Morphology of *Lineopselloides albineus* (Nemertea: Heteronemertea: Lineidae) from Japanese waters, with complementary redescription of the holotype

Hiroshi KAJIHARA & Yuji ISE

Reprinted from the
Bulletin of the Kitakyushu Museum of Natural History and Human History
Series A (Natural History)
March 31, 2008
Morphology of *Lineopselloides albilineus* (Nemertea: Heteronemertea: Lineidae) from Japanese waters, with complementary redescription of the holotype

Hiroshi KAJIHARA$^1$ & Yuji ISE$^2$

$^1$Faculty of Science, Hokkaido University, Sapporo 060-0810, Hokkaido, Japan  
$^2$Misaki Marine Biological Station, the University of Tokyo, Koajiro 1024, Kanagawa, Japan

(Received November 20, 2007; accepted January 9, 2008)

**ABSTRACT** — Re-examination of the holotype of the heteronemertean, *Lineopselloides albilineus* Gibson, 1990, hitherto only known by its original description on a single specimen from Hong Kong, indicated that the peculiar morphology of the foregut-intestine junction in the holotype, which formed the basis of the establishment of this currently monotypic genus, might have resulted from an artifact during fixation; the rhynchocoel wall ruptured inward in a region where the foregut caecum extending backward below the foregut. Six individuals referable to *L. albilineus* based on their external appearances were collected from four localities in Japan. All of them possessed an intestinal caecum extending anteriorly below the foregut, a feature characteristic to *Aetheolineus pulcherrimus* Senz, 1993, *Chilinus glandulosus* (Bürger, 1895), *Lineopsella islandica* (Friedrich, 1958), *Lineopsella pacifica* Friedrich, 1970, *Lineopsella trilineata* (Schmarda, 1859) and *Micrura ambiguca* Friedrich, 1958. The taxonomic status of the genus *Lineopselloides* should be re-appraised by additional material from Hong Kong in future studies.

**KEY WORDS:** Pacific, taxonomy, endoparasitism, metacercaria

**INTRODUCTION**

The currently monotypic genus *Lineopselloides* Gibson, 1990 was established for the heteronemertean *L. albilineus* Gibson, 1990 based on a single specimen from Hong Kong chiefly on the ground of a unique configuration of the foregut-intestine junction (Gibson, 1990). Members in the Heteronemertea, with approximately 400 species in 80 genera (Gibson, 1995), commonly lack appendages in foregut-intestine junction, whereas in *L. albilineus* the foregut was reported to possess a bifurcated caecal appendages extending posteriorly below the anterior end of the intestine, i.e., the intestine is supposed to open to the dorsal wall of the foregut. This foregut-intestine relationship was quite different from that reported in *Aetheolineus pulcherrimus* Senz, 1993, *Chilinus glandulosus* (Bürger, 1895) sensu Friedrich (1970), *Lineopsella islandica* (Friedrich, 1958), *Lineopsella pacifica* Friedrich, 1970, *Lineopsella trilineata* (Schmarda, 1859) [ redescribed by Senz (1996) based on Schmarda’s (1859) material], and *Micrura ambiguca* Friedrich, 1958, in which an intestinal caecum extends anteriorly below the foregut, i.e., the foregut opens to the dorsal wall of the intestine (Friedrich, 1958, 1970; Senz, 1993, 1996).

In a series of faunal surveys in Japanese waters, six individuals referable to *Lineopselloides albilineus* from their external appearances, were collected in four localities including Misaki (one individual), Hamanako (two individuals), Hiroshima Bay (two individuals) and Kitakyushu (one individual) (Fig. 1). The present paper gives the anatomical features observed in these Japanese specimens, mainly those that are either different from

![Fig. 1. Map showing sampling sites.](image-url)
those in the holotype or not mentioned in its original description; a brief complementary note on the morphology of the holotype of *L. albineus* is also provided.

**MATERIALS AND METHODS**

Specimens for histological examination were either directly fixed in 10% formalin seawater, or anaesthetized in 7.5% MgCl₂ before fixed in Bouin’s fluid; these were dehydrated in EtOH, cleared in xylene, embedded in 56-57°C m.p. paraffin wax and sectioned at 8 μm. Sections were subsequently stained by the Mallory trichrome method (Gibson, 1994: 25). Voucher specimens are deposited in the Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan (KMNH IvR) and the Hokkaido University Museum, Sapporo, Japan (ZHU); the type specimen of *Lineopselloides albineus*, deposited in the Natural History Museum, London (BMNH) was examined for comparison.

**RESULTS**

*Lineopselloides albineus* Gibson, 1990

(Figs. 2-12)

**Diagnosis**

A heteronemertean possessing a pair of lateral horizontal cephalic grooves, without caudal cirrus; body colour uniformly brownish, posteriorly lighter, with single white mid-dorsal longitudinal stripe; no eyes.

**Material examined**

*Holotype*: BMNH 1987.2.45., collected on 15 April 1986 by Dr. P. Hutchings from coral boulder, 5-10 m depth off Ping Chau, Hong Kong, China; serial transverse sections of anterior end of body, 6 μm, 35 slides (originally consisted of 37 slides, but two slides supposed to be numbered 1 and 25, are lacking in the loaned material), prepared by Professor Ray Gibson.

*Voucher specimens*: KMNH IvR 500,249, immature, collected on 25 April 2002 by Professor Yasuhisa Hemmi, Mr. Toshio Ando, Ms. Naoko Okamoto, and Mr. Kotaro Matsumoto, from muddy to sandy sediment at a tidal flat, Sonehigata, Kitakyushu, Fukuoka, Japan; probably fixed in 10% formalin-seawater without anaesthetization; serial transverse sections of anterior end of body, 68 slides, 8 μm, with remaining unsectioned posterior fragments preserved in

Fig. 2. *Lineopselloides albineus* Gibson, 1990, photographs taken in life. ZIHU-3130 from Hamanako (A), ZIHU-3262 from Misaki (B, C), and ZIHU-3264 from Hiroshima (D).
Fig. 3. *Lineopselloides albineus* GIBSON, 1990 (ZIHU-3262). Transverse section through the foregut region (A); boxed area is enlarged to show the well developed, but non-lamellar, connective tissue between the body-wall outer longitudinal muscle layer and the dermis (B).
70% EtOH. ZIHU-3121, immature, collected by HK on 31 July 2003 from muddy to sandy tidal flat, Ikarise, Hamanako Lake, Shizuoka, Japan, 34°41’4”N, 137°35’59”E; anaesthetized in MgCl₂ solution, fixed in Bouin’s fluid; serial transverse sections of cephalic tip, 1 cm, 18 slides, 8 µm. ZIHU-3130, immature, collection data same as ZIHU-3121; serial transverse sections of complete body, 238 slides, 8 µm. ZIHU-3262, immature, intertidal, Koajirohigata, Misaki, Kanagawa, Japan, collected by YI on 17 May 2007, anaesthetized in MgCl₂ solution, fixed in Bouin’s fluid; serial transverse sections of the anterior end of the body, 187 slides, 8 µm. ZIHU-3263, mature female, collected by HK on 12 November 2003 among sessile organisms on cultured oysters hung from rafts in Hiroshima Bay, 34°24’N, 132°10’E, Ondocho, Akitun, Hiroshima Prefecture, Japan; anaesthetized in MgCl₂ solution, fixed in Bouin’s fluid; serial transverse sections of anterior end of body, 27 slides, 8 µm. ZIHU-3264, mature male, collection data same as those of ZIHU-3263, serial transverse sections of anterior end of body, 24 slides, 8 µm.

Fig. 4. Lineopselloides albilineus Gibson, 1990 (ZIHU-3130). Transverse section through the intestinal sphincter between the anterior and posterior portions of the intestine; arrowheads indicate the fibres from body-wall middle circular muscle layer contributing to the intestinal sphincter.
Description of Japanese specimens

External features. The head is demarcated by succeeding body by a slight constriction (Fig. 2A-D), but there is no circular cephalic furrow; a pair of horizontal lateral slits extend posteriorly to the mouth region; the body is yellowish brown to greenish brown in colour, posteriorly paler; a white longitudinal mid-dorsal stripe is present (Fig. 2A). Complete specimens collected in Hamanako (ZIHU-3130, 30 cm long, 2 mm wide, Fig. 2A) and Hiroshima (ZIHU-3264, 10 cm long, 2 mm wide, Fig. 2D) possessed no caudal cirrus. In ZIHU-3264, the stripe was anteriorly opaque and bordered by a narrow but distinct white line on each side like in Lineus bilineatus (Renier, 1804) (Fig. 2D). The largest specimen, although lacking its posterior end, collected at Misaki (ZIHU-3262, Fig. 2B), measured 46 cm in length and 4 mm in width when alive.

Body wall and musculature. There is no lamellar connective tissue layer between the dermis and the body-wall outer longitudinal muscles, although in one specimen (ZIHU-3262, the largest individual observed), non-lamellar type of connective tissue is developed between the dermis and the body-wall outer longitudinal muscle layer (Fig. 3). Somatic circular muscles are present around the foregut and the anterior portion of the intestine; they become thickened at the border between the anterior and posterior portions of the intestine, forming an intestinal sphincter, to which circular muscles from the rhynchocoel circular muscle layer is contributed; in addition, fibres from the body-wall middle circular muscle layer, penetrating the body-wall inner longitudinal muscle layer, also merge with the intestinal sphincter (Fig. 4). Above the mid-dorsal portion of the rhynchocoel, muscle crosses are sporadically found between the body-wall inner circular muscle layer and the
Fig. 6. *Lineopselloides albilineus* Gibson, 1990. Transverse sections through the posterior portion of the intestine to show the arrangement of the ovaries in ZIHU-3263 (A) [arrowhead indicates one of the pseudometameric transverse connectives between the lateral blood vessel and the mid-dorsal blood vessel] and the testes in ZIHU-3264 (B).

Fig. 7. *Lineopselloides albilineus* Gibson, 1990 (ZIHU-3121). Serial transverse sections through the frontal organ pits, indicated by arrowheads.
Fig. 8. Serial transverse sections of an endoparasite, probably a trematode metacercaria, found in the pre-cerebral region of *Lineopselloides albilineus* Gibson, 1990 (ZIHU-3130).
rhynchocoel circular muscle layer throughout the body length.

**Rhynchocoel and proboscis.** Rhynchocoel reaches to the hind end of the body. The proboscis is unbranched.

**Alimentary system.** The foregut opens into the dorsal wall of the intestine in all the six individuals examined; an intestinal caecum extends anteriorly below the foregut for 400 µm in KMNH IvR 500.249, 208 µm in ZIHU-3121, 240 µm in ZIHU-3130, 864 µm in ZIHU-3262, 184 µm in ZIHU-3263 and 344 µm in ZIHU-3264; the caecum is anteriorly forked into two in ZIHU-3264, while it is simple in the rest of the material (Fig. 5). The intestine is divisible into anterior and posterior portions with the intestinal sphincter in between them (Fig. 4); the anterior portion lacks lateral pouches, while the main posterior portion possesses them (Fig. 6).

**Blood system.** Pseudometameric transverse connectives are present behind the intestinal sphincter (Fig. 6A).

**Nervous system.** Subepidermal nervous sheath was not found. Rhynchocoel dorsal nerve is locally evident, not appearing to be antero-posteriorly continuous as in the holotype.

**Sensory system.** Frontal organ pits appear to be five in ZIHU-3121 (Fig. 7), not ascertained in KMNH IvR 500.249, three in the rest of the material.

**Reproductive system.** Only the specimens obtained in November at Hiroshima were sexually mature, though their body size was smaller than those of immature specimens collected in April, May and July. Testes and ovaries are arranged between the intestinal lateral pouches; every gonoduct appeared to pass above the lateral nerve cord (Fig. 6). Each ovary contained over 40 oocytes.

**Parasite.** In ZIHU-3130, at least two trematode metacercariae were found in a capsule, 100 µm in diameter, one among criss-crossed muscular fibres below the basophilic cephalic glands just beside the pre-cerebral vascular lacuna (Fig. 8), another in the
Fig. 10. *Lineopselloides albilinus* Gibson, 1990 (holotype, BMNH 1987.2.45). Serial transverse sections from just behind the mouth to show the antero-posteriorly discontinuous nature of the rhynchocoel dorsal nerve, as well as the muscle cross between the body-wall inner circular muscle layer and the rhynchocoel circular muscle layer (A-L).
body-wall outer longitudinal muscle layer near the lateral nerve cord. The metacercaria, 60 µm in diameter, hunching inside the capsule, appeared to possess a circular oral sucker and an elliptical ventral sucker.

**Complementary morphological note on the holotype (BMNH 1987.2.45.)**

Musculature. One of the reasons used to segregate Lineopselloides gibson, 1990 from Lineopella friedrich, 1970 was that “a weakly developed horizontal [sic] muscle plate between the foregut and rhynchocele” (Gibson, 1990: 160) was supposed to be present in Lineopsella islandica, while it was regarded as absent in Lineopselloides albilineus. Friedrich (1958: 20), however, actually stated “there are only very few longitudinal [sic] muscle fibres between the proboscis sheath and the esophagus [=foregut]” in Lineopsella islandica. This might have led Schwartz & Norenburg’s (2001) character coding for “5. Medial longitudinal muscle plate” to be “Absent” in Lineopselloides on their cladistic analysis (Schwartz & Norenburg, 2001: 167, 173). Weakly developed longitudinal muscles are confirmed in the holotype of Lineopselloides albilineus on the foregut and anterior portion of the intestine (Fig. 9), as well as those in the Japanese forms. Muscle crosses between the body-wall middle circular muscle layer and the rhynchocoel circular muscle layer are present, although sporadically (Fig. 10).

Alimentary system. From the posterior region of the foregut to the anterior portion of the intestine, spanning for 126 slices of transverse sections, comparable to 756 µm in antero-posterior length, the rhynchocoel is ruptured on its one of the ventrolateral sides with its wall detached, fragmented and floated inside the rhynchocoel (Figs. 11, 12). This region completely covers the portion where the foregut and the anterior portion of the intestine simultaneously appear in a single transverse section for 98 slices, comparable to 588 µm long. In this region the alimentary tract and excretory collecting tubules are exposed to the interior of the rhynchocoel, with the blood vascular plexus continuous to the rhynchocoel lumen (Fig. 12). The supposed opening of the anterior end of the intestine into the dorsal wall of the foregut is unclear from the serial sections (Fig. 11), although the foregut behind this portion evidently comprises a blind sac and has
no connection with the intestine. The posterior portion of the intestine, possessing lateral pouches, is not included in the sectioned material.

*Vascular system.* Pseudometameric transverse vascular connectives were reported to be absent in the original description (Gibson, 1990: 114). However, compared to the position of the commencement of the transverse connectives in the Japanese specimens, those in the holotype would be present in the posterior portion of the intestine, which remains unsectioned.

**DISCUSSION**

The fact that a part of the rynchocoel wall is detached in a region including the foregut-intestine junction in the holotype of *Lineopselloides albilineus* Gibson, 1990 indicates some sort of unnatural force acted during fixation to puncture the rynchocoel. Whether this force also affected on the topological relation of the foregut and intestine at their junction in the holotype of *L. albilineus* is presently uncertain and should be ascertained by additional specimens from its type locality, Hong Kong, or reasonably closer area.

All the Japanese specimens in the present study, identified as *Lineopselloides albilineus* by their external appearances, possessed an intestinal caecum, instead of a foregut caecum observed in the holotype of *L. albilineus*. The morphology of the foregut-intestine junction found in the Japanese specimens agrees with that of *Lineopsella* Friedrich, 1970, rather than that of *Lineopselloides Gibson*, 1990. Due to the suspicion that the unusual morphology of the foregut-intestine junction in the holotype of *Lineopselloides albilineus* might have been caused by an artifact during fixation, we utilized the external appearances as the index of conspecificity between the Hong Kong and Japanese individuals; whether they can be regarded as a single biological species remain unclear at present and may require molecular identification (e.g., Strand & Sundberg, 2005). Also, the taxonomic status of the genus *Lineopselloides Gibson*, 1990 should be re-considered when new material becomes available.

According to McDermott’s (2006) recent review on
the parasitism in nemerteans by other organisms, trematode metaercariae is likely to have only been reported from the monostiliferous hoplonemertean *Amphiporus lactifloreus* (Johnston, 1828) by McIntosh (1873-1874); the present paper may well represent a second report of trematode parasites in nemerteans.

**ACKNOWLEDGMENTS**

We are grateful to Ms. Emma Sherlock for her help in specimen loan; to Professor Teruo Nishikawa, Dr. Taeko Kimura, and Mr. Shoichi Kimura for their support in HK’s field sampling at Hamanako; to the staff of the Fisheries Laboratory, Graduate School of Agricultural and Life Sciences, the University of Tokyo, for providing the laboratory facilities and accommodation during HK’s stay; to Dr. Manabu Asakawa for his help in collecting specimens at Hiroshima; to Professor Yasuhiro Hemi for conducting faunal survey at Sonohigata and providing us the material; and to Mrs. Junko Sato for her assistance in taking the digital photomicrographic images of the slides. This study was partially supported by Grants-in-Aid from the Japan Society for the Promotion of Science (research grant number 16770059) and Wetlands International Japan.

**REFERENCES**


Renier, S. A., 1804. Prospetto della classe dei Vermi. XV-XXVII.


