TWO SEMI-PARASITIC COPEPODS OF MARINE INVERTEBRATES FROM JAPAN (CYCLOPOIDA: LICHOMOLGIDAE) [1,2]

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With Text-figures 1–42

Two commensal copepods belonging to the family Lichomolgidae were obtained respectively from a cuttlefish, *Sepia esculenta*, and a sabellid polychaete, *Sabellastarte indica*, in the vicinity of the Seto Marine Biological Laboratory in 1971. The commensal of *Sepia*, representing a new species of the genus *Lichomolgus*, is described here under the name of *L. sepiae*. The new species is nearly allied to *L. longicauda* (Claus, 1860) which has been frequently recorded as associating with *Sepia officinalis* and *S. fillioux*i in the Mediterranean and the Atlantic (see Stock, 1956, Humes and Stock, 1973), and these two may probably be regarded as the sibling species, the latter distributed in the Mediterranean or the Atlantic and the former in the Pacific.

The other species here dealt with is identified with *Nasomolgus firmus* Humes and Ho, 1967, originally recorded from *Sabellastarte magnica* in Madagascar. The specimens obtained from *S. indica* in Japan is almost in complete agreement with the original description, except a few minor variations. To verify the present identification, the figures of Japanese specimens are given in this paper together with some measurements.

Lichomolgus sepiae n. sp.

(Figs. 1–19)

Material: Two ovigerous females and 4 males taken from gills of *Sepia esculenta* Hoyle, caught in Tanabe Bay on the Pacific coast of Middle Japan on April 17, 1971. Holotype (female) and paratypes (1 female and 4 males) are depodited at the Seto Marine Biological Laboratory.

Female: Body (Fig. 1) somewhat slender, 1.28 mm long, excluding caudal ramus, 0.58 mm wide; carapace 0.51 mm long on the median line. Female paratype 1.27 mm long, 0.54 mm wide, with carapace 0.48 mm long. First pedigerous

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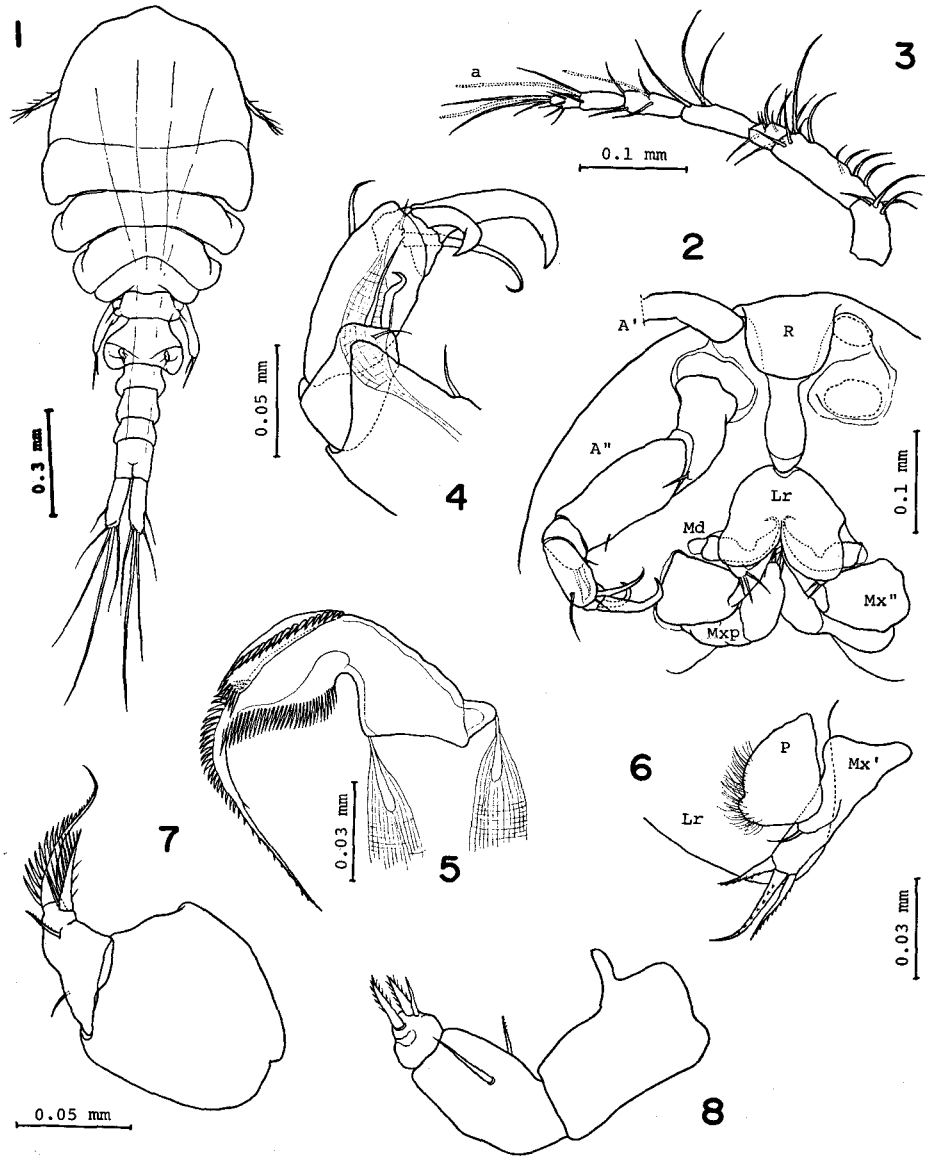
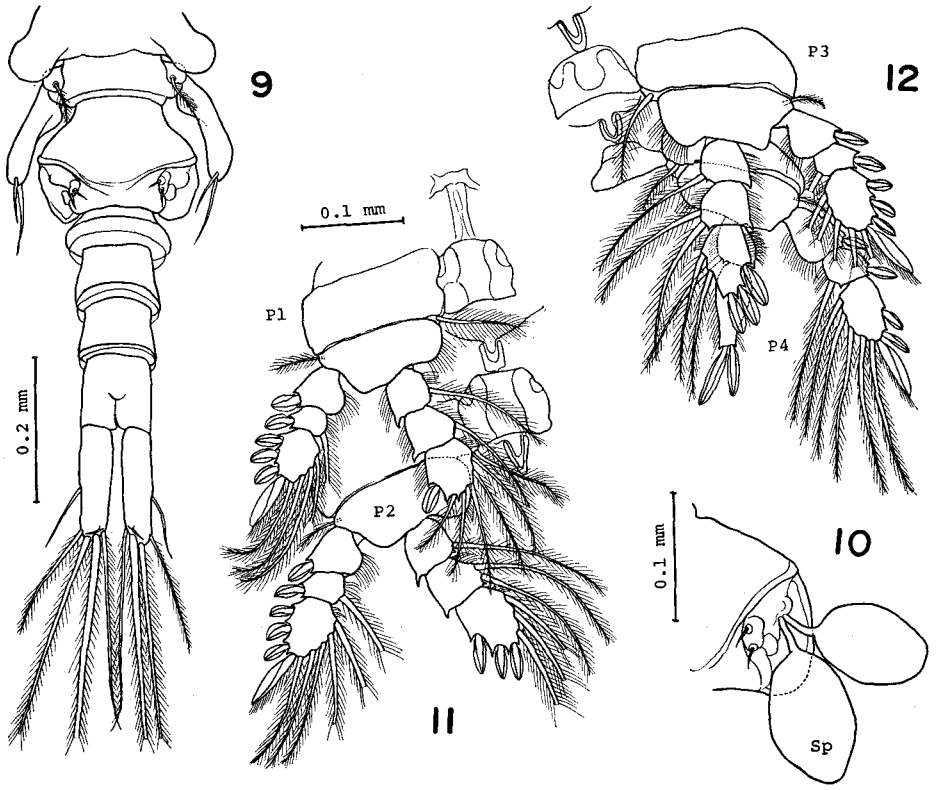
segment distinct from carapace through a dorsal suture. Genital segment distinct from succeeding segment. Translucent; eyes with silvery luster.

First antenna (Fig. 3) 7-segmented; formula of spinules on segments as 4, 11,



Figs. 1–8. *Lichomolgus sepiae* n. sp., female. 1. body, dorsal view. 2. cephalosome, ventral view. 3. first antenna, ventral view. 4. distal portion of second antenna, inner view. 5. mandible, dorsal view. 6. paragnath and first maxilla in situ, ventral view. 7. second maxilla, inner view. 8. maxilliped, inner view, magnification as in fig. 7. Abbreviations: R, rostrum; A′, first antenna; A″, second antenna; a, aesthete; Lr, labrum; Md, mandible; P, paragnath; Mx′, first maxilla; Mx″, second maxilla; Mxp, maxilliped; Pl–4, first-fourth leg.

6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Second antenna (Figs. 2 & 4) 4-segmented; first two segments long, each with a seta; third segment short, with 3 setae, inclusive of a feeble hook-like one; terminal segment intermediate in length, with 2 unequal stout claws and 3 setae. Mandible (Fig. 5) structured as in *L. longicauda* and *Doridicola agilis*; in addition to having a squamiform process fringed by ca. 23 spinules, armed with pectination consisting of ca. 31 setae on the concave side in the middle and with terminal lash serrated with ca. 34 teeth on the convex side, but spineless on the concave side. Paragnath (Fig. 6) is a small lobe



Figs. 9–12. *Lichomolgus sepiae* n. sp., female. 9. urosome, dorsal view. 10. genital segment with spermatophores, dorsal view. 11. first and second legs in situ, ventral view. 12. third and fourth legs in situ, ventral view, magnification as in fig. 11.

hairy on the median margin. First maxilla (Fig. 6) elongate, bearing a seta near the middle and 3 finely denticulate terminal spines. Second maxilla (Fig. 7) 2-segmented; first segment stout, nearly as long as wide; second segment tapering distally, ending in 2, long and short, lash-like spines and bearing 2 short, proximo-distally arranged setae. Longer distal spine fringed on the median side with a row of ca. 19 spinules diminishing the size distally, while shorter one about half as long as the longer with ca. 10 tiny marginal spinules on the median side and 2 or 3 hairs

on the other side. Maxilliped (Fig. 8) 3-segmented; first segment unarmed; second segment slightly shorter than the first, with 2 setae; third segment very short, wider than long, tipped by 2 stout spines spinulated on both sides and a feeble seta.

First four pairs of legs (Figs. 11 & 12) carrying 3-segmented rami except for fourth having 2-segmented endopodite. 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–1; I–4	0–1; 0–1; I–5
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; III–2
Leg 4	I–0; I–1; II, I–5	0–1; II–0

Fifth leg (Fig. 9) 2-segmented; basal segment much shorter, fused with pleuron of somite, and tipped by a plumose seta on the dorsal side; second segment ca. 150 μ long, as long as or slightly longer than genital segment, and with a ventro-proximal bulge and 2 apical setae. Sixth leg may be represented by a small knob situated near gonopore and bearing 2 tiny setae (Fig. 10). Caudal ramus (Fig. 10) long, ca. 160 μ in length and nearly 3.5 times as long as wide.

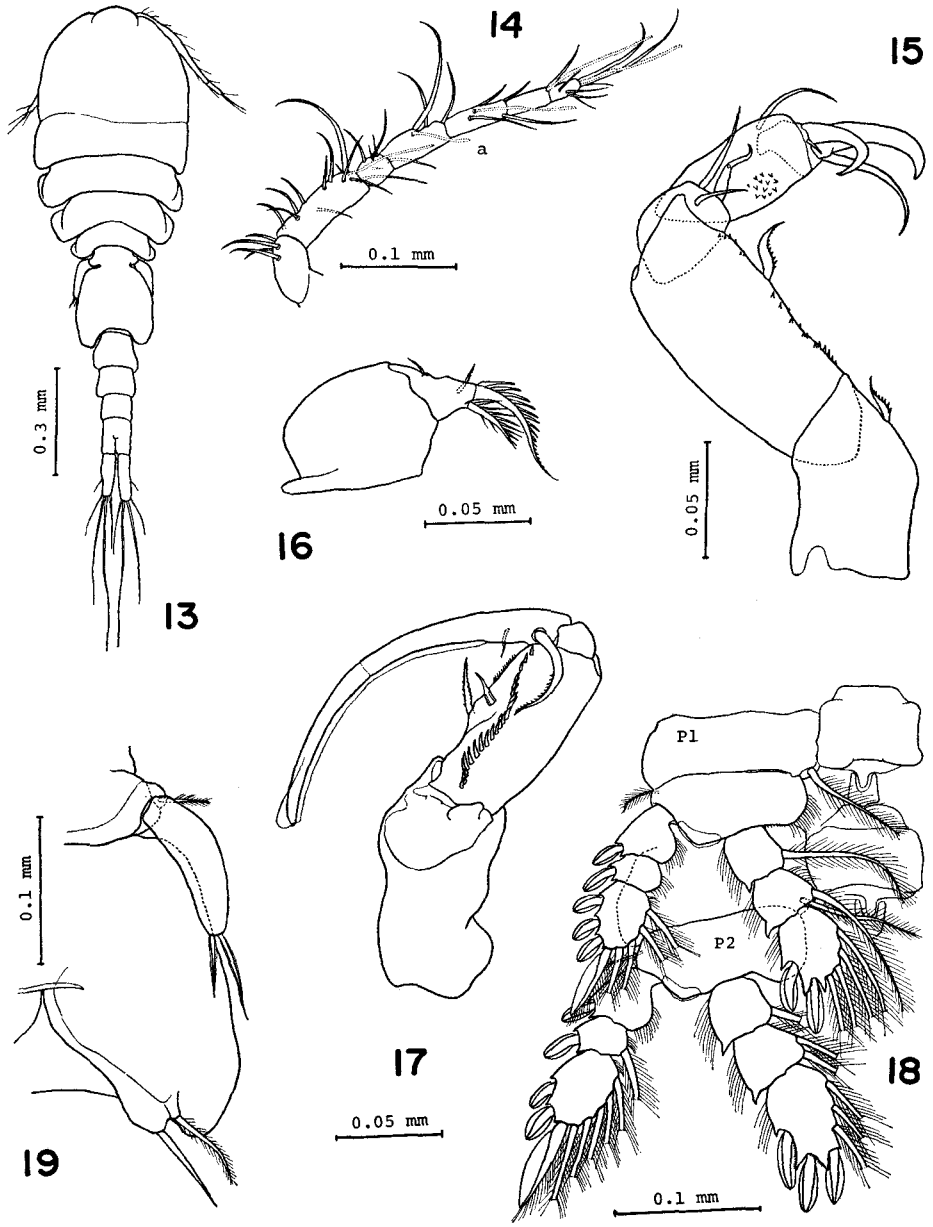
Male: 4 specimens. Body (Fig. 13) slenderer than female. Length excluding caudal ramus 1.19 mm, with 0.38 mm, and carapace length 0.42 mm on an average.

First antenna (Fig. 14) carrying 4, 12+1 aesthete, 6, 3+1 aesthete, 4+1 aesthete, 1+1 aesthete, and 7+1 aesthete, from lst to 7th segment. Second antenna (Fig. 15) slightly different from that of female in spinulation; 2 spines respectively on first and second segments broader and irregularly spinulate on an edge; second and terminal segments more or less spinulose. Labrum, mandible, paragnath and two maxillae similar to those of female. Maxilliped (Fig. 17) 4-segmented; first two segments long, third very small, fouth forming an elongate claw. Second segment armed with a row of ca. 21 short spines, another row of fine spinules and 2 isolated spines on the inner margin; the longer of the spines mentioned last with biserial spinules. Terminal segment falciform, rimmed with a narrow membrane along the whole concave side, carrying a stout basal seta fringed by uniserial spinules and a tiny subbasal simple spinules.

First four pairs of legs as in female in both segmentation and armature, except setation on third endopodite segment of first leg II–4 instead of I–5 in female (Fig. 18). Abnormal setation of third exopodite segment of right third leg, II, I–5, instead of III, I–5 in normal ones, observed in one male. Free segment of fifth leg (Fig. 19) ca. 100 μ long, without basal bulge, and ending in 2 terminal setae with narrow rim on both edges. Caudal ramus ca. 130 μ long.

Remarks: *Lichomolgus sepiae* n. sp. is clearly distinguishable from the closely related species, *L. longicauda*, by having a narrower carapace. The ratio of carapace length to width is 1: 1.13 in the female and 1: 0.90 in the male in the former, whereas 1: 1.22 in the female in the latter. The new species has the fifth leg and caudal ramus longer than those of *longicauda*, though the two species are almost

equal in the body length. The free segment of the fifth leg is about 150 μ long in the female and 100 μ in the male in the former, while about 83 μ and 57 μ in the latter (all the values referring to *L. longicauda* were measured on Stock's (1956)



Figs. 13–19. *Lichomolgus sepiae* n. sp., male. 13. body, dorsal view. 14. first antenna, ventral view. 15. second antenna, inner view. 16. second maxilla, lateral view. 17. maxilliped, inner view. 18. first and second legs in situ, ventral view. 19. fifth leg and genital segment in situ, ventral view.

Figs. 1, 2, 11, and 12). Besides these clear differences, *L. sepiae* slightly differs from *L. longicauda* in the armature on the mandible, second maxilla and maxilliped.

As mentioned by Stock (1956), *L. longicauda* agrees with *Doridicola agilis* Leydig, 1853, in having rather wide basal portion of the mandibular lappet, fairly long fifth leg, and female maxilliped armed with two powerful spines. *L. sepiae* resembles *D. agilis* also in these points. In the shape of the mandible, *L. longicauda* and *sepiae* deviate from the other members of *Lichomolgus* (in strict sense, Humes & Stock, 1973); especially, *L. sepiae* is rather similar to *D. agilis* than to other *Lichomolgus spp.* in having a scaly area on the convex side of the mandibular base.

As regards the generic designation of *D. agilis* described from a nudibranch mollusc *Doris lugubris* at Trieste, there has been a certain controversy, some authors placing it in *Lichomolgus*, while others in *Doridicola* (see Humes & Stock, 1973). Lately, Humes and Stock (1973), retaining the genus *Doridicola*, included 14 species in this genus in addition to the type species, *D. agilis*. Even in this genus, *D. agilis* is peculiar in having slenderer mandible than in other species and in showing the setal formula of the third exopodite segment of the fourth leg II, I–5 (Sars, 1917, Plate XC) instead of III, I–5 in the other species. On the other hand, it agrees well with the majority of species of *Lichomolgus* in the constitution of setae.

The sexual dimorphism in the first leg has been regarded as one of the criteria distinguishing *Doridicola* from *Lichomolgus*. Although *L. inflatus* (Tanaka, 1961, Plate 32, Fig. 3), which has a typical lichomolgid mandible, and *L. sepiae* show a distinct dimorphism in this leg, *L. longicauda* is uncertain of this point as far as deduced from the published works. From these, it can hardly be justified to regard the sexual dimorphism in the first leg as one of the generic criteria.

As noticed above, the three species, *L. longicauda, L. sepiae,* and *D. agilis*, are closely related to one another and seemingly located intermediately between *Doridicola* and *Lichomolgus*.

Nasomolgus firmus Humes and Ho, 1967

(Figs. 20–42)

Nasomolgus firmus Humes and Ho, 1967, pp. 386–390, figs. 60–86.

Material: A number of specimens, including ovigerous females and males, taken from *Sabellastarte indica* (Savigny), at Seto, on April 16, 1971. They are aggregated on the inner surface of the nest tube of the worm.

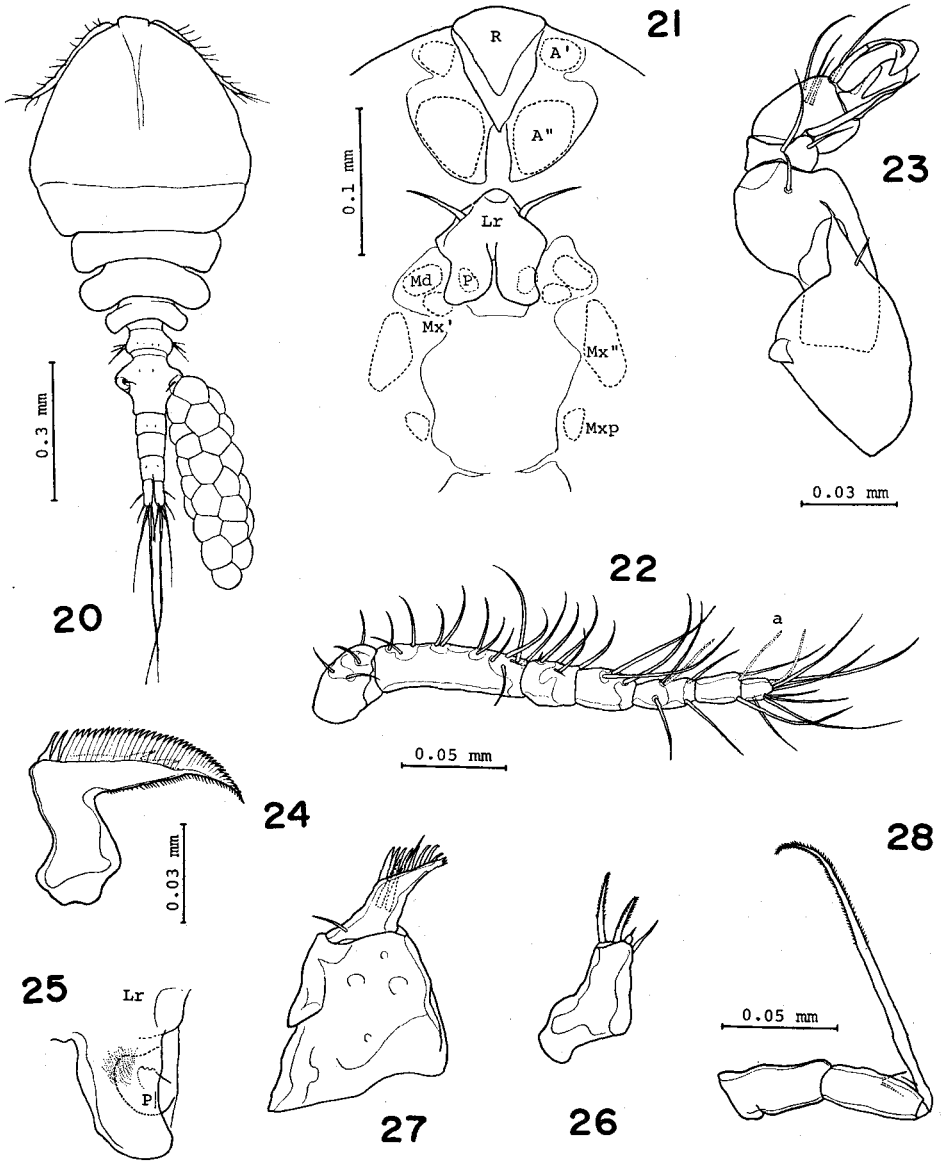
Female: (Figs. 20–33). Mean body length excluding caudal ramus 0.90 mm, mean width 0.41 mm, egg sac 0.56 mm × 0.16 mm, (based on 9 specimens).

Body translucent, with silvery red eyes, intestinal contents brownish.

Male: (Figs. 34–42). Mean length excluding caudal ramus 0.66 mm, mean width 0.22 mm, (based on 5 specimens).

Remarks: The specimens obtained from *S. indica* in Japan are in accord with the original description of the type specimens found on *S. magnifica* in Madagascar, but with some minor variations. The caudal ramus is slightly longer in Japanese

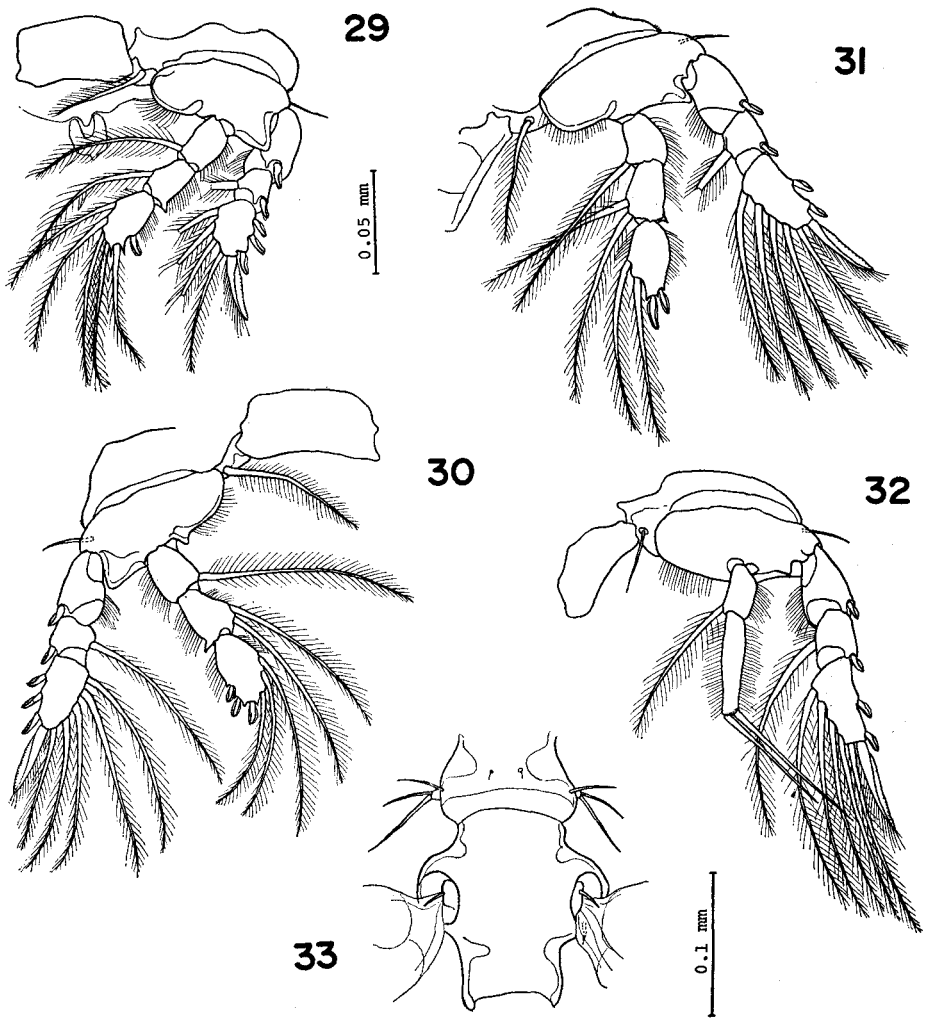
specimens than in the type, about 53 μ long in the female and about 33 μ in the male in the former, whereas 43 μ and 27μ in the latter. The smallest apical seta of the first maxilla (Figs. 26 & 40) has a thickened base in both sexes, this feature is



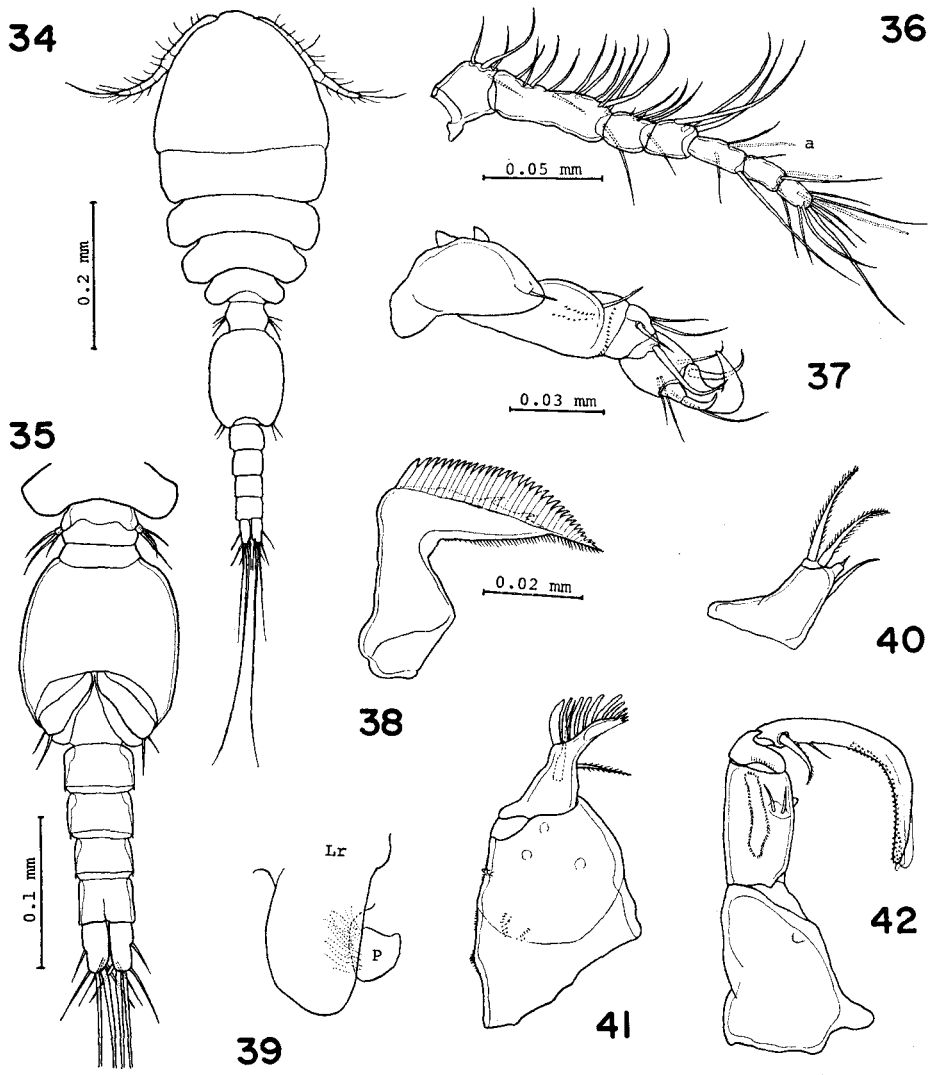
Figs. 20–28. *Nasomolgus firmus* Humes and Ho, female. 20. body with egg sac, dorsal view. 21. antennal and oral area, ventral view. 22. first antenna, ventral view. 23. second antenna, inner view. 24. mandible, ventral view. 25. labrum and paragnath in situ, ventral view, magnification as in fig. 24. 26. first maxilla, lateral view, magnification as in fig. 24. 27. second maxilla, lateral view, magnification as in fig. 24. 28. maxilliped, lateral view.

not shared with the type specimens (Fig. 70 by Humes & Ho). The claw-like second segment of the second maxilla bears a row of 8 teeth feebler but longer than in the type specimens and ends in a trifurcate apex (Figs. 27 & 41). In the type, the second segment is acuminated apically and carries 7 stout teeth (Figs. 71 & 82 by Humes & Ho).

The present record of *N. firmus* is the first from the Pacific and *Sabellastarte indica* (Savigny) is a new host.



Figs. 29–33. *Nasomolgus firmus* Humes and Ho, female. 29. first leg, ventral view. 30. second leg, ventral view, magnification as in fig. 29. 31. third leg, ventral view, magnification as in fig. 29. 32. fourth leg, ventral view, magnification as in fig. 29. 33. fifth leg and genital segment, dorsal view.



Figs. 34–42. *Nasomolgus firmus* Humes and Ho, male. 34. body, dorsal view. 35. urosome, ventral view. 36. first antenna, ventral view. 37. second antenna, inner view. 38. mandible, ventral view. 39. labrum and paragnath in situ, ventral view, magnification as in fig. 38. 40. first maxilla, ventral view, magnification as in fig. 38. 41. second maxilla, lateral view, magnification as in fig. 37. 42. maxilliped, inner view, magnification as in fig. 37.

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LITERATURE

Bresciani, J., 1970. A new *Cholydia* from the mantle cavity of a cephalopod (Crustacea, Harpacticoida, Tisbidae). Steenstrupia, **1** (2): 11–16.

Claus, C., 1975. Neue Beitrage zur Kenntnis parasitischer Copepoden, nebst Bemerkungen über das System derselben. Zeitschrift für Wissenschaftliche Zoologie, **25** (4): 327–360, Pls. 22–24.

Della Valle, A., 1880. Sui Coriceidi parassiti, e sul'anatomia del gen. *Lichomolgus*. Mittheilungen aus der Zoologischen Station zu Neapel, **2**: 83–106, Pls. 5 & 6.

Graeffe, E., 1900. Uebersicht der Fauna des Golfes von Triest nebst Notizen über Vorkommen, Lebensweise aus dem Zoologischen Instituten der Universität Wien und der Zoologischen Station in Triest, **13** (1): 33–80.

Hancock, A. and A. M. Norman, 1863. On Splanchnotrophus, an undescribed genus of Crustacea, parasitic in nudibranchiate Mollusca. Transactions of the Linnean Society of London, **24** (2): 49–60, Pls. 15 & 16.

Humes, A. G. and J.-S. Ho, 1967. New cyclopoid copepods associated with polychaete annelids in Madagascar. Bulletin of the Museum of Comparative Zoology, **135** (7): 377–413.

Humes, A. G. and J. H. Stock, 1973. A revision of the family Lichomolgidae Kossmann, 1877, cyclopoid copepods mainly associated with marine invertebrates. Smithsonian Contributions to Zoology, (127): 1–368.

Leydig, Er., 1853. Zoologische Notizen 1. Neuer Schmarotzerkrebse auf einem Weichthier. Zeitschrift für Wissenschaftliche Zoologie, **4** (3/4): 377–382, Pl. 14.

Monod, T. et R.-Th. Dollfus, 1932. Les copépodes parasites des mollusques. Annales de Parasitologie Humainae et Comparée, **10** (2): 129–204.

Pesta, O., 1909. Beiträge zur Kennthnis parasitischer Copepoden. Denkschriften der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Wien, **84**: 257–267, Pls. 1–3.

Sars, G. O., 1917. An account of the Crustacea of Norway, with short descriptions and figures of all the species. VI. Copepoda, Cyclopoida, pp. 1–225, Pls. I–CXVIII. Bergen Museum, Bergen.

Sewell, R. B. S., 1949. The littoral and semiparasitic Cyclopoida, the Monstrilloida and Notodelphyoida. John Murray Expedition 1933–34, Science Reports, **9** (2): 17–199.

Stock, J. H., 1956. *Lichomolgus longicauda* (Claus, 1860), copepod parasite of *Sepia*, in the North Sea. Beaufortia, **5** (53): 117–120.

Stock, J. H. and G. Kleeton, 1963. Copépodes associés aux invertébrés des côtes du Roussillon. 2. Lichomolgidae ecto-associés d'octocoralliaires. Vie et Miliue, **14** (2): 245–261.

Tanaka, O., 1961. On copepods associated with marine Pelecypoda in Kyushu. Journal of the Faculty of Agriculture, Kyushu University, **11** (3): 249–273, Pls. 22–37.

Wierzejski, A., 1877. Ueber Schmarotzerkrebse von Cephalopoden. Zeitschrift für Wissenschaftliche Zoologie, **29**: 562–582, Pls. 32–34.