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Two Poecilostomatoid Copepods, *Anthessius graciliunguis* n. sp. and *Modiolicola bifidus* TANAKA, 1961 from the Blue Mussel, *Mytilus edulis galloprovincialis* LAMARCK, in Japan

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Anthessius graciliunguis n. sp. is described based on the adult female recovered in the mantle cavity of *Mytilus edulis galloprovincialis* LAMARCK taken from the Himeji Harbor, Japan. This is the fifth poecilostomatoid copepod known from the blue mussel in Japanese waters. *Modiolicola bifidus* TANAKA is redescribed based on the newly collected specimens from *M. edulis galloprovincialis* in Himeji Harbor and Ehime, Japan. The mussel is a new host to *M. bifidus*.

Introduction

Recently, in his paper dealing with the origin and dispersal of *Mytilus edulis* in Japan, HO (1980) reported discovery of only a poecilostomatoid copepod, namely, *Pseudomyicola spinosus* (RAFFAELE and MONTICELLI, 1885) from the Japanese blue mussel taken from both the Sea of Japan (Sado island and Ishikawa) and Pacific coasts (Wakayama and Tokyo Bay). He suggested that discovery of *Modiolicola insignis* AURIVILLIUS (native to European blue mussel) and/or *M. gracilis* WILSON (native to the blue mussel of the Pacific coast of North America) in Japan would reveal the origin of Japanese mussel.

In order to find these two sabelliphilid copepods, and also to complete our knowledge of the parasitic copepod fauna of Japanese blue mussel, we conducted in April, 1982 a survey of the copepod associates of the blue mussel. Nearly two thousand mussels from almost all parts of Japan (except for Kyushu) were examined and 5 species of harpacticoids and 5 species of poecilostomatoids were recovered. The latter group consists of *Pseudomyicola spinosus* (RAFFAELE and MONTICELLI), *Modiolicola gracilicaudus* AVDEEV, *M. bifidus* TANAKA, *Lichomolgus sadoensis* HO, and a new species of *Anthessius* to be described in the following. We failed to find either of the two supposedly indicative sabelliphilids. Therefore, the origin of Japanese blue mussel remains to be worked out. In this report, we shall tentatively call the Japanese blue mussel *Mytilus edulis galloprovincialis* and a redescription of *Modiolicola bifidus* TANAKA, 1961 will also be given.

Material Examined

Only one ovigerous female of *Anthessius graciliunguis* n. sp. was recovered in the mantle cavity of one *Mytilus edulis galloprovincialis* taken from Himeji Harbor on October 18, 1982. The holotype (dissected, NSMT-cr 8927) has been deposited in the National Science Museum in Tokyo, Japan. Three ovigerous females of *Modiolicola bifidus* TANAKA were collected from 2 specimens taken from Ehime and Himeji on October 11 and 18, 1982, respectively. All drawings were made with the aid of a camera lucida.

Results and Discussion

POECILOSTOMATOIDA THORELL, 1859

MYICOLIDAE YAMAGUTI, 1936

Anthessius graciliunguis n. sp.

Female: The measurements are shown as in Table 1. The body (Fig. 1) is oviform, with the subtriangular cephalothorax distinctly separated from the first pedigerous somite. Pedigerous somites are gradually narrowed toward the posterior end, with the fifth somite (Fig. 2) being the smallest. The urosome (Fig. 2) is relatively long, about 42.5% of the total body length. The genital complex and the first two abdominal somites (Fig. 2) bear a short membrane on the

Table 1. Measurements of *Anthessius graciliunguis* n. sp. and *Modiolicola bifidus* TANAKA, 1961 collected from the blue mussel, *Mytilus edulis galloprovincialis* LAMARCK (in μm)

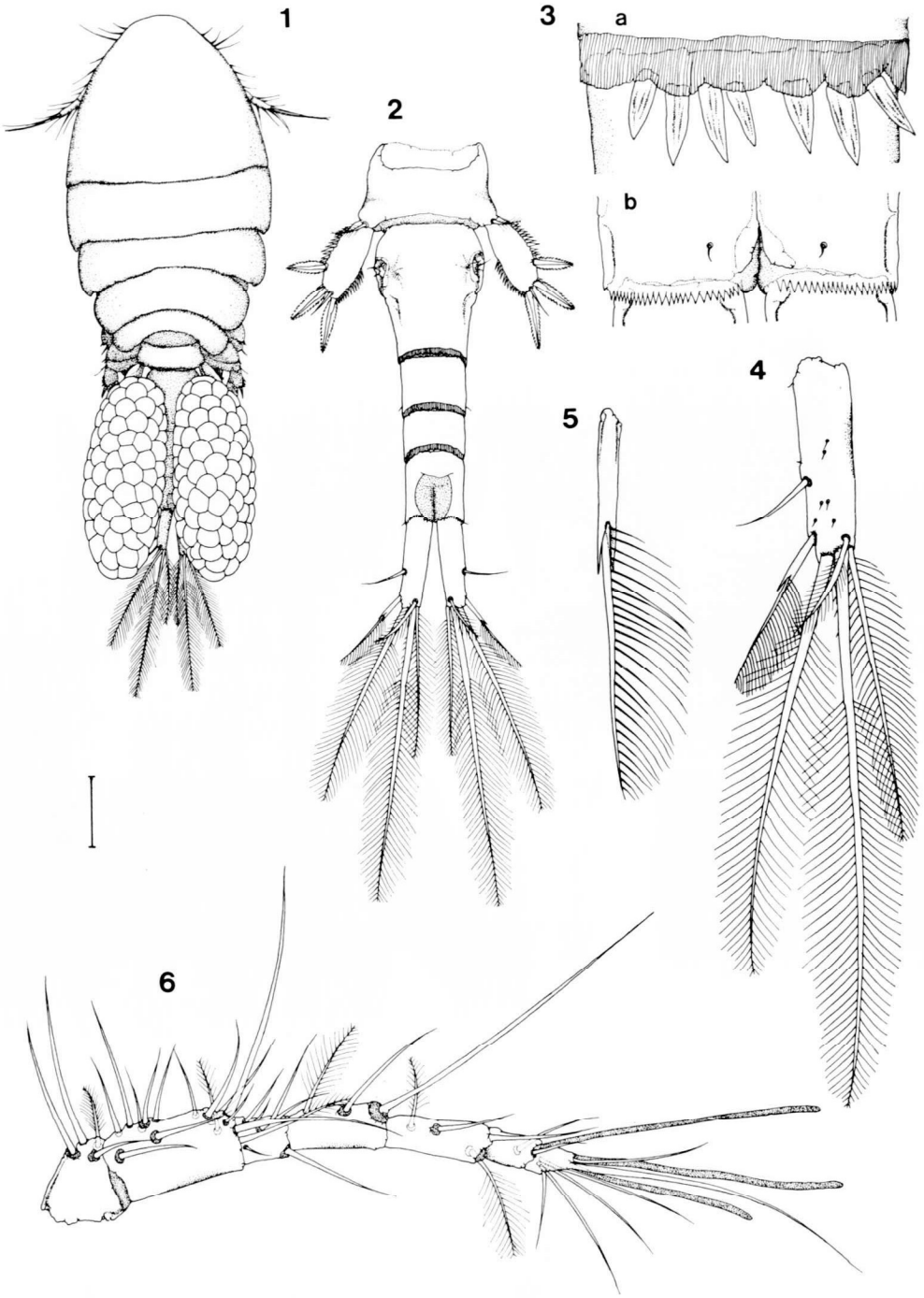
Species	*A. graciliunguis*	*M. bifidus*
Body length	1365×525	1104 (940–1193)×422 (355–500)
Cephalothorax	425×520	286 (245– 315)×418 (350–490)
Pedigerous segments		
1st	145×525	108 (95– 120)×422 (355–500)
2nd	75×490	76 (55– 105)×378 (330–415)
3rd	110×415	82 (70– 90)×296 (265–315)
4th	50×310	65 (40– 90)×203 (180–220)
5th	105×175	53 (45– 60)×120 (105–935)
Genital segment	160×140	167 (160– 175)×137 (170–145)
Abdominal segments		
1st	70× 83	70 (55– 80)× 95 (85–105)
2nd	55× 75	62 (50– 75)× 76 (70– 85)
3rd	85× 75	53 (40– 63)× 63 (60– 70)
Egg sac	520×210	450 (390– 510)×180 (130–230)
number of egg	60	30 (20– 50)
diameter of egg	60 (58–65)	70 (60– 76)
Caudal ramus	105×30	82 (65– 105)× 25
longest seta	365	230 (225– 240)

posterior margin and the anal somite armed with a row of heavy denticles on the anteroventral margin and a row of spinules on the posteroventral margin (Fig. 3). The caudal ramus (Fig. 4) is typical of the genus, 3.5 times as long as wide and bears the usual 6 setae, but the subterminal outer seta is rather characteristic (Fig. 5). The egg sac (Fig. 1) is large, slightly shorter than the urosome, and carrying about 60 eggs in each sac.

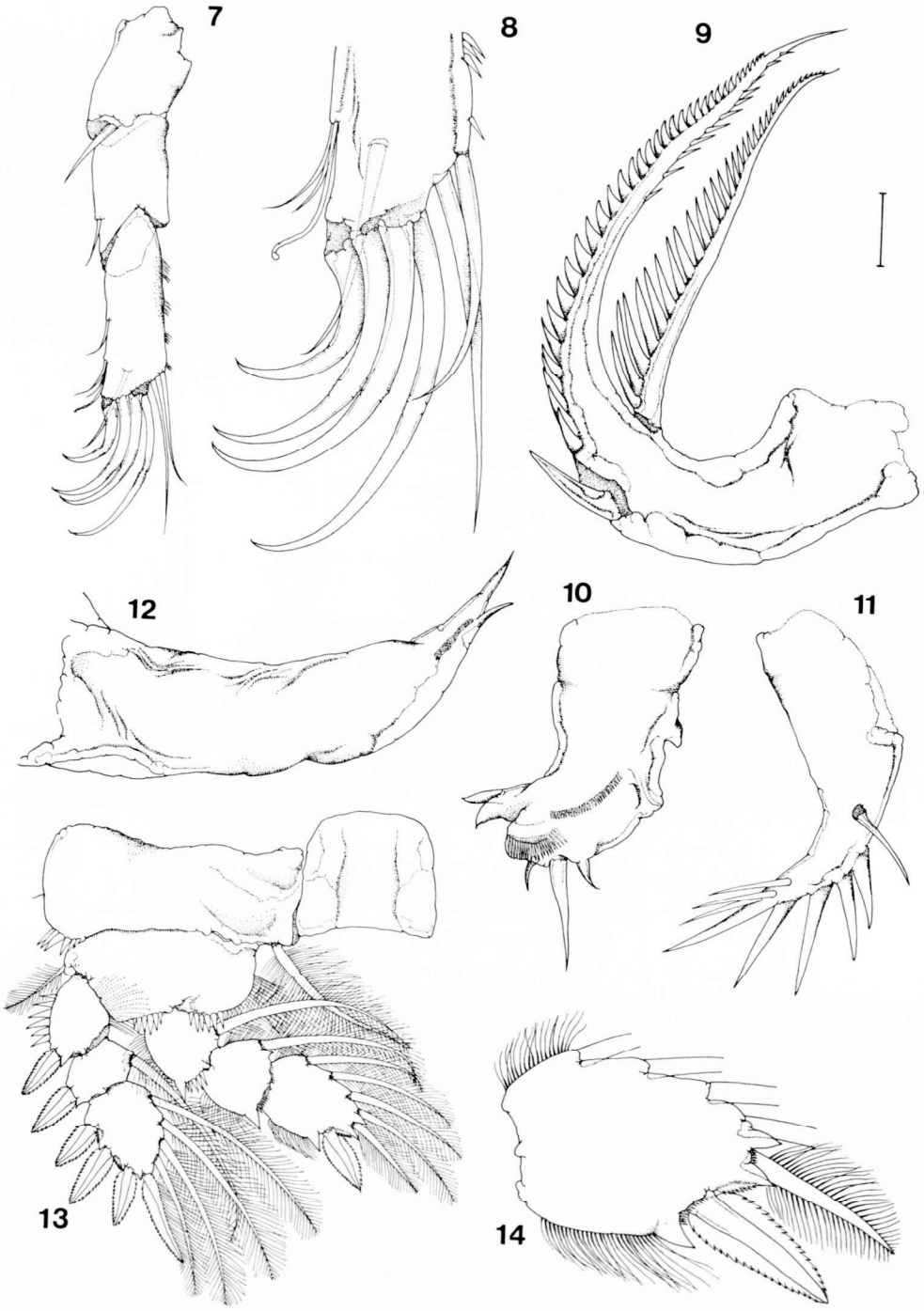
The first antenna (Fig. 6) is elongated and 7-segmented; the armature on these segments is: 4, 15, 6, 3, 4, 2+1 aesthete, and 6+2 aesthetes. The second antenna (Fig. 7) is clearly 3-segmented; first two segments are about equal in length and armed each with a relatively long seta; the terminal segment is about twice as long as the second, armed with 4 subequal setae on the inner lateral margin, 1 subterminal seta on the posterior surface and 4 patches of spinules on the outer margin. Terminally, there are 2 long setae and 4 slender, unequal hooks (Fig. 8). The mandible (Fig. 9) is typical of *Anthessius*; there is no dentale lamella between the long blade and the lashlike auxilliary seta; the former is armed with a row of about 30 cuticularized denticles on the posterior margin with the proximalmost element being the heaviest; there is a row of about 10 small denticles on the anterior margin. The auxilliary seta is armed with a row of relatively long denticles on the posterior margin. The first maxilla (Fig. 10) is bilobed distally; the inner lobe bears two stubby, fleshy elements and the outer lobe, 3 unequal distal setae (middle one being the longest) and two rows of spinules. The second maxilla (Fig. 11) consists of two segments, the distal segment is a pointed process bearing four long teeth on the posterior margin and 3 slender, setiform teeth on the anterior margin. The maxilliped (Fig. 12) is greatly reduced, indistinctly 3-segmented; the terminal segment is a spiniform structure bearing a subterminal fleshy seta.

The legs 1–4 (Figs. 13–18) are biramous, with each ramus being 3-segmented. The intercoxal plates are unarmed in all four legs. All coxae bear a row of small denticles on the outer-distal margin and a long plumose seta on the inner-distal margin. All bases bear a small plumose seta on the outer margin and a row of small denticles near the base of the endopod (except for leg 4). Arrangement of spines (Roman numerals) and setae (Arabic numerals) on these four legs are as follows:

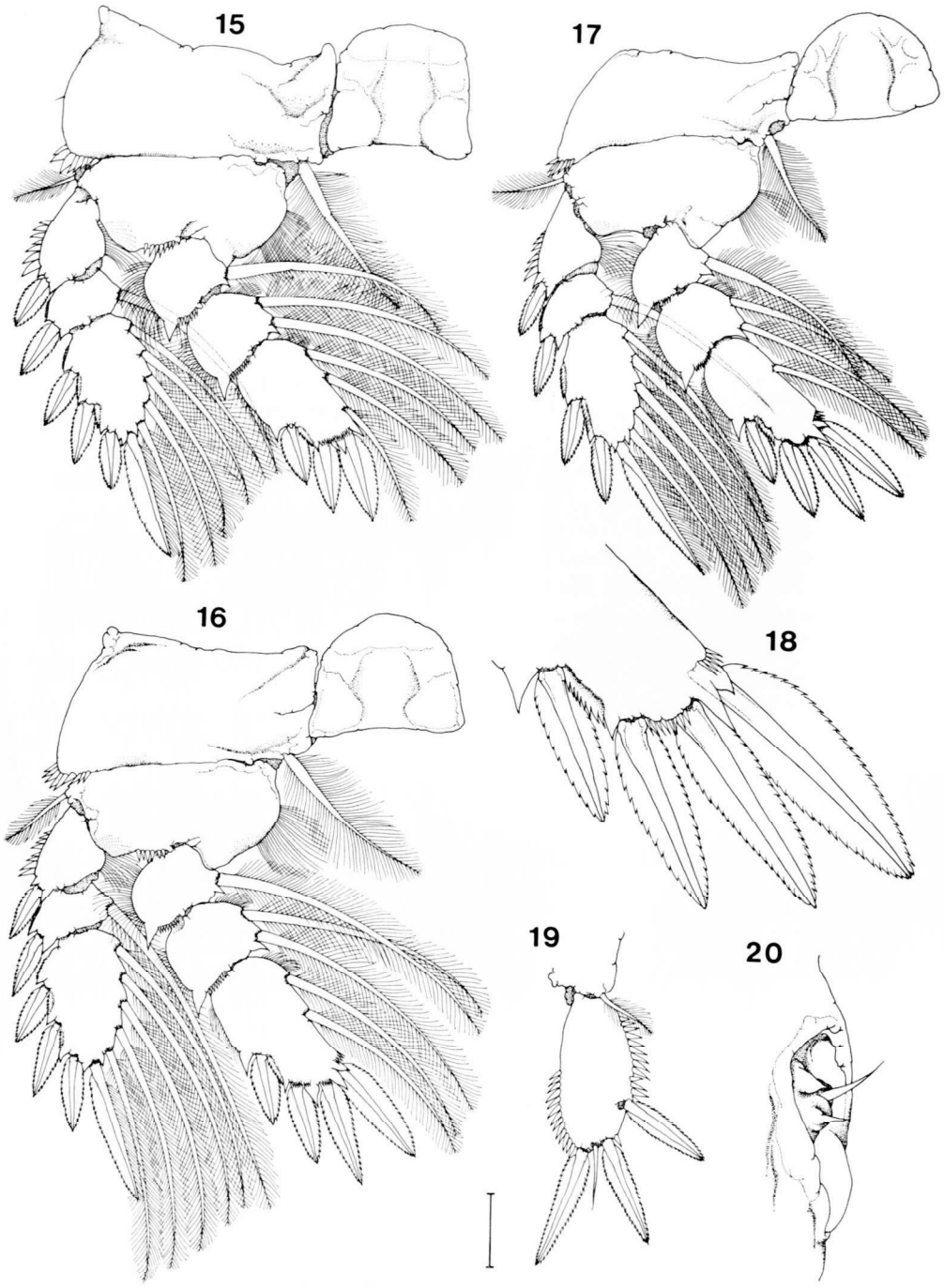
	Exopod	Endopod
Leg 1	I–0; I–1; III, I, 4	0–1; 0–1; I, 5
Leg 2	I–0; I–1; III, I, 5	0–1; 0–2; III, 3
Leg 3	I–0; I–1; III, I, 5	0–1; 0–2; IV, 2



Anthessius graciliunguis n. sp. **Fig. 1.** Ovigerous female, dorsal. **Fig. 2.** Urosome, dorsal. **Fig. 3.** Anteroventral margin of anal somite (a), posteroventral margin (b). **Fig. 4.** Caudal ramus, dorsal. **Fig. 5.** Same, subterminal outer seta, dorsal. **Fig. 6.** First antenna,ventral. Scales: 200 μm in **1**; 100 μm in **2**; 50 μm in **4**, **6**; 20 μm in **3**, **5**.



Anthessius graciliunguis n. sp. **Fig. 7.** Second antenna, anterior. **Fig. 8.** Tip of second antenna, anterior. **Fig. 9.** Mandible, ventral. **Fig. 10.** First maxilla, ventral. **Fig. 11.** Second maxilla, ventral. **Fig. 12.** Maxilliped, anterior. **Fig. 13.** Leg 1, anterior. **Fig. 14.** Same, distal segment of endopod, anterior. Scales: 50 μm in **7, 13**; 20 μm in **8, 9, 10, 11, 12, 14.**



Anthessius graciliunguis n. sp. **Fig. 15.** Leg 2, anterior. **Fig. 16.** Leg. 3, anterior. **Fig. 17.** Leg 4, anterior. **Fig. 18.** Same, distal spines of endopod. **Fig. 19.** Leg 5, dorsal. **Fig. 20.** Leg 6, dorsal. Scales: 50 μm in **15, 16, 17, 19**; 20 μm in **18, 20.**

Leg 4 I–0; I–1; II, I, 5 0–1; 0–2; IV, 1

The spines on these rami are somewhat similar; the 3rd endopod segment of all legs bears a row of spinules at the base of each spine as shown in Figs. 14 (for leg 1) and 18 (for leg 4).

The fifth leg (Fig. 19) is a free segment about twice as long as wide, and a short basal segment bearing a small plumose seta. The former is armed with 3 fringed spines, 1 small naked seta and a row of spines on the outer and inner margins. The sixth leg (Fig. 20) is represented by 2 small setae and 1 pointed lobe in the area of the egg sac attachment.

Male: Unknown.

Etymology: The specific name *graciliunguis*, from Latin *gracilis* (=slender) and *unguis* (=claw), refers to the 4 slender claws at the tip of the second antenna.

Remarks: Members of the genus *Anthessius* DELLA VALLE, 1880 are largely associated with marine pelecypods and gastropods. The first report of *Anthessius* species from Japanese waters was made by TANAKA in 1961 and the present report deals with the second species of the genus.

According to the formula of the third segment of the fourth exopod, the 34 known species of *Anthessius* can be divided into two groups, one has III, I, 5 and the other, II, I, 5. The former group contains 23 species and recently Ho (1983) added the 23rd species, *A. obtusispina*. The present new species belongs to the second group where there are 11 species. Of these 11 species, *A. graciliunguis* can be differentiated from *A. dilatatus* (SARS, 1918), *A. nortoni* ILLG, 1960 and *A. pinnae* HUMES, 1959 by the claws on the terminal segment of the second antenna. It is also distinguishable from *A. navanacis* (WILSON, 1935), *A. proximus* STOCK, HUMES and GOODING, 1963 and *A. varidens* STOCK, HUMES and GOODING, 1963 by the shape and the formula of the free segment of the fifth leg. Among the remaining 5 species [*A. dolabellae* HUMES and Ho, 1965, *A. investigatoris* SEWELL, 1949, *A. leptostylis* (SARS, 1916), *A. saecularis* STOCK, 1964 and *A. sensitivus* STOCK, HUMES and GOODING, 1963], the present species resembles most closely to *A. sensitivus*. However, they can be easily differentiated by the shape of the mandible, the second maxilla, the maxilliped and the free segment of leg 5. The armature of the first antenna with two aesthetes in the terminal segment is rather unusual for *Anthessius*. Since only one specimen was represented in our collection, possible abnormality of this feature can not be ruled out.

The Japanese blue mussel, *Mytilus edulis galloprovincialis*, should be regarded to as an fortuitous host of this new species for only one specimen was recovered from nearly two thousand mussels examined.

SABELLIPHILIDAE GURNEY, 1927

Modiolicola bifidus TANAKA, 1961

Female: The measurements are shown as in Table 1. The general body shape (Figs. 21, 22) is similar to that of TANAKA's plate 32, figure 6. The urosome (Fig. 23) is relatively long, occupying about 44% of the body length. The genital complex and each of the 3-segmented abdomen bear a row of spinules on the posteroventral margin (Fig. 24). The caudal ramus (Fig. 25) bears the usual 6 setae, the segment is a little more than 3 times as long as wide.

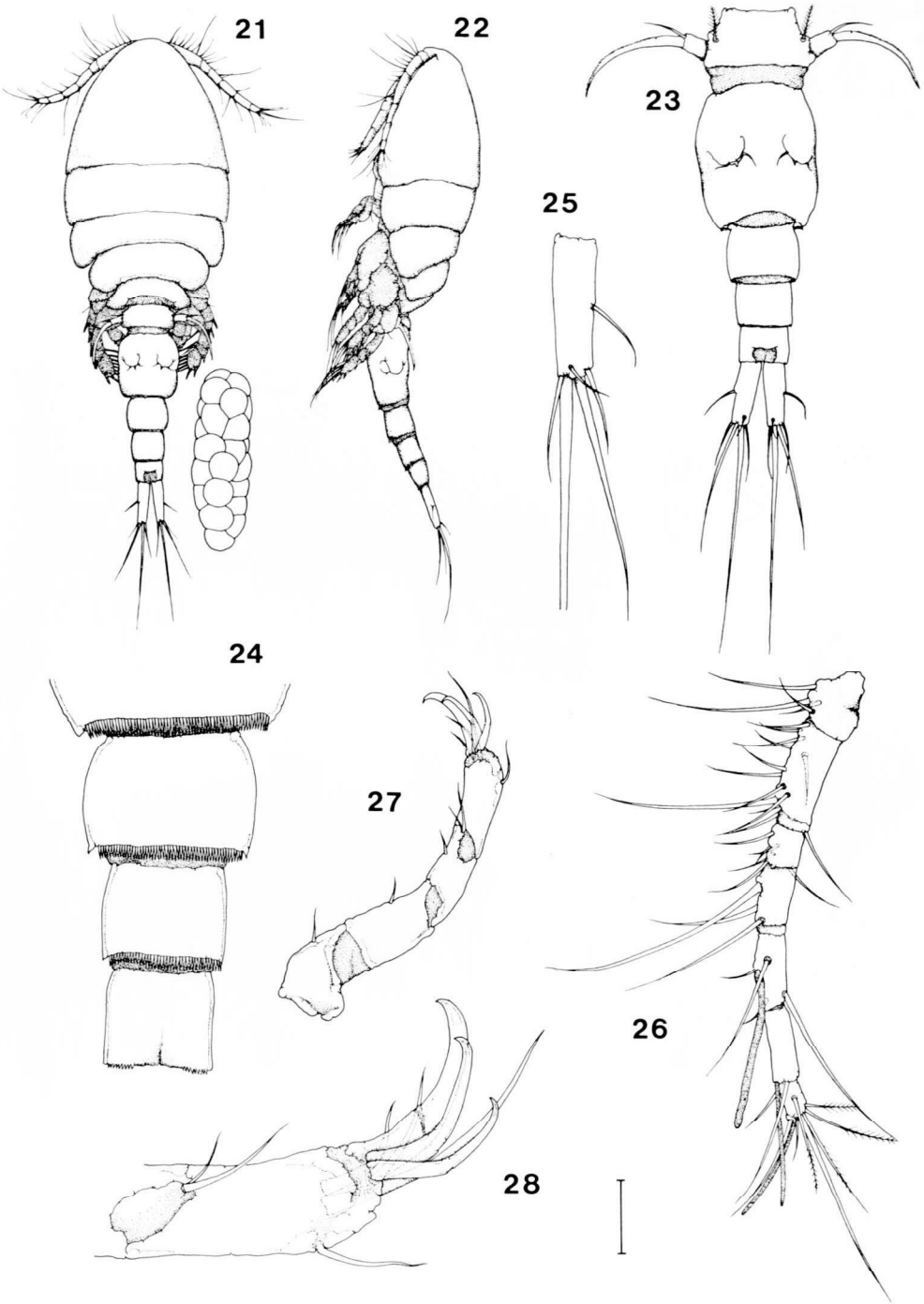
The first antenna (Fig. 26) is elongated and distinctly 7-segmented; the armature on these segments is of typical of the genus, being: 4, 13, 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. The second antenna (Figs. 27, 28) is 4-segmented, with the usual armature of 1, 1, 3, 3 claws, +4 slender setae.

The oral appendages (Figs. 30, 31, 32, 33) and the maxilliped (Fig. 34) are like those described by TANAKA, except for the labrum (Fig. 29) and the paragnath (Fig. 31) which are figured a new. The formulae of the first four legs (Figs. 35–43) are as follows:

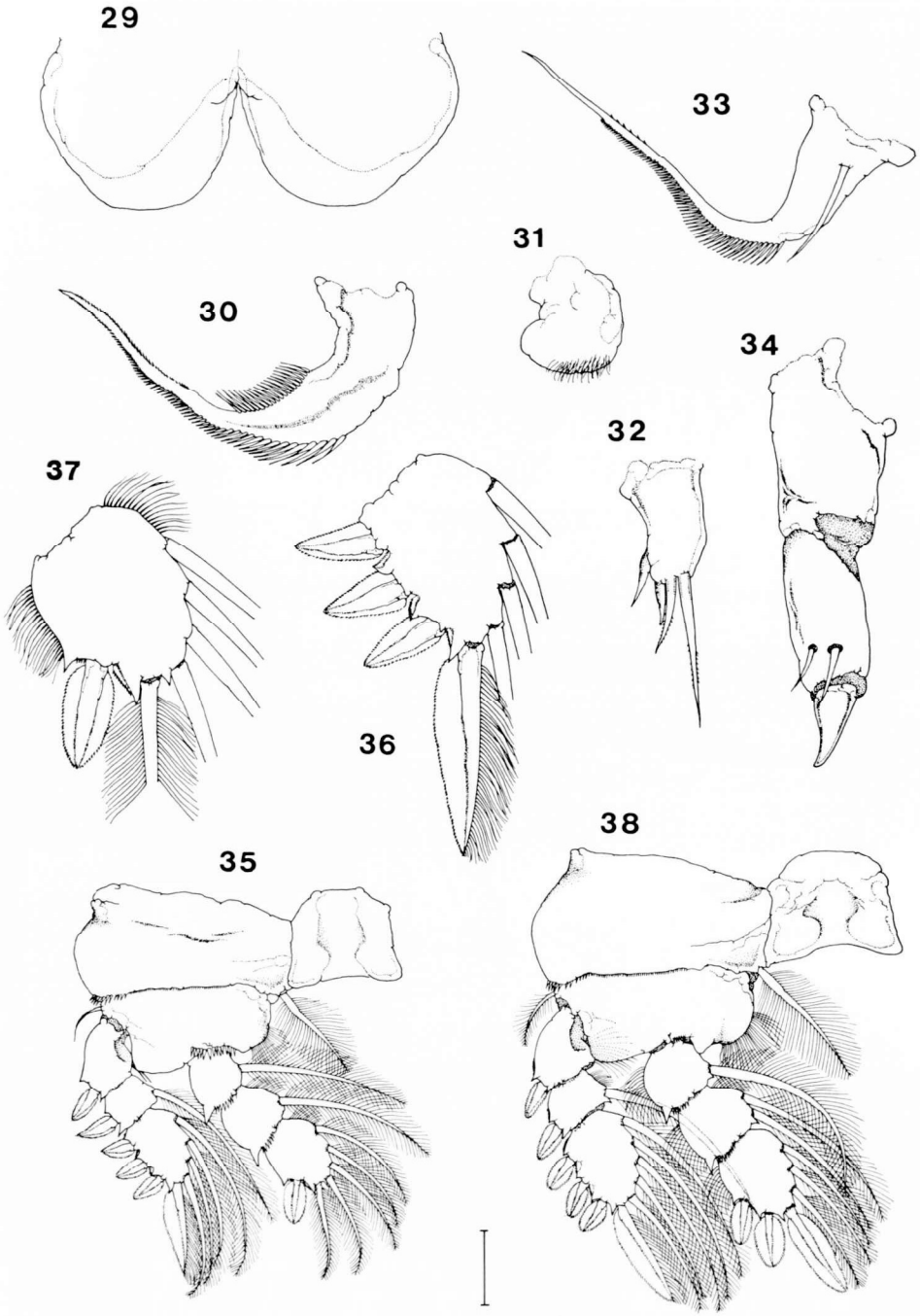
	Exopod	Endopod
Leg 1	I–0; I–1; III, I, 4	0–1; 0–1; I, 5
Leg 2	I–0; I–1; III, I, 5	0–1; 0–2; III, 3
Leg 3	I–0; I–1; III, I, 5	0–1; 0–2; IV, 2
Leg 4	I–0; I–1; II, I, 5	0–1; 0–1; II

The fifth leg (Fig. 44) is represented by a free segment, twice as long as wide, and carrying 2 terminal setae as described in the original description. The sixth leg (Fig. 45) is represented by 2 slender setae and a spiniform process in the area of the egg sac attachment.

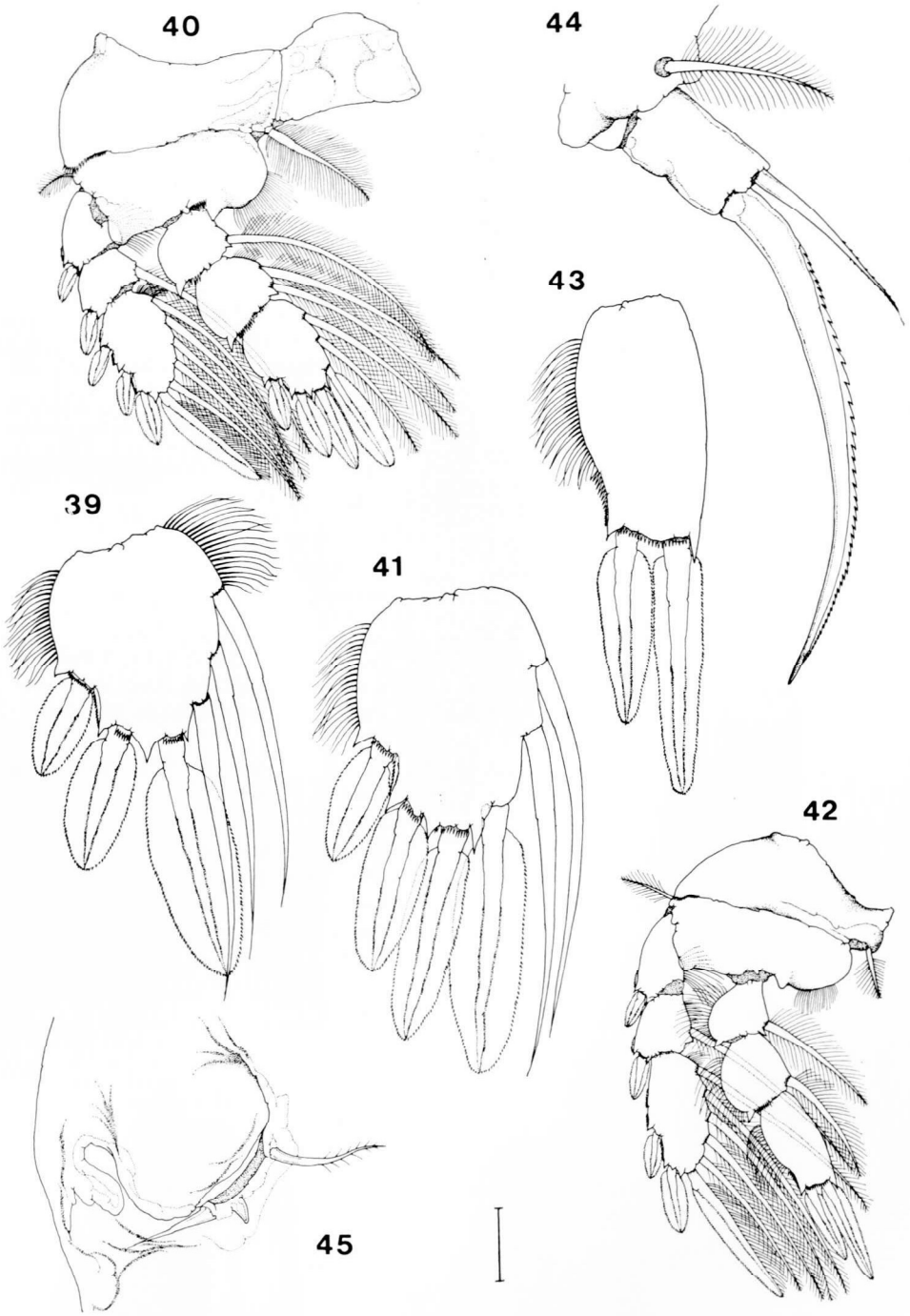
Remarks: The newly collected specimens of *Modiolicola* are identified with TANAKA's *M. bifidus*; although some minor differences are found in the armature of the first antenna, the ornamenta-



Modiolicola bifidus TANAKA, 1961. **Fig. 21.** Ovigerous female, dorsal. **Fig. 22.** Same, lateral **Fig. 23.** Urosome, dorsal. **Fig. 24.** Posterior margins of genital complex and abdomen, ventral. **Fig. 25.** Caudal ramus, dorsal. **Fig. 26.** First antenna, ventral. **Fig. 27.** Second antenna, posterior. **Fig. 28.** Same, distal segment, posterior. Scales: 200 μm in **21**, **22**; 100 μm in **23**: 50 μm in **24, 25, 26, 27**; 20 μm in **28**.



Modiolicola bifidus TANAKA, 1961. **Fig. 29.** Labrum, ventral. **Fig. 30.** Mandible, ventral. **Fig. 31.** Paragnath, ventral. **Fig. 32.** First maxilla, ventral. **Fig. 33.** Second maxilla, ventral. **Fig. 34.** Maxilliped, anterior. **Fig. 35.** Leg 1, anterior. **Fig. 36.** Leg 1, distal segment of expod, anterior. **Fig. 37.** Leg 1, distal segment of endopod, anterior. **Fig. 38.** Leg 2, anterior. Scales: 50 μm in **35**, **38**; 20 μm in **29**, **30**, **31**, **32**, **33**, **34**, **36**, **37**.



Modiolicola bifidus TANAKA, 1961. **Fig. 39.** Distal segment of second endopod, anterior. **Fig. 40.** Leg 3, anterior. **Fig. 41.** Same, distal segment of endopod. **Fig. 42.** Leg 4, anterior. **Fig. 43.** Same, distal segment of endopod. **Fig. 44.** Leg 5, dorsal. **Fig. 45.** Leg 6, dorsal. Scales: 50 μm in **40, 42**; 20 μm in **39, 41, 43, 44, 45**.

tion of the terminal segment of the second antenna and the mouth-parts, they are considered as the result of inadequate original description and not genuine differences.

M. bifidus was first reported from *Paphia* species by TANAKA (1961), later, it was recovered from *Tapes japonica* DESHAYES and *Mactra sulcataria* REEVE by Kô (1969) and Kô *et al.* (1962). The Japanese blue mussel, *Mytilus edulis galloprovincialis* LAMARCK, is a new host of this copepod. It is not surprising to discover only a few specimens of this Japanese sabelliphilid in the blue mussel, because it is a recent immigrant to Japanese waters.

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日本産ムラサキイガイ (*Mytilus edulis galloprovincialis*) に寄生する橈脚類の新種, *Anthessius graciliunguis* n. sp. および *Modiolicola bifidus* TANAKA, 1961 について

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(昭和 58 年 10 月 28 日受理)

兵庫県姫路港内で採集されたムラサキイガイ (*Mytilus edulis galloprovincialis* LAMARCK) の外套膜に寄生する橈脚類の新種, *Anthessius graciliunguis* n. sp. (Copepoda: Myicolidae) を記載した。本新種は第2触角末節先端に細長い4本の鉤爪を有することから, *Anthessius* 属の他の34種と容易に区別される。また, 姫路港および愛媛県浴岸のムラサキイガイより本種では初めて見いだされた *Modiolicola bifidus* TANAKA について, その形態を詳しく観察し再記載した。これより, 日本産ムラサキイガイの寄生性橈脚類のうち Poecilostomatoida 目で記載されたものは5種類となった。

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