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TWO NEW PARASITIC COPEPODS (CYCLOPOIDA: MYICOLIDAE) FROM JAPANESE GASTROPOD MOLLUSCS[1,2)]

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With Text-figures 1–51

It is interesting that the copepods parasitic to gastropods are rather specialized. In this paper, two new species of snail-parasitic copepods of the family Myicolidae are described from Japan. One of them, to which a new genus is proposed here, was discovered by Mr. N. Nunomura, a graduate student of Kyoto University studying parasitic turbellarians at that time, from inside the soft body of a spindle whelk, *Pleuroploca trapezium audouini* [Neogastropoda, Fasciolariidae], collected in the vicinity of the Seto Marine Biological Laboraotry in August 1971 and the collected specimens were submitted to the present author for identification. Shortly later, a number of additional specimens were collected from the same snail in the same place, and further some specimens were obtained at Minabe near Seto in January 1972 from another related snail, identified, though not strictly, with *Fusinus nigrirostratus*. This new species is limited to the renal sac of the host, creeping into a complicated network of renal lamellae, and seemingly is found commonly from spindle whelks in the vicinity of Seto. It is named here *Neanthessius renicolis* n. gen. and n. sp., the new generic name implies a close relation to the genus *Anthessius*.

The other new species here dealt with was obtained from the buccal cavity of a horned turban, *Batillus cornutus* [Archaeogastropoda, Tubinidae], collected at Kinagashima and Sugari on the east coast of Kii Peninsula in 1972 and 1975. This species roughly agrees with *Panaietis incamerata* Stebbing redescribed by Yamaguti (1936) on the specimens from the same snail in the Sea of Japan, however, *P. incamerata* was originally recorded only briefly in 1900 from an unidentified gastropod collected at Panaieti, the Louisiade Archipelagos, and its detailed morphorogy and host had remained uncertain till it was rediscovered by Monod (1934) from the buccal cavity and the oesophagus of *Trochus niloticus* [Archaeogastropoda, Trochidae] collected from the Islands of Andaman, the Bay of Bengal, and redescribed and figured in detail. Though the Japanese specimens from *Batillus* resembles *P. incamerata* in the general body appearance, they differ from this species in having much shorter

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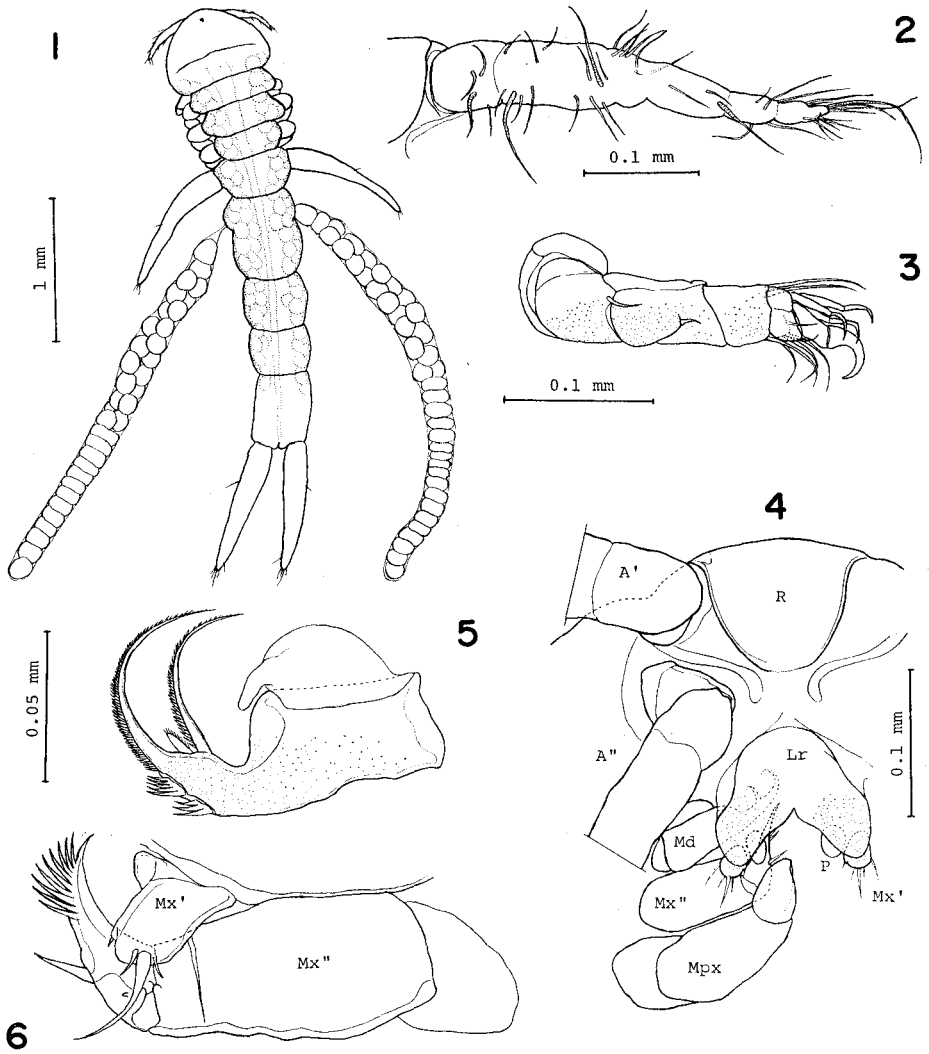
fifth legs and in bearing some different features in the other appendages. Therefore the Japanese specimens may probably be regarded to represent a new species distinct from *P. incamerata* but forming with this species a sibling species complex parasitic to different hosts. Of course, the present new species differs from the other species of the genus, *P. haliotis* Yamaguti from Japanese abalone and is named here *P. yamagutii* n. sp.



Figs. 1–6. *Neanthessius renicolis* gen. et sp. nov., female. 1. total view, dorsal. 2. first antenna, ventral view. 3. second antenna, inner view. 4. antennae and oral appendages in situ, ventral view. 5. mandible, ventral view. 6. first and second maxillae in situ, ventral view, maginified as in Fig. 5. Abbreviations: A′-first antenna, A″-second antenna, a-aesthete, Lr-labrum, Md-mandible, Mx′-first maxilla, Mx″-second maxilla, Oe-oesophagus, P-paragnath, R-rostrum.

Genus *Neanthessius*, nov.

A genus of the family Myicolidae.

Female: Body thin, with distinct metamerism; with fifth legs conspicuously long and laterally extending symmetrically as wings; posteriorly ending in caudal rami, as long as fifth legs. Habitus weak, translucent, with red eyes. Urosome plump and cylindrical, occupying about two thirds of body length. Oviduct developed on either side of body, along almost the whole length. Egg sac slender, as long as body; eggs uniseriate distally and multiseriate proximally. Egg large; nauplius lecithotrophic.

Male: Body roughly as in female, though more stumpy.

Appendages structured essentially as in the genus *Anthessius*. First antenna somewhat flesy. Maxilliped highly sexually dimorphic, very massive in male incomparably with any species of *Anthessius*. First four pairs of legs larger posteriorly and each carrying 3-segmented rami. Third endopodite segment with II-4 on first leg in both sexes. Spines on endopodite of first two pairs of legs uniquely hairy in male.

Type species: *Neanthessius renicolis* n. sp.

This new genus is closely related to the genus *Anthessius* Della Valle, 1880.

Neanthessius renicolis n. sp.

(Figs. 1–27)

Material: About 150 females and 50 males from renal sac of *Pleuroploca trapezium audouini* (Jonas) collected at Seto in August-Octorber, 1971; 6 females and 4 males from the same organ of another related gastropod, probably *Fusinus nigrirostratus* (Smith), collected at Minabe near Seto on January 29, 1972. Holotype (female) and 30 paratypes including both sexes are deposited at the Seto Marine Biological Laboratory.

Type host: *Pleuroploca trapezium audouini* (Jonas), (Neogastropoda, Fasciolariidae).

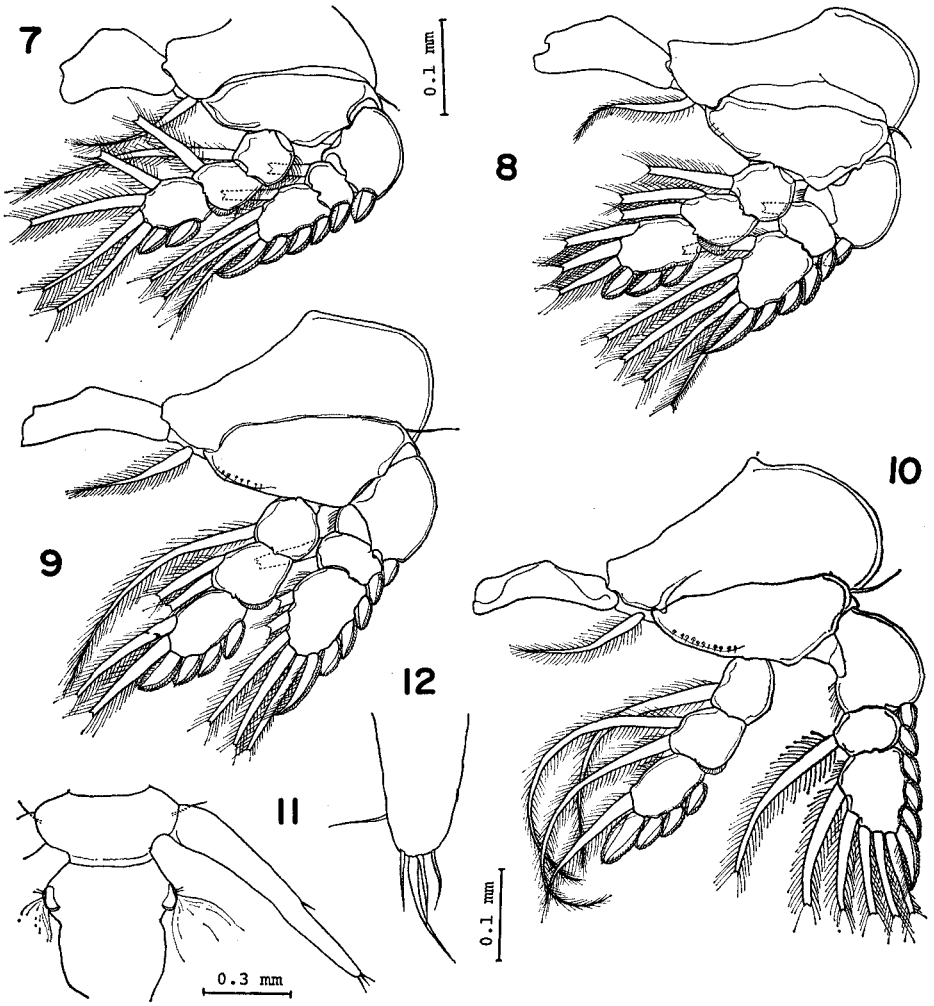
Female: Mean length excluding caudal ramus 2.66 mm, ranging 2.19–3.51 mm; width of cephalosome 0.70 mm on an average of 138 specimens. Body (Fig. 1) slender; cephalosome, metasome and urosome delimited clearly; habitus weak, translucent, with red eyes. Pale yellow oviduct, full of eggs, along either side from the posterior portion of cephalosome through the anterior portion of anal segment.

Cephalosome including first pedigerous segment definable distinctly by a dorsal suture from the other portion; small, somewhat flattened and roughly triangular, length to width ca. 1:1.4. Metasome, consisting of 3 somewhat flattened leg-bearing segments, slightly longer than cephalosome. Urosome, consisting of 5 segments, elongate and occupying about two thirds of body length, plump and cylindrical, but feebler than cephalosome or metasome. First urosomal segment with very long fifth legs extending laterally like wings. Second urosomal or genital segment com-

posed of proper genital and first post-genital segments fused together, gonopores opening ventro-laterally in the proper genital portion. Third and fourth segments naked. Caudal rami longer than anal segment. Proportional lengths and widths of cephalosome and succeeding 8 segments are approximately as follows:

	Cephalosome	Metasome				Urosome				
		1	2	3	1	2	3	4	5	total
Length	16.2	5.8	6.5	6.3	9.1	18.5	11.1	10.1	16.1	100
Width	1	0.85	0.33	0.66	0.73	0.69	0.63	0.59	0.54	

Egg sac slender, as long as body; eggs uniseriate distally but multiseriate proximally; large, ca. $130 \times 170\ \mu$ on an average; usually 30–50 eggs in a sac.



Figs. 7–12. *Neanthessius renicolis* gen. et sp. nov., female. 7. first leg, ventral view. 8. second leg, ventral view. 9. third leg, ventral view. 10. fourth leg, ventral view. 11. fifth leg and genital segment in situ, ventral view. 12. distal portion of caudal ramus, ventral view. Figs. 8, 9, and 10 magnified as in Fig. 7.

Rostrum moderate, with round posterior margin. First antenna (Fig. 2) somewhat fleshy, indistinctly 7-segmented; spinule formula on segments 4, ca. 13, ca. 7, 3, 4+1 aesthete, 2+1 aesthete and 7+1 aesthete. Second antenna (Fig. 3) 3-segmented, almost the same in thickness throughout the whole length and spinulose on the ventral surface; first two segments almost equal in length, each with a ventral seta; third segment slightly shorter than second, indistinctly divided into 2 unequal subjoints, proximal subjoint with 2 outer and 4 inner setae at the end, distal subjoint with a ventral setule and 4 articulated apical claws, the innermost claw much stronger. Labrum (Fig. 4) assuming an inverted V, spinulose. Mandible (Fig. 5) as in the genus *Anthessius*; in addition to almost similar terminal and subterminal lashes pectinated along the median side, with 2 teeth at the median base of terminal lash, respectively tri- and pentacuspidate, and a small digitiform lamellar process spinulated on the outer margin between the bases of two lashes. Paragnath (Fig. 4) represented as a small unarmed lobe. First malilla (Fig. 6) longer than wide, somewhat flattened, bearing an outer seta at the middle, a spinule at the inner-distal angle, and a long and 2 short setae at the end. Second maxilla (Fig. 6) 2-segmented, stout; first segment 2 times as long as wide, unarmed; second segment ending in a claw-like process, armed with ca. 10 teeth on the median side in the distal half, a stout seta on the same margin at proximal one third and 2 spinules dorso-ventrally arranged near the base. Maxilliped (Fig. 4) digitiform, obscurely 3-segmented, longer than second maxilla; no armature except for a slight, longitudinal bulge on the dorsal side of third segment.

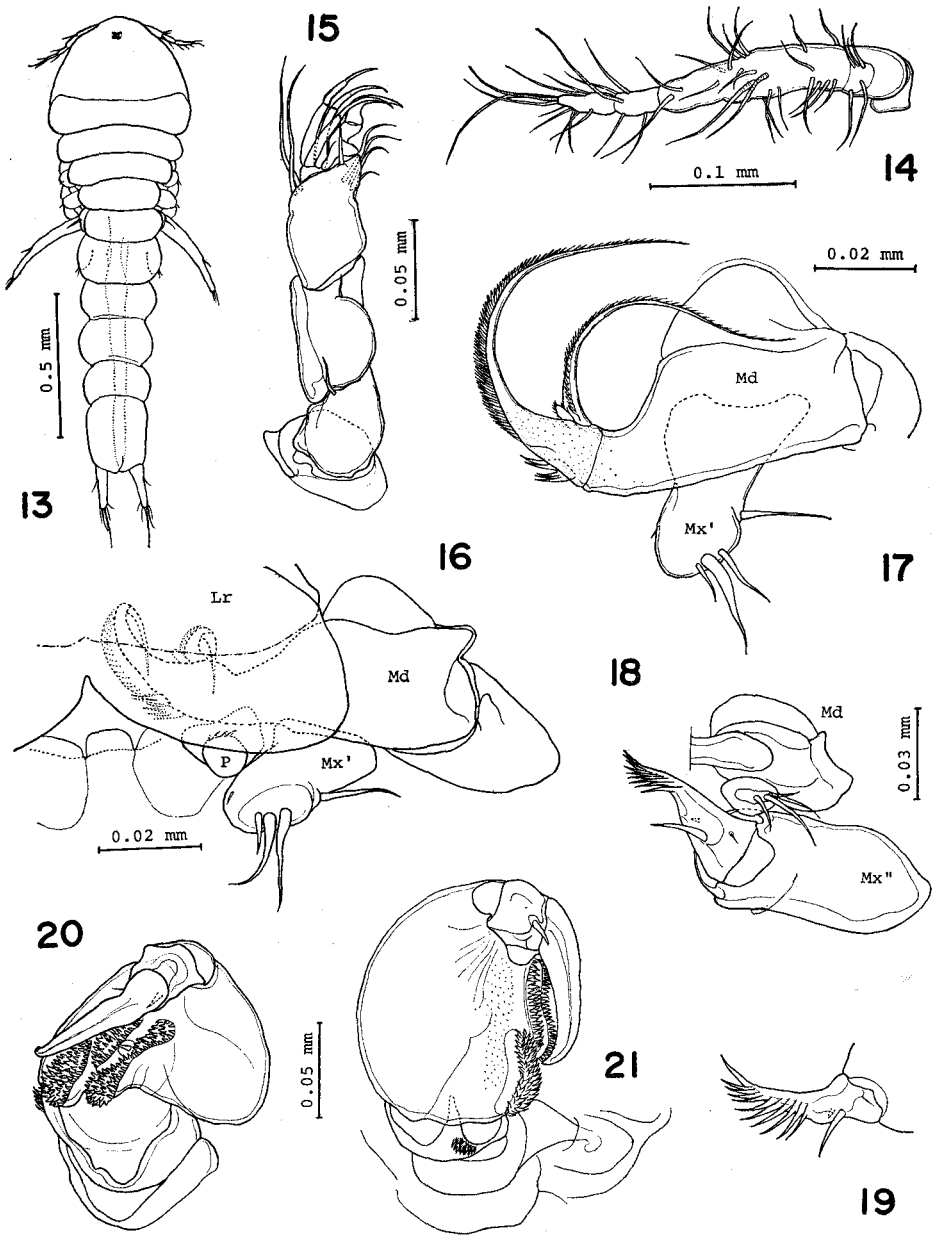
Anterior four pairs of legs (Figs. 7–10) larger posteriorly, carrying 3-segmented rami, and with the following setal formulae (number of spines in Roman and that of setae in Arabic numerals):

	Exopodite	Endopodite
Leg 1	I–0; I–1; III,I–4	0–1; 0–1; II–4
Leg 2	I–0; I–1; III,I–5	0–1; 0–2; III–3
Leg 3	I–0; I–1; III,I–5	0–1; 0–2; IV–2
Leg 4	I–0; I–1; III,I–5	0–1; 0–2; IV–1

Segments of rami devoid of any spiniform projections seen generally in *Anthessius* spp. Fifth leg (Fig. 11) falciform, ca. 900 μ long, about 6 times as long as wide, with a seta at the middle on the anterior side and 3 setae at the end. Caudal ramus (Figs. 1 & 12) elongate, tapering distally, almost as long as fifth leg, about 5 times as long as wide, and with an outer seta at the proximal one third, an inner subterminal seta and 4 terminal setae.

Male: There are noticed two types of the amle as to the body length and lengths of the fifth leg and the caudal ramus as shown below, though no other differences are detectable in the appendages between the two types:

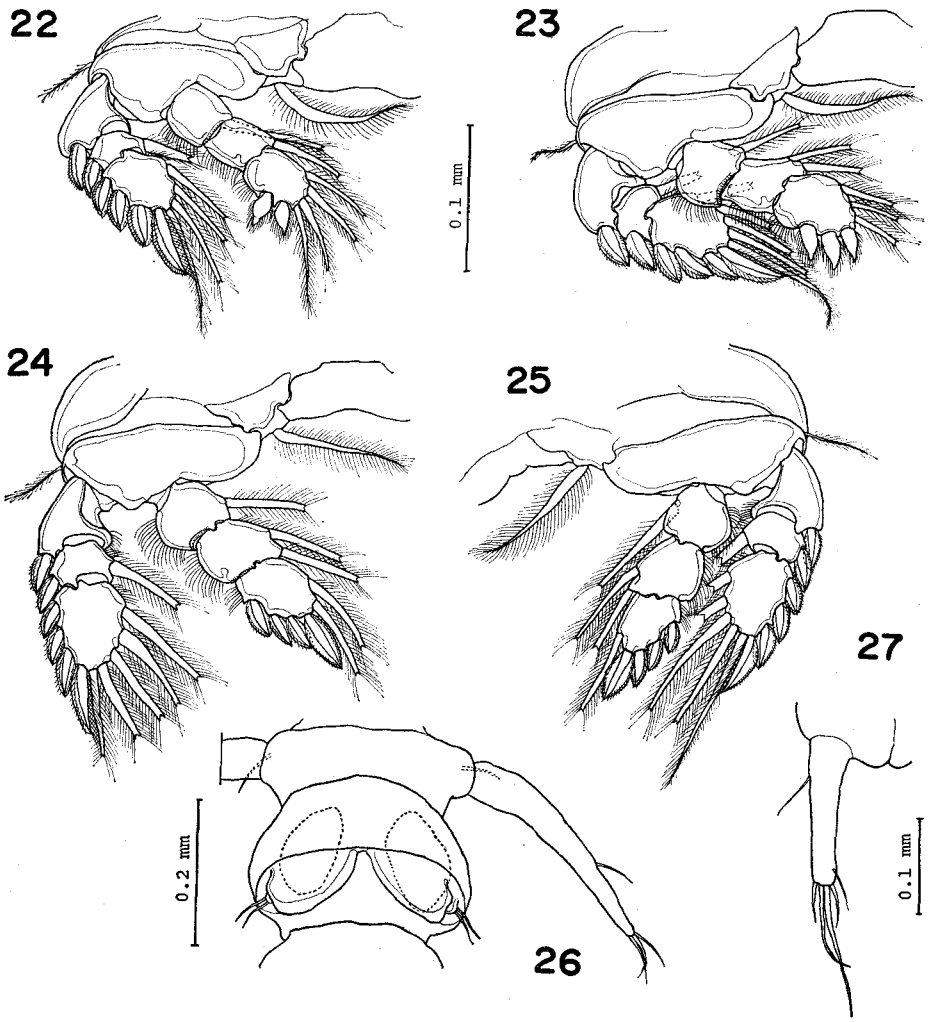
	Body length (Bl., mm)	Length of 5th leg (mm)	Length of caudal ramus (mm)
Type A	mean: 1.55	0.33 (ratio to Bl. 0.21)	0.18 (ratio to Bl. 0.12)
(32 specimens)	range: 1.30–1.80	0.18–0.50	0.13–0.28
Type B	mean: 1.96	0.75 (ratio to Bl. 0.38)	0.58 (ratio to Bl. 0.30)
(6 specimens)	range: 1.73–2.12	0.70–0.80	0.50–0.70



Figs. 13–21. *Neanthessius renicolis* gen. et sp. nov., male. 13. total view, dorsal. 14. first antenna, ventral view. 15. second antenna, inner view. 16. labrum, mandible, paragnath, and first maxilla in situ, ventral view. 17. mandible and first maxilla, ventral view. 18. first and second maxillae in situ, ventral view. 19. terminal process of second maxilla, ventral view, magnified as in Fig. 18. 20. maxilliped, ventral view. 21. the same, posterior view at the same magnification.

In smaller type A (Fig. 13) the fifth leg and the caudal ramus are shorter than type B which bears a resemblance to the female in having somewhat elongate urosome and longer fifth legs and caudal rami. As the occurrence rate of type A is about five times as high as that of type B, the former type may safely be regarded as the usual male in this species, while the latter type might represent some intersexual state, though the individuals of type B are provided with the genital segment containing fully developed spermatophores and therefore seem to function actually as the male.

Description of type A: Body (Fig. 13) stumpy, constructed as in female except



Figs. 22–27. *Neanthessius renicolis* gen. et sp. nov., male. 22. first leg, ventral view. 23. second leg, ventral view. 24. third leg, ventral view. 25. fourth leg, ventral view. 26. fifth leg and genital segment in situ, ventral view. 27. caudal ramus in situ, dorsal view. Figs. 23–25 magnified as in Fig. 22.

for 6-segmented urosome. Proportional lengths and widths of cephalosome and succeeding 9 segments approximately as follows:

	Cephalosome	Metasome			Urosome						
		1	2	3	1	2	3	4	5	6	total
Length	23.6	6.3	5.9	7.1	7.1	9.1	7.7	9.2	8.1	15.9	100
Width	1	0.88	0.73	0.58	0.61	0.60	0.54	0.54	0.48	0.43	

First antenna (Fig. 14), second antenna (Fig. 15) and mouth parts (Figs. 16–19) as in female. Maxilliped (Figs. 20 & 21) highly modified from that of female into a strong, 4-segmented, prehensile appendage. First segment short, but broad, with a lateral area covered with spinules. Second segment very massive, almost as long as wide; with the ventral side roughly triangular in outline and with the broad basal margin slightly depressed at the middle; armed with numerous thick spinules arranged into 3 longitudinal bands on the inner half of the ventral side and 2 additional spinules respectively inserted isolately between these bands. Third segment very small, with 2 distal setules. Terminal segment forming a stout naked claw curved moderately, about 4.5 times as long as wide and 2/3 as long as the second segment.

Anterior four pairs of legs (Figs. 22–25) structured as in female. Setal formulae of these legs as in female, but spines on third endopodite segment of first two pairs uniquely fringed with fine hairs on both sides instead of being serrated as in succeeding two pairs in male or in all pairs in female. Fifth leg (Fig. 26) ca. 330 μ long on an average, setation as in female. Caudal ramus (Fig. 27) ca. 180 μ long on an average, rod-like, setation as in female.

Remarks: The present new genus *Neanthessius* is undoubtedly closely related to the genus *Anthessius* as seen from the morphology of appendages of *N. renicolis* described above, but the mode of life differs considerably between these genera; the former is completely parasitic, while the latter is commensal. This difference is reflected in the grade of deformation of the body and also in egg size with relation to the nuturitional condition. *N. renicolis* yields much larger, ca. 130 $\times$ 180 μ, eggs containing a significant amount of yolk and its nauplii develop to the first copepodids on only the yolk, while eggs of *Anthessius* spp. are only 40–110 μ in diameter as measured on the figures given in the published papers and it is suggested that feeding may be indispensable to the nauplii developed from such smaller eggs.

Anthessius fitchi Illg, which is so far the largest species of the genus, resembles somewhat *N. renicolis* in having more or less deformed body and longer fifth legs and caudal rami. However, structures of all the appendages of *A. fitchi* are quite consistent with those of other members of the genus as emphasized by Illg, in addition eggs of this species are only 70–80 μ in diameter as measured on the text-figure in the original paper (Illg 1960, fig. 72). Variations in length of the fifth leg and the caudal ramus seem to belong rather to usual trend within the family Lichomolgidae, including myicolids, of an old definition.

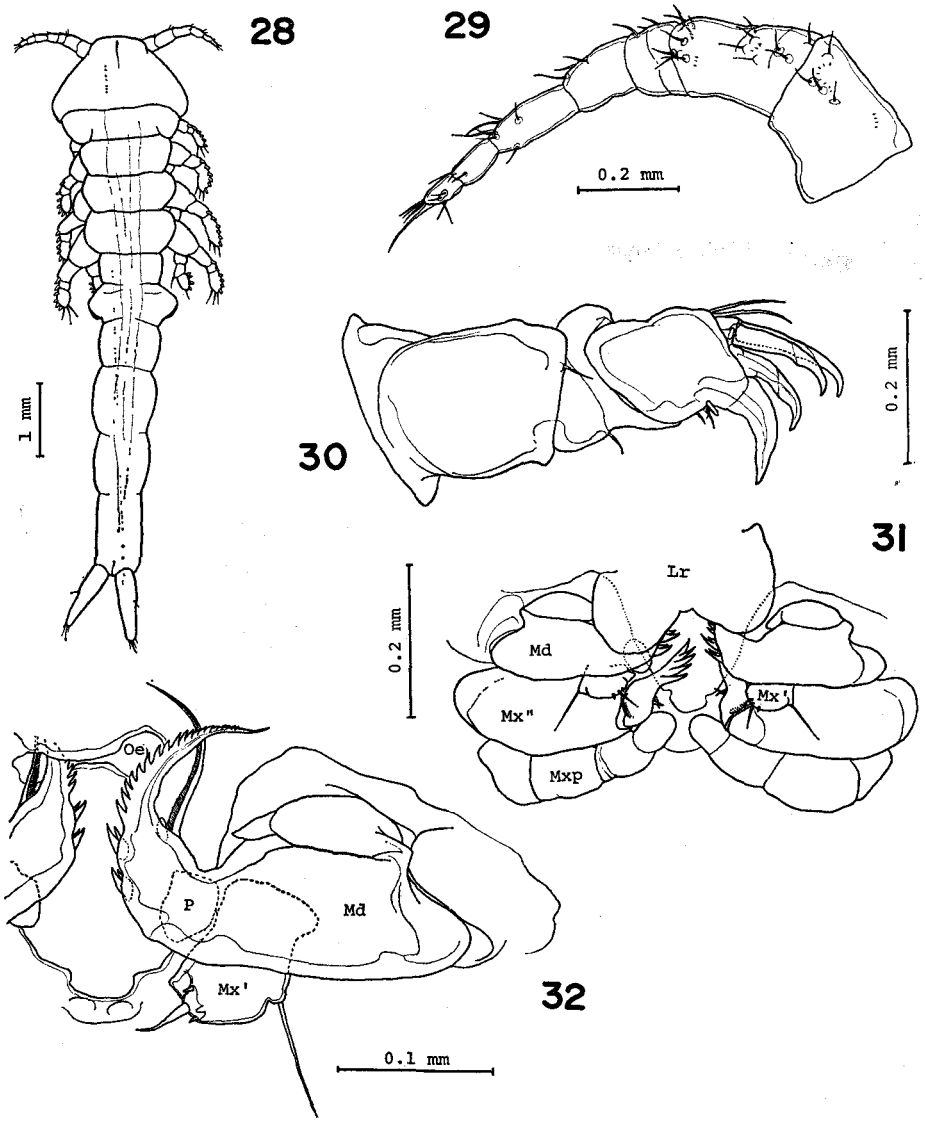
In the morphology of appendages, *N. renicolis* differs distinctly from any species of *Anthessius* in having far massive maxilliped and unique armature with spines on

the third endopodite segment of the first two pairs of legs in the male and in showing the setal formula II-4 of the third endopodite segment of the first leg in both sexes.

Panaietis yamagutii n. sp.

(Figs. 28–51)

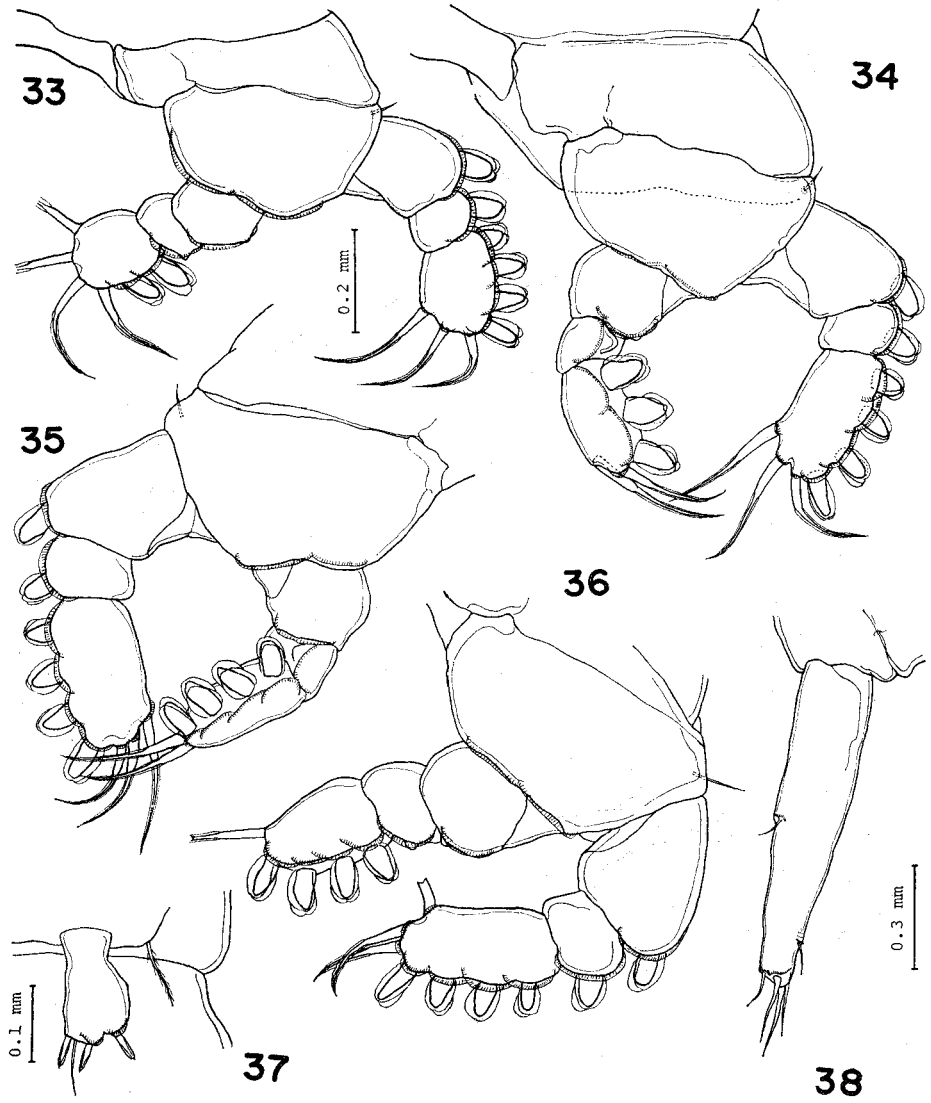
Panaietis incamerata; Yamaguti, 1936, pp. 116–118, pls. 9 & 10.



Fgs. 28–32. *Panaietis yamagutii* n. sp., female. 28. total view, dorsal. 29. first antenna, ventral view. 30. second antenna, ventral view. 31. mouth parts in situ, ventral view. 32. mandible and first maxilla in situ, lashes of left mandible moved to show the site of oesophagus, ventral view.

Material: One ovigerous female and 8 males from buccal cavity of *Batillus cornutus* (Lightfoot) collected at Sugari on May 14, 1972; 13 females, 5 males and 3 juveniles from the same body part of the same gastropod collected at Kiinagashima in August-November, 1975.

Female: Length excluding caudal ramus 4.8–7.5 mm and 5.6 mm on an average; width 1.2–1.8 mm and 1.3 mm on an average of 14 speciments. Body (Fig. 28) closely resembles *P. incamerata* in outline, but fifth leg much shorter; habitus strong, translucent; eyes burried under hypodermis at the anteo-ventral side of head red and



Figs. 33–38. *Panaietis yamagutii* n. sp., female. 33. first leg, ventral view. 34. second leg, ventral view. 35. third leg, ventral view. 36. fourth leg, ventral view. 37. fifth leg in situ, ventral view. 38. caudal ramus in situ, dorsal view. Figs. 34–36 magnified as in Fig. 33.

intestinal contents orange.

First antenna (Fig. 29) 7-segmented; formula of spinules on segments 4, 15, 3, 3, 7, 3 and 8; aesthete indistinguishable. Second antenna (Fig. 30) 3-segmented; first segment as long as combined length of distal two segments, with a distal setule on the anterior side; second segment with an inner setule at the middle; third segment bearing a stout claw at the inner-distal angle, 3 thinner articulated terminal claws, 2 feeble setae at the outer-distal corner and 4 feeble inner setules at the middle. Mandible (Fig. 32) structured as in *P. incamerata* or *P. haliotis*; in addition to a strong terminal lash serrated with ca. 19 teeth on the median side and a slender subterminal lash fringed by fine membraneous pectination on the same side, 2 isolated stout bicuspidate teeth found on the median base of terminal lash and a small naked process between the bases of two lashes. Paragnath (Fig. 32) naked. First maxilla (Fig. 32) somewhat flattened antero-posteriorly, about 1.5 times as long as wide, with a long, feeble outer seta near the middle and a seta and 2 spinules at the end. Second maxilla (Fig. 31) 2-segmented; first segment about 2 times as long as wide, unarmed; second segment forming a claw-like process armed with 4 stout teeth on the median margin in the distal half and 2 setules at the proximal one third on the same margin. Maxilliped (Fig. 31) digitiform, obscurely 4-segmented, unarmed.

Anterior four pairs of legs (Figs. 33–36) larger posteriorly and each carrying 3-segmented rami. Setal formulae of these legs as follows (number of spines in Roman and that of setae in Arabic numerals):

	Exopodite	Endopodite
Leg 1	I–0; I–0; IV–3	0–0; 0–0; II–4
Leg 2	I–0; I–0; IV–3	0–0; 0–0; III–2
Leg 3	I–0; I–0; IV–3	0–0; 0–0; IV–2
Leg 4	I–0; I–0; IV–3	0–0; 0–0; IV–1

Abnormal setation of third exopodite segment of first leg, V-3 in right and III-3 in left, observed in a female. Fifth leg (Fig. 37) arising from a common ventral bulge of somite, furnished with a plumose seta at each lateral corner; small, about 150 μ long, broader distally, about 1.7 times as long as wide, and armed with 3 spines and a seta on the distal margin. Caudal ramus (Fig. 38) ca. 900 μ long, about 4.5 times as long as wide, bearing an outer seta at the middle, an inner seta near the end and 4 terminal setae.

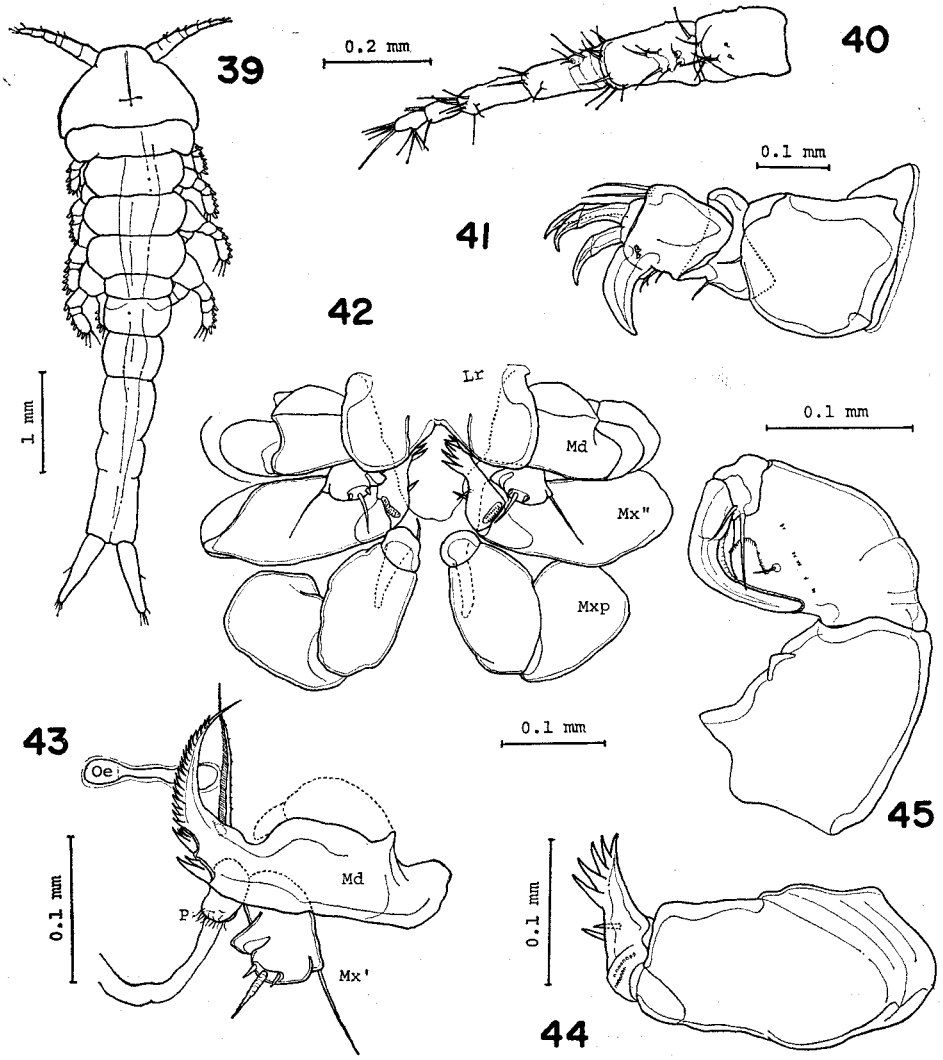
Male: Length excluding caudal ramus 2.9–6.0 mm and 4.5 mm on an average; width 0.8–1.4 mm and 1.2 mm on an average of 10 specimens.

Appendages almost as in female except for maxilliped. First antenna (Fig. 40) armed with spinules as 4, 15, 5, 3, 7, 3 and 8 on 7 segments, aesthete indistinguishable either. Paragnath (Fig. 43) hairy on the distal margin. Maxilliped (Fig. 45) structured differently from that of female, 4-segmented; first segment stout, as long as second segment, with a conical projection on the inner margin about the middle; second segment bearing on the inner surface a transverse row of denticles, about 10 spinules sparsely arranged in a longitudinal row and a seta; fourth segment forming a stout claw, ending bluntly, curved strongly at the middle, and rimmed with a

narrow membrane along the whole concave side.

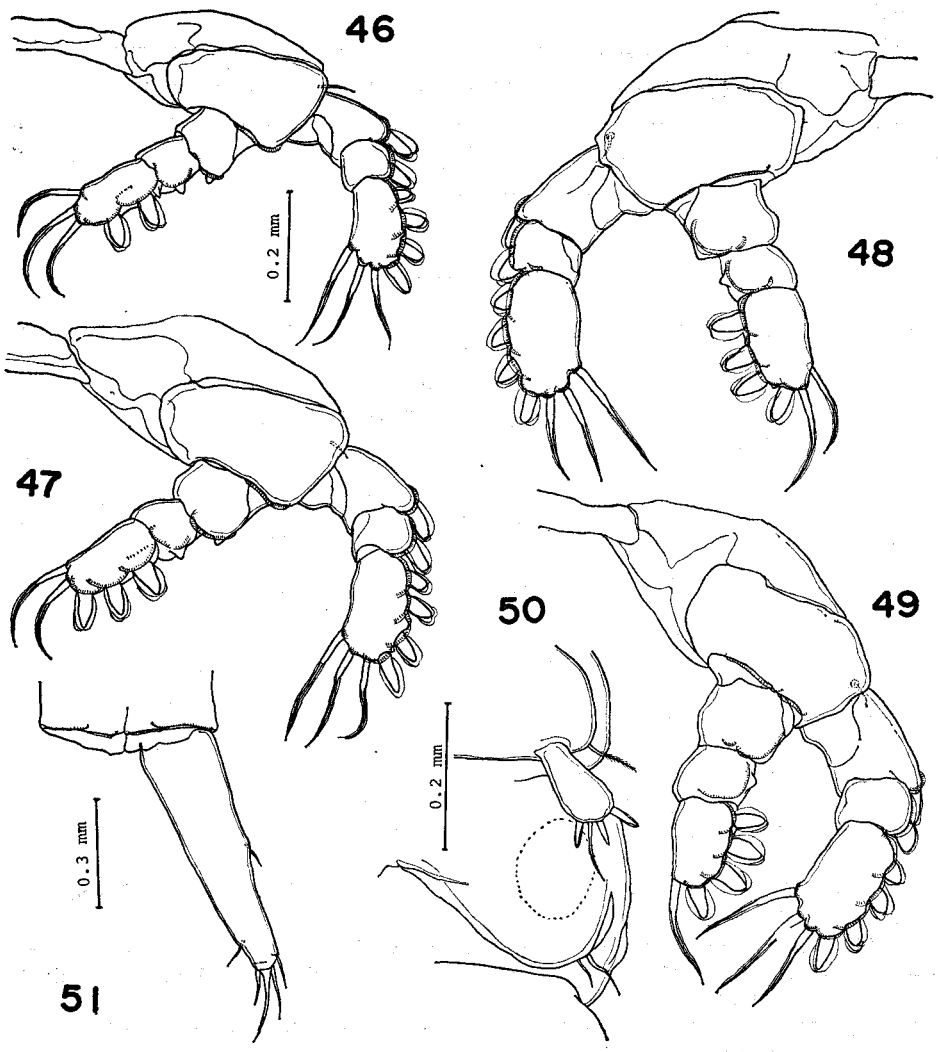
Anterior four pairs of legs (Figs. 46–49) the same as in female in both segmentation and armature, except the setation of third endopodite segment of first leg II-3 instead of II-4 as seen in female. Fifth leg (Fig. 50) ca. 125 μ long; setation as in female. Caudal ramus (Fig. 51) ca. 700 μ long; setation as in female.

Remarks: This new species is clearly distinguishable from the closely related species, *P. incamerata* Stebbing, by having much shorter fifth legs that are arising from the postero-ventral surface of the somite and ca. 150 μ long in the female and 125 μ in the male; in *P. incamerata* they are arising from the lateral side of the somite



Figs. 39–45. *Panaietis yamagutii* n. sp., male. 39. total view, dorsal. 40. first antenna, ventral view. 41. second antenna, ventral view. 42. mouth parts in situ, ventral view. 43. mandible, paragnath and first maxilla in situ, lashes of mandible moved to show the site of oesophagus, ventral view. 44. second maxilla, ventral view. 45. maxilliped, dorsal view.

and ca. 900 μ and 650 μ respectively in female and male. In addition to this clear difference, *P. yamagutii* n. sp. differs from *P. incamerata* in the following points: the strongest terminal claw of the second antenna is thicker and less curved in the former than in the latter; labrum is not so deeply indented on the posterior margin in the former as in the latter; the second maxilla bears 4 teeth on the terminal process in the former, but 6–7 teeth in the latter; the terminal claw of male maxilliped in the former is thicker and more strongly curved at the middle than in the latter and ending in a blunt tip; rami of all biramous legs are stumpier in the former than in the latter, ca. 700 μ and 500 μ long respectively in exopodite and endopodite of the



Figs. 46–51. *Panaietis yamagutii* n. sp., male. 46. first leg, ventral view. 47. second leg, ventral view. 48. third leg, ventral view. 49. fourth leg, ventral view. 50. fifth leg and genital segment in situ, ventral view. 51. caudal ramus in situ, ventral view. Figs. 47–49 magnified as in Fig. 46.

fourth leg in the former, whereas ca. 1000 μ and 800 μ in the latter; the first leg shows a sexual dimorphism in setation of the third endopodite segment of the first leg, II-4 in the female and II-3 in the male in the former, but II-3 in both sexes in the latter; spines carried by all biramous legs are ending bluntly and thicker in the former than in the latter; caudal rami are somewhat stumpier in the former than in the latter, about 1/8 as long as the total length and about 4.5 times as long as wide in the former, whereas about 1/6 and 6–7 times in the latter. All comparisoms given above were made against the values of *P. incamerata,* described in Monod's paper (1934) or measured on the text-figures in the same paper.

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