; pleopods as small buds; 8 + 8 posterior telson setae; gill buds present. | STAGE TWO |
| 5 (8) Endopodite of 2nd antennae less than twice the length of exopodite, and endopodite not visibly segmented; mandibles without palp; 5th pereopods not chelate; lamellae of gill buds not differentiated. | |
| 6 (7) Protopodite of 2nd antennae incompletely divided into two segments; endopodite of 2nd antennae about $1\frac{1}{2}$ times the length of exopodite; exopodites of 1st and 2nd maxillipeds with 14 natatory setae; 3rd maxillipeds and pereopods unsegmented; 1st pereopods not chelate; pleopod buds small, unsegmented | Stage 2a (Fig. 2) |
| 7 (6) Protopodite of 2nd antennae two-segmented; endopodite of 2nd antennae slightly less than twice the length of exopodite; exopodites of 1st and 2nd maxillipeds with 16 natatory setae; 3rd maxillipeds and pereopods incompletely segmented; 1st pereopods with rudimentary chela; pleopod buds large, incompletely divided into two segments. | Stage 2b (Fig. 3) |
| 8 (5) Endopodite of 2nd antennae greater than twice the length of exopodite, and endopodite visibly segmented beneath cuticle; mandibles with short, bud-like palp; 5th pereopods with rudimentary chela at tip; lamellae of gill buds visible | Stage 2c (Fig. 4) |

STAGE ONE ZOEAL

Stage 1a

Stage 1a zoeal larvae (Fig. 1, A) were obtained from the plankton, and by moult from the pre-zoeal larva in the laboratory. All pre-zoeal larvae moulted to

stage 1a and it is therefore an essential larval stage. Stage 1a is the most common of the zoea larval stages occurring in the plankton.

Description

Cephalothorax: Total carapace length 12.2mm to 13.9mm. Rostrum 7.4mm to 8.0mm in length, with small anteriorly-inclined setae arranged in a double ventral row and two ventro-lateral rows from base to within about 1.0mm of tip. Ventral setae long near base of rostrum but shorter towards tip. Upper surface without setae. Carapace 1.4mm to 1.5mm in length, heart-shaped, smooth, and without setae. Posterior carapace spines 3.4mm to 4.4mm in length, each with a ventral row of 20 to 24 curved setae which decrease in length towards tips of spines. Eyes large, sessile, and without stalks.

Cephalic Appendages: First antenna (Fig. 1, C) unjointed, with three long aesthaetes and three shorter aesthaetes at tip.

Second antenna (Fig. 1, D) with unjointed protopodite. Endopodite three-quarters the length of exopodite with one small seta at tip. Exopodite a slender spine having three small setae on inner distal margin.

Mandible (Fig. 1, F) with a ridged molar surface and prominent incisor process, but without a palp.

First maxilla (Fig. 1, G) with unjointed palp having two short plumose setae at tip and three subterminal plumose setae on inner margin. Proximal and distal endites each with two rows of four, short, coarsely plumose setae

Second maxilla (Fig. 1, H) comprises four endites, a palp, and a broad, flattened scaphognathite. Proximal pair of endites (coxopodite) and distal pair (basipodite) separated by a deep cleft. First (proximal) endite with three plumose setae along inner margin and five plumose setae at tip. Second, third, and fourth (distal) endites fringed by five, five, and seven plumose setae respectively. Palp with four long plumose setae at tip and two pairs of plumose setae on inner margin. Scaphognathite has five long plumose setae along inner proximal margin and seven similar setae spaced along outer distal margin.

Thoracic Appendages: First maxilliped (Fig. 1, I) functional and natatory. Basipodite with eight sparsely plumose setae arranged in four groups of two along inner margin. Endopodite of five segments and as long as exopodite. Ischiopodite, meropodite, and carpopodite of endopod each with three sparsely plumose setae on inner distal margins. Propodite with four such setae on inner distal margin, and one, long, densely plumose seta on outer distal margin. Dactylopodite with three long sparsely plumose setae at tip and three similar subterminal setae. Exopodite incompletely divided into two segments of unequal length, and has four very long, jointed natatory setae at tip.

Second maxilliped (Fig. 1, J) similar to first, but differs in possessing a four-segmented endopodite. Coxopodite short and without setae. Basipodite with a sparsely plumose seta midway along inner margin and two similar setae distally on inner margin. Ischiopodite, meropodite, and longer third segment (probably carpopodite + propodite) with two, three, and three setae respectively on inner margins. Third segment with long, densely plumose seta on outer distal margin. The probable point of fusion of carpopodite and propodite is indicated by two plumose setae on inner margin. Dactylopodite with three long terminal setae and three subterminal setae. Exopodite as in first maxilliped.

Third maxilliped (Fig. 1, J) biramous, but rami short and bud-like.

Five pairs of pereopods all as bud-like rudiments with the fifth much smaller.

Gill buds and epipodites not present.

Abdomen: Abdomen (Fig. 1, L) comprises five segments and a telson. Segments finely toothed along posterior dorsal margins. Fourth and fifth segments each with a pair of stout postero-lateral spines. Pleopods absent.

Telson spatuliform with a posterior central prominence, an anal spine, and seven pairs of posterior setae.

First (outer) pair of setae short and smooth. Second pair much reduced and hair-like. Third, fourth, fifth, sixth and seventh pairs each long and plumose, with the seventh pair slightly shorter, and arising from central prominence as in previously described *Petrolisthes* larvae except *P. novaezelandiae*. Five medial pairs of setae with about six curved hooklets distally.

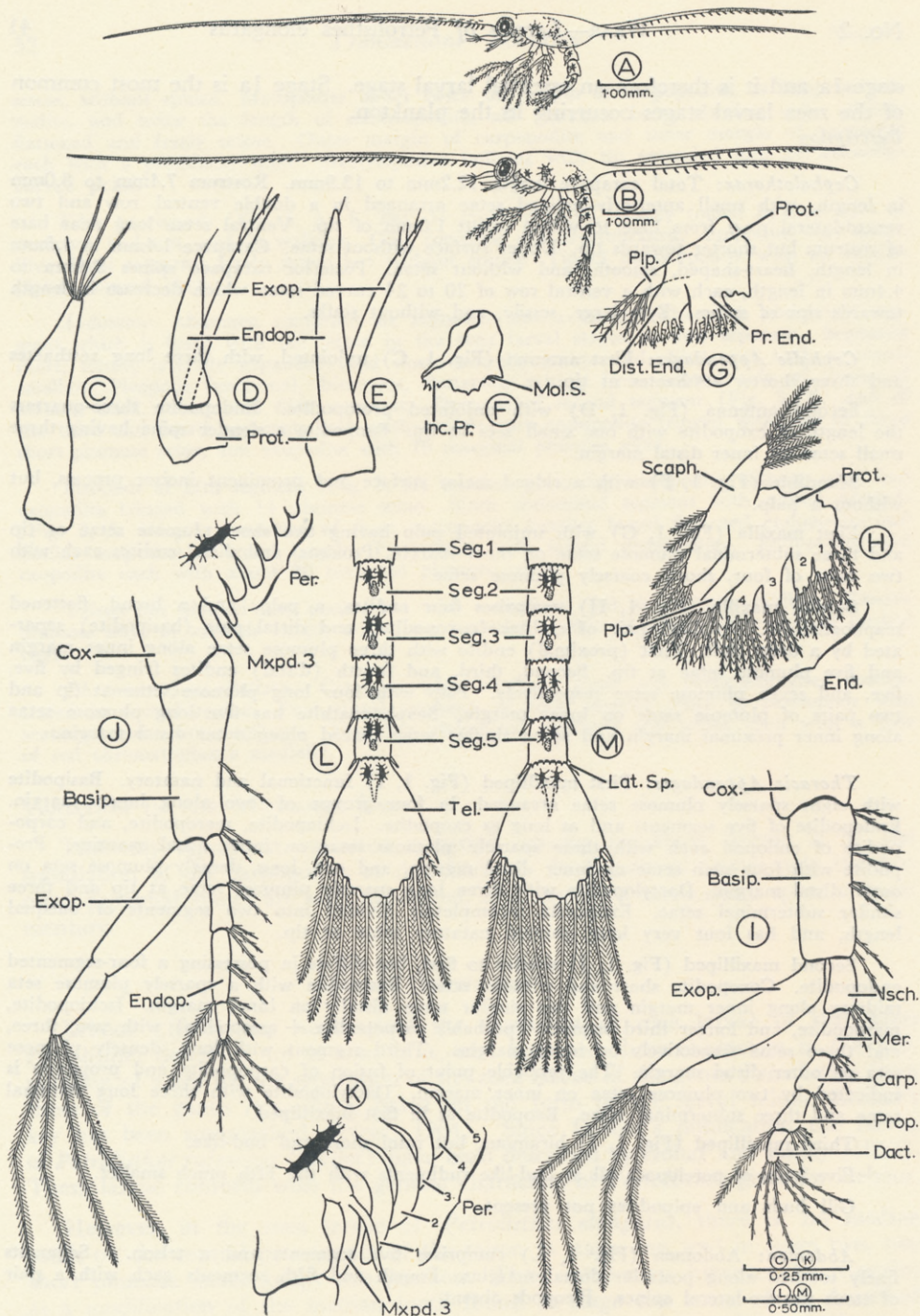


Fig. 1.—Stage 1a, Zoa Larva. A—Stage 1a Zoa Larva: Lateral view. C—First Antenna of Left Hand Side: Ventral view. D—Second Antenna of Left Hand Side: Inner view. F—Mandible of Left Hand Side: Dorsal view. G—First Maxilla of Left Hand Side: Ventral view. H—Second Maxilla of Left Hand Side: Ventral view. I—First Maxilliped of Left Hand Side: Posterior view. J—Second Maxilliped, Third Maxilliped, and Pereiopods of Left Hand Side: Lateral view. L—Abdomen and Telson: Dorsal view. Stage 1b, Zoa Larva. B—Stage 1b Zoa Larva: Lateral view. E—Second Antenna of Left Hand Side: Inner view. K—Third Maxilliped and Pereiopods of Left Hand Side: Lateral view. M—Abdomen and Telson: Dorsal view.

Chromatophore Pattern: The chromatophore pattern characterising all the zoea larval stages of *P. elongatus* is seen in the stage 1a zoea. Distal half of rostrum and posterior carapace spines orange-brown. First antennae and mandibles with paired red or orange chromatophores at base. Thoracic region with a paired red chromatophore above third maxillipeds and anterior pereopods. Mid-gut yellow. Second, third, fourth and fifth abdominal segments each with paired red chromatophore along lateral walls of hind-gut and an unpaired orange chromatophore in the ventral midline. Telson with a paired red chromatophore surrounding anus.

Stage 1b

Stage 1b zoea larvae were obtained from the plankton and by moult from stage 1a in the laboratory. Several stage 1a larvae obtained by moult from the pre-zoea larva in the laboratory later moulted to stage 1b. However the majority of stage 1a larvae bypassed stage 1b and moulted to stage 2a. Stage 1b occurs only rarely in plankton samples, suggesting that this stage is often bypassed in natural conditions.

Stage 1a and 1b of *P. elongatus* are more easily separated than are the equivalent stages of *P. novaezelandiae*. Stage 1b larvae of *P. elongatus* are distinguished from stage 1a by the characters described below.

Description

Cephalothorax: Total carapace length 14.4mm to 15.5mm, rostrum length 8.5mm to 9.0mm, carapace length 1.4mm to 1.6mm and posterior carapace spine length 4.5mm to 4.9mm.

Cephalic Appendages: Exopodite and endopodite of second antenna (Fig. 1, E) are of equal length.

Thoracic Appendages: Endopodite and exopodite of third maxillipeds (Fig. 1, K) long, rod-like, but without setae. Pereiopod buds (Fig. 1, K) as long unsegmented rods.

Abdomen: Posterior telson setae longer than in stage 1a, with seventh (inner) pair as long as the third, fourth, fifth and sixth pairs. (Fig. 1, M).

STAGE TWO ZOEAE

Stage 2a

Stage 2a zoea larvae (Fig. 2, A) were obtained from the plankton, and by moult from stages 1a and 1b in the laboratory. During laboratory experiments several stage 1b larvae bypassed stage 2a and moulted to stage 2b. Stage 2a larvae are common in the plankton but it does not appear to be an essential stage in the life history. Stage 2a can be readily distinguished from stages 1a and 1b by the characters below.

Description

Cephalothorax: Total carapace length 17.0mm to 18.4mm, rostrum length 10.0mm to 10.7mm, carapace length 2.4mm to 2.5mm and posterior carapace spine length 4.6mm to 5.1mm. Eyes now stalked and movable.

Cephalic Appendages: First antenna (Fig. 2, B) comprises a long peduncle incompletely divided into two segments of approximately equal length, and two short distal rami. Peduncle with two short hairs midway along outer margin. Inner ramus unsegmented, with two short simple setae arising from base on inner margin. Outer ramus incompletely divided into six segments, with long aesthaetes arising from inner margin in four distal groups. (Fig. 2, C.)

Second antenna (Fig. 2, D) with protopodite incompletely divided into two segments (coxopodite and basipodite). Endopodite about $1\frac{1}{2}$ times the length of exopodite.

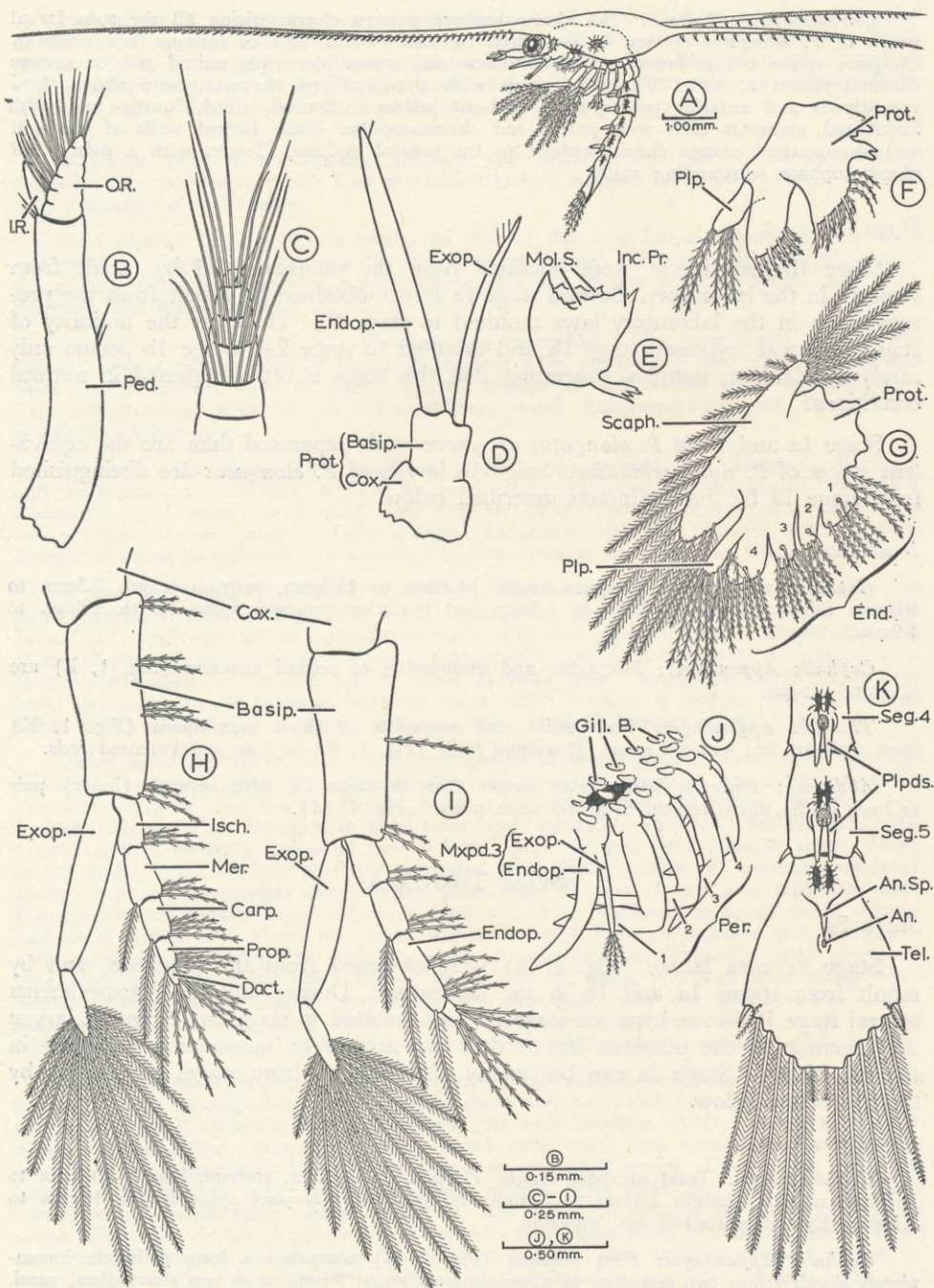


Fig. 2.—Stage 2a Zoea Larva. A—Stage 2a Zoea Larva: Lateral view. B—First Antenna of Left Hand Side: Lateral view. C—Outer Ramus of First Antenna of Left Hand Side: Inner view showing arrangement of aesthaetes. D—Second Antenna of Left Hand Side: Ventral view. E—Mandible of Left Hand Side: Ventral view. F—First Maxilla of Left Hand Side: Ventral view. G—Second Maxilla of Left Hand Side: Ventral view. H—First Maxilliped of Left Hand Side: Posterior view. I—Second Maxilliped of Left Hand Side: Posterior view. J—Third Maxilliped and Pereiopods of Left Hand Side: Lateral view. K—Fourth and Fifth Abdominal Segments and Telson: Ventral view showing Pleopods.

First maxilla (Fig. 2, F) with three short setae on inner margin of proximal endite.

Second maxilla (Fig. 2, G) larger and more setose than in stage one. Each of the four endites now with a small ventral seta. Two distal endites each with eight marginal setae, and palp with five setae at tip. Proximal tip of scaphognathite with six long plumose setae, and outer distal margins fringed by 17 setae.

Thoracic Appendages: The setation of the first maxilliped (Fig. 2, H) is as follows: Basipodite with ten setae in two proximal groups of two, and two distal groups of three setae along inner margin. Ischiopodite, meropodite, carpopodite and propodite of endopod with three, three, four and four setae respectively on inner distal margins. Dactylopodite with three long, sparsely plumose terminal setae and three similar subterminal setae. Meropodite, carpopodite and propodite each with one long, densely plumose seta on outer distal margin. Exopodite (Fig. 2, H. Exop.) now completely divided into two segments. Shorter terminal segment with 14 jointed natatory setae.

Endopodite of second maxilliped (Fig. 2, I. Endop.) more strongly developed than in stage one, and setation differs in the presence of a long, densely plumose seta on outer distal margin of meropodite, and mid-way along outer margin of third segment respectively. Exopodite as that of first maxilliped of stage 2a.

Third maxilliped (Fig. 2, J. Mxpd. 3) distinctly biramous, with slender unsegmented exopodite arising as a process of endopodite from near its base. Exopodite with four short, plumose setae at tip.

Anterior four pairs of pereopods (Fig. 2, J. Per. 1-4) strongly developed, unsegmented and bent forward under thorax. Fifth pair slender, much reduced, and hidden behind anterior four pairs.

Gills present as bud-like rudiments (Fig. 2, J). The gill formula is tabulated hereunder, and can be determined in stage 2a zoeae.

	3rd maxillipeds rudiment + 1	per	1	2	3	4	5
Arthrobranchs	—	2	2	2	2	2	1
Pleurobranchs	—	—	1	1	1	1	—

Abdomen: Four pairs of pleopods (Fig. 2, A; K. Plpds.) as short, unsegmented, ventral buds on segments two, three, four and five. Telson (Fig. 2, K) with eight pairs of posterior setae. Eighth (inner) pair very short, plumose, without distal hooklets, arising from central prominence.

Stage 2b

Stage 2b zoea larvae (Fig. 3, A) were obtained from the plankton, and by moult from stage 1b and stage 2a larvae in the laboratory. On no occasion was stage 2b bypassed, and is therefore probably essential in the planktonic life history. Stage 2b larvae are common in the plankton, and are distinguished from stage 2a by the characters below.

Description

Cephalothorax: Total carapace length 19.9mm to 22.5mm. Rostrum extremely long, 12.0mm to 13.3mm in length. Carapace length 2.4mm to 2.7mm and posterior carapace spine length 5.5mm to 6.5mm.

Cephalic Appendages: Second antenna (Fig. 3, B) with protopodite divided into two segments. Endopodite slightly less than twice the length of exopodite.

Thoracic Appendages: First maxilliped (Fig. 3, C) with now four setae on inner distal margin of meropodite, and five setae on inner distal margin of propodite. Ischiopodite with one, long, densely plumose seta on outer distal margin. Exopodite with 16 natatory setae.

Second maxilliped (Fig. 3, D) with one, long plumose seta on outer distal margin of ischiopodite, and exopodite with 16 natatory setae.

Third maxilliped (Fig. 3, E) more strongly developed than in stage 2a. Endopodite incompletely divided into five segments and exopodite incompletely divided into three segments.

Pereopods (Fig. 3, E. Per. 1-5) well developed. First pereopods with a rudimentary chela at tip. Second, third, fourth, and slender fifth pereopods incompletely segmented, but not chelate. Gill buds large, but lamellae not differentiated.

Abdomen: Pleopods (Fig. 3, F. Plpds.) incompletely divided into long proximal segment and shorter distal segment.

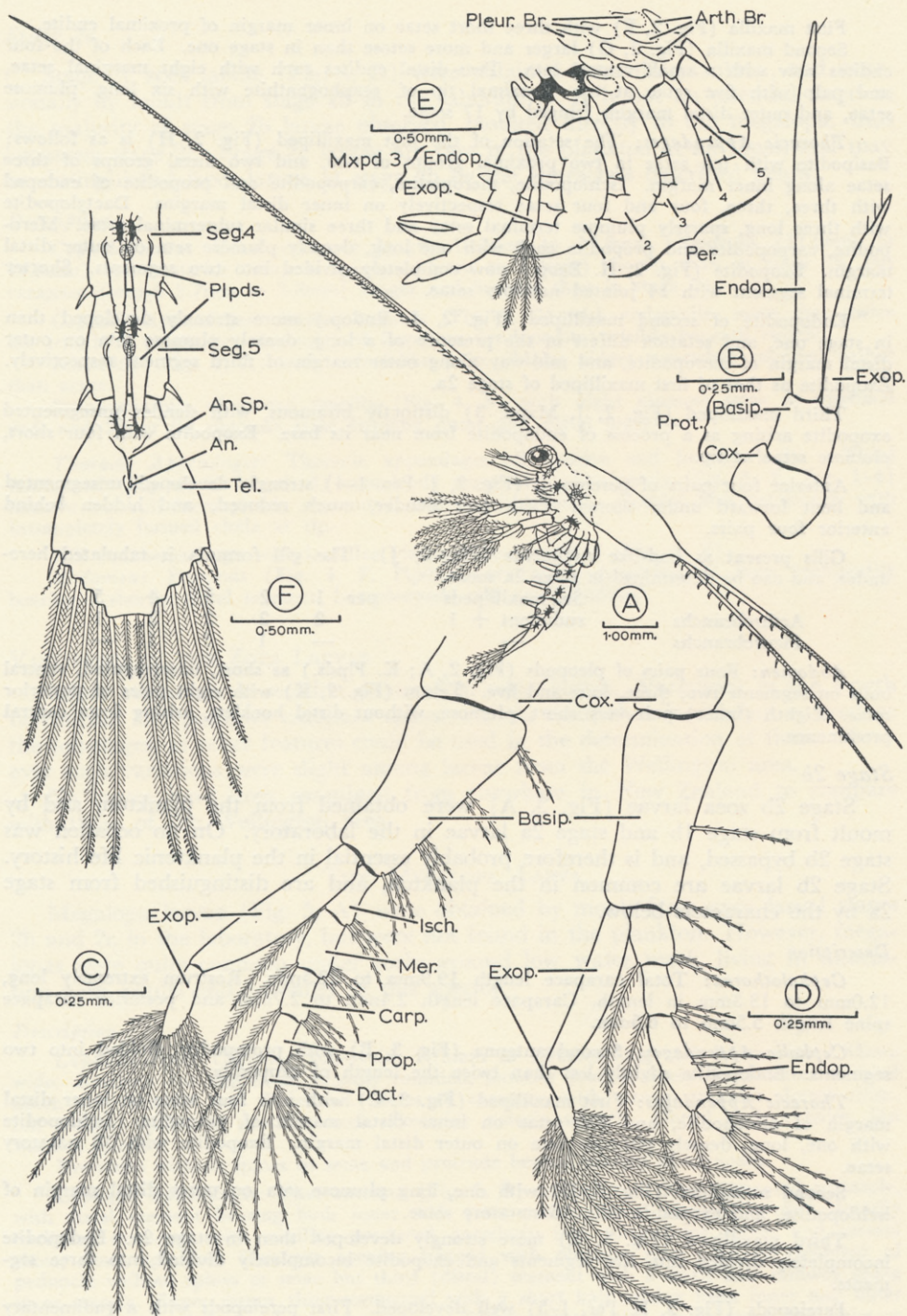


Fig. 3.—Stage 2b, Zoea Larva. A—Stage 2b Zoea Larva: Lateral view. B—Second antenna of Left Hand Side: Ventral view. C—First Maxilliped of left Hand Side: Posterior view. D—Second Maxilliped of Left Hand Side: Posterior view. E—Third Maxilliped, Pereiopods, and Gill Buds of Left Hand Side: Lateral view. F—Fourth and Fifth Abdominal Segments and Telson: Ventral view showing Pleopods.

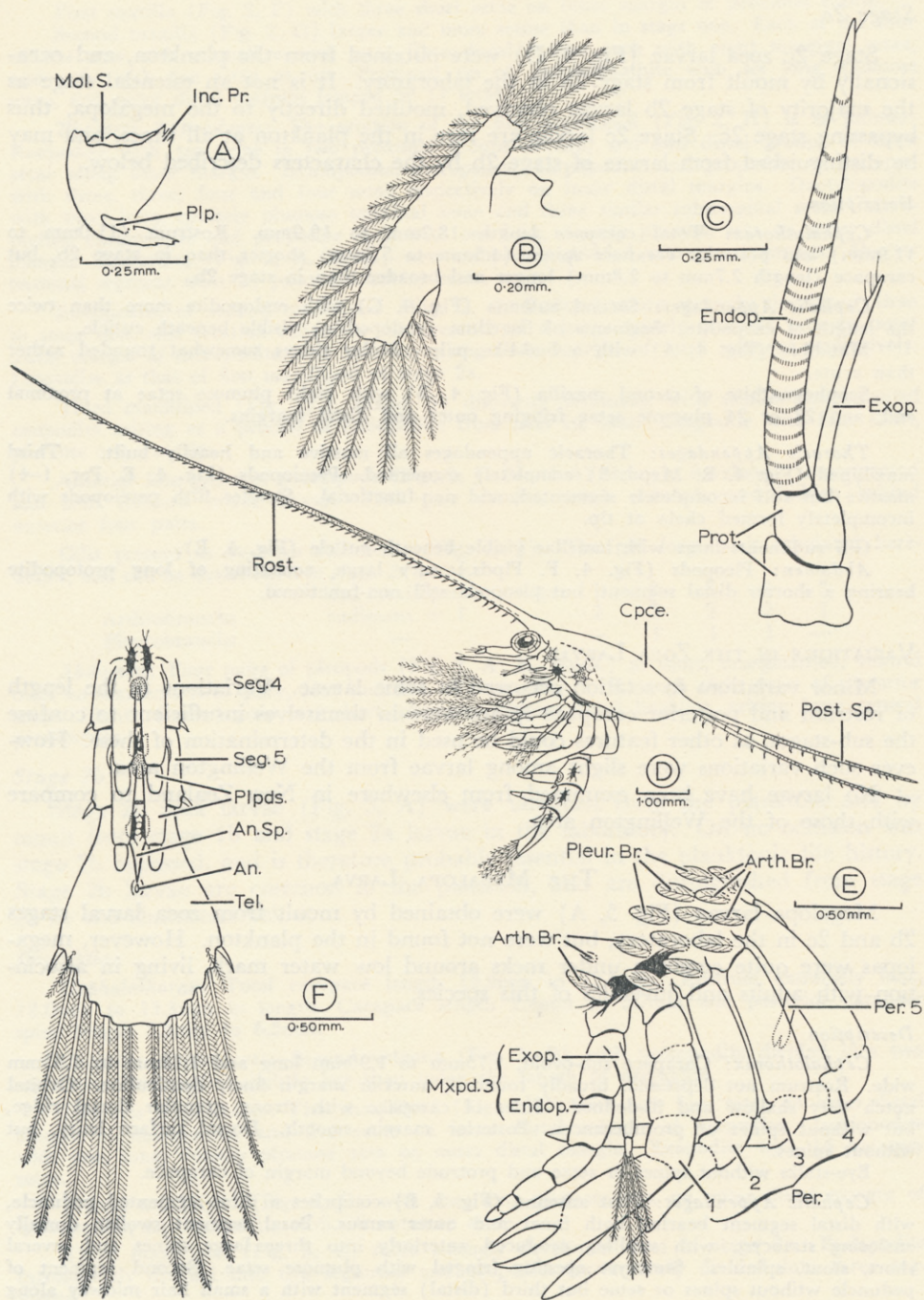


Fig. 4.—Stage 2c, Zoa Larva. A—Mandible of Right Hand Side: Dorsal view. B—Scaphognathite of Second Maxilla of Left Hand Side: Ventral view. C—Second Antenna of Left Hand Side: Ventral view. D—Stage 2c Zoa Larva: Lateral view. E—Third Maxilliped, Pereiopods, and Gill Buds of Left Hand Side: Lateral view. F—Fourth and Fifth Abdominal Segments and Telson: Ventral view showing Pleopods.

Stage 2c

Stage 2c zoea larvae (Fig. 4, D) were obtained from the plankton, and occasionally by moult from stage 2b in the laboratory. It is not an essential stage as the majority of stage 2b larvae observed, moulted directly to the megalopa, thus bypassing stage 2c. Stage 2c larvae are rare in the plankton at all times, and may be distinguished from larvae of stage 2b by the characters described below.

Description

Cephalothorax: Total carapace length 18.2mm to 19.9mm. Rostrum (11.0mm to 11.9mm) and posterior carapace spines (4.5mm to 5.2mm) shorter than in stage 2b, but carapace (length 2.7mm to 2.8mm) longer and broader than in stage 2b.

Cephalic Appendages: Second antenna (Fig. 4, C) with endopodite more than twice the length of exopodite. Segments of flagellum (endopodite) visible beneath cuticle.

Mandible (Fig. 4, A) with a bud-like palp. Molar ridges somewhat rounded rather than acute.

Scaphognathite of second maxilla (Fig. 4, B) with eight plumose setae at proximal end, and 23 or 24 plumose setae fringing outer and distal margins.

Thoracic Appendages: Thoracic appendages all massive and heavily built. Third maxilliped (Fig. 4, E. Mxpd. 3) completely segmented. Pereiopods (Fig. 4, E. Per. 1-4) massive but still incompletely segmented, and non-functional. Slender fifth pereiopods with incompletely formed chela at tip.

Gill rudiments large with lamellae visible beneath cuticle (Fig. 4, E).

Abdomen: Pleopods (Fig. 4, F. Plpds.) very large, consisting of long protopodite bearing a shorter distal segment, but pleopods still non-functional.

VARIATIONS IN THE ZOEAL LARVAE

Minor variations in setation occurred in some larvae. Variations in the length of rostrum and posterior carapace spines were in themselves insufficient to confuse the sub-stages, as other features could be used in the determination of these. However such variations were slight among larvae from the Wellington area.

No larvae have been examined from elsewhere in New Zealand to compare with those of the Wellington area.

THE MEGALOPA LARVA

Megalopa larvae (Fig. 5, A) were obtained by moult from zoea larval stages 2b and 2c in the laboratory, but were not found in the plankton. However, megalopas were quite common under rocks around low water mark, living in association with adults and juveniles of this species.

Description

Cephalothorax: Carapace sub-ovoid, 1.75mm to 1.90mm long and 1.18mm to 1.35mm wide. Rostrum not depressed, broadly rounded, anterior margin finely denticulate. Orbital notch very shallow and ill-defined. Sides of carapace with strong granular dorsal ridge, but without spines or protuberances. Posterior margin smooth. Dorsal surface hairy, but without spines.

Eye-stalks without spines or setae and protrude beyond margin of carapace.

Cephalic Appendages: First antenna (Fig. 5, B) comprises a three-segmented peduncle, with distal segment bearing both inner and outer ramus. Basal segment swollen dorsally enclosing statocyst, with swelling produced anteriorly into three large spines and several short, stout, spinules. Statocyst opening fringed with plumose setae. Second segment of peduncle without spines or setae but third (distal) segment with a small hair midway along inner margin. Inner ramus three-segmented with a short hair arising from inner and outer margins of each of first and second segments. Third segment with six or seven fine hairs at tip. Outer ramus of six short segments. Five basal segments with many long aesthaetes on inner margins. Arrangement of these aesthaetes is shown in Fig. 5, C. Outer distal margin of each of fourth, fifth and sixth segments with a fine hair. Inner margins of fifth and sixth segments also with a distal hair. Sixth segment with a long terminal aesthaete.

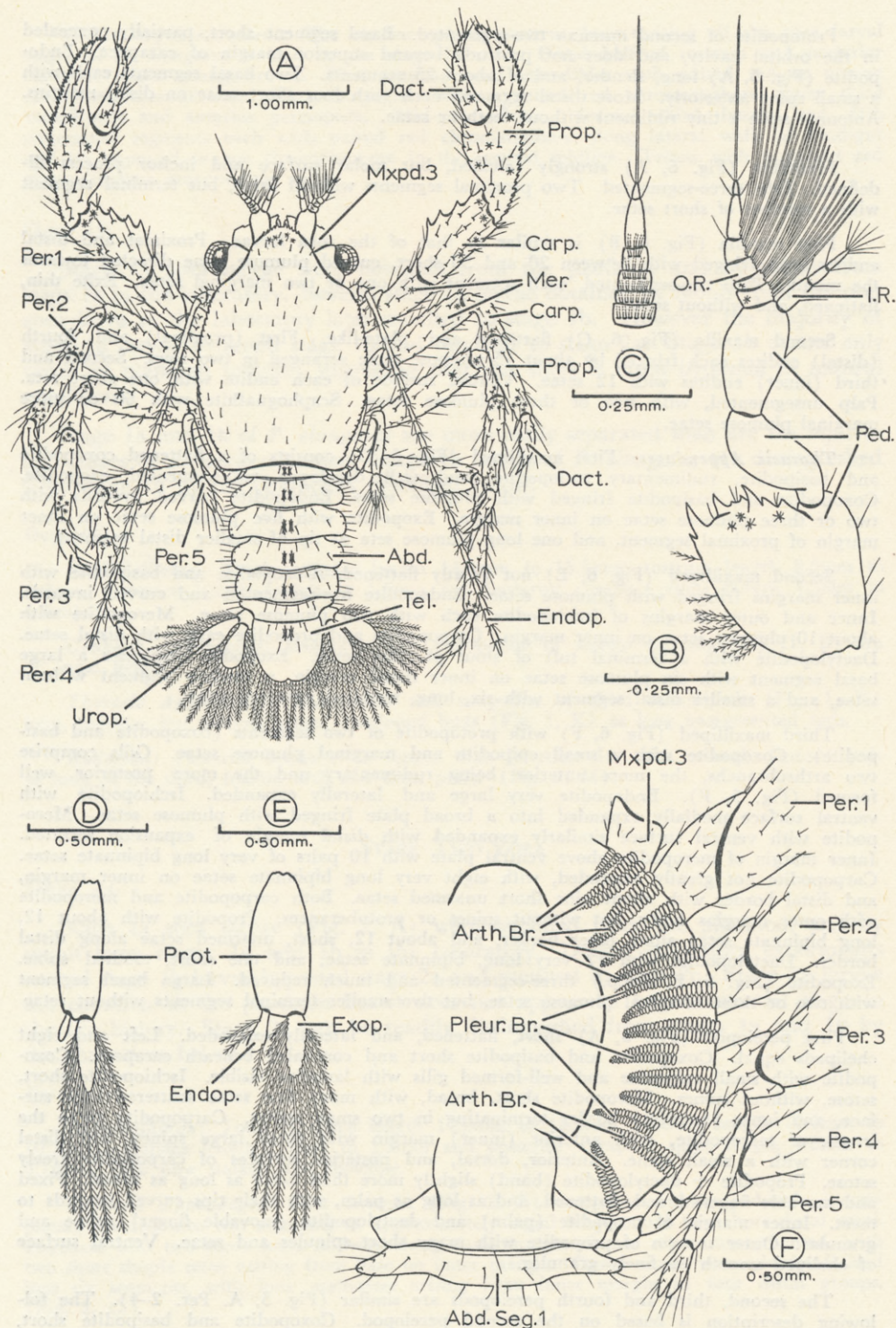


Fig. 5.—*Megalopa* Larva. A—*Megalopa* Larva, Abdomen and Telson extended: Dorsal view. B—First Antenna of Left Hand Side: Dorsal view. C—Outer Ramus of First Antenna of Left Hand Side: Inner view showing arrangement of aesthaetae. D—Left Pleopod of Fifth Abdominal Segment: Ventral view. E—Left Pleopod of Second Abdominal Segment: Ventral view. F—Carapace removed to show arrangement of Gills: Dorsal view.

Protopodite of second antenna two-segmented. Basal segment short, partially concealed in the orbital cavity, and does not protrude beyond superior margin of carapace. Endopodite (Fig. 5, A) long, slender, and of about 25 segments. Two basal segments each with a small spine anteriorly. More distal segments each with four short setae on distal margins. Antennal scale a tiny rudiment without teeth or setae.

Mandible (Fig. 6, A) strongly calcified, but molar surface and incisor process ill-defined. Palp three-segmented. Two proximal segments without setae, but terminal segment with a number of short setae.

First maxilla (Fig. 6, B) is similar to that of the zoea larvae. Proximal and distal endites each fringed with between 20 and 30 short, curved plumose setae directed towards the mouth. Palp two-segmented, each segment with one or two marginal setae. Exite thin, flattened, and without setae.

Second maxilla (Fig. 6, C) flattened and plate-like. First (proximal) and fourth (distal) endites each fringed by about 15 plumose setae arranged in two rows. Second and third (inner) endites with 12 setae. Ventral surface of each endite with one short seta. Palp unsegmented, with two or three plumose setae. Scaphognathite with 60 or more marginal plumose setae.

Thoracic Appendages: First maxilliped (Fig. 6, D) consists of a flattened coxopodite and basipodite, rudimentary endopodite, and well developed two-segmented exopodite. Coxopodite and basipodite fringed with plumose setae. Endopodite curved inwards with two or three plumose setae on inner margin. Exopodite with five plumose setae on inner margin of proximal segment, and one long plumose seta at tip of smaller distal segment.

Second maxilliped (Fig. 6, E) not greatly flattened. Coxopodite and basipodite with inner margins fringed with plumose setae. Endopodite five-segmented and curved inwards. Inner and outer margins of ischiopodite each with two plumose setae. Meropodite with about 10 plumose setae on inner margin. Carpopodite and propodite each with distal setae. Dactylopodite with a terminal tuft of stout plumose setae. Exopodite comprises a large basal segment with six plumose setae on inner distal margin, a median segment without setae, and a smaller distal segment with six, long, terminal natatory setae.

Third maxilliped (Fig. 6, F) with protopodite of two segments (coxopodite and basipodite). Coxopodite with a small epipodite and marginal plumose setae. Gills comprise two arthrobranchs, the more anterior being rudimentary and the more posterior well formed (Fig. 5, F). Endopodite very large and laterally expanded. Ischiopodite with ventral surface medially expanded into a broad plate fringed with plumose setae. Meropodite with ventral surface similarly expanded with distal margin of expansion serrated. Inner margin of meropodite above ventral plate with 10 pairs of very long bipinnate setae. Carpopodite not greatly expanded, with eight very long bipinnate setae on inner margin, and distal border with about nine short unarmed setae. Both carpopodite and meropodite with outer margins hairy, but without spines or protuberances. Propodite with about 12, long bipinnate setae along inner border, and about 12, short, unarmed setae along distal border. Dactylopodite with 12 very long, bipinnate setae, and one short, toothed spine. Exopodite (Fig. 6, F. Exop.) three-segmented and much reduced. Large basal segment with two or three marginal plumose setae, but two smaller terminal segments without setae.

First pereopod (Fig. 5, A) short, flattened, and laterally expanded. Left and right chelipeds equal. Coxopodite and basipodite short and concealed beneath carapace. Coxopodite with small epipodite and well-formed gills with lamellae visible. Ischiopodite short, setose, without spines. Meropodite short, broad, with many fine setae scattered over surface, and inner (anterior) border terminating in two small spines. Carpopodite twice the length of meropodite, with anterior (inner) margin with three large spines, and distal corner with a small spine. Anterior, dorsal, and posterior surfaces of carpopodite freely setose. Propodite + dactylopodite (hand) slightly more than twice as long as broad. Fixed and movable fingers broad, flattened, and as long as palm, with their tips curved inwards to meet. Inner margin of propodite (palm) and dactylopodite (movable finger) setose and granular. Outer margin of propodite with many short spinules and setae. Ventral surface of cheliped smooth or finely granular.

The second, third and fourth pereopods are similar (Fig. 5, A. Per. 2-4). The following description is based on the second pereopod. Coxopodite and basipodite short, setose, without spines, and hidden beneath carapace. Gills comprise two arthrobranchs and one pleurobranch with lamellae visible (Fig. 5, F). Epipodite small. Ischiopodite short,

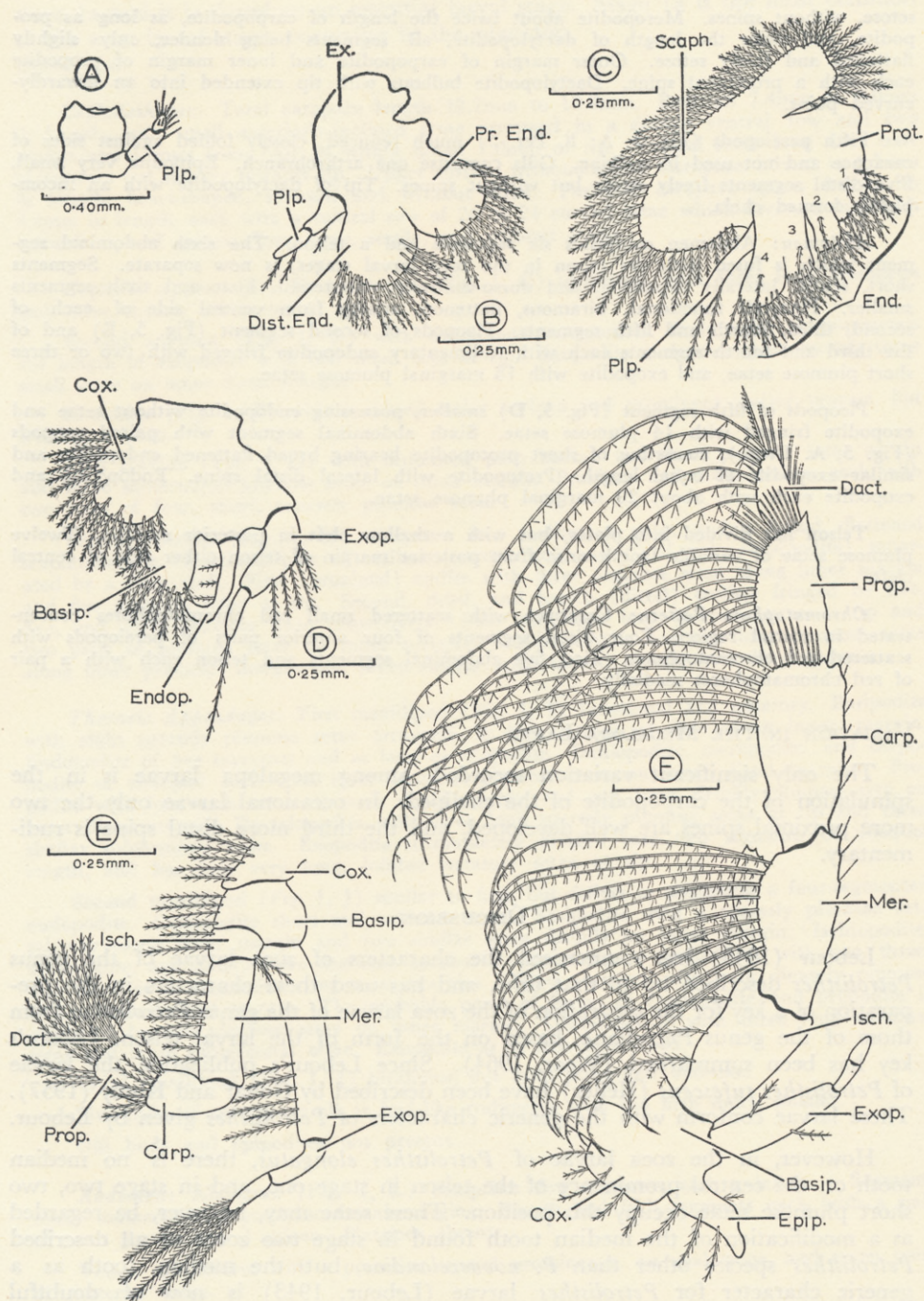


Fig. 6.—*Megalopa* Larva. A—Mandible of Left Hand Side: Dorsal view. B—First Maxilla of Left Hand Side: Ventral view. C—Second Maxilla of Left Hand Side: Ventral view. D—First Maxilliped of Left Hand Side: Dorsal view. E—Second Maxilliped of Left Hand Side: Dorsal view. F—Third Maxilliped of Right Hand Side: Dorsal view.

setose, without spines. Meropodite about twice the length of carpopodite, as long as propodite, and twice the length of dactylopodite, all segments being slender, only slightly flattened and freely setose. Outer margin of carpopodite and inner margin of propodite each with a prominent spine. Dactylopodite bulbous with tip extended into an inwardly-curved point.

Fifth pereopods (Fig. 5, A; F. Per. 5) much reduced, closely folded against sides of carapace and not used in walking. Gills comprise one arthrobranch. Epipodite very small. Five distal segments freely setose but without spines. Tip of dactylopodite with an incompletely formed chela.

Abdomen: Abdomen comprises six segments and a telson. The sixth abdominal segment which is fused with the telson in the zoea larval stages, is now separate. Segments short, setose, laterally expanded, and dorso-ventrally compressed. First and sixth segments smaller. Pleopods functional, biramous, flattened, arising from ventral side of each of second, third, fourth and fifth segments. Pleopods of second segment (Fig. 5, E) and of the third and fourth segments each with rudimentary endopodite fringed with two or three short plumose setae, and exopodite with 16 marginal plumose setae.

Pleopods of fifth segment (Fig. 5, D) smaller, possessing endopodite without setae and exopodite fringed with 14 plumose setae. Sixth abdominal segment with paired uropods (Fig. 5, A. Urop.), consisting of short protopodite bearing broad flattened endopodite and similar exopodite of equal length. Protopodite with lateral distal spine. Endopodite and exopodite each with about 20 marginal plumose setae.

Telson not divided into plates, but with a shallow cleft in posterior midline. Twelve plumose setae of variable length arise from posterior margin of telson either side of central cleft.

Chromatophore Pattern: Carapace with scattered small red chromatophores concentrated in rostral region. Four distal segments of four anterior pairs of pereopods with scattered red chromatophores. First five abdominal segments and telson each with a pair of red chromatophores medially.

VARIATION IN THE MEGALOPA LARVA

The only significant variation recorded among megalopa larvae is in the spinulation of the carpopodite of the cheliped. In occasional larvae only the two more proximal spines are well developed, and the third more distal spine is rudimentary.

DISCUSSION

Lebour (1943) has summarised the characters of zoea larvae of the genus *Petrolisthes* described up to that time, and has used these characters in the preparation of a key for the separation of the zoea larvae of the genus *Petrolisthes* from those of the genus *Porcellana*, based on the form of the larval telson. Lebour's key has been summarised (Wear, 1964). Since Lebour's publication the larvae of *Petrolisthes rufescens* (Heller) have been described by Gohar and Kholy (1957). These larvae conform with the generic characters of *Petrolisthes* given by Lebour.

However, in the zoea larvae of *Petrolisthes elongatus*, there is no median tooth on the central prominence of the telson in stage one, and in stage two, two short plumose setae occupy this position. These setae may, however, be regarded as a modification of the median tooth found in stage two zoeas of all described *Petrolisthes* species other than *P. novaezelandiae*, but the median tooth as a generic character for *Petrolisthes* larvae (Lebour, 1943) is now of doubtful significance.

With the zoea larvae of *P. novaezelandiae* and *P. elongatus* now fully described, no other features have been found which could be used to distinguish zoea larvae of the genus *Petrolisthes* from those of the genus *Porcellana*.

ACKNOWLEDGMENTS

I wish to thank Dr R. B. Pike (Marine Department) for assistance with literature and for encouraging discussions. I am indebted to the technicians, academic staff, and students of the Zoology Department, Victoria University of Wellington, who were together responsible for plankton collections from Wellington Harbour under the direction of Professor L. R. Richardson. I am grateful to Professor L. R. Richardson for placing the Zoology Department's plankton collection at my disposal.

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ROBERT G. WEAR,
Zoology Department,
Victoria University,
P.O. Box 196, Wellington.