



REDESCRIPTION OF *ORBITACOLAX LEPTOSCARI* (YAMAGUTI, 1953)  
(COPEPODA, CYCLOPOIDA, BOMOLOCHIDAE), WITH DESCRIPTIONS  
OF THE LATE COPEPODID STAGES

BY

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ABSTRACT

*Orbitacolax leptoscari* (Yamaguti, 1953) is redescribed based on specimens of both adults, both sexes of copepodid V, and copepodid IV sex undetermined, all based on specimens recovered from under the scales of *Pseudolabrus sieboldi* Mabuchi & Nakabo, 1997 and *Pteragogus flagellifer* (Valenciennes, 1839) (Labridae), as well as *Calotomus japonicus* (Valenciennes, 1840) (Scaridae) in Japan. Descriptions of the copepodid V male and copepodid IV sex undetermined are the first time for the genus. The results also show that the number of setal elements on leg 5 and the possession of rostral processes, are useless for sex determination in the copepodid stages of species of this genus.

RÉSUMÉ

*Orbitacolax leptoscari* (Yamaguti, 1953) est redécrite à partir de spécimens adultes des deux sexes, des deux sexes du copépode V et de copépode IV de sexe indéterminé, tous à partir de spécimens collectés sous les écailles de *Pseudolabrus sieboldi* Mabuchi & Nakabo, 1997 et *Pteragogus flagellifer* (Valenciennes, 1839) (Labridae), ainsi que de *Calotomus japonicus* (Valenciennes, 1840) (Scaridae) au Japon. Les descriptions du copépode V mâle et du copépode IV de sexe indéterminé sont les premières pour le genre. Les résultats montrent aussi que le nombre de soies sur la P5 et la possession de processus frontaux ne sont pas utiles pour la détermination du sexe chez les stades copépoditiques des espèces de ce genre.

INTRODUCTION

In this paper, *Orbitacolax leptoscari* (Yamaguti, 1953) is redescribed based on specimens of both sexes of the adult and of copepodid V, as well as the sex undetermined copepodid IV, all recovered from under the scales of two species of wrasse, *Pseudolabrus sieboldi* Mabuchi & Nakabo, 1997 and *Pteragogus flagellifer* (Valenciennes, 1839) (Labridae), and the Japanese parrotfish, *Calotomus*

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*japonicus* (Valenciennes, 1840) (Scaridae) in Japan. The descriptions of copepodid V male and copepodid IV sex undetermined in this species are the first time for the genus. Sexually dimorphic features in the late copepodid stages of species in this genus are discussed.

#### MATERIAL AND METHODS

Specimens recovered from hosts were fixed in formalin and preserved in 70% alcohol. The specimens were stained with chlorazol black E in lactic acid and examined with a differential interference contrast microscope using the “wooden slide method” of Humes & Gooding (1964). Drawings were made with the aid of a drawing tube. The terminology for copepod morphology is based on Huys & Boxshall (1991). Common and scientific names of the hosts follow Froese & Pauly (2022). The specimens were deposited in the National Museum of Nature and Science, Tsukuba (NSMT).

#### TAXONOMIC DESCRIPTIONS

##### ***Orbitacolax leptoscari*** (Yamaguti, 1953) (figs. 1-9)

Material examined. — Ninety-three females, 31 males, 11 copepodid V females, and 6 copepodid V males, recovered from under the scales of *Pseudolabrus sieboldi* Mabuchi & Nakabo, 1997 (Labridae) [common name in Japanese: hosisasanohabera], at Seto, Wakayama Prefecture, on 7 May 1971 (NSMT Cr-24849); 125 females, 13 males, 1 copepodid V female, and 3 copepodid IV sex undetermined, from the same anatomical site, of the Japanese parrotfish, *Calotomus japonicus* (Valenciennes, 1840) (Scaridae), at the same locality, on 12 May 1971 (NSMT Cr-24855); 8 females, from the same site, of the red naped wrasse, *Pseudolabrus eoethinus* (Richardson, 1846), at the same locality, on 2 July 1971 (NSMT Cr-24915); 15 females, 1 male, and 5 copepodid V females, from the same site, of *P. sieboldi*, at Minamiuwa, Ehime Prefecture, in 1986 (NSMT Cr-25333).

Parasitic behaviour. — Never was more than one individual of the female found under each scale.

Female (figs. 1, 2). — Habitus (fig. 1A), flattened dorsoventrally, body length excluding caudal rami 0.95–1.08 mm ( $1.03 \pm 0.04$ ) ( $n = 17$ ), cephalothorax 0.36–0.42 ( $0.38 \pm 0.02$ )  $\times$  0.52–0.71 mm ( $0.56 \pm 0.04$ ), width ratios of pedigers 2 and 3 to cephalothorax 1.04 and 0.95, respectively. Genital somite wider than long, about 1.5 times as wide as long, with leg 6 in lateral gonopore on each side, represented by small lobe bearing 3 short setae (fig. 1B). Abdomen (fig. 1B) 3-segmented, all somites wider than long, with spinulose ventral patch, anal somite about 2.1 times as wide as long. Caudal ramus (fig. 1B, C) 1.5 times as long as wide, spinulose ventrally, with 6 setae including 1 major seta. Egg sac (fig. 1A) 0.53  $\times$  0.03 mm, flattened dorsoventrally, containing 34 single-layered eggs ( $n = 1$ ).

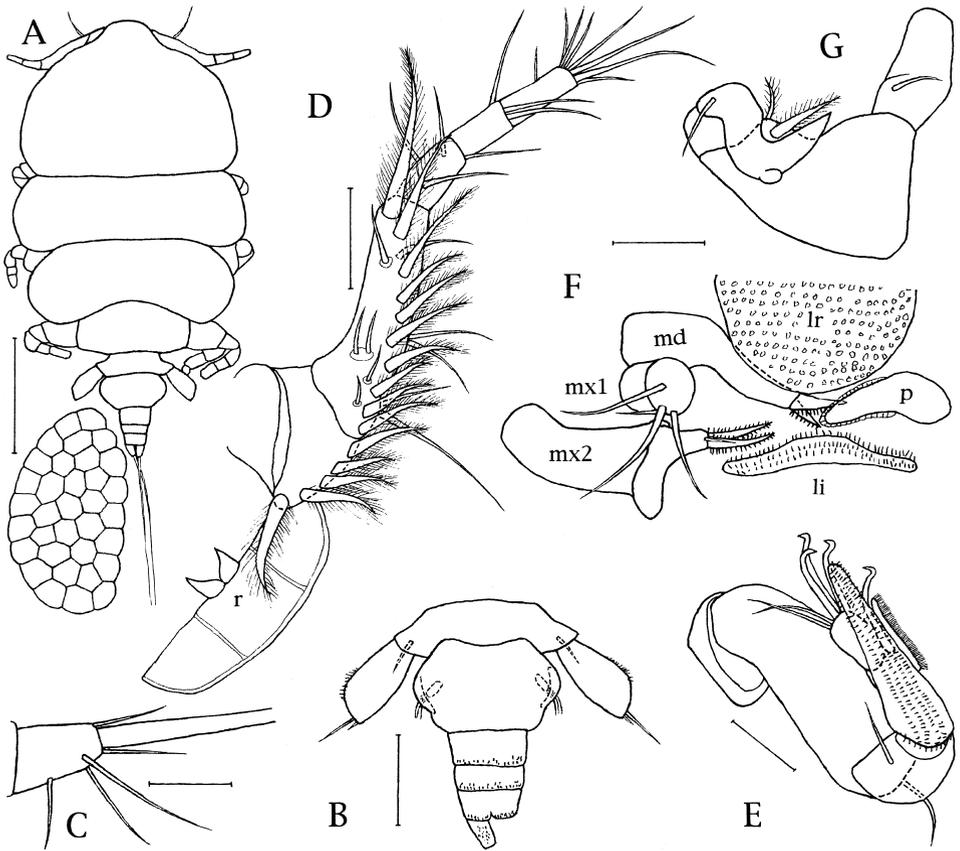


Fig. 1. *Orbitacolax leptoscari* (Yamaguti, 1953), female. A, Habitus, dorsal; B, urosome, ventral; C, caudal ramus, dorsal; D, rostral plate and antennule, ventral; E, antenna, ventral; F, mouthparts, ventral; G, maxilliped, ventral. Abbreviations: li, labium; lr, labrum; md, mandible; mx1, maxillule; mx2, maxilla; p, paragnath; r, rostral plate. Scale bars: 0.3 mm for A; 0.1 mm for B; 0.05 mm for D, F, G; 0.03 mm for C, E.

Rostral plate (fig. 1D, r) with pair of sharply pointed ventral processes. Antennule (fig. 1D) 6-segmented, first segment forming pedestal, number of setal elements per segment (base to apex) as follows: 0, 5, 10 + 10, 4, 3, 8. Antenna (fig. 1E) 5-segmented, first segment unarmed, second with distal seta, third with medial seta, fourth tapered distally, spinulose ventrally, with 1 hook-like seta and comb-plate anteriorly, fifth with 3 hook-like setae and 2 simple setae distally.

Mouthparts (fig. 1F), labrum (lr) tuberculose ventrally, mandible (md) with 2 blades, paragnath (p) thumb-shaped, pectinate on distal lobe, maxillule (mx1) with 4 setae, maxilla (mx2) 2-segmented, second segment protruded proximoposteriorly, with setula distally, tipped by 2 pectinate processes, labium (li) thin longitudinally, spinulose ventrally. Maxilliped (fig. 1G) 3-segmented, syncoxa

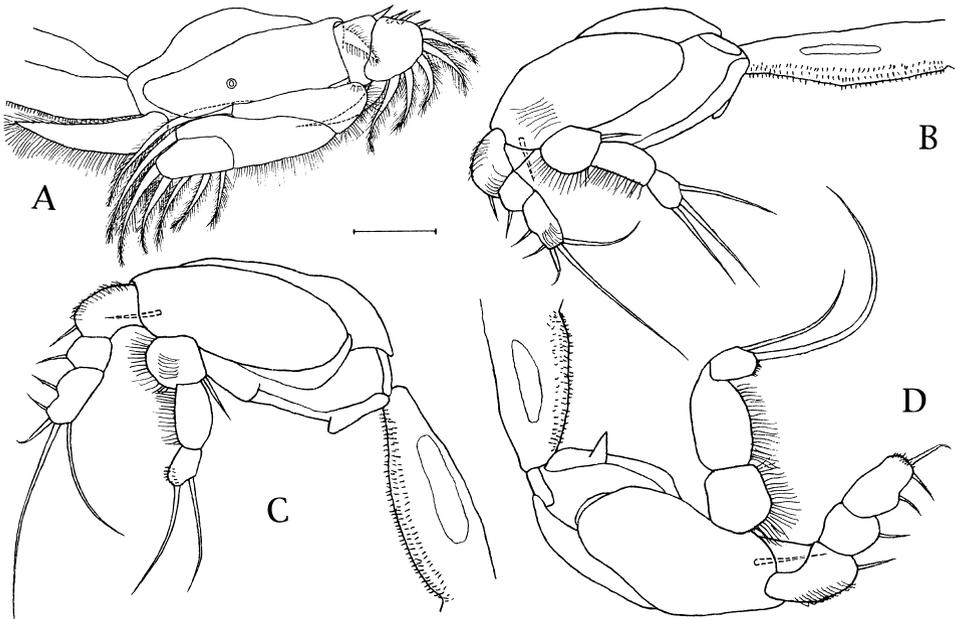


Fig. 2. *Orbitacolax leptoscari* (Yamaguti, 1953), female. A, Leg 1, ventral; B, leg 2, ventral; C, leg 3, ventral; D, leg 4, ventral. Scale bar: 0.05 mm for A-D.

with seta, basis broadened proximally, with 2 medial setae, endopod forming recurved claw, claw with seta proximally and roundish accessory process.

Legs 1-4 (fig. 2A-D) each with intercoxal plate, biramous, rami 3-segmented except 2-segmented leg 1 exopod. Formulae for spines (Roman numerals) and setae (Arabic numerals) of these legs as follows:

Leg 1 coxa 0-1 basis 1-1 exopod I-0; III, 6 endopod 0-1; 0-1; 5

Leg 2 coxa 0-0 basis 1-0 exopod I-0; I-0; II, I, 2 endopod 0-1; 0-0; 3

Leg 3 coxa 0-0 basis 1-0 exopod I-0; I-0; II, I, 2 endopod 0-1; 0-0; 2

Leg 4 coxa 0-0 basis 1-0 exopod I-0; I-0; II, I, 0 endopod 0-0; 0-0; 2

Coxae of legs 2-4, each with medio-posterior process. Medial seta of leg 1 basis atrophied, lateral spines of exopods of legs 2-4 seta-like. Distal spine on third exopodal segments in legs 2-4 pectinate laterally, each tipped with fine tip. Leg 5 (fig. 1A, B) 2-segmented, first segment fused to somite, with dorsodistal seta, second segment twice as long as wide, with 2 setal elements distally.

Male (figs. 3, 4). — Habitus (fig. 3A), with body length excluding caudal rami 0.50-0.56 mm ( $0.53 \pm 0.02$ ) ( $n = 10$ ), cephalothorax slightly wider than long, 0.19-0.22 ( $0.21 \pm 0.01$ )  $\times$  0.20-0.23 mm ( $0.22 \pm 0.01$ ). Pedigers 2-4 successively decreasing in width. Genital somite wider than long, 1.3 times as wide as long, with genital slits distoventrally. Abdomen (fig. 3AC) 2-segmented, spinulose ventrally.

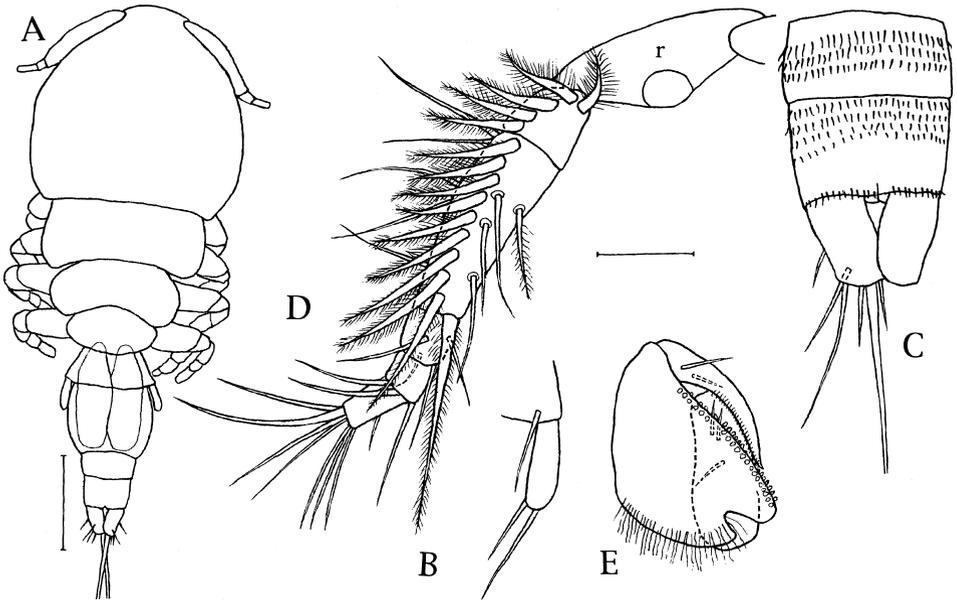


Fig. 3. *Orbitacolax leptoscari* (Yamaguti, 1953), male. A, Habitus, dorsal; B, leg 5, dorsal; C, abdomen and caudal rami, ventral; D, rostral plate and antennule, ventral; E, maxilliped, ventral. Scale bars: 0.1 mm for A; 0.03 mm for B-E.

Caudal ramus (fig. 3C) 1.6 times as long as wide, with 6 setae including 1 major seta, which is very long, about 78% of body length.

Rostral plate (fig. 3D, r) with round swelling distoventrally. Antennule (fig. 3D) 6-segmented, first segment forming pedestal, number of setal elements per segment (base to apex) as follows: 0, 5, 10 + 9, 4, 3, 8. Antenna and mouthparts almost as in female. Maxilliped (fig. 3E) sexually dimorphic, subchelate, 3-segmented, syncoxa with ventral seta, basis broadened proximally, with depression on proximal margin, bearing denticles and 2 setae on inner margin, and row of cilia along proximal margin, endopod forming claw, with 2 setae proximally and row of notches on inner margin of claw.

Legs 1-4 (fig. 4A-D) each with intercoxal plate, biramous, rami 3-segmented except 2-segmented endopod of leg 4, formulae for spines (Roman numerals) and setae (Arabic numerals) of these legs as follows:

- Leg 1 coxa 0-1 basis 1-1 exopod I-0; I-1; II, I, 4 endopod 0-1; 0-1; 5
- Leg 2 coxa 0-0 basis 1-0 exopod I-0; I-1; II, I, 5 endopod 0-1; 0-2; II, 3
- Leg 3 coxa 0-0 basis 1-0 exopod I-0; 0-1; II, I, 5 endopod 0-1; 0-2; II, 2
- Leg 4 coxa 0-0 basis 1-0 exopod I-0; 0-1; II, I, 4 endopod 0-1; I, 1, I

Lateral spines of exopod in legs 2-4 seta-like, distal spines on third exopodal segments in legs 2-4 pectinate laterally, each tipped with fine tip. Leg 5 (fig. 3B)

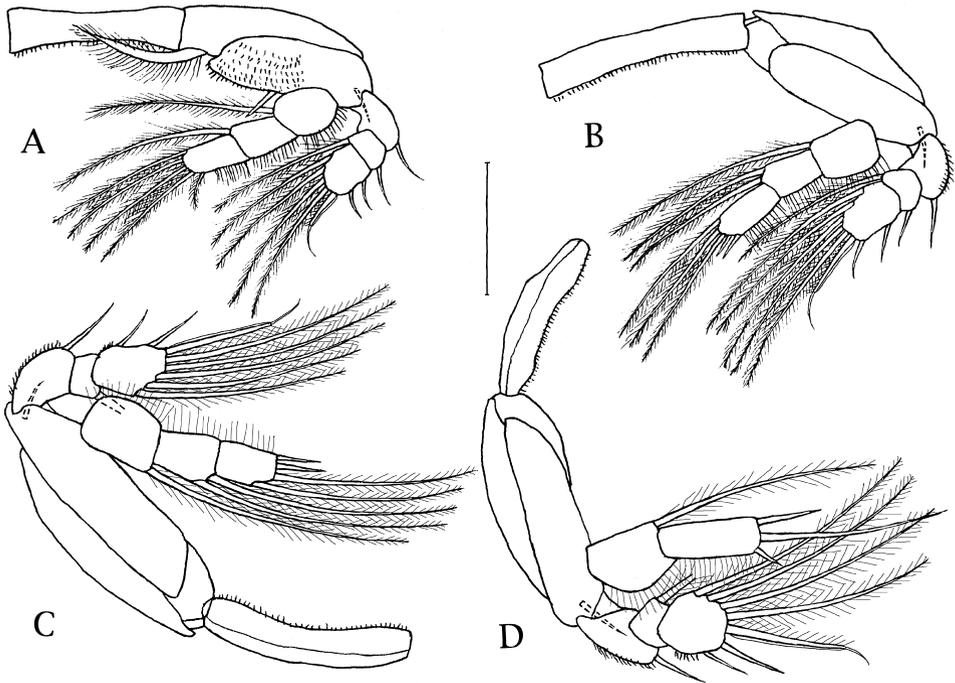


Fig. 4. *Orbitacolax leptoscari* (Yamaguti, 1953), male. A, Leg 1, ventral; B, leg 2, ventral; C, leg 3, ventral; D, leg 4, ventral. Scale bar: 0.05 mm for A-D.

2-segmented, first segment with dorsodistal seta, reaching almost distal end of next segment, second segment about 3 times as long as wide, with 2 distal setae.

Copepodid V female (figs. 5, 6). — Body (fig. 5A), body length excluding caudal rami 0.65–0.78 mm ( $0.72 \pm 0.04$ ) ( $n = 11$ ), cephalothorax wider than long, 0.29–0.34 ( $0.31 \pm 0.01$ )  $\times$  0.36–0.42 mm ( $0.38 \pm 0.02$ ), width ratios of pedigers 2 and 3 to cephalothorax 0.97 and 0.87, respectively. Genital somite (fig. 5B) slightly wider than long, 1.1 times as wide as long, without gonopore and leg 6, abdomen 3-segmented, spinulose ventrally, anal somite 2 times as wide as long. Caudal ramus (fig. 5B) 1.6 times as long as wide, spinulose ventrally, with 6 setae including major seta.

Rostral plate (fig. 5C) with ventral processes. Maxilliped (fig. 5D) almost as in adult female.

Legs 1–4 (fig. 6A–D), each with intercoxal plate, rami 3-segmented except 2-segmented exopod in leg 1, formulae for spines (Roman numerals) and setae (Arabic numerals) of these legs as follows:

Leg 1 coxa 0-1 basis 1-1 exopod I-0; III, 6 endopod 0-1; 0-1; 5

Leg 2 coxa 0-0 basis 1-0 exopod I-0; I-0; II, I, 3 endopod 0-1; 0-1; 3

Leg 3 coxa 0-0 basis 1-0 exopod I-0; I-0; II, I, 3 endopod 0-1; 0-1; 2

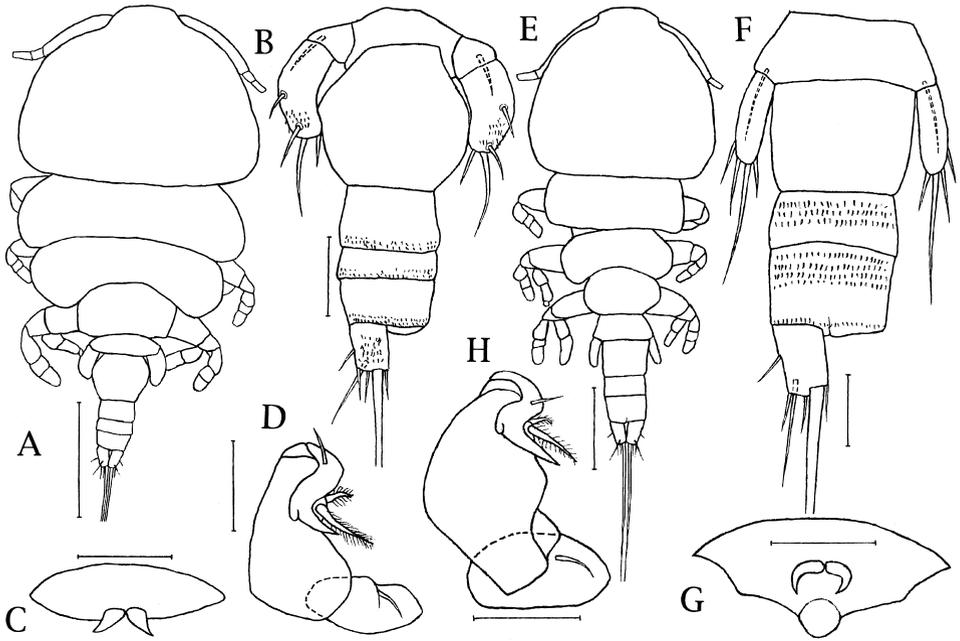


Fig. 5. *Orbitacolax leptoscari* (Yamaguti, 1953), copepodid V. A-D, Female; A, body, dorsal; B, urosome, ventral; C, rostral plate, ventral; D, maxilliped, ventral. E-H, Male; E, body, dorsal; F, urosome, ventral; G, rostral plate, ventral; H, maxilliped, ventral. Scale bars: 0.2 mm for A; 0.1 mm for E; 0.05 mm for B-D; 0.03 mm for F-H.

Leg 4 coxa 0-0 basis 1-0 exopod I-0; I-0; II, I, 3 endopod 0-1; 0-1; 2

Coxae on legs 2-4 each with medio-posterior process. Medial seta of leg 1 basis atrophied, lateral spines of exopod in legs 2-4 seta-like, distal spine of third exopodal segments in legs 2-4 pectinate laterally, each tipped with fine tip. Leg 5 (fig. 5B), second segment about 2.4 times as long as wide, with 4 setal elements and ventral spinulose patch distolaterally.

Copepodid V male (figs. 5, 7). — Body (fig. 5E), with body length excluding caudal rami 0.51-0.57 ( $0.53 \pm 0.02$ ) ( $n = 10$ ), cephalothorax slightly wider than long, 0.20-0.22 ( $0.21 \pm 0.01$ )  $\times$  0.22-0.24 mm ( $0.23 \pm 0.01$ ), pedigers 2-4 successively decreasing in width, genital somite (fig. 5F) slightly wider than long, about 1.3 times as wide as long, without genital slits, abdomen 2-segmented, spinulose ventrally, caudal ramus about 1.6 times as long as wide, with 6 setae including 1 major seta, this very long, about 60% of body length.

Rostral plate (fig. 5G) with ventroposterior swelling and ventral processes. Maxilliped (fig. 5H) of female-type.

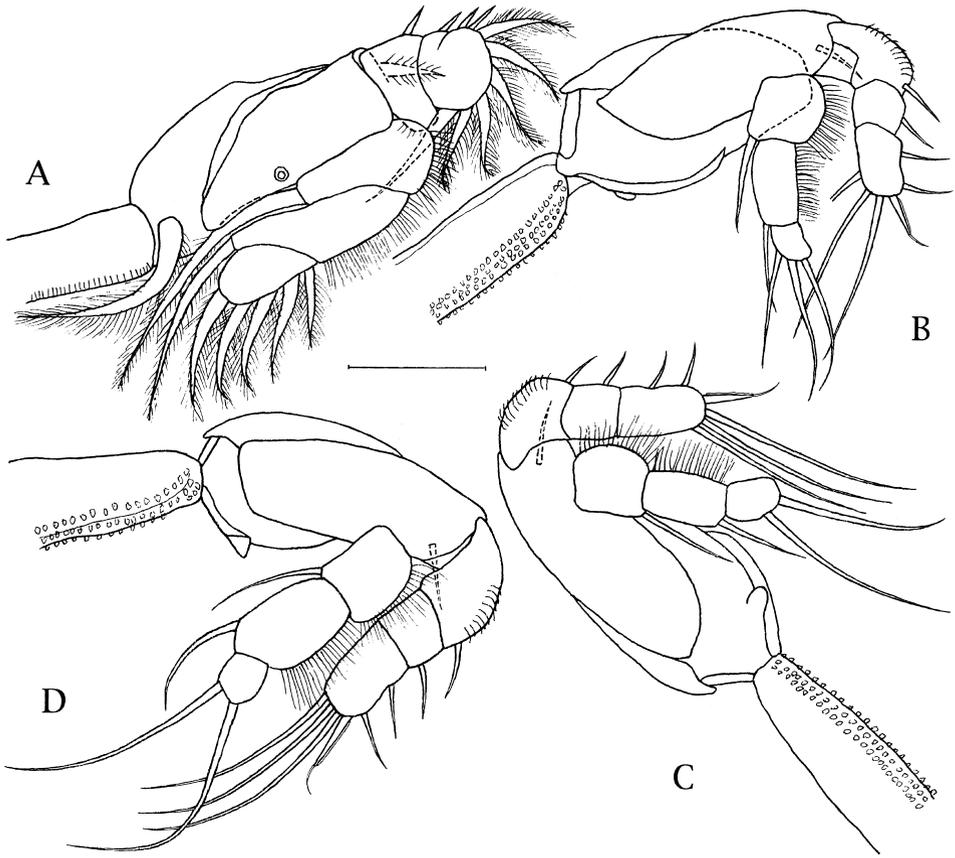


Fig. 6. *Orbitacolax leptoscari* (Yamaguti, 1953), copepodid V female. A, Leg 1, ventral; B, leg 2, ventral; C, leg 3, ventral; D, leg 4, ventral. Scale bar: 0.05 mm for A-D.

Legs 1-4 (fig. 7A-D), each with intercoxal plate, rami 3-segmented except both 2-segmented exopod of leg 1 and endopod of leg 4, formulae for spines (Roman numerals) and setae (Arabic numerals) of these legs as follows:

Leg 1 coxa 0-1 basis 1-1 exopod I-0; III, 6 endopod 0-1; 0-1; 5

Leg 2 coxa 0-0 basis 1-0 exopod I-0; I-1; II, I, 4 endopod 0-1; 0-1; II, 3

Leg 3 coxa 0-0 basis 1-0 exopod I-0; I-1; II, I, 4 endopod 0-1; 0-1; II, 2

Leg 4 coxa 0-0 basis 1-0 exopod I-0; I-1; II, I, 4 endopod 0-1; I, 1, I, 1

Lateral spines of exopods in legs 2-4 seta-like, distal spines of third exopodal segments in legs 2-4 pectinate laterally, pinnate medially, each tipped with fine tip. Leg 5 (fig. 5F), first segment with dorsodistal seta, almost reaching distal end of next segment, second segment about 3 times as long as wide, with 4 setal elements.

Copepodid IV sex undetermined (figs. 8, 9). — Body (fig. 8A), with body length excluding caudal rami 0.46-0.51 mm ( $0.48 \pm 0.02$ ) ( $n = 3$ ), cephalothorax slightly

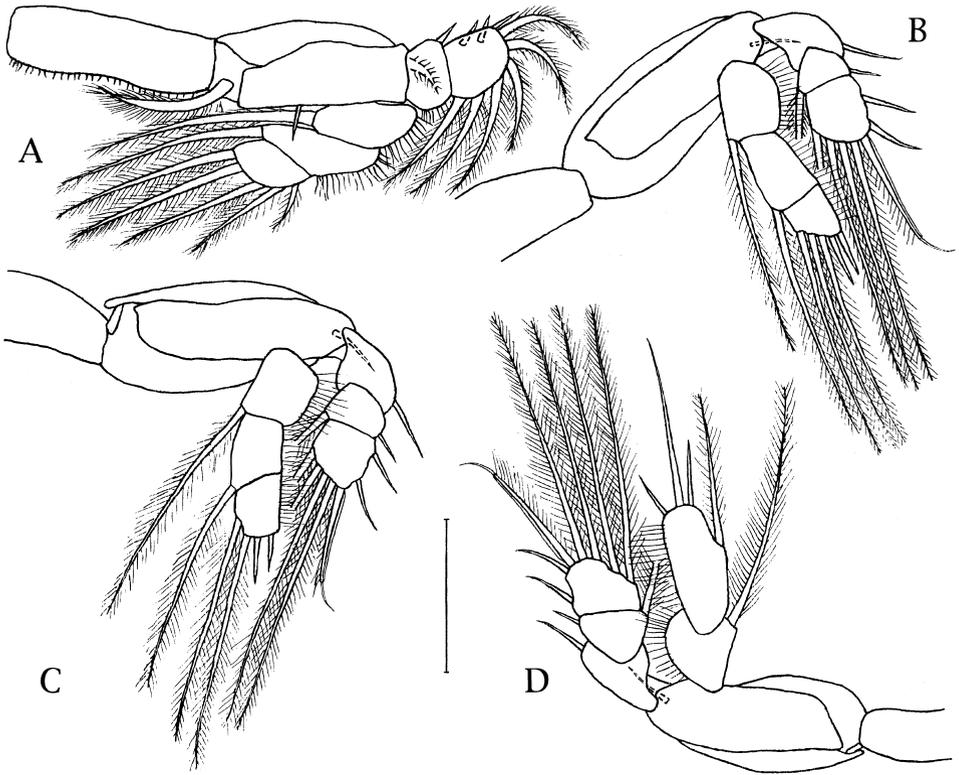


Fig. 7. *Orbitacolax leptoscari* (Yamaguti, 1953), copepodid V male. A, Leg 1, ventral; B, leg 2, ventral; C, leg 3, ventral; D, leg 4, ventral. Scale bar: 0.05 mm for A-D.

wider than long,  $0.21\text{--}0.22$  ( $0.21 \pm 0.01$ )  $\times$   $0.21\text{--}0.23$  ( $0.22 \pm 0.01$ ), pedigers 2-4 successively decreasing in width, genital somite slightly wider than long, about 1.2 times as wide as long, abdomen (fig. 8C) 2-segmented, anal somite about 1.4 times as wide as long, with transverse row of spinules ventrally, caudal ramus about 1.6 times as long as wide, with 6 setae including 1 major seta, this very long, about 75% of body length.

Rostral plate (fig. 8D, r) with ventral processes. Antennule (fig. 8D) 6-segmented, first segment forming pedestal, number of setal elements per segment (base to apex) as follows: 0, 4, 8 + 7, 4, 3, 7. Antenna and mouthparts almost as in adult. Maxilliped (fig. 8E) of female-type.

Legs 1-4 (fig. 9A-D) each with intercoxal plate, rami 2-segmented, formulae for spines (Roman numerals) and setae (Arabic numerals) of these legs as follows:

Leg 1 coxa 0-1 basis 1-1 exopod I-0; III, 5 endopod 0-1; 6

Leg 2 coxa 0-0 basis 1-0 exopod I-0; III, I, 5 endopod 0-1; II, 5

Leg 3 coxa 0-0 basis 1-0 exopod I-0; III, I, 5 endopod 0-1; II, 3

Leg 4 coxa 0-0 basis 1-0 exopod I-0; III, I, 5 endopod 0-1; I, 1, I, 1.

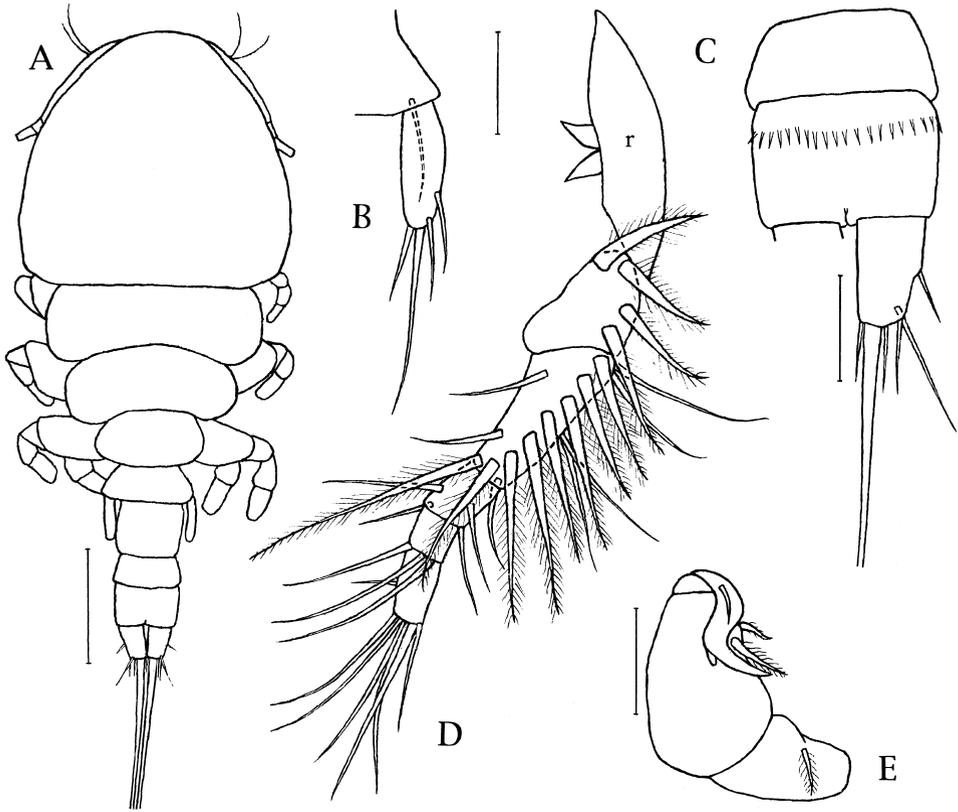


Fig. 8. *Orbitacolax leptoscari* (Yamaguti, 1953), copepodid IV, sex undetermined. A, Body, dorsal; B, leg 5, dorsal; C, abdomen and caudal ramus, ventral; D, rostral plate and antennule, ventral; E, maxilliped, ventral. Scale bars: 0.1 mm for A; 0.03 mm for B-E.

Medial seta of leg 1 basis atrophied, lateral spines of exopods in legs 2-4 seta-like, distal spines of second exopodal segments in legs 2-4 pectinate laterally, pinnate medially, each tipped with fine tip. Leg. 5 (fig. 8B), first segment with dorsodistal seta, almost reaching distal end of next segment, second segment about 2.8 times as long as wide, with 4 setal elements.

Remarks. — The rostral plate, maxilliped, and legs 1-5 are sexually dimorphic in the adult in *Orbitacolax*. Presenting descriptions of both sexes of the copepodid V in *O. leptoscari* is the first time for the genus. These data revealed that the rostral plate (fig. 5C, G) and the maxilliped (fig. 5D, H) are not sexually dimorphic in the copepodid stages prior to the adult in this genus. The rostral plate bears ventral processes in both sexes of copepodid V (fig. 5C, G) and copepodid IV sex undetermined (fig. 8D). The maxilliped exhibits the female-type in both sexes of copepodid IV, just as in *Naricolax sphyraenae* Izawa, 2020 (cf. Izawa, 2021d) and

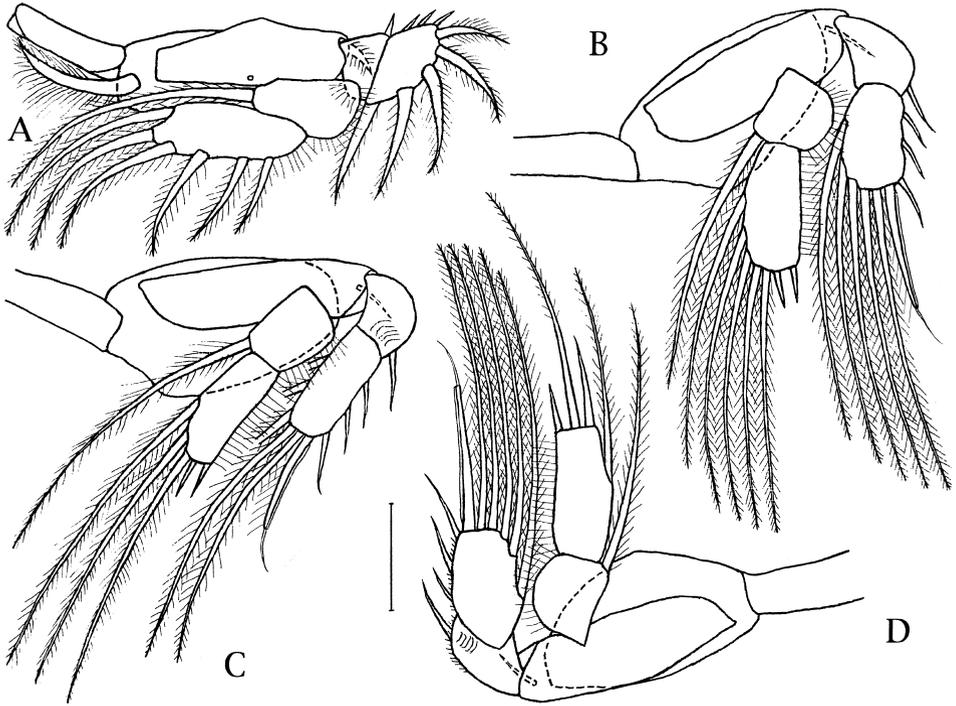


Fig. 9. *Orbitacolax leptoscari* (Yamaguti, 1953), copepodid IV, sex undetermined. A, Leg 1, ventral; B, leg 2, ventral; C, leg 3, ventral; D, leg 4, ventral. Scale bar: 0.03 mm for A-D.

in *Nothobomolochus tricerus* (Bassett-Smith, 1898) (cf. Izawa, 2021e). From the studies on the late copepodid stages in *Na. sphyraena* and *No. tricerus*, the present author mentioned that the leg 5 armature makes a convenient criterion to judge sex in the adult and late copepodid stages in the family, with the exception of *Boylea* Cressey, 1977 (cf. Cressey, 1977), *Megacolax* Izawa, 2021 (cf. Izawa, 2021c), and *Tegobomolochus* Izawa, 1976 (cf. Izawa, 1976): because representatives of these three genera possess 4 setal elements on the distal segment in both sexes. As shown in this study, leg 5 bears 4 setal elements on the distal segment in both sexes of copepodid V (fig. 5B, F) and copepodid IV sex undetermined (fig. 8B); thus, the leg 5 armature is useless also in *Orbitacolax*. The medial seta of the leg 1 basis is atrophied in the adult (fig. 2A) and copepodid V (fig. 6A) in the female, whereas it is process-like in the adult male (fig. 4A) and copepodid V male (fig. 4A). The leg 1 exopod is extending laterally in the adult female (fig. 2A), whereas it is extending medially in the adult male (fig. 4A). The leg 1 exopod is strangely extending laterally in both sexes of copepodid V (figs. 2A, 4A) and copepodid IV sex undetermined (fig. 9A): this is a morphological feature of the female. Legs 2-4 are much degenerative in the females of the genus as seen in *O. bispinus* Izawa, 2021 (cf. Izawa, 2021b, fig. 2), *O. brevispinus* Moon, Choi & Venmathi Maran,

2018 (cf. Izawa, 2020, fig. 19), *O. kukiensis* Izawa, 2022 (cf. Izawa, 2022, fig. 2), *O. leptoscari* (cf. Izawa, 2021b, fig. 2; this paper, fig. 2), *O. scombropsi* Izawa, 2020 (cf. Izawa, 2020, fig. 21), and *O. unguifer* Kim & Moon, 2013 (cf. Izawa, 2020, fig. 23), while these legs are not degenerative in the male. The leg 4 endopod is 3-segmented in the female in adult and copepodid V, but it is 2-segmented in the male in these stages. However, all rami in legs 1-4 are 2-segmented in both sexes in copepodid IV. The copepodid IV of the species was described in this study (fig. 9), however, of which sex is undetermined at the present time. By the way, from having ventral processes on the rostral plate, the maxilliped is of the female-type, and 4 setal elements on the distal segment of leg 5, the copepodid IV was described as the female in *O. unguifer* (cf. Izawa, 2020, figs. 27, 28) and *O. bispinus* (cf. Izawa, 2021b, figs. 3, 4), however, that should in both cases rather be as sex undetermined.

Furthermore, the copepodid V female described earlier as *O. leptoscari* (cf. Izawa, 2021b, fig. 7) was noted to be distinct from that of *O. leptoscari* described in this paper. Morphological features of the rostral processes and an accessory process of the maxilliped claw disagree with those of the copepodid V female presented here. Rostral processes are blunt in Izawa (2021b, fig. 7B), while they are sharply pointed in the current description (this paper, fig. 5C), and the accessory process of the maxilliped claw is pointed in Izawa (2021b, fig. 7F), whereas it is roundish in *O. leptoscari* herein, i.e., as in the adult female (this paper, fig. 5D).

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