THE EASTERN AUSTRALIAN, BURROWING MUD-SHRIMP **LAOMEDIA HEALYI** (CRUSTACEA, MACRURA REPTANTIA, LAOMEDIIDAE) WITH NOTES ON LARVAE OF THE GENUS **LAOMEDIA**

by

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(Plates VI-VII; figs. 1-20)

INTRODUCTION

In volume 15 part 3 of this journal a preliminary description was published of a new thalassinid shrimp of the family Laomediidae from eastern Australian shallow waters (Yaldwyn & Wear, 1970). A preliminary account, with a systematically available new name, became necessary as a colour plate of the new species was due to appear in a general publication on Australian crustaceans (Healy & Yaldwyn, 1970) before the full description and figures presented here could be completed for the *Australian Zoologist*. The species concerned is *Laomedia healyi* Yaldwyn and Wear, 1970, a relatively large, burrowing mud-shrimp known from mangrove swamps, and from subtidal channels draining such swamps, along the eastern Australian coastline between northern Queensland and central New South Wales.

Listed as an unidentified axiid in the Australian Museum collections, where specimens have been accumulating since last century, *L. healyi* was first recognized as a new laomediid by T. S. Hailstone of the University of Queensland (see Australian Museum files) and then recorded as an undescribed *Laomedia* by Wear and Yaldwyn (1966: 2, 3). The genus *Laomedia,* upon which the poorly-known family Laomediidae is based, is apparently restricted to the Indopacific where the only other described member is *Laomedia astacina* de Haan, 1841, from Japan, Korea and the Ryukyu Islands (see Sakai, 1962, for general account). *L. astacina* is a burrowing form, known from intertidal and estuarine areas where they have been described as "hollowers in the muddy sand of tidal zone, their openings of holes circling around with piled sand" (Sakai, 1962: 30).

A third species of *Laomedia,* at present undescribed, was recognized by us during this study of *L. healyi.* A single ovigerous female thalassinid, small in size and pale yellow in colour, was collected by one of us (J.C.Y.) from a *Sesarma* (marsh crab) burrow system in the muddy bank of a mangrove-lined stretch of the Barron River, near Cairns, Northern Queensland. It is a true *Laomedia,* but differs in a number of features from the (?) relatively larger, pink *L. healyi,* which was also collected from the same complex and extensive burrow system together with gobies, alpheid shrimps and two species of *Sesarma* (family Grapsidae). This undescribed *Laomedia* from northern Queensland (carapace length 9.5 mm, Australian Museum P.18362) will be referred to as *"Laomedia* n.sp. (Barron River)" in the text and table below. An illustrated account of this new form will be published later.

A laomediid larval series was described by Dakin and Colefax (1940) from Sydney Harbour and regarded by them and later workers (Wear & Yaldwyn, 1966: 19) as representing an unnamed, and unknown in the adult stage, eastern Australian species of the laomediid genus *Jaxea*. The possibility that this Sydney larval series could be the larvae of *Laomedia healyi* led one of us (R.G.W.) to obtain known first stage zoea larvae of *L. astacina* from Japan in order to establish the identity of larvae of the genus *Laomedia* with certainty. It was found that the Japanese larvae differ greatly from those of *Jaxea*, including the Dakin and Colefax series, and we must still assume that an unknown "Sydney" *Jaxea* adult species is present in eastern Australian waters. Every effort should be made to hatch larvae from ovigerous female *Laomedia healyi* thus confirming the generic characters of *Laomedia* larvae and directly establishing their distinction from the Dakin and Colefax *"Jaxea"* series.

The body of this paper is divided into two parts: the first, by both authors, is a detailed description of *L. healyi* and the second, by R.G.W. alone, consists of observations and comments on the relationships of larvae of the genus *Laomedia*. All drawings in both parts were done by R.G.W., all photographs were taken by Anthony Healy, Sydney.

PART 1. DESCRIPTION OF *LAOMEDIA HEALYI WITH NOTES ON* DISTRIBUTION AND HABITS

In the present account, as in Wear and Yaldwyn (1966), the laomediid genera and their thalassinid allies are regarded as belonging to the supersection Macrura Reptantia and their relationship to the Anomura will not be considered.

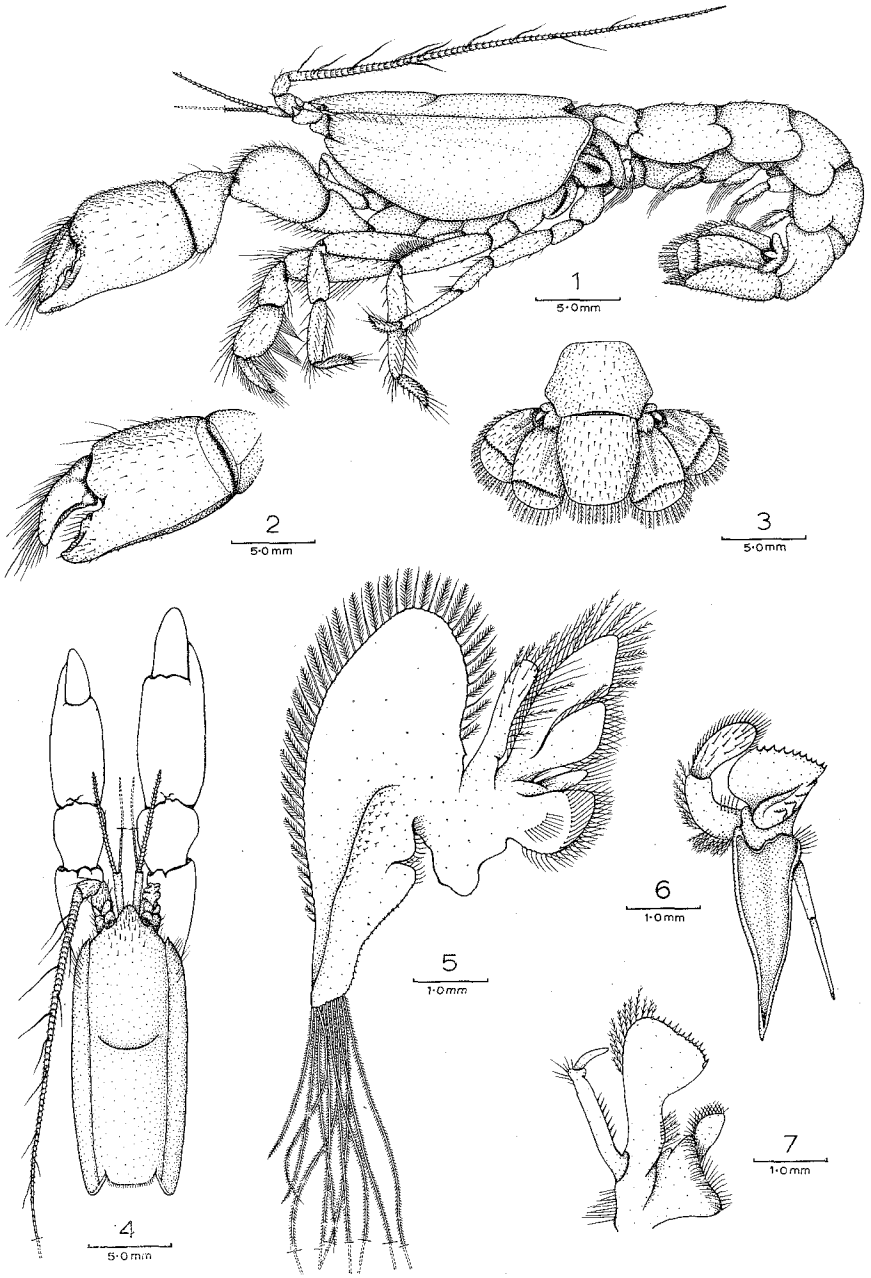
Order DECAPODA
Supersection MACRURA REPTANTIA
Section THALASSINIDEA

Seven families are currently placed in this section (for detailed discussion and key see Gurney, 1938: 339-343), these are the Callianassidae (Australian genera *Callianassa, Trypaea* and *Ctenocheles*), Callianideidae, Upogebiidae (Australian genus *Upogebia*), Axiidae (Australian genera *Axius* and *Axiopsis*), Axianassidae, Laomediidae (Australian genera *Laomedia* and, known only from larval series as yet, *Jaxea* and *Naushonia*) as well as the Thalassinidae (Australian genus *Thalassina*). As summarized by us previously (1966: 2) thalassinids (the seven-family section) are all apparently burrowing forms characterized by:- a reasonably well calcified, compressed carapace; a symmetrical, extended, often feebly calcified abdomen terminating in a well developed tail fan; the first pair of legs chelate or subchelate, second chelate, subchelate or simple, and third legs always non-chelate.

Family LAOMEDIIDAE Borradaile, 1903

The Laomediidae consists of three thalassinid genera having:- a *linea thalassinica* (a transverse, hinged groove along each side of the carapace) present; 1st pereiopods subequal (in shape and form, but not necessarily in size), and chelate or subchelate; 2nd pereiopods subchelate or simple, never chelate; no appendix interna on pleopods; uropods with transverse suture on both endopod and exopod; podobranch on at least 2nd and 3rd maxillipeds and 1st and 2nd pereiopods, and epipods on 1st to 4th pereiopods.

A key to the three known laomediid genera is given in Wear and Yaldwyn (1966: 3). No modifications can be made to that key and the footnote comments are all confirmed by this more detailed study of the eastern Australian *Laomedia healyi*. Although the 5th pereiopod of *L. healyi* can be described as "subchelate", it is not strongly so and the significance of this feature in the key is probably overstressed.



Figures 1-7—*Laomedia healyi* Yaldwyn & Wear, holotype, adult female; Fig. 1, whole animal, lateral view; Fig. 2, right chela, medial view; Fig. 3, 6th abdominal segment, uropods and telson, dorsal view; Fig. 4, carapace, cephalic appendages and chelipeds, dorsal view; Fig. 5, left 2nd maxilla; Fig. 6, left mandible; Fig. 7, left 1st maxilla.

Genus *Laomedia* de Haan in Siebold, 1841
Laomedia de Haan, 1841: 162, 164.
Laomedia Borradaile, 1903: 540.
Laomedia Wear and Yaldwyn, 1966: 2.
Not *Laomedia* Hassall, 1841, an incorrect subsequent spelling of *Laomedea* Lamouroux, 1812.

To establish the nomenclatural status of the generic name *Laomedia* de Haan three points need to be discussed—date of publication, status of *Laomedia* Hassall and significance of *Laomedea* Lamouroux.

(a) *Date of publication of* LAOMEDIA *de Haan.*

De Haan's volume on Crustacea in von Siebold's *Fauna Japonica* was published in a series of parts between 1833 and 1850. Holthuis (1953) and Holthuis and Sakai (1970: 77) give a table of dates for these parts and a list of the text pages and plates which made up each part. From this table it can be seen that the generic name *Laomedia* in the key on de Haan's page 162, the formal use of the generic name in the text followed by the first few lines of the generic description on page 164 and plate 35 with the name *"Laomedia astacina* n.sp." in the caption were all published in 1841. However, the remainder of the generic description followed by the formal use of the specific name in the text and the specific description, all on page 165, were not published till 1849. As the generic name *Laomedia,* part of the generic description, and figures of an included species associated with the specific name *astacina* were all available in 1841, we consider that both the genus *Laomedia* and the species *L. astacina* must be regarded as validly published in 1841, even though part of the generic description and the formal specific description did not appear till 1849. In the absence of any information as to when in 1841 pages 162, 164 and plate 35 appeared we must follow Article 21 of the *International Code of Zoological Nomenclature* (I.C.Z.N., 1964) and regard the generic name *Laomedia* de Haan as being available for nomenclatural purposes from the last day of the year 1841.

(b) *Status of* LAOMEDIA *Hassall.*

Neave included the name *Laomedia* Hassall, 1841, in his *Nomenclator Zoologicus* (1939) with the comment "(pro *-dea* Lamouroux 1812)". As Hassall's use of this name in *Ann. Mag. Nat. Hist.* VII (44): 281 can be dated to June 1841 it could have priority over *Laomedia* de Haan. However, it is clear that *"Laomedia"* Hassall, 1841, is an incorrect subsequent spelling of *Laomedea* Lamouroux, 1812, as in an earlier part of the same series of papers on "Irish Zoophytes" Hassall (1840: 169) used the spelling *"Laomedea"* twice without comment and associated it with the same specific name (*gelatinosa*) with which he used *"Laomedia"* without comment in 1841. Article 33b of the *International Code* (I.C.Z.N., 1964) states that an incorrect subsequent spelling has no status in nomenclature. Thus *Laomedia* Hassall, 1841, has no status in nomenclature and does not have priority over *Laomedia* de Haan.

(c) *Significance of* LAOMEDEA *Lamouroux.*

The existence of *Laomedea* Lamouroux, 1812 (used for a coelenterate) does not invalidate the subsequent use of *Laomedia* as a generic name. Article 56a of the *International Code* (I.C.Z.N., 1964) makes it clear that a single letter difference is sufficient to prevent homonymy. Neave (1939) also lists *Laomeda, Laomedaea, Laomedes* and *Laomodea* as subsequent spellings of *Laomedea* Lamouroux. None of these invalidates *Laomedia* de Haan.

The genus *Laomedia* consists of laomediids with a firm, white exoskeleton (the single small female *Laomedia* n.sp. "Barron Rive" has a relatively soft and translucent, rather than white, exoskeleton) and with setae of various lengths present on body and appendages (a close fur-like covering of very short

TABLE 1. Summary of differences between known species of *Laomedia*

Character	*L. astacina*	*L. healyi*	*L.* n.sp. (Barron River)
Antennal flagellum	no "branches"	"branches" present	?
Chela	free finger with outer (dorsal) edge rounded in section and bearing several irregular longitudinal rows of low tubercles under a dense mat of setae, deep groove along lateral face of finger	free finger with outer edge rounded in section and bearing a low crest of tubercles under a fringe of setae, shallow proximal groove on lateral face of finger	free finger with outer edge flattened, without tubercles but with a distinct angle between flattened surface and the (ungrooved) lateral and median faces of finger
Propodus of 2nd pereiopod	flattened and expanded in lateral view with both dorsal and ventral margins convex	flattened and expanded in lateral view with both dorsal and ventral margins convex	flattened but not expanded in lateral view, both dorsal and ventral margins straight, segment slightly deeper proximally than distally
Telson	no longitudinal groove on dorsal surface, no teeth on lateral edge	a weak median longitudinal groove on dorsal surface, 3-4 indistinct teeth at midpoint of lateral edge	no longitudinal groove on dorsal surface, no teeth on lateral edge
Rostrum	about 4-6 small teeth on each side of rostrum behind terminal tooth	3-6 small teeth on each side behind terminal tooth	1 small tooth on each side behind terminal tooth
Anterolateral margin of carapace	small orbital spine above origin of *linea thalassinica,* but no antennal spine below *linea*	orbital spine above origin of *linea thalassinica* and a small antennal spine below *linea*	no orbital or antennal spines

setae as seen in *Jaxea* is not present). The *linea thalassinica* of the carapace is distinct and well developed. The eye is reduced but not hidden under the rostrum in dorsal view, cornea black. The peduncles of both the antennules and antennae are relatively short (penultimate segment of antennal peduncle up to one and half time length of ultimate). The scaphocerite is rudimentary but distinct (scaphocerite absent in the *Laomedia* n.sp. "Barron River" specimen). First maxilliped with flagellum on exopod but no podobranch. First pereiopods subequal in shape and form (but often slightly unequal in size) with stout and heavy chelae, 2nd pereiopod subchelate or simple, 5th pereiopod (at least partially) subchelate. A single anthrobranch on 1st maxilliped and two on 2nd and 3rd maxillipeds and on 1st to 4th pereiopods. Podobranchs on 2nd and 3rd maxillipeds and on 1st to 3rd pereiopods. Male 1st pleopods absent, female 1st pleopods reduced and uniramous, 2nd to 5th pleopods biramous and similar in both sexes.

The type of the genus is *Laomedia astacina* de Haan, 1841, from Japan, Korea and the Ryukyu Islands. (Note: there is no trace of a podobranch on the 1st maxilliped of specimens of *L. astacina* from Japan examined by us—for discussion of this feature see Wear and Yaldwyn, 1966: 3).

As the only available specimen of *Laomedia* n.sp. (Barron River) has the flagella of both antennae missing and thus does not show the presence or absence of the distinctive hair-like "branches" so characteristic of *L. healyi* (see "description" below and pls VI & VII upper), a comparative table of differences is given for the three known species of *Laomedia* rather than a conventional key.

Laomedia healyi Yaldwyn and Wear, 1970
"undescribed *Laomedia* from eastern Australia" Wear and Yaldwyn, 1966: 2, 3.
Laomedia healyi Yaldwyn and Wear, 1970: 384, fig. 1.
Laomedia healyi, Healy and Yaldwyn, 1970: 68, frontispiece.

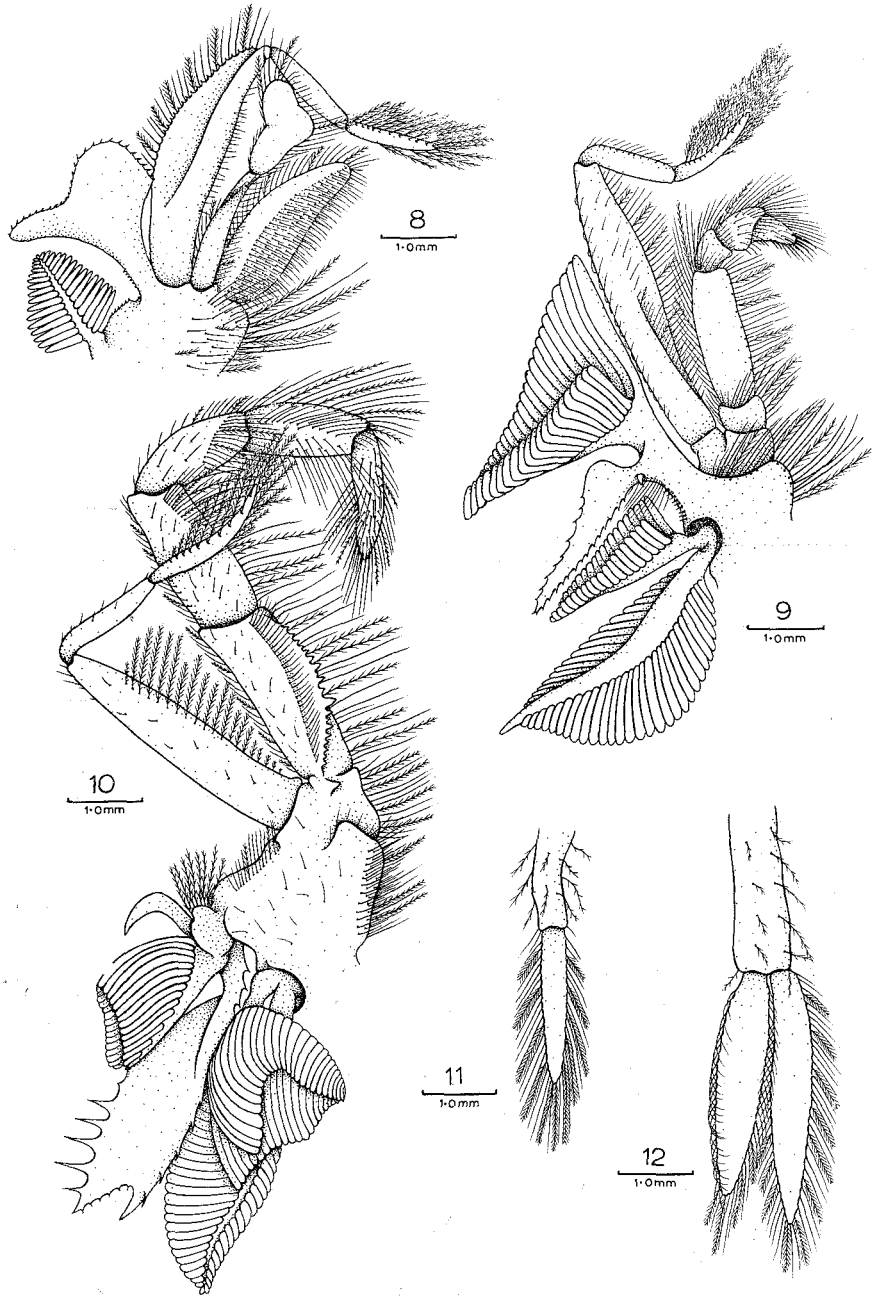
Material examined

Queensland: Barron River, near Cairns, from *Sesarma* burrow system in muddy south bank downstream from Cook Highway road bridge, J. C. Yaldwyn, 27/11/1963, one female carapace length 17 mm (Australian Museum P.18361). Port Curtis, M. Ward & W. Boardman, 1929, one female 22 mm (P.15058).

New South Wales: Hunter River, D. G. Stead, 23/4/1910, one female 25 mm (P.4746). Hawkesbury River, near Brooklyn, A. A. Racek, June 1956, one female 15 mm (P.12944). Careel Bay, Pittwater, near Sydney, from burrow in intertidal mangrove mud, A. Healy & J. C. Yaldwyn, Dec. 1967, one female 16 mm (P.15820). Parramatta River, Port Jackson, Haswell Collection, one male approx. 18 mm (P.15057). Hen and Chicken Bay, Parramatta River, near Sydney, from storm water channel under construction, M. E. Gray, 27/9/1935, 5 males 26-28 mm, 2 ovigerous females 27-28 mm (P.10725). Bonny Doon golf course, mouth of Cook's River, Botany Bay, from shore of muddy creek, J. J. Johnston, one female 26.5 mm (P.11578). Lugarno, George's River, near Sydney, in sandy mud, 21/12/1955, one ovigerous female 18 mm (P.13506). N.S.W. (no detailed locality), State Trawling Industry, 1920, one male 21 mm (P.15819).

Type Material

The holotype is the female (P.15820) from Careel Bay, Pittwater, now dissected, but recorded alive in both colour (Healy & Yaldwyn, 1970: frontispiece) and black and white photographs (pls VI & VII). The exact locality where the holotype was collected from a short, horizontal burrow roofed by a piece of wood was in soft mud among mangrove pneumatophores at the foot of the grey mangrove tree (*Avicennia marina*) on the left of colour plate 9 in Gillett and Yaldwyn (1969). The remainder of the material examined is all paratypic. The holotype and the majority of the paratypes are in the Australian Museum (P. registration numbers) with two paratypes in the



Figures 8-12—*Laomedia healyi* Yaldwyn & Wear, holotype, adult female; Fig. 8, left 1st maxilliped; Fig. 9, left 2nd maxilliped; Fig. 10, left 3rd maxilliped; Fig. 11, 1st pleopod; Fig. 12, 2nd pleopod.

Dominion Museum, Wellington (male from P.10725 = Z. Cr. 1897; P.11578 = Z. Cr. 1898) and two in the Rijksmuseum van Natuurlijke Historie, Leiden (male from P.10725; P.12944).

All measurements given in the material examined list are of carapace length only (from posterior corner of orbit to level of dorsal midpoint of hind margin of carapace) and thus exclude the rostrum. Figures 1 to 12 are all drawn from the holotype, while the formal description is based on the male P.15819 but is modified to cover all type material.

Description

A small-eyed, relatively-large, burrowing shrimp with stout, heavily-built and slightly unequal chelipeds.

The carapace is laterally compressed and shorter than the abdomen. Long and short setae present on many parts of the animal, distinct clumps of long setae present on chelipeds and laterally on carapace, but body and appendages are not covered with a short and dense "pile" of fine, fur-like setae as described for *Jaxea novaezealandiae*. A fine, rust-coloured layer partly or almost completely coats the exoskeleton in several of the specimens available. Where this layer is not present, or has been mechanically removed, the cuticle is firm, white (in preserved specimens), translucent rather than completely opaque, and smooth except for the hands which are minutely and evenly tuberculate. There is a very distinct *linea thalassinica* laterally on each side of the carapace forming a hinge line upon which each pterygostomiobranchial portion of the carapace can move. A distinct cervical groove is situated dorsally a little anterior to midpoint of carapace exclusive of rostrum, but does not extend ventrally across *linea*. Anterodorsal surface of carapace smooth and produced anteriorly as a depressed, flattened, slightly downcurved, bluntly rounded rostrum, armed on each side of a terminal tooth with about 3 to 6 small teeth. Anterodorsal margin of carapace with an orbital spine above origin of *linea thalassinica* and a smaller, antennal spine immediately below origin. There is a short ? branchiostegal groove, directed posteroventrally, below level of antenna; remainder of anterolateral and ventrolateral border smooth and unarmed.

Abdomen of uniform depth throughout; pleuron of 1st segment reduced and in life overlapping anteriorly the convex posterolateral margin of carapace at level of *linea*. Pleura of other segments broadly rounded, each overlapping posteriorly the next segment; pleuron of 2nd segment overlapping anteriorly the pleuron of 1st. Telson subquadrate with distal edge weakly convex, setose and unarmed; there is an indistinct, median, longitudinal groove dorsally and about 3 to 4 indistinct teeth at the midpoint of each lateral margin.

Eyes reduced, but not degenerate, extending laterally from beneath rostrum so that cornea is visible in dorsal view; cornea small, narrower than short flattened stalk, and entirely black.

Antennules arise close together under rostrum, which extends anteriorly beyond midpoint of 2nd segment of antennular peduncle but does not reach distal margin of 2nd segment (Note: articulation between 2nd and 3rd segments of antennular peduncle not shown in fig. 4). Second segment about half 3rd antennular peduncle segment. Antennular flagella about three and a half times 3rd segment; outer ramus with about 30-50 segments, subequal in length to more slender inner ramus. Peduncle of antenna 5-segmented (Note: right antennal peduncle damaged and flagellum missing in holotype, see fig. 4 and pl. VI); no segment greatly elongated; 4th or penultimate segment about one and a half times length of ultimate segment (not subequal as stated in "preliminary description"). Scaphocerite greatly reduced and extending anteriorly from dorsodistal margin of 2nd peduncle segment, rounded in outline, unarmed. Antennal flagellum ranging in length from a little less than twice carapace length (as in holotype) to about two and half times carapace length; bearing several (as many as 15 in some specimens), prominent, relatively-long, hair-like "branches" irregularly spaced along its length. These "branches", clearly seen in photographs of living animal (pls VI & VII upper), are rather stoutly built,

modified setae arising from individual antennal segments in a distinct, unevenly spaced, medioventral row along flagellum (as flagellum is thrown back over body in fig. 1, the "branches" appear to be "dorsal").

Mandible consists of molar process with a curved toothed ridge and a 2-segmented palp. First maxilla with two endites armed with stout bristles and setae medially, and a 2-segmented endopod with distal segment shorter and more slender than proximal. Second maxilla with two endites each partially divided into two, simple endopod and large scaphognathite with proximal lobe unusually long, tapering, truncate and bearing a long whip of setae. All three maxillipeds have long and prominent exopods, consisting of two parts, peduncle and flagellum, articulated at a distinct angle to one another; flagellum with single proximal segment nearly as long as, or as long as, multi-segmented portion. First maxilliped with 2 endites; 2-segmented endopod with distal segment irregularly enlarged, and large epipod. Second maxilliped with penultimate segment slightly expanded, with well developed podobranch and slender serrated epipod. Third maxilliped small and pediform, endopod of 5 segments with ischium bearing a prominent median crest of about 17 to 20 sharp teeth; complex epipod consisting of a small, curved, anterior lobe, a podobranch and a posteriorly directed, serrate-margined mastigobranch. Two arthrobranchs are present on 2nd and 3rd maxillipeds but only one on 1st.

Chelipeds strongly developed and heavily calcified, subequal in shape and form, but slightly unequal in size (right more often bigger than left); large cheliped about equal in length to carapace and 1st and 2nd or 1st to 3rd abdominal segments. Free finger relatively short, from two thirds to subequal with palm in length, stout and curved; inner or cutting edge, armed with one, enlarged, blunt tooth proximally but sharp and non-serrate distally; outer or convex edge, bearing a low crest of rounded tubercles almost concealed in setae along its length. Fixed finger short, broadly triangular, armed on cutting edge with one, main, low, broad-based tooth at middle and (varying from specimen to specimen) some secondary, blunt teeth and distal serrations.

Hand varying in length between about two thirds and three quarters of carapace excluding rostrum; hand length less than twice width; palm parallel-sided, rather than swollen, weakly angled proximally along dorsal margin and with a distinct, longitudinal, narrow crest of low, closely-spaced tubercles along full length of ventral margin extending onto ventral margin of fixed finger almost to tip. Carpus short, broad distally but abruptly narrowed proximally, unarmed. Merus rounded in lateral view, with flattened median face, maximum width more than three quarters length; unarmed dorsally but with proximal row of 5 or more, short teeth on narrow ventral margin. Ischium short, triangular and armed with a double row of short teeth along entire ventral margin culminating in two much stronger teeth distally. Basis short and unarmed. *Linea impresae,* or weakened and nearly transparent lines on the cuticle (presumably to facilitate moulting, cf. presence in alpheid shrimps), occur across inner distal face of hand (see fig. 2), diagonally across inner face of carpus, and on inner face of merus and ischium along both dorsal and ventral edges.

Second to 5th pereiopods short, compressed and, except for dactyls and propodi, rather similar in structure. Second pereiopod, unlike others, with fringe of setae along most of dorsal and ventral edges; dactyl flattened and blade-like, acute distally but otherwise unarmed, subequal to propodus; dactyl articulated to propodus so as to close with ventral edge against part of broad distal margin of latter and thus qualifying as "subchelate"; propodus subequal in length to carpus and with other segments of this appendage unarmed except for setal fringe; merus relatively broad, a little more than twice length carpus. Third and 4th pereiopods similar; both limbs with dactyl slender, curved distinctly laterally (out of plane of appendage), acute distally, armed dorsally with an irregularliy spaced (closer together proximally) row of about 8 or more short, stout teeth and armed ventrally for entire length with a curved, comb-like row of numerous, slender, closely-spaced teeth; dactyl subequal with propodus; carpus a little longer than propodus and a little more

than half merus (distinctly more than half merus in 4th); all segments except dactyls unarmed. Fifth pereiopod more slender than others; propodus straight, but twisted in plane of appendage so that dactyl moves medially rather than ventrally; dactyl in both sexes slender, acute, depressed (i.e. flattened dorsoventrally in its original morphological plane), articulated with propodus so as to close with part of its flat ventral face against distal end of propodus, and armed for entire length of lateral edge with a comb-like row of short, closely-spaced teeth; propodus with bunch of slender spines on distal end which meet ventral face of dactyl when latter is in closed position, and with triangular patch of short, closely-spaced setae distally on outer surface; remainder of propodus and other segments unarmed; dactyl a little shorter than carpus, dactyl equal to half produs, and propodus subequal to merus.

First pleopods absent in male; reduced, uniramous, slender and setose in female. Second to 5th pleopods in both sexes similar, well developed, biramous, with exopod and endopod in each subequal, lanceolate and setose. No appendix interna or appendix masculina present. Uropods with exopod and endopod subequal in length and a little longer than telson; both exopod and endopod with transverse suture at about $\frac{3}{4}$ length of ramus and with row of short spines overlapping suture; a few inconspicuous spines on lateral edge of exopod immediately proximal to suture; each ramus with low, broad, longitudinal ridge in midline. Protopod of uropod with spined lobe overlapping base of endopod.

Opening of vas deferens in male on raised tubercle distomedially on coxa of 5th pereiopod; oviduct opening in female medially on coxa of 3rd pereiopod. Eggs very small and numerous on ovigerous female P.13506. Both male and female have triagular plate on thoracic sternite immediately behind base of 4th pereiopods. This plate is oriented apex posteriorly, concave in transverse section with a longitudinal median groove which is deeper and narrower in the male.

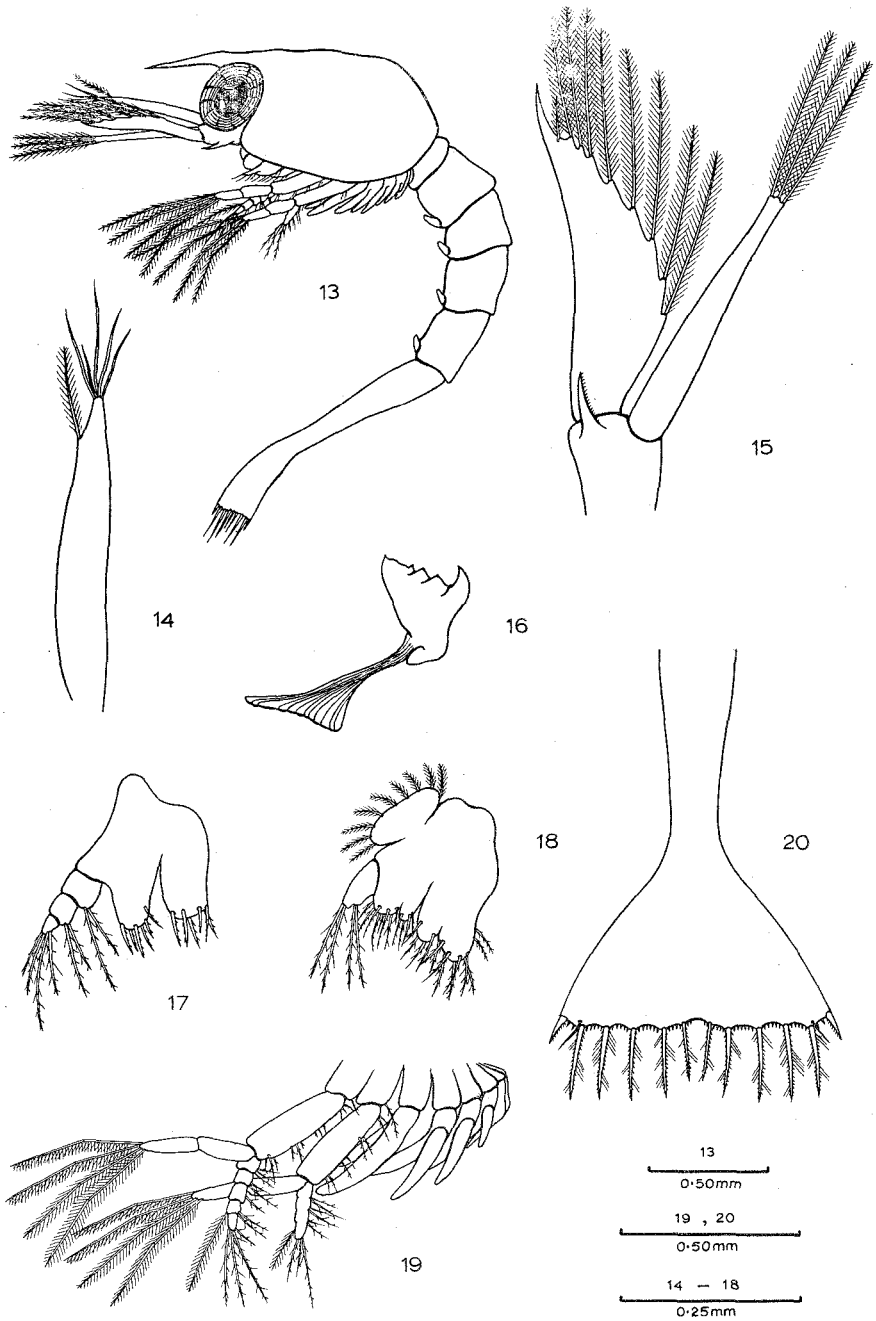
Branchial formula

	Maxillipeds			Pereiopods				
	1st	2nd	3rd	1st	2nd	3rd	4th	5th
Pleurobranchiae	—	—	—	—	—	—	—	—
Arthrobranchiae	1	2	2	2	2	2	2	—
Podobranchiae	—	1	1	1	1	1	—	—
Epipodites	1	1	1	1	1	1	1	—
Exopodites	1	1	1	—	—	—	—	—

This formula agrees in complete detail with that established for *Jaxea novaezealandiae* and for *J. nocturna* Nardo by Wear and Yaldwyn (1966) and, except for the rudimentary podobranch on the first maxilliped discussed above, agrees in number with that published for *Laomedia astacina* by Sakai (1962). Our examination of *L. astacina* specimens from Japan gives the same detailed formula established here for *L. healyi*. As Chace (1939) records 18 gills for each of two species of *Naushonia,* it would appear that all examined adult species of the family Laomediidae have 18 gills though there is some minor differences in distribution between Chace's formula for *N. portoricensis* (Rathbun) and that established for the other five species.

Egg-carrying "formula"

Eggs in *L. healyi* are small (less than 0.5 mm in diameter), numerous, and carried on all five pairs of pleopods in the female. The number of pleopod pairs which carry eggs is called the "egg formula" by Sakai (1962). Both *L. astacina* and *Laomedia* n.sp. (Barron River) carry eggs on all five pairs of pleopods. Ovigerous females of *L. healyi* were taken in September and December (eyes visible within eggs), while the ovigerous female *Laomedia* n.sp. (Barron River) was taken in November (eyes visible).



Figures 13-20—*Laomedia astacina* de Haan, stage 1 zoea larva from Japan; Fig. 13, stage 1 zoea, lateral view; Fig. 14, left 1st antenna; Fig. 15, left 2nd antenna; Fig. 16, left mandible; Fig. 17, left 1st maxilla; Fig. 18, left 2nd maxilla; Fig. 19, 1st to 3rd maxillipeds and 1st to 5th pereiopods, lateral view; Fig. 20, telson, ventral view.

Colour in life

Two specimens of *L. healyi* were examined alive. The holotype (for colour photograph see Healy & Yaldwyn, 1970: frontispiece) was a uniform pinkish-red dorsally with scattered pale areas along the edges of the carapace and at the articulation of some cheliped segments, and much paler (almost white in places) ventrolaterally, ventrally and on the walking legs and pleopods; eyes black. The female *L. healyi* (P.18361) from Barron River, north Queensland, taken in the same area as the yellow *Laomedia* n.sp. (Barron River) was dark pinkish-red (almost purplish-red) on the dorsal surface of the body and chelipeds with the ventral surface much paler in colour.

Notes on burrowing

Laomedia healyi is a burrowing animal as all thalassinid shrimp appear to be. Unlike the case of the subtidal *Jaxea novaezealandiae* (see Wear & Yaldwyn, 1966: 11), where burrowing was assumed from indirect evidence such as general facies, diurnal/nocturnal collecting ratios and behaviour in laboratory aquaria, burrow living in *L. healyi* has been directly observed. The holotype was taken from a short burrow in soft mud roofed over by a piece of timber, while the Barron River *L. healyi* was dug from a complex crab burrow system, many feet underground. The seven large specimens from Hen and Chicken Bay, Parramatta, were found during the construction of a storm water channel and were presumably dug from burrows.

Observations on living animal.

The holotype was kept alive for several days in an aquarium by Anthony Healy, one of its collectors. In captivity it was markedly thigmotactic and negatively phototropic, but did not turn away from light very vigorously. The cornea was small, intensely pigmented and clearly photosensitive. The eyestalk projected out from under the rostrum in dorsal view. The animal was an active walker but never attempted to swim in any way. When disturbed it was capable of violent backward movement by a sudden flexure of the abdomen and telson. The pleopods were in almost constant motion, beating with a metachronal rhythm at different speeds depending on the activity of the animal. The distinctive hair-like "branches" on the antennal flagellum hung limply down medioventrally and were not seen to move independently of the flagellum. When in poorly aerated water the sides of the carapace, ventral to the *linea thalassinica*, could "pant" quite vigorously out of phase with each other at a rate of about two in and out movements per second. The "panting" movement originated from the *linea* which acted as a hinge line for the pterygostomiobranchial portion of the carapace on each side of the animal.

PART 2. NOTES ON LARVAE OF THE GENUS *LAOMEDIA*

Since our previous publication on thalassinid Crustacea (Wear & Yaldwyn, 1966), the authors have given serious consideration to the possibility that larvae of the unknown eastern Australian species of *Jaxea* described from Sydney Harbour by Dakin and Colefax (1940: 179-182) may in fact belong to *Laomedia healyi*. This possibility is supported by circumstantial evidence, as only two laomediid larval series have been found in the eastern Australian plankton, and one of these can certainly be attributed to the genus *Naushonia*. The remaining larval series, identified as larvae of *Jaxea* by Dakin and Colefax, could well have been linked with *Laomedia healyi* which is the only adult laomediid shrimp known from the eastern Australian region.

More recently, first stage zoea larvae of *Laomedia astacina* from Japan have been hatched and recorded by Sakai and Miyake (1964). This work became known to us after our 1966 paper went to press, and provided the first opportunity to establish the identity of larvae of the genus *Laomedia* with certainty. These larvae differ greatly from those of *Jaxea* (including the Dakin and Colefax series), *Naushonia* and other laomediids, and without

the positive identification now available, they would be classified as upogebiid larvae rather than larvae of the family Laomediidae.

We are greatly indebted to Dr. Sakai for sending us this larval material and for his permission to publish a complete description of the first stage larva of *Laomedia astacina*.

Description of First Zoea of *Laomedia astacina* de Haan

Total length of larva 3.25 mm (measured from tip of rostrum to posterior telson margin excluding setae); carapace length including rostrum 1.20 mm; rostrum slender and unarmed, tapering to a point and extending well beyond the level of the unstalked eyes (fig. 13); region between mouth and antennae not lengthened, and there is no evidence of a "neck".

First antenna (fig. 14) uniramous, unjointed, and bearing five terminal aesthetascs and one subterminal biplumose seta on its inner margin. Second antenna (fig. 15) with protopod bearing one large, finely toothed ventral spine; endopod with three long biplumose setae arising from its tip; squamous exopod slightly longer than endopod and with its tip smooth and acicular, inner margin armed with eight long biplumose setae and one much smaller seta.

Left and right mandibles almost symmetrical, with incisor process of left mandible only slightly extended (fig. 16); left and right paragnaths symmetrical as is normal among decapod larvae other than *Jaxea, Naushonia* and related forms, and left paragnath not produced into a sickle-shaped process. First maxilla (fig. 17) with proximal and distal endites each bearing six marginal plumose setae arranged as illustrated; endopod three-segmented, first and second segments each bearing two sparsely plumose setae, terminal segment with four such setae. Second maxilla (fig. 18) with first (proximal), second, third and fourth (distal) endites having ten, four, four and eight marginal plumose setae respectively; endopod a single segment with four such setae; scaphognathite rudimentary, with eight or nine small biplumose setae spaced along its margin.

First maxilliped (see fig. 19) with one seta arising from posterior margin of coxa; basis with 12 setae arranged in four groups of three setae along inner margin; endopod of five segments each of about the same length and provided with setae as illustrated; exopod of two segments, slightly longer than endopod, and with four biplumose, natatory setae arising from its tip. Second maxilliped similar to first, but endopod here incompletely divided into four segments each bearing setae as illustrated in fig. 19. Third maxilliped biramous and with exopod a little longer than endopod; both rami unsegmented and lacking setae; endopod arises from near base of basipod. Pereiopods all present as unsegmented rods; first to third pereiopods each with a rudimentary exopod; fourth and fifth pereiopods without exopod buds (fig. 19). Gill buds are not developed in the first stage zoea larva.

Abdomen (fig. 13) consists of five segments and a telson; sixth segment and telson are not separate; abdominal segments unarmed and lacking procurved pleural hooks; bud-like pleopod rudiments occur ventrally on segments two to five. Telson (fig. 20) spatuliform, almost straight across the posterior margin, and with a very indistinct posterior cleft. Posterior telson margin armed with numerous small teeth and seven pairs of setae: first (outer) seta very short and stout, articulating with telson plate, and finely serrated along its inner margin; second seta reduced to a fine hair as is usual among thalassinid larvae; third to sixth setae about equal in length, finely serrated along their inner and outer margins, and with scattered fine lateral hairs; seventh (inner) seta smaller than third to sixth pairs, but otherwise similar to these.

Later Larval Stages

Several first stage larvae of *Laomedia astacina* showed a second larval stage beneath the cuticle. In this second stage the inner ramus of the first antenna is developed and is separate from the peduncle, pereiopods are strongly developed, and the sixth abdominal segment is divided from the telson which

bears nine pairs of posterior setae. Biramous uropod buds are present. It was not possible to observe further detail.

These characters are those of the third or later larval stages in *Naushonia* (Dakin & Colefax, 1940: 179) and in *Jaxea* (Wear & Yaldwyn, 1966: 17; Caroli, 1924) and it seems likely that there are fewer larval stages in the life history of *Laomedia astacina* than in either *Naushonia* with six stages or *Jaxea* with six or occasionally seven stages.

Discussion

There are many larval characters previously thought to be characteristic of the family Laomediidae, and present in the larvoe of *Jaxea, Naushonia* and in laomediid larvae of unknown parentage (Gurney, 1924: 156; 1938: 334-338), which do not appear in *Laomedia astacina.* A comparison of larval characters of the three genera *Jaxea, Naushonia* and *Laomedia* reads as follows:

1—There are six larval stages in *Jaxea* and *Naushonia,* but probably only four stages in *Laomedia.*

2.—In *Jaxea* the region between the antennae and the mouth is greatly exaggerated in length, and the larvae are very long and slender. Larvae of *Laomedia* have no such "neck", are much stouter than those of *Jaxea,* and are rather similar in general facies to larvae of other thalassinid groups, especially those of the Upogebiidae. *Naushonia,* and an apparently related form (Gurney, 1938: 334-337, figs 36, 37), represent an intermediate stage between these two extremes of development.

3—The rostrum is much reduced in both *Jaxea* and *Naushonia,* but in *Laomedia* it is well developed and extends forward well beyond the level of the eyes.

4—In *Jaxea* and *Naushonia* the pleura of the second to fifth abdominal segments, and often also of the first segment, are extended as procurved hooks. *Laomedia* lacks these pleural processes in stage one, but these structures may appear in later larval stages.

5—In the first larval stage of *Jaxea,* the widely forked telson is deeply cleft and the two rami are long and slender. In *Laomedia,* the telson is spatuliform in stage one, and almost straight across the posterior margin. *Naushonia* possesses a telson intermediate between these two shapes in stage one.

6—The left mandible and paragnath of *Jaxea, Naushonia* and all other larvae so far attributed with certainty to the family Laomediidae, are both drawn out into a sharp sickle, but in *Laomedia* these structures are unmodified as in other thalassinid larvae.

7—The endopod of the first maxilla is unsegmented in *Jaxea* and *Naushonia,* but three-segmented in *Laomedia* as is the case in *Upogebia.*

8—The endopod of the second maxilla is reduced in *Jaxea* and *Naushonia,* but is not reduced in *Laomedia.*

9—In all three genera the endopod of the third maxilliped arises from near the base of the basipod as in *Upogebia* and the Anomura.

10—Other distinctive characters of the first stage larva of *Laomedia astacina* (such as the presence of well developed pereiopods with exopods, and the presence of pleopod buds) are features relating to the degree of development on hatching, and cannot therefore be used as features of difference from the stage one larvae of *Jaxea* and *Naushonia* in which these characters appear in later larval stages (Caroli, 1924; Dakin & Colefax, 1940; Wear & Yaldwyn, 1966). However, exopods occur on pereiopods one to three as in the Upogebiidae (Gurney, 1942: 246-249) and there is no exopod on the fourth or fifth pereiopods. *Jaxea, Naushonia* and all other laomediid larvae possess an exopod on the fourth pereiopod in later larval stages, but it is rudimentary in *Jaxea.*

While the larvae of *Laomedia astacina* are undoubtedly related to those of *Jaxea, Naushonia* and described laomediid larvae of unknown parentage,

they effectively bridge the gap between these previously described laomediid larvae and those of the Upogebiidae. It is also evident that the larvae of *Laomedia astacina* share more larval characters with the Upogebiidae than they do with other laomediid larvae. This is further evidence of close relationship between the Upogebiidae and the Laomediidae, which together form an "anomuran" larval group within the Thalassinidea (Gurney, 1938: 339-343). A further point of interest is that larvae of *Naushonia* can be placed between *Jaxea* which shows extreme development of such exclusively laomediid larval characters as the long "neck", procurved pleural hooks, and sickle-shaped mandible and paragnath, and *Laomedia* in which these characters are not developed or are restricted in their degree of development.

Several unidentified laomediid larvae (Gurney, 1938: 334-338) are similar to those of *Upogebia* and *Laomedia astacina* in general form, but possess asymmetrical mandibles and paragnaths, and have an unsegmented endopod on the first maxilla as in *Jaxea* and *Naushonia*. A larval series described by Menon (1933) and attributed to the "Upogebinae", is rather similar to the larva of *Laomedia astacina,* but can be excluded from both the Upogebiidae and Laomediidae as the post-larval stage of Menon's species possesses an appendix interna on the pleopods. However, Gurney (1924: 156, fig. 62) recorded a stage three larva from off Three Kings Islands, northern New Zealand, which has larval characters one would expect to occur in a comparable larval stage of a second species of the genus *Laomedia*. It is therefore quite possible that an adult *Laomedia,* even perhaps *L. healyi,* occurs in the soft mud of the poorly investigated and extensive mangrove swamp areas of northern New Zealand.

ACKNOWLEDGEMENTS

We wish to thank Dr. Katsushi Sakai, Seika Women's College, Fukuoka, Japan, for sending us both larval and adult material of *Laomedia astacina;* Anthony Healy, Sydney, for the care and trouble taken with both the colour and black and white photography of the holotype of *L. healyi;* the authorities of the Australian Museum for the loan of *Laomedia* material, and finally Gilbert Whitley for his interest in and editorial advice on this joint manuscript.

REFERENCES

Borradaile, L. A., 1903.—On the Classification of the Thalassinidae. *Ann. Mag. Nat. Hist.* ser. 7, XII: 534-551.

Caroli, E., 1924.—Sviluppo larvale e primo stadio postlarvale della *Jaxea nocturna* (=*Callaxius adriatica* Heller). *Pubbl. Staz. zool. Napoli* V: 153-197, 29 figs, 1 pl.

Chace, F. A., 1939.—On the Systematic Status of the Crustacean Genera *Naushonia, Homoriscus,* and *Coralliocrangon*. *Ann. Mag. Nat. Hist.* ser. 11, 3(17): 524-530, 14 figs.

Dakin, W. J., & Colefax, A. N., 1940.—The Plankton of the Australian Coastal Waters off New South Wales. Part. 1. *Publ. Univ. Sydney Dept. Zool.* 1: 1-215, 303 figs, 4 pls.

Gillett, K., & Yaldwyn, J. C., 1969.—*Australian Seashores in Colour*. A. H. & A. W. Reed, Sydney, 112 pp., 67 figs, 52 pls.

Gurney, R., 1924.—Crustacea. Part IX—Decapod Larvae. *Brit. Ant. (Terra Nova) Exped. 1910,* Zool. VIII (2): 37-202, 78 figs.

———— 1938.—Larvae of Decapod Crustacea. Part V. Nephropsidea and Thalassinidea. *Discovery Repts* XVII: 291-344, 38 figs.

———— 1942.—*Larvae of Decapod Crustacea*. Ray Society, London. 306 pp., 122 figs.

de Haan, W., 1833-1850.—Crustacea. *In*: de SIEBOLD, P. F., *Fauna Japonica sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava Imperium tenent, suscepto, annis 1823-1830 collegit, notis, observationibus et adumbrationibus illustravit.* Apud J. Müller et Co., Amsterdam. 243 pp., pls 1-55, A-Q.

Hassall, A. H., 1840.—Catalogue of Irish Zoophytes. *Ann. Mag. Nat. Hist.* VI(36): 166-175, pls V-VII.

———— 1841.—Supplement to a Catalogue of Irish Zoophytes. *Ann. Mag. Nat. Hist.* VII(44): 276-287.

Healy, A. & Yaldwyn, J. C., 1970.—*Australian Crustaceans in Colour.* A. H. & A. W. Reed, Sydney. 112 pp., 57 figs, 52 pls.

Holthuis, L. B., 1953.—On the Dates of Publication of W. de Haan's Volume on the Crustacea of P. F. von Siebold's "Fauna Japonica". *Jour. Soc. Bibliography Nat. Hist.* 3(1): 36-47, 1 pl.

Holthuis, L. B., & Sakai, T., 1970.—*Ph. F. von Siebold and Fauna Japonica—a History of Early Japanese Zoology.* Academic Press of Japan, Tokyo. 323 pp., 32 pls.

I.C.Z.N., 1964.—*International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology.* International Commission on Zoological Nomenclature, London. Second Edit. 176 pp.

Lamouroux, J. V. F., 1812.—Extrait d'un Mémoire sur la Classification des Polypes coralligènes non entièrement pierreux. *Nouv. Bull. Sci. Soc. philomatique* 3: 184.

Menon, M. K., 1933.—The Life-histories of Four Species of Decapod Crustacea from Madras. *Bull. Madras Govt. Mus.* n.ser. *Nat. Hist. Sect.* III (3): 1-45, 10 pls.

Neave, S. A., 1939.—*Nomenclator Zoologicus. A List of the Names of Genera and Subgenera in Zoology from the Tenth Edition of Linnaeus 1758 to the End of 1935.* Vol. II, D-L. Zoological Society of London, 1025 pp.

Sakai, K., 1962.—Systematic Studies on Thalassinidea 1. *Laomedia astacina* de Haan. *Publ. Seto Mar. Biol. Lab.* X(1): 27-34, pls V-VII.

Sakai, K., & Miyake, S., 1964.—Description of the First Zoea of *Laomedia astacina* de Haan (Decapoda, Crustacea). *Sci. Bull. Fac. Agri. Kyushu Univ.* 21(1): 83-87, 3 figs.

Wear, R. G., & Yaldwyn, J. C., 1966.—Studies on Thalassinid Crustacea (Decapoda, Macrura, Reptantia) with a Description of a New *Jaxea* from New Zealand and an Account of its Larval Development. *Zool. Publ. Victoria Univ. Wellington* 41: 1-27, 5 figs.

Yaldwyn, J. C., & Wear, R. G., 1970.—Preliminary Description of a New Burrowing Mud-shrimp from Eastern Australia (Crustacea, Macrura Reptantia, Laomediidae). *Aust. Zool.* 15(3): 384-385, 1 fig.

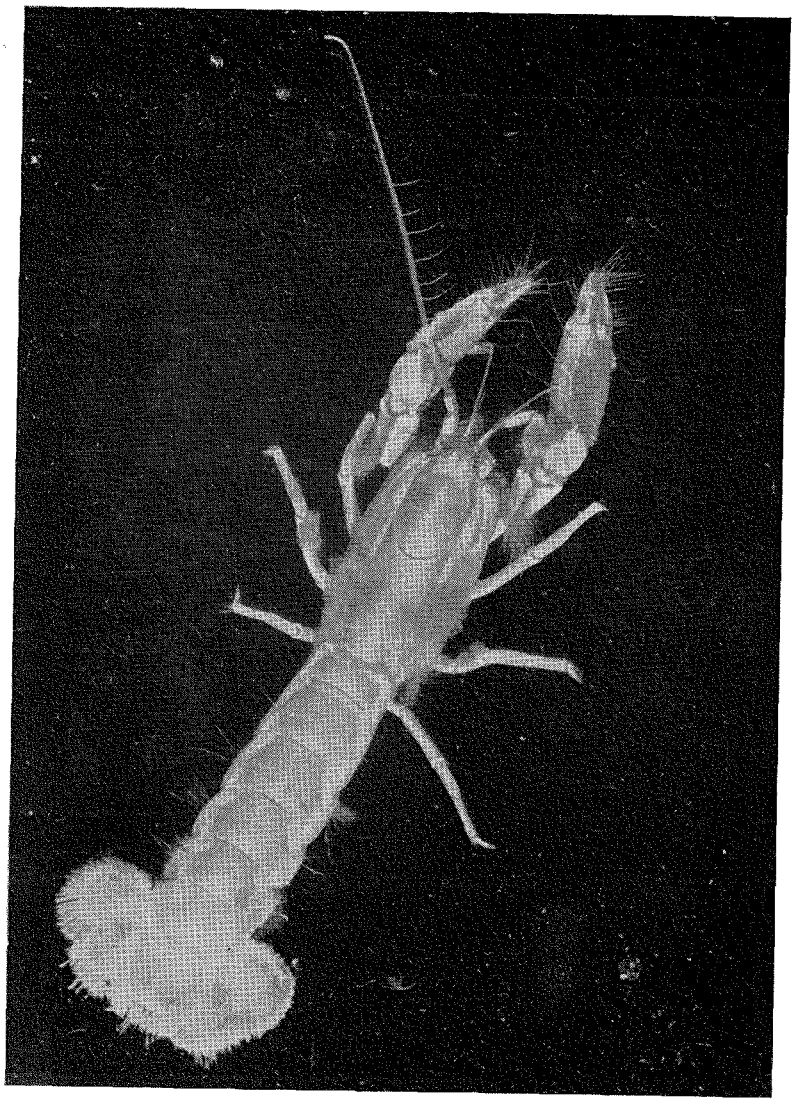


Plate VI. *Laomedia healyi* Yaldwyn & Wear, holotype alive, dorsal view; New South Wales. Right antennal flagellum missing.

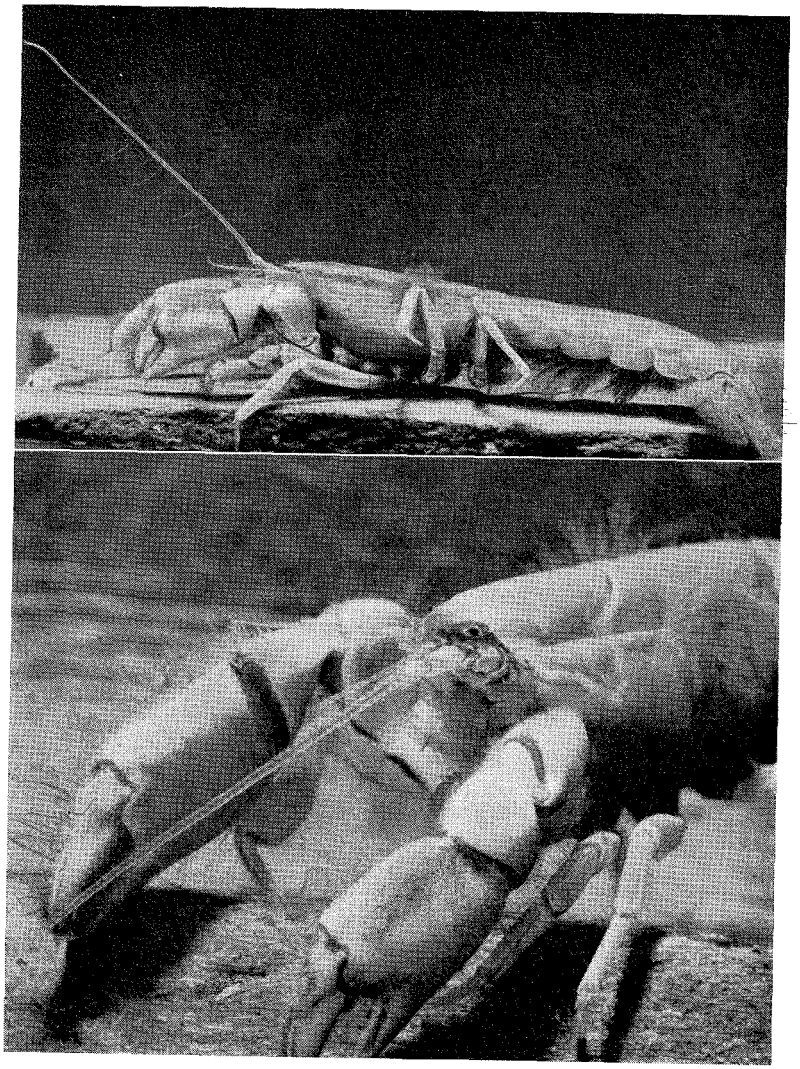


Plate VII upper. *Laomedia healyi,* holotype alive, lateral view. Note "branches" on antennal flagellum.

Plate VII lower. *Laomedia healyi,* holotype alive, anterolateral view. Note small but functional eyes.

(All photos of the holotype alive were taken in black and white, and also in colour, by A. Healy).