

A Notodelphyid Copepod, *Lonchidiopsis hartmeyeri* VANHÖFFEN,
Associated with a Simple Ascidian from Ago Bay

By

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Abstract Descriptions of the female and male of *Lonchidiopsis hartmeyeri* VANHÖFFEN, 1917 from Ago Bay are given. There are certain anatomical differences between the specimens from Ago Bay and the type species described from Australia, but we consider that the significant characters for the species are presented in the Ago Bay material. This is the first report on the species from the western Pacific coast.

The genus *Lonchidiopsis* created by VANHÖFFEN has been known to be characteristically modified but distinctly related to the less modified Notodelphyidae (Copepoda, Cyclopoida). The species so far known are *L. hartmeyeri* VANHÖFFEN, 1917 from Australia (Sharks Bay), *L. tripes* STOCK, 1967 from the Red Sea (off Landing Bay, Dahalk Archipelago, Ethiopia) and *L. setosus* JONES et MONTEZ MORENO, 1981 from the Caribbean (The Gulf of Cariaco, Venezuela). The former 2 species were found from the branchial sac of members of the genus *Ascidia* and the third species from another solitary ascidian *Rodosoma*.

During the processing of copepods associated with ascidians on the oyster beds in Ago Bay, located on the central Pacific coast of Japan, a transformed notodelphyid definitely belonging to this genus was found from the branchial sac of *Ascidia sydneyensis divisa* (SLUITER), which is one of the common solitary ascidians there. The copepod specimens from Ago Bay are designated as *L. hartmeyeri*, but show minute differences from the type species from Australia on readily determinable anatomical ground in both sexes. Specimens of the present host ascidian generally harbor 1 or 2 associates (females are larger in number), whereas a large number of associates (females and males in equal number) were collected from only one specimen of *A. sydneyensis* STIMPSON among many of the same ascidians from the type locality. Although there are certain anatomical and ecological differences between the specimens from the different localities, this variation is not considered sufficient to demarcate any taxonomic designation at the present level of knowledge of the type

species for which many anatomical details in both sexes are lacking in its original description.

In the following descriptions a full account is given of the female and male of *L. hartmeyer* (Fig. 1a, b) from Ago Bay. All the drawings were made on specimens in lactic acid preparation. This is the first report on the species from the western Pacific coast.

Abbreviations in the figures. A1, antennule; A2, antenna; L, labrum; L1, leg 1; MD, mandible; MX1, maxillule; MX2, maxilla; MXP, maxilliped; PAG, paragnath; RP, rostral protrusion.

***Lonchidiopsis hartmeyer* VANHÖFFEN**

(Figs. 2–8)

For synonymy see ILLG (1958, p. 485).

Material. Ago Bay, 34°16'N, 136°48'E, May 20, 1983, 15 females and 5 males, from *Ascidia sydneiensis divisa* (SLUITER); 5 females and 3 males from this collection have been deposited in the National Science Museum, Tokyo, and received a catalogue number of NSMT-Cr 8956.

Description. Female: The body (Fig. 2a, b) is strongly depressed, without dorsal curvature. It is divided into 3 regions of cephalosome, metasome and urosome including caudal rami, with their proportional lengths about 1:4.5:0.8. The body length of a single representative specimen is 2.8 mm, measured from anteriormost to the end of the caudal rami. The anterior cephalosome is posteroventrally protruded into the enlarged and rounded rostrum and laterally widens into pleural epimeral areas, forming a wing-like cephalic shield. The antennules arise from lobular bases at both sides of the rostrum and with these form part of the cephalic shield anterolaterally. A tiny subconical projection (Fig. 2 b–d) is protruded from the midpoint of the broad anteroventral surface of the rostrum between the antennules. The appendages of the cephalosome (Fig. 3 f) consist of 6 pairs of antennules, antennae, mandibles, maxillules, maxillae and maxillipeds. There is a semicircular postoral protrusion between the maxillipeds.

Dorsally the metasome (Fig. 2 a, b) exhibits 3 short segments corresponding to legs 1 to 3 and 1 elongated and cylindrical segment with legs 4 and 5, with their proportional lengths about 1: 1.6: 2.3: 26. The anterior 2 segments form the narrowest body region, anteriorly constricting from the broad posterior margin of the cephalosome. The third segment posteriorly widens and protrudes into a semicircle on the dorsal side toward the fourth "segment", which is a complex of fused anatomically fourth and fifth segments and encloses the incubatory pouches. The fourth legs are placed on the anterior end of the complex close to the third legs whereas the much reduced fifth legs are implanted posteroventrally near the posterior margin of the complex at a distance from the fourth legs. The incubatory pouches contain eggs arranged longitudinally and a series of much smaller ova are seen in the oviducts situated on the

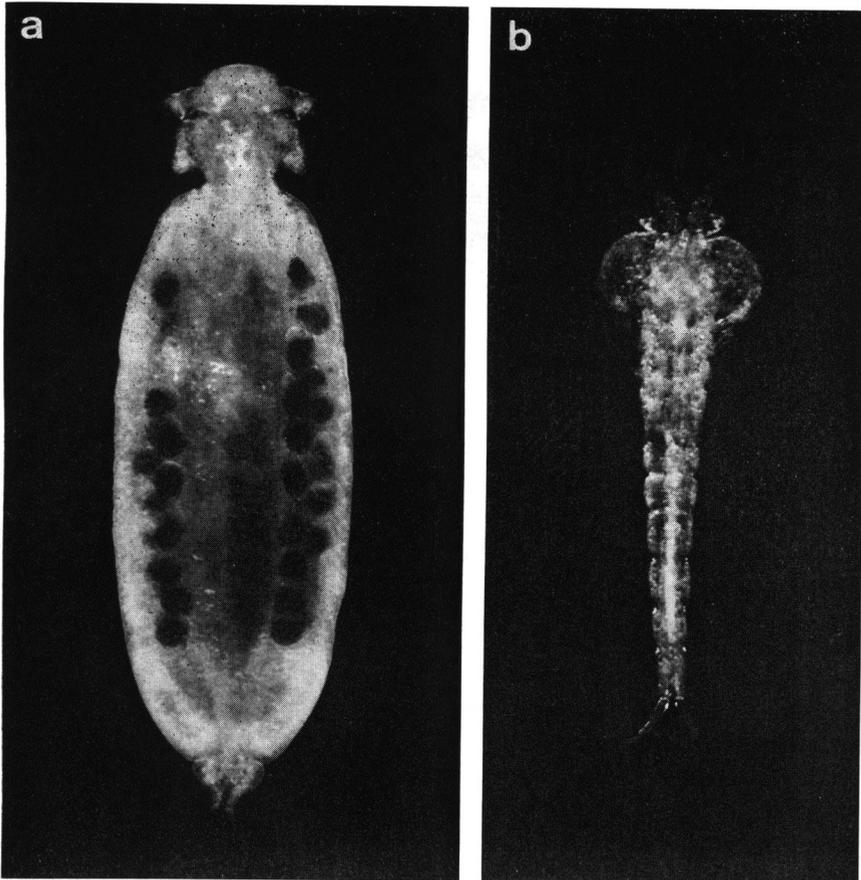


Fig. 1. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay: a, female (live specimen), $\times 36$; b, male (live specimen), $\times 79$.

dorsolateral sides of the gut internally.

The weakly 3-segmented urosome (Fig. 2 e) gradually tapers toward the truncated distal end, bearing small caudal rami with short setae. The first segment includes a small insemination pore placed midventrally at the anterior limit of the segment. There are 4 tiny papillae on either side of the insemination pore.

The body integument is furnished with minute hairs. In life, the small red eye is internally visible; the gut is yellow and the eggs are dark green to dark purple in color.

The antennule (Fig. 3 f–h) is 8-segmented with complicated segmentation. The first segment is strongly enlarged, being about one third as long as the appendage. The second segment slightly tapers and is ventrally so expanded that the dorsal margin is much shorter than the ventral margin. The third segment is about as long as the dorsal margin of the second segment. The second and third segments are sclerotized

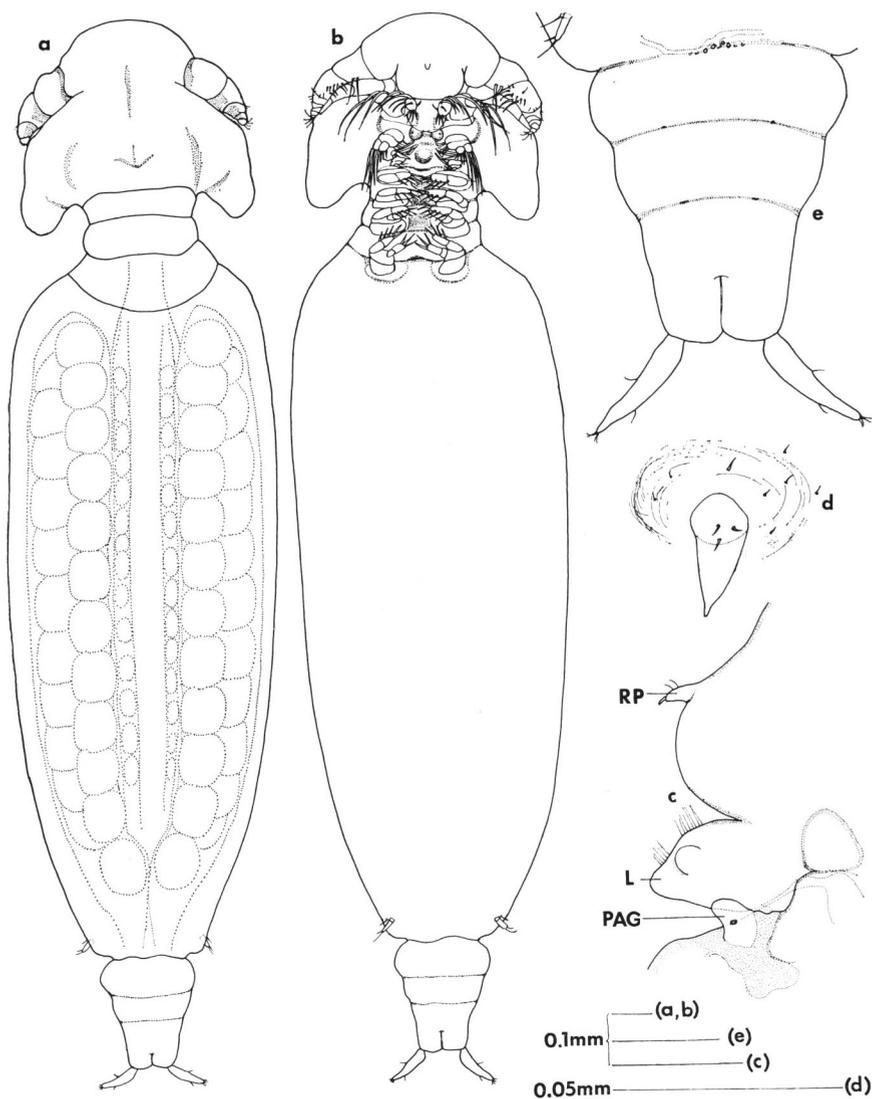


Fig. 2. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, female: a, habitus, dorsal; b, same, ventral; c, oral area, lateral; d, rostral protrusion, anterior; e, urosome, ventral.

on the dorsal surfaces, but unsclerotized on the ventral surfaces where the antenna is receivable. The following fourth to eighth segments are much narrower than the basal 3 segments and strongly curved ventrally at the fourth segment, which is characteristically sclerotized. The fifth to eighth segments are longer than wide. The ornamentation includes about 44 naked setae with the following tabulation of arrangement of long (ls) and short (ss) setae in the 8 segments (I–VIII): (I)–2 ls; (II)–5

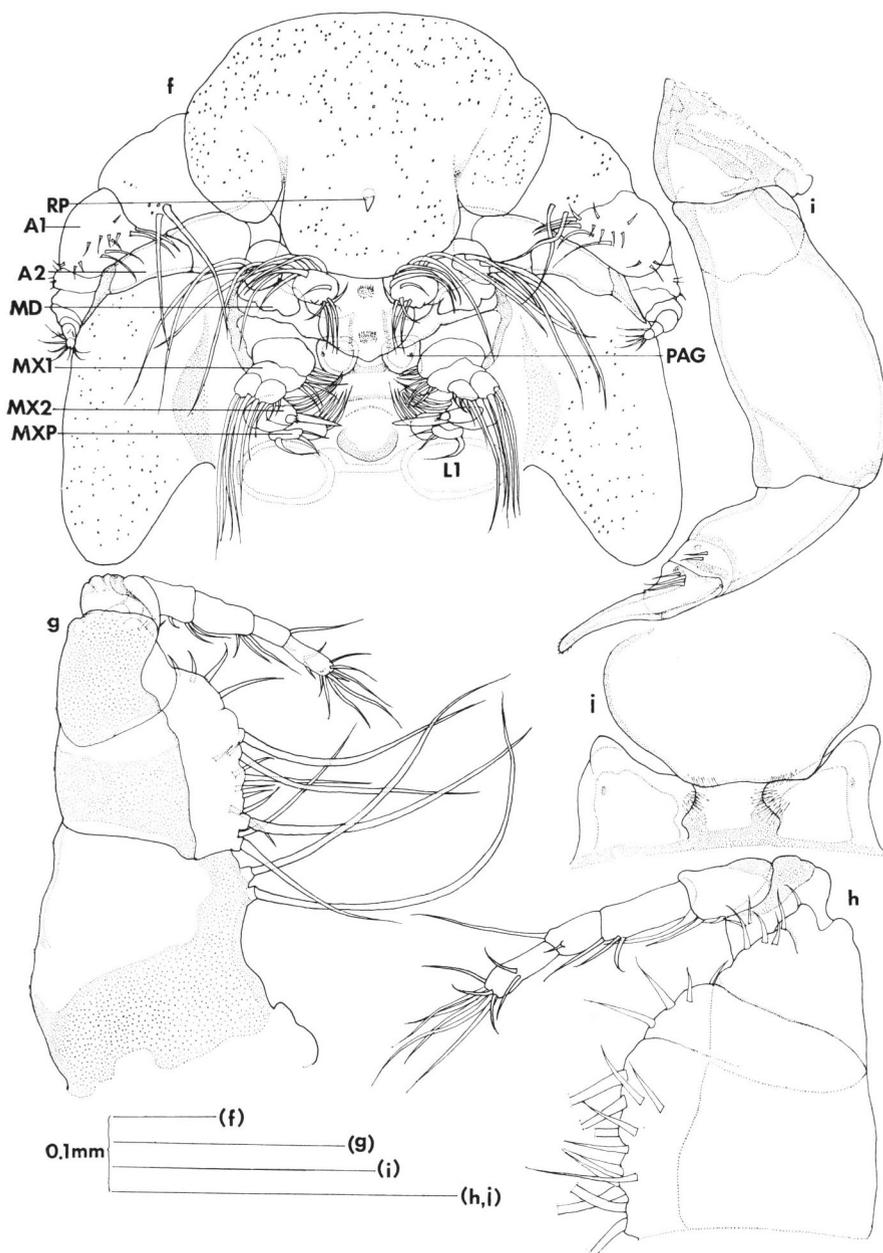


Fig. 3. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, female: f, oral area, ventral; g, antennule, right, dorsal; h, same, ventral; i, antenna, right; j, labrum and paragnaths, posterior.

ls, 12 ss; (III)–5 ss; (IV)–2 ss; (V)–3 ss; (VI)–3 ss; (VII)–2 ss; (VIII)–10 ss. Most of the setae are borne on the unsclerotized ventral margin of the appendage.

The antennae (Fig. 3 f, i) consists of 3 segments, with their proportional lengths about 1:3:2, measured on the anterior margin. The proximal 2 segments are unarmed. The distal segment is armed with 2 short naked setae at the outer distal corner and ends in a stout claw with 3 short similar setae at its base.

The labrum (Fig. 3 f, j) is broad, with a ventrally protruded, subtriangular margin and armed by 2 groups of hairs implanted anteriorly and posteriorly on the outer middle surface and by 2 more groups, one on either side of the distal margin.

The mandible (Fig. 4 k) is well-developed, consisting of bimerous protopodite and rami with plumose setae. The medial margin of the masticatory process of the coxopodite consists of 5 teeth, of which the largest distal tooth is separated from the 4 smaller teeth by a wider break; a finely serrated edge; and 2 seta-like projections, of which the more proximal is much elongate and separated widely. The basipodite bears a single relatively short seta on the medial margin. The endopodite is weakly 2-segmented, without distinct articulation on the basipodite, bearing 13 setae; the proximal segment with 4 (3 short and 1 long) medial setae and the distal segment with 9 (2 short and 2 long medial, 4 long distal and 1 long lateral) setae. The unimerous exopodite is wider than long and not clearly articulated on the basipodite, with 5 graduated long setae.

The paragnath (Fig. 3 f, j) is located between the mandible and the maxillule and nearer the midline than the mouthpart series. It is a simple membranous protrusion from the body surface and armed with short hairs on the mediodistal corner.

The maxillule (Fig. 4 l) is composed of bimerous protopodite and unimerous rami. The armature consists of plumose setae in various lengths. The coxopodite is medially provided with 10 setae on the major endite and 1 seta on the probable secondary endite as well as laterally 1 long and 1 more distal short seta on the epipodite. The basipodite bears 4 medial setae. The endopodite is armed with 5 graduated setae along the medial and distal margins. The exopodite is larger than the endopodite, bearing 4 long setae on the distal margin.

The maxilla (Fig. 4 m) consists of 3 segments. The basal segment is about 4 times as long as the remaining segments combined and armed with 10 long (ls) and short (ss) setae on 4 endites (I–V): (I)–4 ls; (II)–1 ls; (III)–2 ls; (IV)–2 ls, 1 ss. The second segment is sclerotized and produced medially as 1 long stout claw with a row of fine setules along its outer margin, 1 short slender seta, arising from the posterior base of the claw, and 1 long seta from the anterior base. The small third segment bears 5 short slender setae on the rounded apical margin. All setae are feathered.

The maxilliped (Fig. 4 n) is relatively small, consisting of 2 segments with their proportional lengths about 2.5:1 from proximal to distal. The proximal segment is armed with 5 setae on the upper half on the medial margin. The much smaller second segment bears 3 setae, of which the distal seta is longest and bent at the proximal third medially.



Fig. 4. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, female: k, mandible, posterior; l, maxillule, right, posterior; m, maxilla, left, posterior; n, maxilliped, left, anterior.

The first to fourth legs are composed of bimerous protopodite and rami. In these legs the coxopodite is unarmed. The usual intercoxal plate is not developed but the midventral body wall of each of the first to third leg-bearing segments is characteristically sclerotized. The endopodites and exopodites are medially directed and

their segments are somewhat flat.

In the first leg (Fig. 5 o) the basipodite has 1 extremely long lateral seta and 1 medial spine. In the endopodite the basal segment is about one third as long as the distal segment. The ornamentation consists of 6 setae and 1 spine in all; 1 long medial seta on the basal segment and 5 (2 medial, 1 apical and 2 lateral) setae and 1 apical spine on the second segment. The lateral margin of each segment is armed with long hairs. The exopodite is about twice as long as the endopodite, with 1 seta and 6 spines in all. The basal segment is about twice as long as the distal segment; 1 medial seta and 1 lateral spine on the basal segment and 5 (2 apical and 3 lateral) spines on the distal segment. Each spine is fringed with a finely serrated hyaline flange around its upper two thirds and there is a row of fine spinules near its base protruding from the margin of the segment. All setae are feathered and most of them have the same type of spinules near their bases also.

In the second leg (Fig. 5 p) the protopodite is narrower than that in the first leg but the endopodite and exopodite are more developed in size. The basipodite bears 1 short, lateral naked seta. The endopodite bears 1 medial seta on the basal segment and 5 (2 medial, 2 apical and 1 lateral) elongated spines on the distal segment. These spines are generally longer than the second segment and fringed with hyaline flanges around their upper halves. The ornamentation (1 seta and 6 spines) of the exopodite is comparable to that of the first leg.

The third leg (Fig. 5 q) is similar to the second leg in structure but differs in armature; the exopodite is reduced by 1 spine on the second segment.

The fourth leg (Fig. 5 r) is distinctive from the second and third legs. The protopodite and rami are more slender than those of the preceding legs. The armature on the rami includes only graduated spines. The endopodite bears 3 spines along the upper margin on the second segment, of which the middle one is longest. The exopodite is armed with 5 spines; 1 lateral spine on the basal segment and 4 (2 apical and 2 lateral) spines on the distal segment, of which the mediobasal spine on the second segment is longest.

The formula of spines (Roman numerals) and setae (Arabic numerals) in the legs 1 to 4 is as follows; the total (T) of their numbers (Italic numerals) is shown within parentheses.

	Prp	(T)	Enp	(T)	Exp	(T)
Leg 1	O-0; I-1	.....(2)	O-1; I-5	.....(7)	I-1; V-0	.....(7)
Leg 2	O-0; O-1	.....(1)	O-1; V-0	.....(6)	I-1; V-0	.....(7)
Leg 3	O-0; O-1	.....(1)	O-1; V-0	.....(6)	I-1; IV-0	.....(6)
Leg 4	O-0; O-1	.....(1)	O-0; III-0	.....(3)	I-0; IV-0	.....(5)

The fifth leg (Fig. 5 s) is composed of a small cylindrical, weakly 2-segmented ramus (proportional lengths about 1:4 from basal to distal), with 2 naked setae (the apical seta longer than the subapical one) on the distal segment; and a single similar seta implanted at the upper lateral base of the ramus but separated from it.

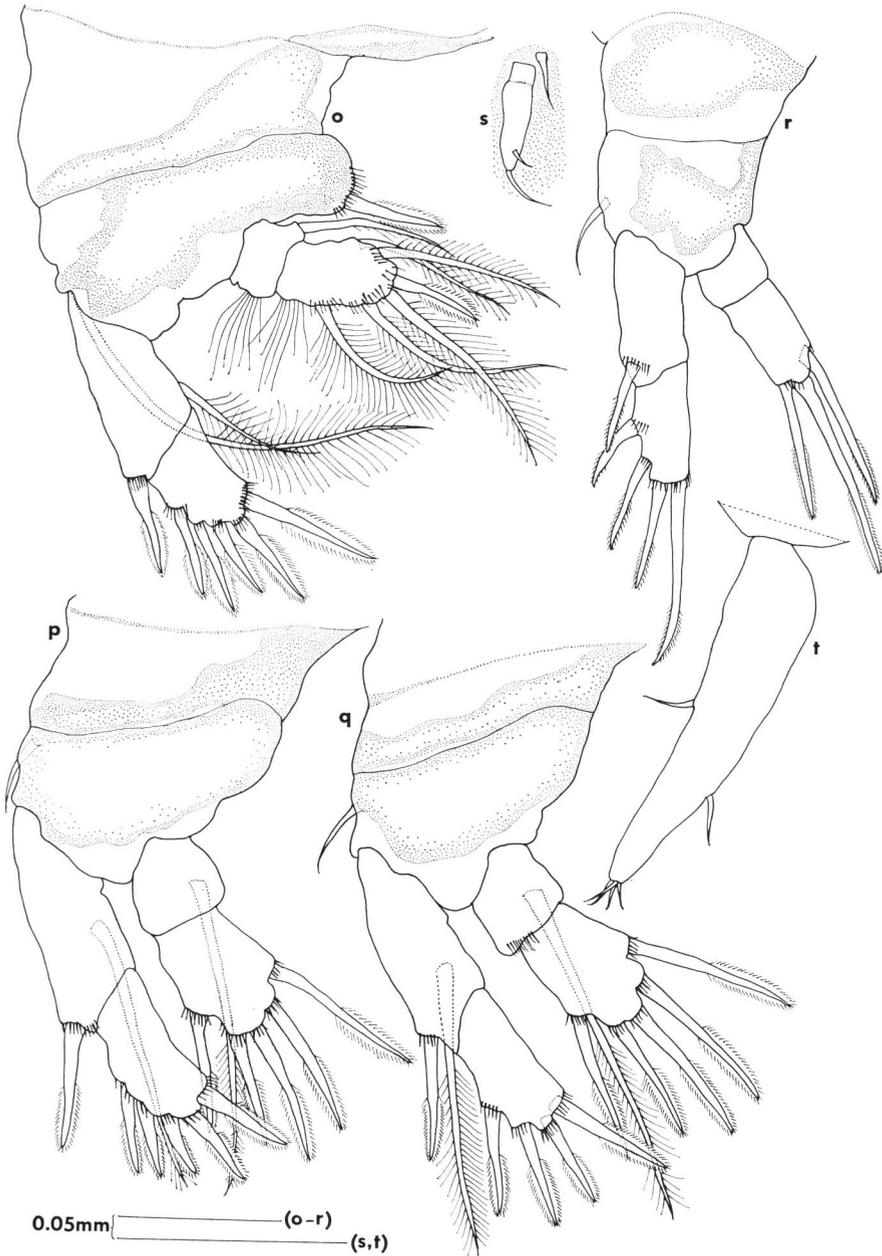


Fig. 5. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, female: o, leg 1, right, anterior; p, leg 2; q, leg 3; r, leg 4; s, leg 5, left, anterior; t, caudal ramus, right, ventral.

The caudal ramus (Fig. 5 t) is about 4 times as long as the widest width and about as long as the last urosomal segment. The armature consists of 6 short naked setae; 1 at about the middle on the lateral margin, 1 at the distal third on the medial margin and 4 on the apical margin.

Male: The body (Fig. 6 a, b) is markedly smaller than that of the female, being 0.87 mm in a single representative specimen, measured from anteriormost to the end of the caudal rami. It is composed of cephalosome, metasome and urosome including caudal rami, with their proportional lengths about 1:2:4.2. The cephalosome is laterally prolonged, forming leaf-like pleural areas which can recurve ventrally. It is anteriorly protruded into a small subtriangular rostrum with a tiny finger-like rostral protrusion from the tip (Fig. 6 c, d). The antennules are anteriorly protruded from both sides of the rostrum and beyond the anterior margin of the cephalosome. The distal part of the antenna on each side is directed anterolaterally between the antennule and the anterior margin of the cephalosome. Four pairs of mouthparts (Fig. 6 c, e) including mandibles, maxillules, maxillae and maxillipeds are as in the female.

The narrow, cylindrical metasome consists of 4 segments, which are gradually elongated and slightly taper from proximal to distal, with their proportional lengths about 1:1.3:1.7:2.6 and each bears a pair of swimming legs.

The similarly narrow urosome consists of 6 segments: the first 2 segments are wider than long, bearing respectively the fifth legs and usual sixth leg-lappets; the third to fifth segments are longer than wide; the sixth segment is also longer than wide, with the anus as a posterodorsal slit and with terminal caudal rami. There is no marked constriction between the metasome and the urosome.

The antennule (Fig. 6 f) is substantially comparable to that of the female but more slender and gradually tapers from proximal to distal. It consists of 8 segments with about 41 setae; the second segment has a suggestion of incomplete division into 2 segments. The tabulation of arrangement of non-plumose long (ls) and short (ss) setae in the 8 segments (I–VIII) is as follows: (I)–2 ls; (II)–5 ls, 11 ss; (III)–4 ss; (IV)–2 ss; (V)–3 ss; (IV)–3 ss; (VII)–2 ss; (VIII)–9 ss.

The antenna (Fig. 7 g) is distinctively modified from the basic pattern for the female, being chelate. It is apparently 3-segmented. The first segment is depressed anteriorly, having a system of sclerites. The broad second segment anterodistally extends into a rigid pointed projection to receive the claw of the chela. The claw is basally articulated with the short and narrow third segment. The setal armature is substantially comparable to that of the female with 5 short naked reduced setae.

The labrum (Fig. 6 c) is somewhat narrower than that in the female and seemingly without hairs on the outer middle surface. The paragnaths and postoral protrusion are like those in the female.

The mandible (Fig. 7 h), maxillule (Fig. 7 i), maxilla (Fig. 7 j) and maxilliped (Fig. 7 k) are the same as those of the female in structure and armature.

The first to fourth legs (Fig. 8 l–o) are comparable to those of the female in structure but somewhat longer and more slender after the mode of the elongated body.

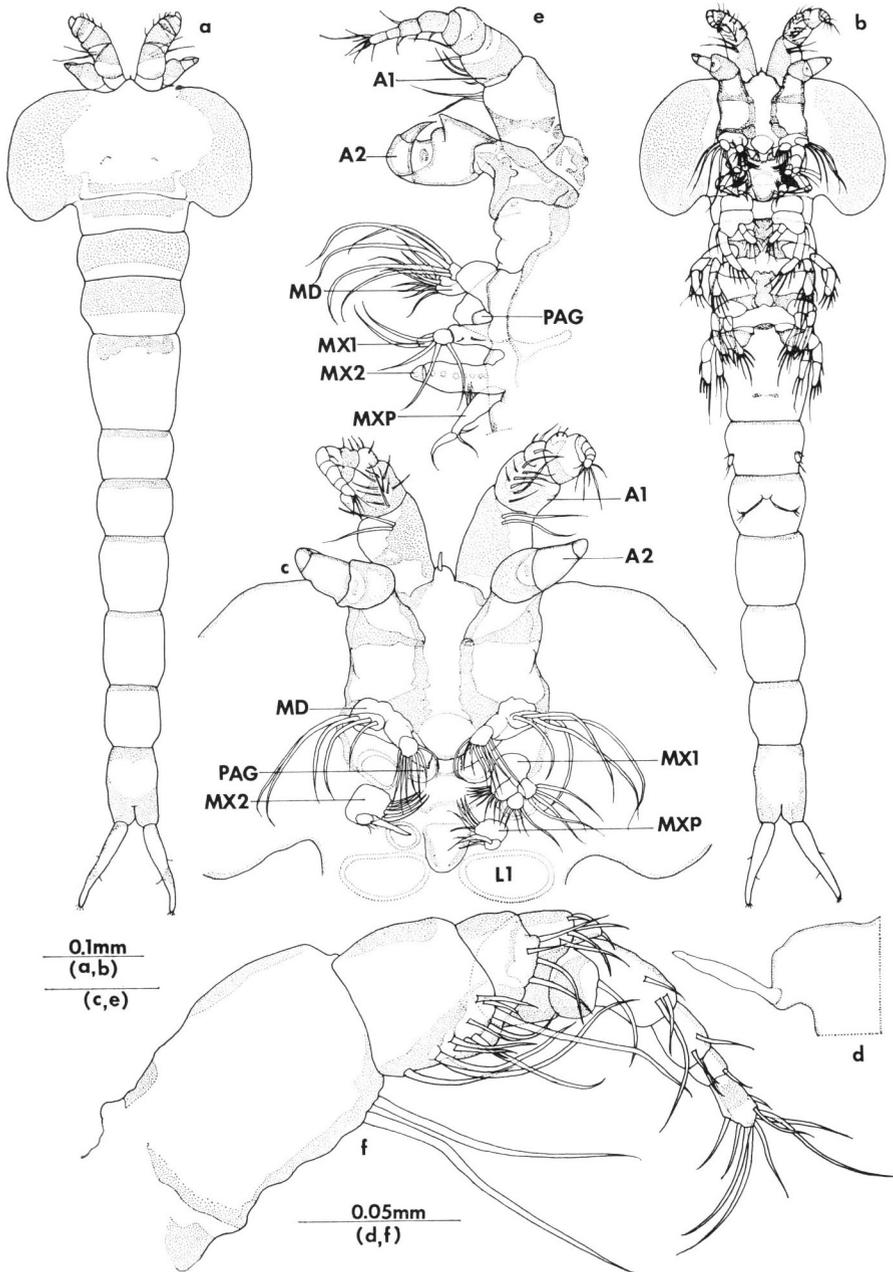


Fig. 6. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, male: a, habitus, dorsal; b, same, ventral; c, oral area, ventral; d, rostral protrusion, lateral; e, oral area, lateral; f, antennule, left.

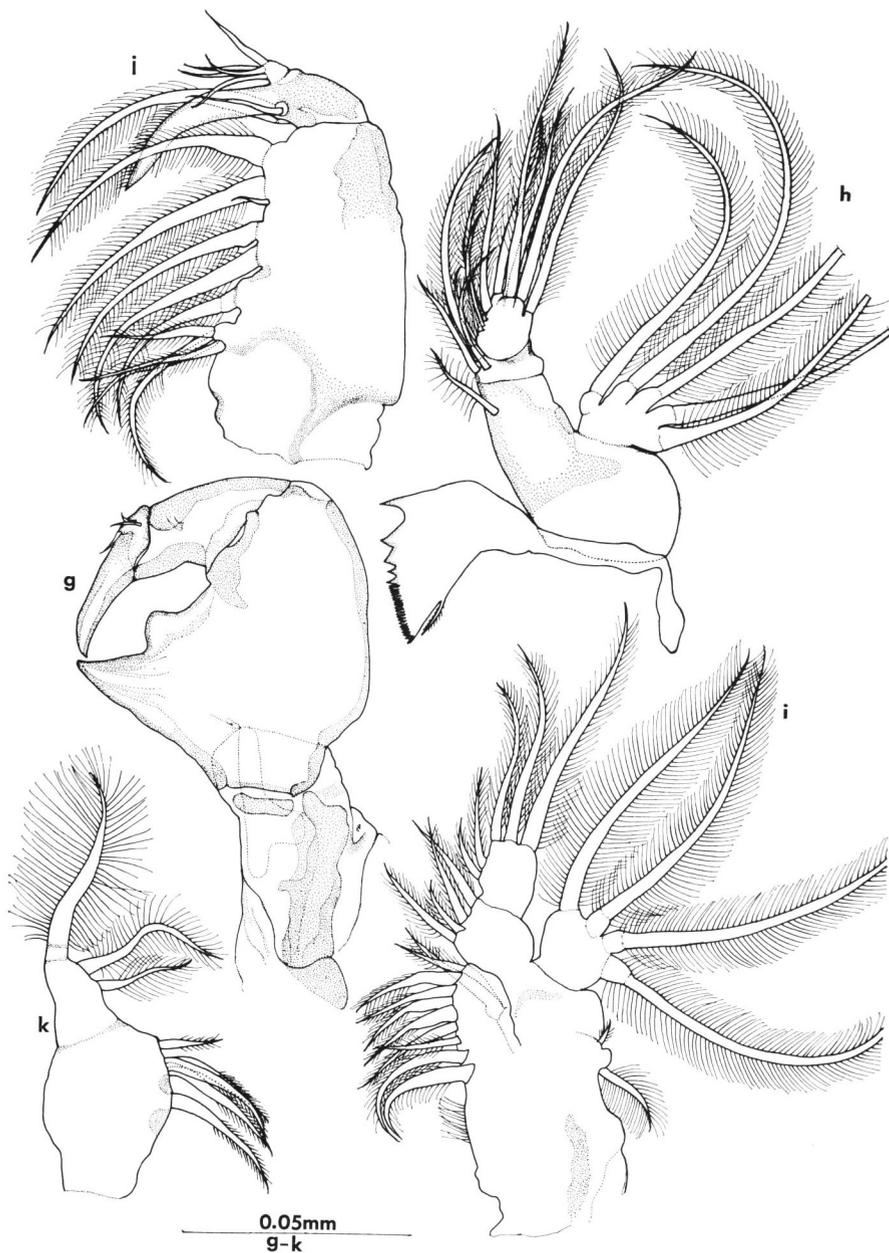


Fig. 7. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, male: g, antenna, left; h, mandible, left, posterior; i, maxillule, left, posterior; j, maxilla, left, posterior; k, maxilliped, left, anterior.

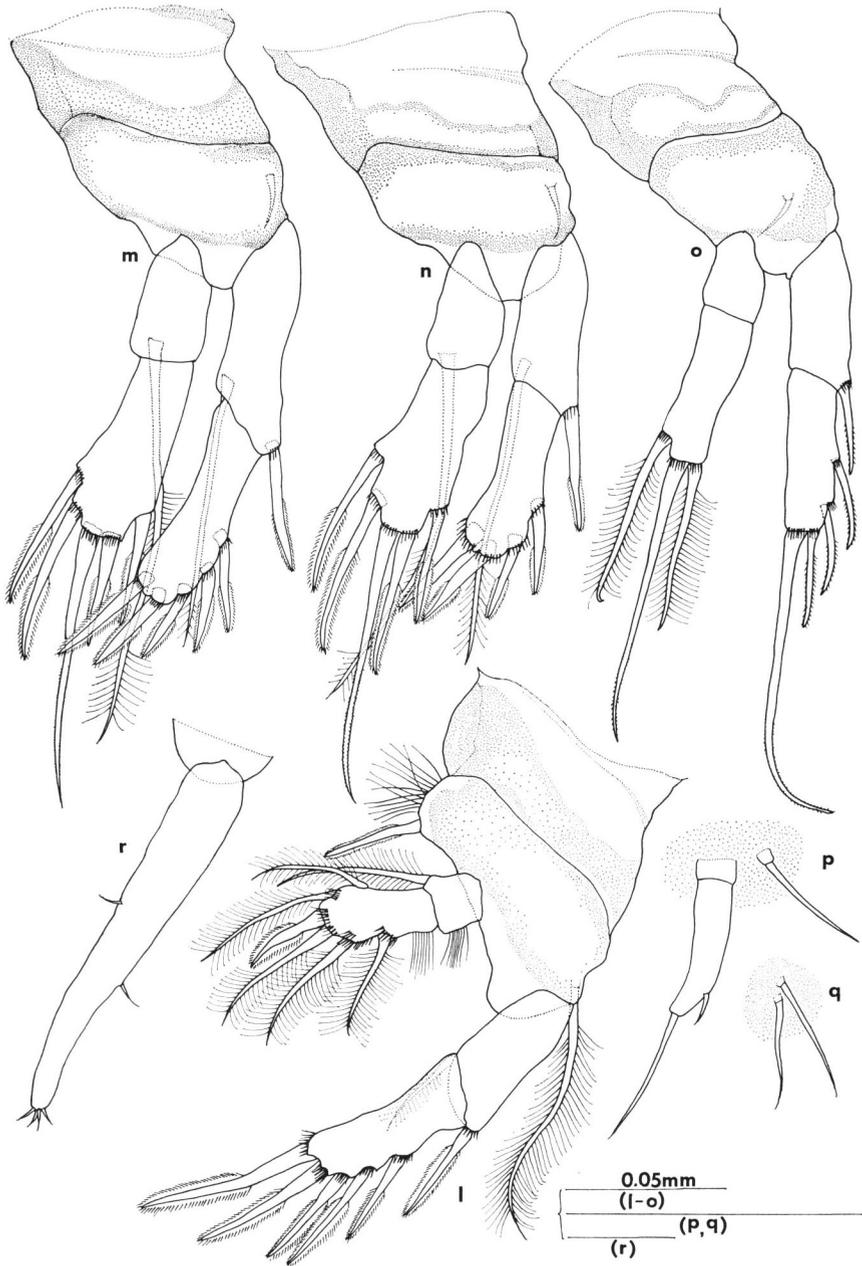


Fig. 8. *Lonchidiopsis hartmeyeri* VANHÖFFEN, from Ago Bay, male: 1, leg 1, left, anterior; m, leg 2; n, leg 3; o, leg 4; p, leg 5; q, leg 6; r, caudal ramus, left, dorsal.

The midventral body wall of each of the first to third leg-bearing segments is more distinctly sclerotized than in that of the female (Fig. 6 b). In the armature its numerical composition is the same as that of the female from the first to fourth legs, but in its anatomy the male is distinguishable from the female in bearing spines, extremely long setiform elements and plumose setae replacing some spines described for the female on the second to fourth legs. In the second and third endopodites the distal segment is armed with 4 (2 medial, 1 apical and 1 lateral) spines and 1 long apical setiform element. In the fourth legs the distal segment of the endopodite is provided with 2 (1 medial and 1 apical) plumose setae and 1 long apical setiform element and the distal segment of the exopodite with 3 (1 apical and 2 lateral) spines and 1 long apical setiform element.

The formula of spines (Roman numerals) and setae (Arabic numerals) is as follows; the total (T) of their numbers (Italic numerals) is shown within parentheses.

	Prp	(T)	Enp	(T)	Exp	(T)
Leg 1	O-0; I-1	.....(2)	O-1; I-5	.....(7)	I-1; V-0	.....(7)
Leg 2	O-0; O-1	....(1)	O-1; IV-1	....(6)	I-1; V-0	.....(7)
Leg 3	O-0; O-1	....(1)	O-1; IV-1	....(6)	I-1; IV-0	.....(6)
Leg 4	O-0; O-1	....(1)	O-0; O-3	....(3)	I-0; III-1	....(5)

The fifth leg (Fig. 8 p) is comparable to that of the female in structure and armature. The sixth leg (Fig. 8 q) is represented by 2 short naked setae placed side by side on the curved distal free margin of the flap-like cover on the male genital orifice.

The caudal ramus (Fig. 8 r) is about 6 times as long as the greatest width and slightly longer than the last urosomal segment, bearing 6 short naked setae. The arrangement of the setae is comparable to that in the female.

Remarks. The female (2.8 mm in length) from Ago Bay is larger than that (1.87 mm in length) from Australia, but we also have a matured female 2 mm long from Ago Bay. Differences readily demarcating the Ago Bay material from the type from Australia in both sexes are found in the relatively short caudal rami which are about as long as the last urosomal segment (about twice in the type) and the mandible exopodite with 5 setae (4 setae in the type). There are seemingly additional slight differences from the type species regarding the anatomical details. The specimens from Ago Bay are characterized by having the rostral protrusions and paragnaths in both sexes as well as spines, setiform elements and plumose setae in legs 2 to 4 in the male. These characters are not described in the original paper, but we consider that the essential characters for the species as described by VANHÖFFEN are presented in the specimens from Ago Bay. STOCK (1967) mentioned that the original description left a slight doubt as to the presence of 2-segmented rami in the fourth legs of the female of *L. hartmeyer*, but there is no doubt regarding their presence as determined in the present material. In Japan there are 3 closely related ascidians belonging to *Ascidia*, *A. pacifica* TOKIOKA, *A. sydneyensis samea* OKA and *A. s. divisa* (SLIUTER), but associates of the former 2 kinds of ascidians have not been found yet. Finding

these associates or reexamining the Australian material would be useful in solving all the problems above or in knowing the host-dependent and geographical variations.

Lonchidiopsis hartmeyeri is markedly distinguishable from the other known 2 species, *L. tripes* STOCK and *L. setosus* JONES et MONTEZ MORENO, by having the relatively well-developed fourth legs as mentioned-above. In the latter 2 species the fourth legs are greatly reduced, consisting of 2 (fused or separated) papillae with a single short seta or 2 setules in each respectively. JONES & MONTEZ MORENO (1981, p. 55) pointed out that another feature distinguishing *L. hartmeyeri* from the other 2 species is that the caudal rami are longer than the anal segment in the former species. However, it seems that their shape may be a more remarkable feature than their lengths regarding the caudal rami; STOCK (1967, p. 51) mentioned that the shape and mutual measurements of caudal rami and anal segment are the easiest characters to distinguish it from *L. tripes*. We agree with their opinions that *L. tripes* is similar to *L. hartmeyeri* (by STOCK) or that all 3 species are very similar (by JONES & MONTEZ MORENO) in morphology. In this connection it is pointed out that the mandible and maxillule studied by us are the same as those of *L. setosus* in setation and basic structure and regarding the mandible there is no difference between *L. hartmeyeri* from Ago Bay and the other 2 species.

Acknowledgement

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