Metasychis varicollaris sp. nov., and report of *Metasychis gotoi* (Maldanidae, Annelida) from the China Seas (#50223)

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Metasychis varicollaris sp. nov., and report of *Metasychis gotoi* (Maldanidae, Annelida) from the China Seas

Yueyun Wang [1], **Xinzheng Li** [2, 3, 4, 5], **Chunsheng Wang** [Corresp. 1, 6]

[1] Key Laboratory of Marine Ecosystem Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, China

[2] Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China

[3] Center for Ocean Mega-Science, Chinese Academy of Sciences, Qingdao, China

[4] University of Chinese Academy of Sciences, Beijing, China

[5] Laboratory for Marine Biology and Biotechnology, Pilot National Laboratory for Marine Science and Technology (Qingdao), Qingdao, China

[6] School of Oceanography, Shanghai Jiao Tong University, Shanghai, China

Corresponding Author: Chunsheng Wang
Email address: wangsio@sio.org.cn

Polychaete species are widely distributed throughout Indo-Pacific and European waters. We collected *Metasychis* specimens from the China Seas to report on *Metasychis varicollaris* sp. n. and *Metasychis gotoi* (Izuka, 1922) in greater detail. Geographic analysis of the potential distribution areas of *M. gotoi* indicates that it may be found in most coastal areas of China. The newly discovered species, *M. varicollaris* and *M. gotoi,* have an overlapping distribution in the northern South China Sea. *Metasychis varicollaris* sp. n. is characterized by a crenulated cephalic rim, complete collar on the first chaetiger, a packet-shaped anal funnel, and a spirally-fringed notochaetae with spiral pectinate bands imbricated over the main shaft. Our study provides a taxonomic key to all species of *Metasychis*.

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Yueyun Wang[1], Xinzheng Li[2, 3, 4, 5], Chunsheng Wang[1, 6*]

[1] Key Laboratory of Marine Ecosystem Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, Zhejiang, China
[2] Institute of Oceanology, Chinese Academy of Sciences, Qingdao, Shandong, China
[3] Center for Ocean Mega-Science, Chinese Academy of Sciences, Qingdao, Shandong, China
[4] University of Chinese Academy of Sciences, Beijing, China
[5] Laboratory for Marine Biology and Biotechnology, Pilot National Laboratory for Marine Science and Technology (Qingdao), Qingdao, Shandong, China
[6] School of Oceanography, Shanghai Jiao Tong University, Shanghai, China

Corresponding Author:
Chunsheng Wang[1]
Baochubei Road 36, Hangzhou, Zhejiang, 310012, China
Email address: wangsio@sio.org.cn

Abstract

Polychaete species are widely distributed throughout Indo-Pacific and European waters. We collected *Metasychis* specimens from the China Seas to report on *Metasychis varicollaris* sp. n. and *Metasychis gotoi* (Izuka, 1922) in greater detail. Geographic analysis of the potential distribution areas of *M. gotoi* indicates that it may be found in most coastal areas of China. The newly discovered species, *M. varicollaris* and *M. gotoi,* have an overlapping distribution in the northern South China Sea. *Metasychis varicollaris* sp. n. is characterized by a crenulated cephalic rim, complete collar on the first chaetiger, a packet-shaped anal funnel, and a spirally-fringed notochaetae with spiral pectinate bands imbricated over the main shaft. Our study provides a taxonomic key to all species of *Metasychis*.

Introduction

Maldanids, with their cylindrical bodies, are an easily recognizable member of the Capitellida polychaetes. Individuals have elongated segments from the median to the posterior regions of the body, with the parapodia resembling slender bamboo-shoots at one end (Fauchald, 1977). Maldanids are found in hard or soft substrates from the intertidal region to the deep sea (Paterson et al., 2009; De Assis & Christoffersen, 2011). Malmgren erected the family Maldanidae in 1867. Arwidsson (1906) subsequently divided the family into five subfamilies: Euclymeninae, Lumbriclymeninae, Maldaninae, Nicomachinae, and Rhodininae. Three additional subfamilies have since been proposed: Clymenurinae (Imajima and Shiraki, 1982a), Bogueinae (Wolf, 1983), and Notoproctinae (Detinova, 1985). De Assis and Christoffersen (2011) proposed the phylogenetic relationships of Maldanidae subgroups based morphological data, however, the subfamilies Clymenurinae and Bogueinae were not supported by the character-based phylogenetic tree estimated using maximum parsimony. Therefore, Clymenurinae was included with Euclymeninae, and Bogueinae with Rhodininae. Kobayashia et al. (2018) reconstructed the molecular phylogeny and confirmed the monophyly of the subfamilies Rhodininae, Maldaninae, Lumbriclymeninae, and Nicomachinae. The subfamily Euclymeninae was shown as monophyletic (De Assis and Christoffersen, 2011), but was recovered as paraphyletic and Nicomachinae was clustered in it (Kobayashia et al., 2018).

The Maldaninae genus, *Metasychis,* was erected by Light (1991) to include four species: *M. collariceps* (Augener, 1906), *M. disparidentatus* (Moore, 1904), *M. fimbriatus* (Treadwell, 1934), and *M. gotoi* (Izuka, 1902). The members of *Metasychis* are distinguished by their well-developed cephalic rim with crenulations or cirri, J- or U- shaped nuchal grooves, chaetiger 1 with reduced or complete collar, notochaetae on the middle body with spirally fringed distal ends, and a funnel-like pocket anal plate. Only one *Metasychis* species, *Asychis gotoi,* was recorded from the China Sea (Liu, 2008; Yang & Sun, 1988). We examined the Maldaninae specimens deposited in the Marine Biological Museum of the Chinese Academy of Sciences (MBMCAS) and describe a new species of *Metasychis* from the northern South China Sea where the species are known to overlap.

Materials & Methods

We examined all of the Maldaninae specimens deposited in the Marine Biological Museum of the Chinese Academy of Sciences (MBMCAS) in the Institute of Oceanology (IOCAS) that were collected during the National Comprehensive Oceanography Survey (NCOS, 1958–1960) and the Sino-Vietnam Joint Comprehensive Oceanographic Survey of Beibu Gulf (1959–1961). The

specimens were preserved in a solution of 75% ethanol. The sampling sites are shown in Figure 1.

The potential geographic distributions of *Metasychis gotoi* were predicted using the MaxEnt program (Steven et al., 2019) with dismo packages (Hijmans et al., 2017) in an R environment. Ten environmental variables (mean of chlorophyll, dissolved oxygen, iron, nitrate, phosphate, phytoplankton, primary productivity, salinity, silicate, and temperature at present benthic mean depth) were downloaded from Bio-ORACLE (Tyberghein et al., 2012; Assis et al., 2017) and 115 presence localities were used in the analysis. Twenty-five percent of the locations were selected randomly for modeling and were evaluated using the evaluate function in dismo package.

We made morphological observations with a Zeiss Stemi 2000-C stereo microscope and compound microscope. Line drawings were made using a UGEE electronic drawing tablet in Adobe Photoshop. We rinsed the samples for viewing with a scanning electron microscope (SEM) with distilled waters for 12 hours to dissolve mineral crystals. We then ran the samples through a series of ethanol concentrations and stored them in absolute alcohol until observations were made.

Nomenclatural acts

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Results

Family Maldanidae Malmgren, 1867

Subfamily Maldaninae Malmgren, 1867

Genus *Metasychis* Light, 1991

Metasychis Light, 1991: 133–146; Wang & Li, 2016: 13.

Type species: *Metasychis disparidentatus* (Moore, 1904)

Diagnosis (after Light 1991, different feature highlighted in italicized). Body with 19 chaetigers, without neurochaetae on the first chaetigers. Lateral cephalic rim with crenulations or digitate cirri, fusing with expanded prostomial palpode or setting off from it by furrows, *connecting to J- or U-shaped nuchal groove or not*. Collar on chaetiger 1 complete, or reduced to a thick ventral roll of tissue. Notochaetae including spirally-fringed fimbriae. One pygidial achaetigerous segments or none. No anal valve. Pygidium well developed, forming a deep, posterior, funnel-like pocket, with a pair of deep lateral notches. Dorsal lobe of the pygidium with or without cirri.
Remarks. In Light's (1991) description, the *Metasychis* species usually has type B notochaetae, in which the fimbriae are more delicate and expanded away from the shaft (sometimes type A) in which the fimbriae are spinose and closely imbricated over the main shaft. The notochaetae examined here in *M. varicollaris* sp. n. and *M. gotoi* are closer to type A notochaetae in Light (1991).
Several specimens with a distinct collar were observed in the *Metasychis* material in the Marine Biological Museum of the Chinese Academy of Sciences and they should belong to a new species. They are described below.

***Metasychis varicollaris* sp. n.**
(Figs. 2–3)
Material examined. Holotype. MBM 012597, South China Sea, st. 6052, 21.5°N, 114°E, 54.5 m depth, 9 Apr. 1959. Complete specimen, length ca. 67mm, width ca. 2.2 mm at chaetiger 1, with muddy tube encompassment. Paratypes. MBM 012647, South China Sea, st. 6045, 21.75°N, 114.5°E, 61 m depth, 20 Mar. 1959. Anterior fragment with 10 chaetigers. Chaetigers 11– 12 were used in SEM examination. MBM 012658, South China Sea, st. 6045, 21.75°N, 114.5°E, 59.6 m, muddy sediment, 8 Apr. 1960. MBM 012676, South China Sea, st. 6116, 21°N, 111.5°E, 41 m depth, muddy sediment, 12 Apr. 1959. Other specimens examined. MBM 012576, South China Sea, st. 6051, 21.75°N, 114°E, 44 m, muddy sediment, 9 Dec. 1959. MBM 012674, South China Sea, st. 6131, 20°N, 111.25°E, 50 m, muddy sediment, 6 Apr. 1960. MBM 012645, South China Sea, st. 6131, 20°N, 111.25°E, 44 m, 29 Oct. 1959.
Description. Body cylindrical, with 19 chaetigers, and a funnel-shaped pygidium (Fig. 2A–D; Fig. 3E, F). Body color in alcohol yellow. The first 6–7 parapodial tori with glandular pads (Fig. 3A). Anterior end obliquely truncate, with an elliptical cephalic plate (Fig. 2B, E; Fig. 3D). Cephalic rim divided into three parts by a pair of deep lateral notches. Triangular to rounded crenulations on cephalic rim well-developed; 4–6 crenulations on lateral part, 12–16 on posterior part (Fig. 2B; Fig. 3D). Prostomial palpode broadly rounded. Eyes absent. Nuchal groove curved, slightly J-shaped (Fig. 2B, E), with many small curly cilia (Fig. 2F). Cephalic keel remarkable, high and long, wider posteriorly (Fig. 2B, E).

First three chaetigers relatively short, about 1–2 times as long as wide, biannulate in lateral view (Fig. 2A; Fig. 3A). Prominent complete collar on chaetiger 1. Dorsal part well-developed, longer than ventral part, extending forward (Fig. 2A; Figs. 3B, C). Mid-body, and posterior chaetigers typically with inflated neuropodial tori. Neurochaetae present from chaetiger 2, typically rostrate uncini similar on all chaetigers without significant variation between the first three uncini from subsequent uncini, arranged in a row on neuropodial tori (Figs. 2G, H). Capitium of uncinus with 5–6 transverse arcs of small teeth. First arc with about 12 small teeth larger than on other arcs. A tuft of bristles under main fang. Anterior chaetigers with two kinds simple capillary notochaetae (Fig. 2I): limbate capillary with narrow wing on one side (Fig. 2L) and common capillary without similar structures (Fig. 2M). Middle and posterior chaetigers with long spirally-fringed notochaetae and companion geniculate notochaetae (Figs. 2J, K, N). Long spirally-fringed notochaetae with two spirally pectinate bands imbricated over the main shaft.

Pre-pygidial achaetigerous segment absent. Anal mound well-developed (Fig. 2C; Figs.3E, F). Anal pore without anal valve. Anal funnel elliptical in end view. Deep lateral notches separating anal funnel into dorsal and ventral lobes. Dorsal lobe expanded, disc-shaped, without marginal cirri observed. Ventral lobe forming shallow posterior pocket, with a widen midventral notch.

Etymology. “vario”, Latin: different, various; “collare”, Latin: collar, neck. The specific name *varicollaris* referres to the collar shape of this species different from that of congeneric members.

Distribution. Northern South China Sea.

Remarks. *Metasychis varicollaris* sp. n. is morphologically similar to *M. gotoi*, especially in body size and cephalic plate. However, the new species has a fully developed collar in chaetiger 1, as opposed to a ventral collar in *M. gotoi*. *Metasychis collariceps* (Augener, 1906) and *M. fimbriatus* (Treadwell, 1934) also have a complete collar on chaetiger 1. The new species can be distinguished from the two species by the shape of collar and cephalic rim. Collar is laterally notched in *M. collariceps*, but is full in the new species. The margin of the posterior cephalic rim is complete in *M. fimbriatus* but is crenulated in the new species.

***Metasychis gotoi* (Izuka, 1902)**

(Fig. 4)

Maldane gotoi Izuka, 1902, p.109, Pl. 28, figs. 1–8

Asychis gotoi (Izuka, 1902) – Imajima and Shiraki, 1982b, p.75, fig. 36a–l; Yang and Sun, 1988, pp.264–265, fig. 125F–K

Maldane coronata Moore, 1903, p. 483–485, Pl. 28, figs. 94–96

Metasychis gotoi (Izuka, 1902)–Light, 1991, fig.1L–M

Material examined. MBM 006305–006307; 006310–006312; 006317; 006320; 006347; 006355; 006412; 007966; 007967; 008113; 008119; 008138; 012498; 012518; 012564–012566;

012569; 012571; 012573–012574; 012577–012580; 012582; 012586; 012588–012591; 012593;012603–012607; 012611; 012615–012619; 012621–012626; 012628; 012630; 012633; 012636; 012640–012643; 012646; 012648; 012650–012652; 012654–012655; 012657; 012660; 012664–012665; 012668–012670; 012675; 012677; 012679; 012681; 012685–012687; 012708; 012715; 012730; 201449–201455; 201457–201461; 201463; 201466; 201475–201492.

Diagnosis. Cylindrical body with nineteen chaetigers. Chaetiger 1 with a short ventral collar (Fig. 4B, C). First four chaetigers biannulate dorsally, and usually with epidermal glands. Following 5–6 chaetigers only with ventral epidermal glands (Fig. 4D).

Cephalic plate elliptical (Fig. 4A). Prostomial palpode broadly rounded, mushroom-shaped. Cephalic rim developed, divided into three parts by two lateral notches. Lateral cephalic rim with 5–7 digitate cirri (Figs. 4A–C). Posterior rim with irregular crenulations, sometimes with several small cirri. Cephalic keel short and broad. Nuchal groove curved, slightly J–shaped, extending outwards and forwards, forming a faint notch separating lateral cephalic rims from prostomial palpode.

Anal plate well developed, divided into a flaring dorsal lobe and a deep funnel-shaped ventral lobe (Figs. 4E, F). Margin of the dorsal lobe usually with six slender cirri.

Notochaetae arranged in two rows. Anterior chaetigers with simple capillary notochaetae including stout notochaetae and short companion chaetae (Figs. 4G, J). Middle and posterior chaetigers with geniculate companion chaetae and spirally fringed notochaetae, spinose spiral bands closely imbricated over main shaft (Figs. 4H, I, N, O). Chaetiger 1 without neurochaetae. Neurochaetae from chaetiger 2, rostrate uncini with several transversal rows of small teeth on main fang (Figs. 4K–M).

Tube encrusted with mud.

Distribution. *Metasychis gotoi* is widely distributed in the Indo-Pacific Ocean (Fauvel, 1932; Yang & Sun, 1988; Liu, 2008) and may be introduced in the Mediterranean Sea (Zenetos et al., 2010). Predicted potential distribution shows that *M. gotoi* may occur in most coastal areas of China (Fig. 1).

Remarks. *Metasychis gotoi* is distinguishable from other species of *Metasychis* by its developed crenulated cephalic rim, ventral collar on chaetiger 1 and anal cirri. This combination of characteristics is most similar to *M. disparidentatus*. However, there is no cirrus on the anal plate of *M. disparidentatus*.

Discussion

In the WoRMS database (Read & Fauchald, 2018), only *Metasychis gotoi* is listed under *Metasychis* genus and other species (*M. collariceps*; *M. disparidentatus*; *M. fimbriatus*) of this

genus are mistakenly listed under genus *Asychis*. The three species all have a collar on chaetiger 1. Light (1991) revised the subfamily Maldaninae. Wang and Li (2016) proposed a key to distinguish the Maldaninae genera. Based on those definitions, *Asychis* has no collar on chaetiger 1. Three genera of Maldaninae, *Chirimia* (Light, 1991), *Metasychis* (Light, 1991), and *Sabaco* (Kinberg, 1867) have a collar on chaetiger 1; *Sabaco* is characterized by crescentic nuchal grooves and a smooth cephalic rim. *Chirimia* and *Metasychis* have a mushroom-shaped palpod, and J or U-shaped nuchal grooves. *Chirimia* is distinguishable from *Metasychis* by the presence of an anal valve. Additionally, the pygidium of *Metasychis* is more developed than that of *Chirimia*. *Metasychis collariceps* was first described as a member of genus *Maldane* (Augener, 1906). Hartman (1938) transferred it to the genus *Asychis*. Light (1991) revised the subfamily Maldaninae and transferred it to the genus *Metasychis*. *Metasychis collariceps* has a complete collar on chaetiger 1 and a dentate lateral cephalic rim, based on its original description. Additional information is needed to confirm its taxonomic status. The species identification has been temporarily assigned based on the information that was available at the time. *Metasychis disparidentatus* is genotype of this genus designated by Light (1991). It has a collar limited to the ventral side of chaetiger 1, J-shaped nuchal grooves, and a well-developed pygidium. *Metasychis fimbriatus* was first described as a member of genus *Maldanella* by Treadwell (1934). Hartman (1956) transferred it to the genus *Asychis*. Later, Light (1991) transferred it to the genus *Metasychis*. It has a complete collar on chaetiger 1 and a well-developed pygidium with cirri on its dorsal lobe based on original description (Treadwell, 1934).

Conclusions

Maldaninae is a poorly known subfamily of Maldanidae because of inadequate descriptions of early-described species, requirements for complete specimens for complete identification. Correct taxonomy is critical for biodiversity mapping and environmental surveillance monitoring. The present study reported the most comprehensive survey of *Metasyshis* species from coastal waters of China, detailed information of taxonomy and destribution. The description of new *Metasyshis* species from southern China contributes to better understand its diversity worldwide. To date, members of *Metasychis* are reported to have limited geographical distribution except *M. gotoi*. *Metasychis collariceps* distributed in Caribbean Sea, *M. disparidentatus* from western Canada south to Southern California and Japan, *M. fimbriatus* is distributed in Puerto Rico. The five species may be distinguished by the following key:

Key to species of *Metasychis* Light, 1991

1. Fully developed collar on chaetiger 1 2
   Collar limited to ventral side of chaetiger 1 4
2. Collar entire without lateral notches 3

Collar with lateral notches .....*M. collariceps* **(Augener, 1906)**

3. Posterior part of cephalic rim crenulated .....***M. varicollaris* sp. nov.**

Posterior part of cephalic rim entire .....***M. fimbriatus* (Treadwell, 1934)**

4. Cephalic rim with faint crenulations; anal plate without cirri..***M. disparidentatus* (Moore, 1904)**

Lateral lobes of cephalic rim usually with digitate cirri; dorsal lobe of the anal plate with slender cirri .....***M. gotoi* (Izuka, 1902)**

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Figure 1

Sampling sites of *Metasychis varicollaris* sp. n. (×) and *Metasychis gotoi* (+)

Colors indicating predicted probability of suitable conditions for *M*. *gotoi*.

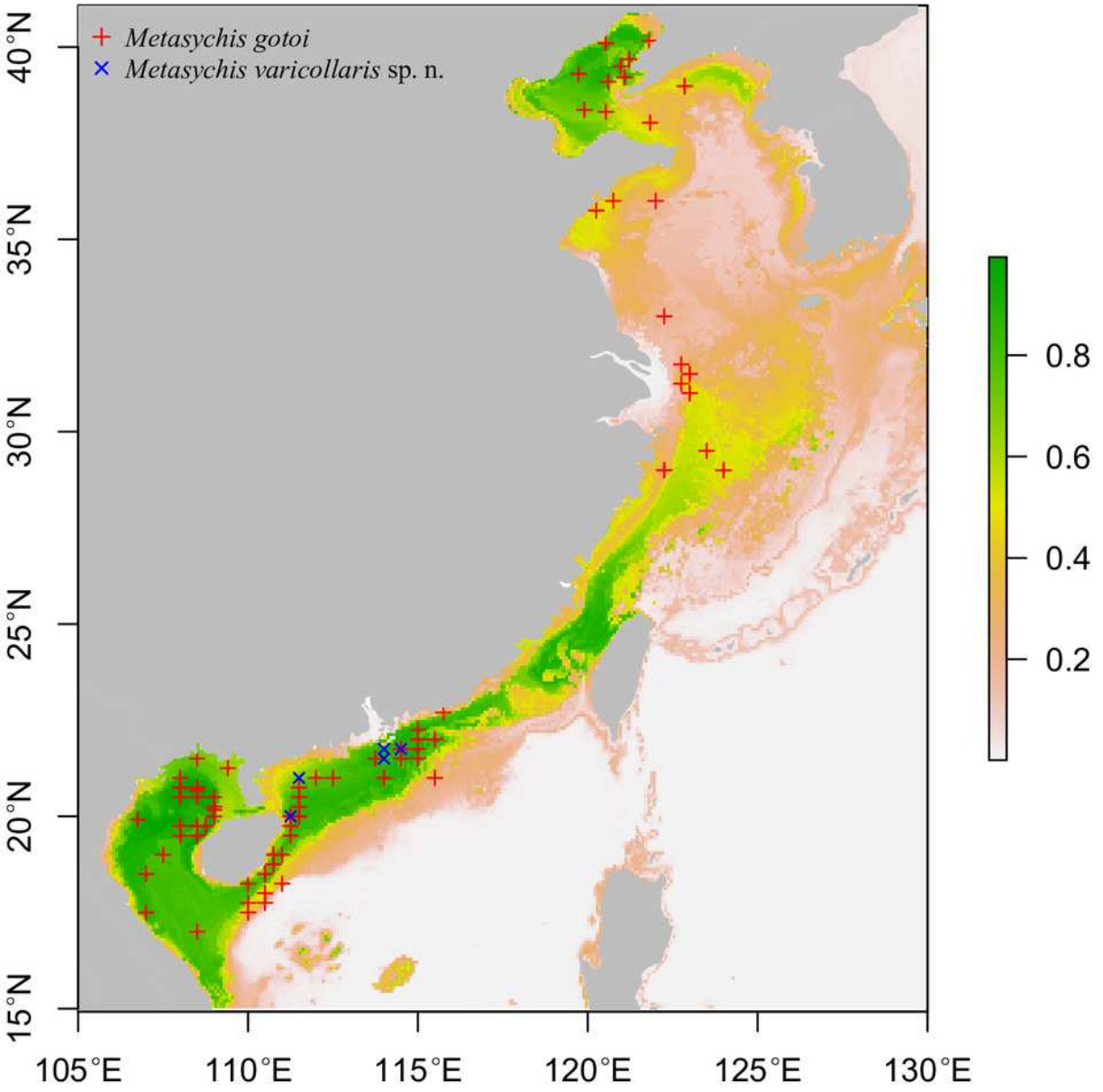
Metasychis gotoi
Metasychis varicollaris sp. n.
40°N
35°N
30°N
25°N
20°N
15°N
105°E
110°E
115°E
120°E
125°E
130°E
0.8
0.6
0.4
0.2

Figure 2

Metasychis varicollaris sp. n.

(A) Anterior region in lateral view. (**B**) Cephalic plate in dorsal view. (**C**) Pygidium in lateral view. **(D**) Pygidium in ventral view. (**E**) Cephalic plate in dorsal view. (**F)** Nuchal groove. (**G)** Neurochaetae in chaetiger 6. (**H)** Neurochaetae in chaetiger 11. (**I)** Notochaetae in chaetiger 5. (**J)** Notochaetae in chaetiger 11. (**K)** Spinose part of notochatae. (**L)** Limbate capillary. (**M**) Common capillary. **(N)** Geniculate notochaetae. Scale bars: 1.0 mm (A–E), 10 µm (F–H, K), 100 µm (I–J).

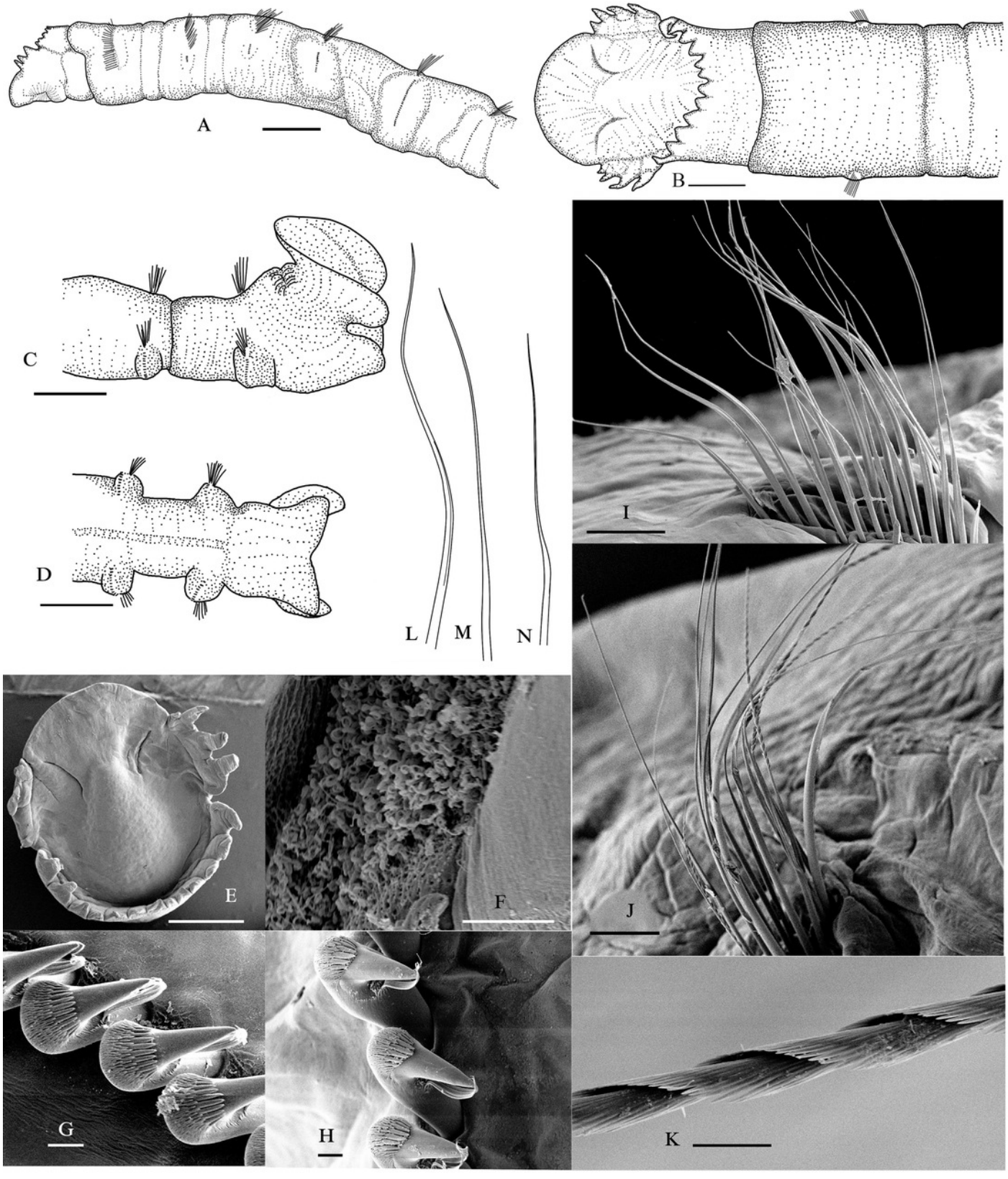
A
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Figure 3

Metasychis varicollaris sp. n.

(A) Anterior region in lateral view. (**B–C)** Head in lateral view. (**D)** Head in dorsal view. (**E)** Pygidium in ventral view. (**F)** Pygidium in dorsal view. Scale bars: 1.0 mm.

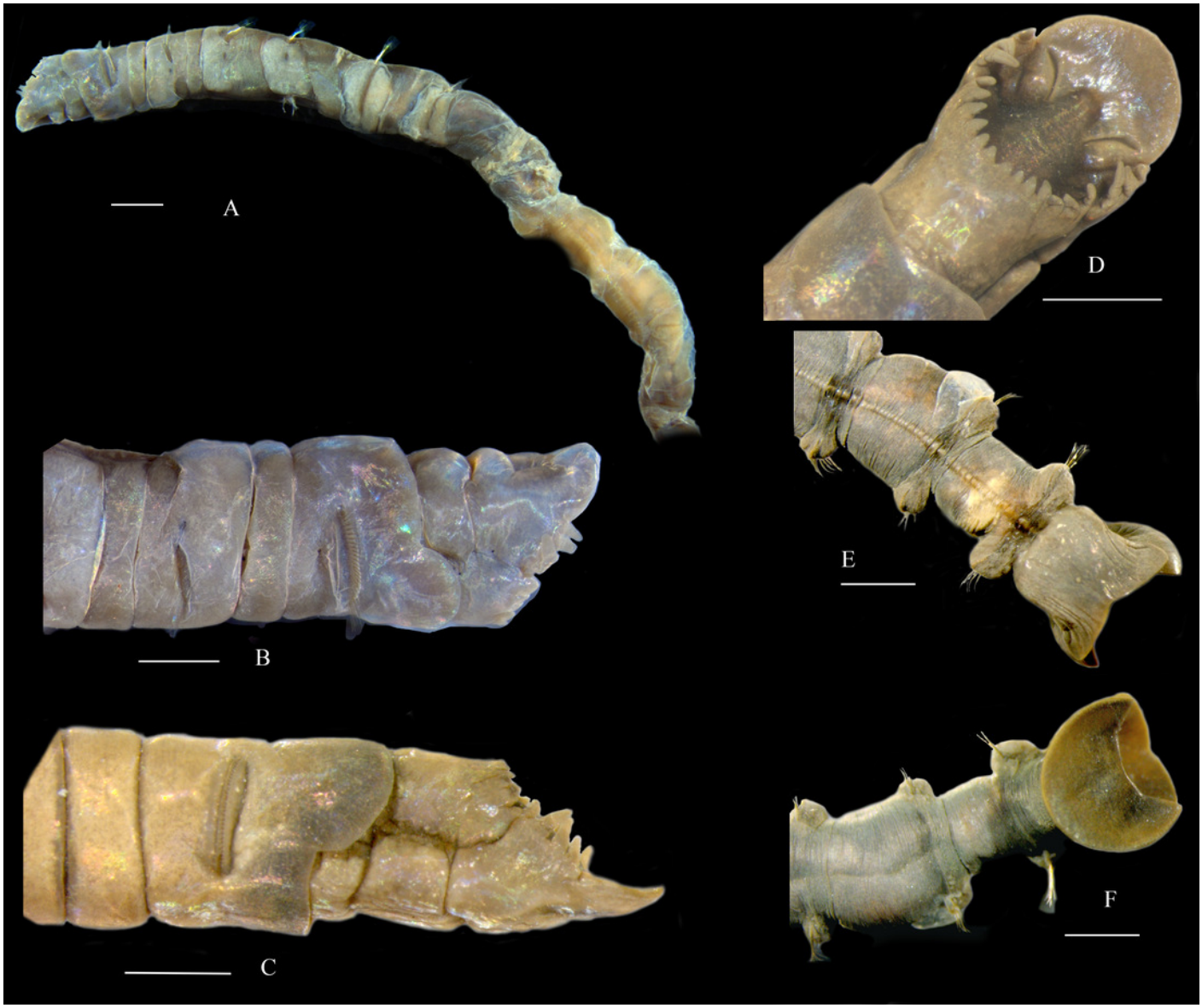
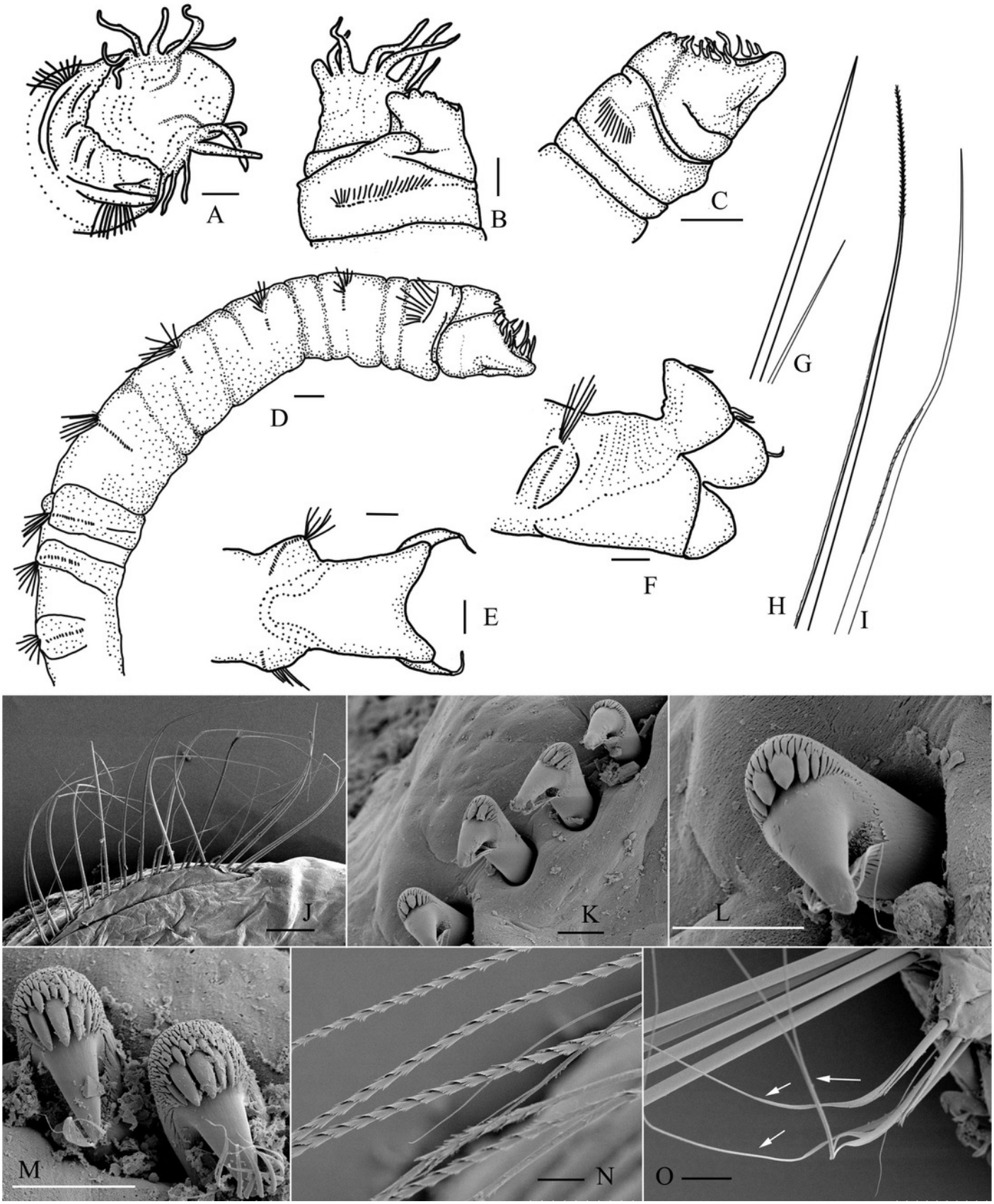


Figure 4

Metasychis gotoi (Izuka, 1902)

(A) Head region in dorsal view. (**B**–**C)** Head region in lateral and ventral views, respectively. **(D)** Anterior segments in lateral view. (**E**–**F)** Pygidium in ventral and lateral view. (**G)** Capillary notochaeta and short slender companion notochaetae on anterior segments. (**H**–**I)** Limbate notochaeta with spirally fringed tip and geniculate notochaeta on middle segments. (**J**–**O)** SEM images of chaetae. (**J)** Notochaetae on chaetiger 2. (**K–L)** Neurochaetae on chaetiger 2. (**M)** Uncini on chaetiger 11 in apex view. (**N)** Spirally fringed notochaetae. (**O)** Geniculate companion notochaetae. Scale bars: 0.5 mm (A–F), 250 µm (J), 20µm (K–N), 50 µm (O).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