ZOOLOGICAL SCIENCE **20**: 1171–1177 (2003)

A New Species of *Euzonus* (Polychaeta: Opheliidae) from Subtidal Zones in Japan

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ABSTRACT—A new opheliid polychaete, *Euzonus japonicus* sp. nov., is described. This species was collected from subtidal zones in Japanese coasts, while most *Euzonus* species inhabit intertidal sandy beaches. *E. japonicus* sp. nov. is morphologically most similar to another subtidal species, *E. flabelliferus* (Ziegelmeier, 1955) collected from northern Europe, but different from that in the form of branchiae. They share a unique characteristic on setiger 10, i. e., a pair of lateral transverse rows of conical cirri, instead of a pair of lateral smooth ridges that are common to all intertidal *Euzonus* species.

Key words: taxonomy, new species, Polychaeta, Opheliidae, subtidal habitat

INTRODUCTION

Species of the genus *Euzonus* (Polychaeta: Opheliidae) are distinguished from other opheliids by the body divided into three distinct regions: cephalic, thoracic and abdominal region. At present, 11 current species are known in this genus: *E. arcticus* Grube, 1866, *E. furciferus* (Ehlers, 1897), *E. mucronatus* (Treadwell, 1914), *E. ezoensis* (Okuda, 1936), *E. dillonensis* (Hartman, 1938), *E. williamsi* (Hartman, 1938), *E. flabelliferus* (Ziegelmeier, 1955), *E. profundus* Hartman, 1967, *E. heterocirrus* Rozbaczylo and Zamorano, 1970, *E. otagoensis* Probert, 1976, and *E. zeidleri* Hartmann-Schröder and Parker, 1995.

Most *Euzonus* species inhabit intertidal sandy beaches consisting of well-sorted, medium to fine sands (Okuda, 1934; McConnaughey and Fox, 1949; Dales, 1952; Probert, 1976; Kemp, 1988; Buzhinskaja, 1991; Jaramillo *et al.*, 1993; Jaramillo, 1994; Hartmann-Schröder and Parker, 1995; Souza and Gianuca, 1995). However, *E. flabelliferus* was collected from subtidal zones in the North Sea and the White Sea (Ziegelmeier, 1955; Tzetlin, 1978; Hartmann-Schröder, 1996), and *E. profundus* was collected from an abyssal depth of 4008 m, southeast off the Cape Horn (Hartman, 1967). The subtidal species, *E. flabelliferus*, has a unique morphological characteristic on setiger 10, i. e., a pair of lateral transverse rows of conical cirri, while all intertidal species have a pair of lateral smooth ridges on setiger 10 instead of conical cirri.

In East Asia including the Far East Region of Russia (Annenkova, 1935; Uschakov, 1955), northern Japan (Okuda, 1934, 1936; Imajima and Hartman, 1964), and the Chinese coast of the Yellow Sea (Dejian and Ruping, 1988), three intertidal species of the genus *Euzonus*, *E. arcticus*, *E. ezoensis* and *E. dillonensis* have been recorded, but no subtidal species has been recorded. *Thoracophelia yasudai* described by Okuda (1934) from Japanese coast of the Sea of Japan was regarded as a junior synonym of *E. arcticus* by Imajima and Hartman (1964).

In the course of our examination of Japanese opheliid polychaetes, we found a species belonging to the genus *Euzonus* from subtidal habitats. This species is similar to *E. flabelliferus* in both the unique morphological characteristic on setiger 10 and the subtidal habitat, but different from that in the form of branchiae. In the present paper, we describe this species as new to science and as the second subtidal species of the genus *Euzonus*.

MATERIALS AND METHODS

Specimens were collected using a bottom sampler from subtidal sandy bottoms at four collection sites in Japan (Fig. 1). These worms were fixed in 10% formalin for more than 24 hr, rinsed in freshwater and transferred to 80% ethanol for preservation, except for specimens collected from off Yura Beach, Miyazu in 25 September 2001, which were fixed in 100% ethanol for future DNA analysis. For the preserved specimens, body length (BL) and body height (BH) at setigers 5 and 15 were measured. The characteristics of lat-

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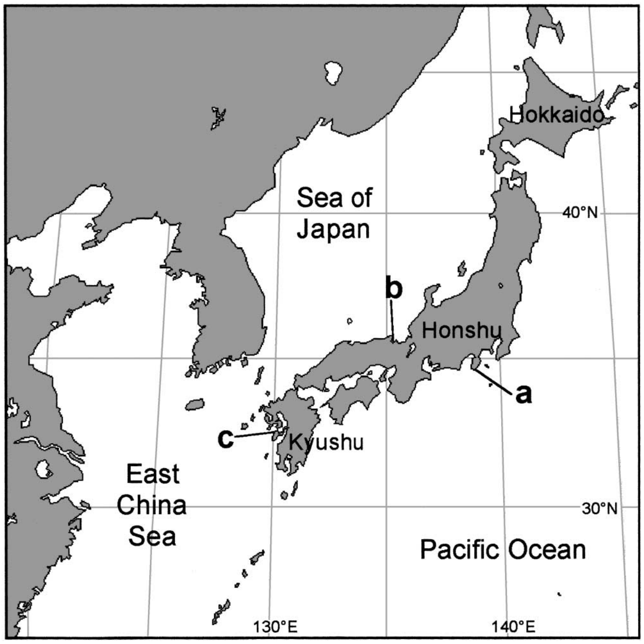

Fig. 1. Map showing location of collection sites in Japan. **a**: Oura Bay, Shimoda, and off Yumigahama Beach, Minami-izu, Izu Peninsula. **b**: Off Yura Beach, Miyazu. **c**: Tomioka Bay, Reihoku, Amakusa-Shimoshima Island.

eral cirri and branchiae were examined basically on the left side of the body except for some injured specimens. Drawings were made with a camera lucida and pictures were taken with a digital camera through a binocular microscope. The type materials are deposited in the National Science Museum, Tokyo (NSMT), Coastal Branch of Natural History Museum and Institute, Chiba (CMNH), the Senckenberg Museum, Frankfurt/M. (SMF), Zoological Museum, University of Copenhagen (ZMUC), and the United States National Museum of Natural History (Smithsonian Institution), Washington, D. C. (USNM).

SYSTEMATICS

Family Opheliidae Malmgren, 1867

Genus *Euzonus* Grube, 1866

Euzonus japonicus sp. nov.

Figs. 2–3

Euzonus ezoensis: Yokoyama and Hayashi, 1980: 46–58.
Euzonus sp. 1: Nishi *et al.*, 2001: 256.

Type material. Holotype (NSMT-Pol-H459, BL: 13 mm) and 4 paratypes (CMNH-ZW001939, SMF-13240, ZMUC, USNM-1014014, BL: 7–15 mm): subtidal sandy bottom, depth of 15 m, Oura Bay (34°39'N, 138°57'E), Shimoda, Izu Peninsula, Shizuoka Prefecture, 27 May 1996, coll. T. Kato. All materials complete.

Other material examined. Subtidal sandy bottom, depth of 11.5–16 m, off Yumigahama Beach (34°37.5'N, 138°53.8'E), Minami-izu, Izu Peninsula, Shizuoka Prefecture, 25 May 2000, coll. R. Ueshima, 7 specimens (BL: 11–16 mm). Subtidal sandy bottom, depth of 3–5 m, off Yura Beach (35°31'N, 135°17'E), Miyazu, Kyoto Prefecture, 20 August 1973, coll. I. Hayashi, 10 specimens (BL: 4–11 mm); 25 September 2001, coll. T. Misaka, 7 specimens (BL: 8–18 mm). Subtidal fringe of intertidal sandflat, Tomioka Bay (32°31'N, 130°02'E), Reihoku, Amakusa-Shimoshima Island, Kumamoto Prefecture, 14 June 1999, coll. A. Tamaki, 6 specimens (BL: 8–11 mm). All materials complete.

Diagnosis. Pair of lateral transverse rows of 6–11 dorsal and 2–4 ventral conical cirri present on setiger 10. Fifteen pairs of branchiae present, occurring on setigers 12 to 26. Branchiae palmatifid with 3–7 finger-shaped branches. Pygidium lacking triangular midventral anal plate. Each lateral lobe of pygidium fringed with 7–12 cirri. Midventral anal cirrus present as tiny round protrusion between lateral lobes, often obscure.

Description of the holotype. Body fusiform, divided into three distinct regions: cephalic region consisting of small pointed prostomium and 2 setigers; inflated thoracic region consisting of 8 setigers, separated from cephalic region by constriction behind setiger 2; abdominal region consisting of 22 setigers and pygidium, separated from thoracic region by swollen setiger 10; total of 32 setigers (Figs. 2a and 3a). Longitudinal midventral groove present, shallow in thoracic region, deep in abdominal region; pair of longitudinal lateral grooves present in abdominal region. Pair of dorsolateral nuchal grooves present in cephalic region. Ventral mouth slit present in cephalic region, proboscis eversible. Prostomial eyes absent.

Pair of lateral transverse rows of 11 dorsal and 3 ventral conical cirri present on setiger 10 (last thoracic setiger) (Figs. 2b and 3c). Ventral conical cirri present on setigers 9 to 25: 3 cirri on setigers 9 to 12, 2 cirri on setigers 13 to 15, and single cirrus on setigers 16 to 25, decreasing gradually to posterior setigers in size.

15 pairs of branchiae present, occurring on setigers 12 to 26 (Figs. 2a, c and 3a, b, e); branchiae palmatifid with 4–7 finger-shaped branches.

Parapodia biramous, minute. Segmental eyes absent. Notosetae and neurosetae all simple capillary setae, arising from slightly posterior to each parapodial lobe. Notosetae longer than neurosetae at all setigers, except for last 6 setigers (setigers 27 to 32) where notosetae and neurosetae equal in length. Setae on setigers 2 to around 5 and setigers 27 to 31 markedly longer than setae on other setigers.

Last 5 setigers (setigers 28 to 32) decreasing rapidly to pygidium in size (Fig. 3b). Pygidium consisting of two lateral lobes, lacking triangular midventral anal plate; each lateral lobe fringed with 12 minute tapering cirri; midventral anal cirrus obscure (Fig. 3g).

Allometry and variation. All 35 specimens collected from four localities were pooled for the analysis of allometry and variation. Body height (BH_1 mm for setiger 5, BH_2 mm for setiger 15) was correlated with body length (BL mm) according to the regression formulae (Fig. 4): BH_1=0.08 BL+0.6 (r^2=0.64, P<0.0001), BH_2=0.1 BL+0.2 (r^2=0.67, P<0.0001). Maximum body length was 18 mm. Total number of setigers was 31 or 32 possibly, though its exact count

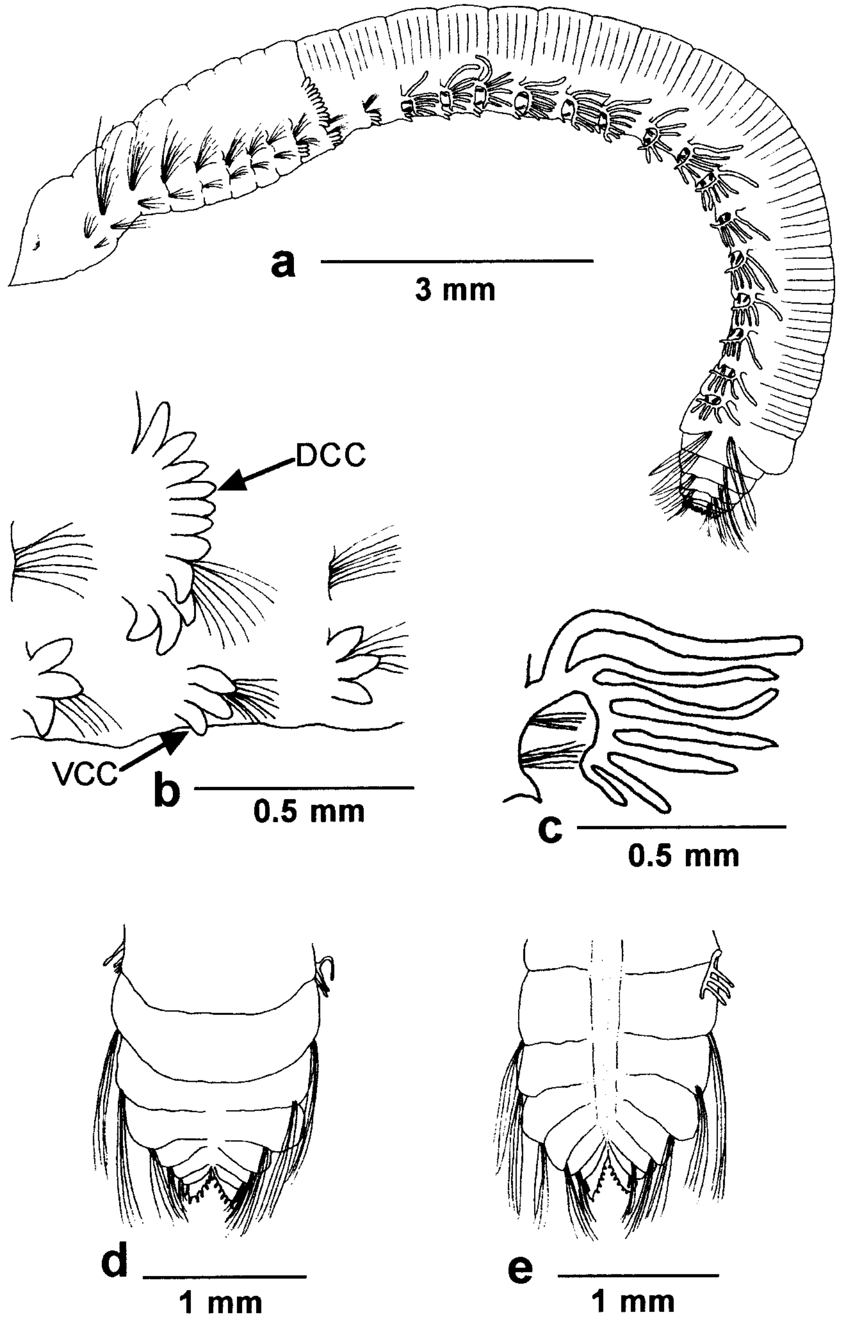

Fig. 2. *Euzonus japonicus* sp. nov. **a-c**: Holotype (NSMT-Pol-H459). **d, e**: Paratype (CMNH-ZW001939). **a**: Whole body, lateral view. **b**: Lateral transverse rows of dorsal conical cirri (DCC) on setiger 10 and ventral ones (VCC) on setiger 9 to 11. **c**: Branchia on setiger 20, well-stretched. **d**: Posterior end, dorsal view. **e**: Posterior end, ventral view.

was difficult because the last 2–3 setigers were often immersed into an anterior one owing to various extent of constriction by fixation.

The number of dorsal and ventral conical cirri on setiger 10 varied between 6 and 11 (average±SD: 9.2±1.4) and between 2 and 4 (2.5±0.6), respectively. The number of dorsal conical cirri (D) was correlated with body length according to the regression formula (Fig. 5a): D=0.18 BL+7.2 (r^2=0.25, P=0.002). The number of ventral conical cirri on setiger 10 was almost constant at 2 or 3, and not significantly correlated with body length (r=0.18, P=0.3) (Fig. 5b). The first setiger with ventral conical cirri was setiger 9 constantly, but the last setiger with those varied between setiger 17 and setiger 25. Therefore, number of setigers with ventral cirri (VC) varied between 9 and 17 (14.7±2.1), and it was correlated with body length according to the regression formula (Fig. 5c): VC=0.25 BL+12 (r^2=0.22, P=0.004).

All the specimens had 15 pairs of branchiae occurring on setigers 12 to 26 without any variation in their arrangement. The maximum number of branches of a branchia (B)

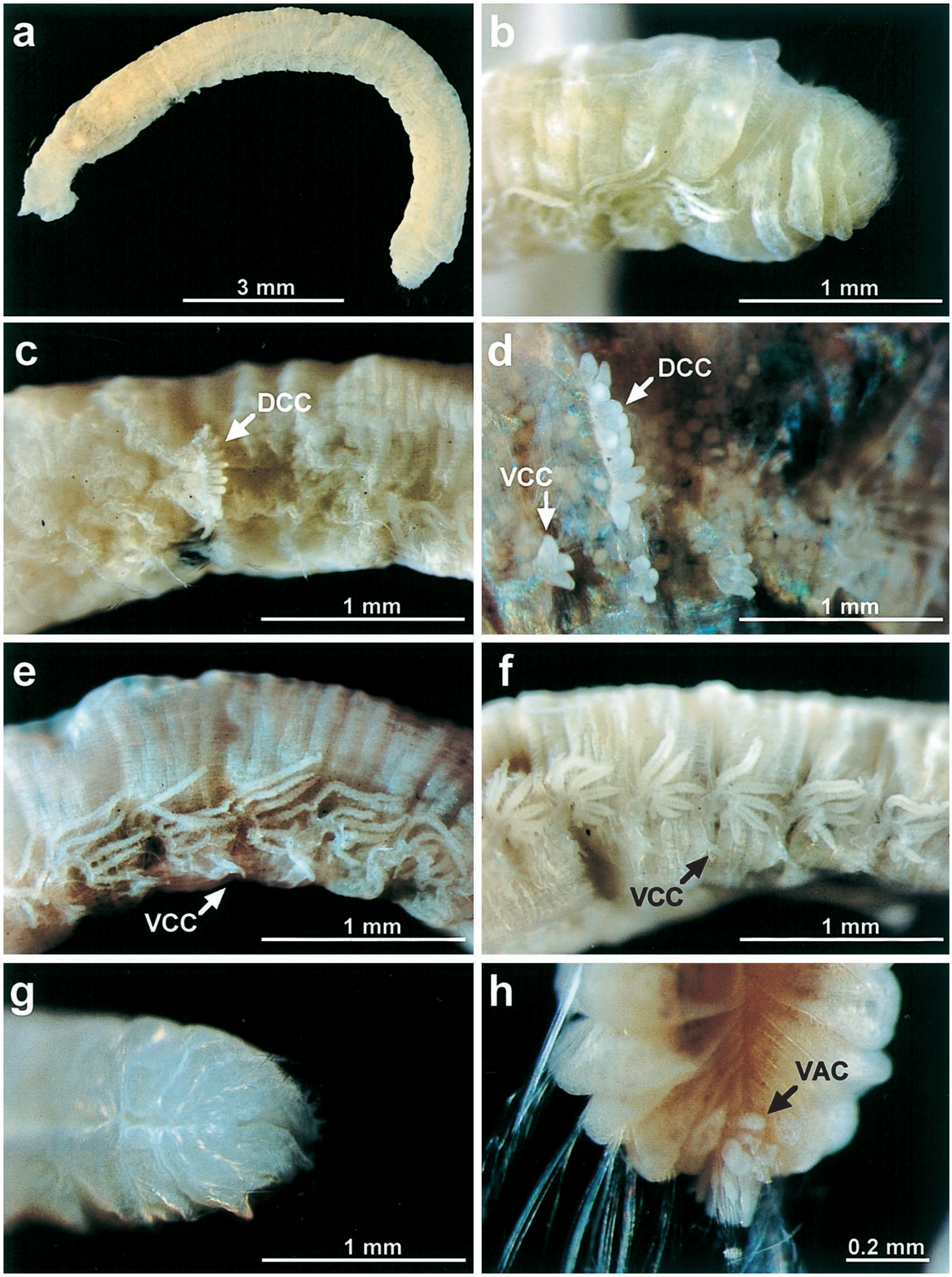

Fig. 3. *Euzonus japonicus* sp. nov. **a–c, e, g**: Holotype (NSMT-Pol-H459). **d**: Nontype collected from off Yura Beach, Miyazu in 25 September 2001. **f**: Paratype (CMNH-ZW001939). **h**: Nontype collected from off Yumigahama Beach, Minami-izu in 25 May 2000. **a**: Whole body, lateral view. **b**: Posterior end, lateral view. **c**: Lateral transverse row of dorsal conical cirri (DCC) on setiger 10. **d**: Lateral transverse row of dorsal conical cirri (DCC) on setiger 10 and ventral conical cirri (VCC) from setiger 9. **e**: Branchiae, well-stretched, and ventral conical cirri (VCC) on the middle abdominal region. **f**: Branchiae, relatively shrinked, and ventral conical cirri (VCC) on the middle abdominal region. **g**: Posterior end, ventral view. The midventral anal cirrus is invisible. **h**: Posterior end, ventral view. The midventral anal cirrus is visible (VAC).

varied between 3 and 7 (5.3±1.0), and it was correlated with body length according to the regression formula (Fig. 5d): B=0.19 BL+3.3 (r^2=0.49, P<0.0001). The branchiae were well-stretched in some specimens (Figs. 2c and 3e), while relatively shrinked in other ones (Fig. 3f), probably owing to various extent of constriction by fixation.

The number of cirri on each lateral lobe of pygidium varies between 7 and 12, though exact count was difficult because of the minute size of the cirri. Midventral anal cirrus was often obscure, but visible as a tiny round protrusion between the two lateral lobes at least in some specimens (Fig. 3h).

Reproduction. Oocytes (70–80 μm in diameter) were contained in the body cavity of 5 females: 3 specimens (BL: 11–14 mm) collected from off Yumigahama Beach, Minami-izu in 25 May 2000 and 2 specimens (BL: 16–17 mm) collected from off Yura Beach, Miyazu in 25 September 2001.

Habitat. Subtidal sandy bottoms.

Distribution. Japanese coasts of the Pacific Ocean, the Sea of Japan and the East China Sea (Fig. 1).

Etymology. The specific name refers to Japan, the type locality of this species.

Remarks. *Euzonus japonicus* sp. nov. is morphologically most similar to *E. flabelliferus* (Ziegelmeier, 1955) known in northern Europe (the North Sea and the White Sea); they share a unique characteristic on setiger 10, i. e., a pair of lateral transverse rows of conical cirri, instead of a pair of lateral smooth ridges that is common to most *Euzo-*

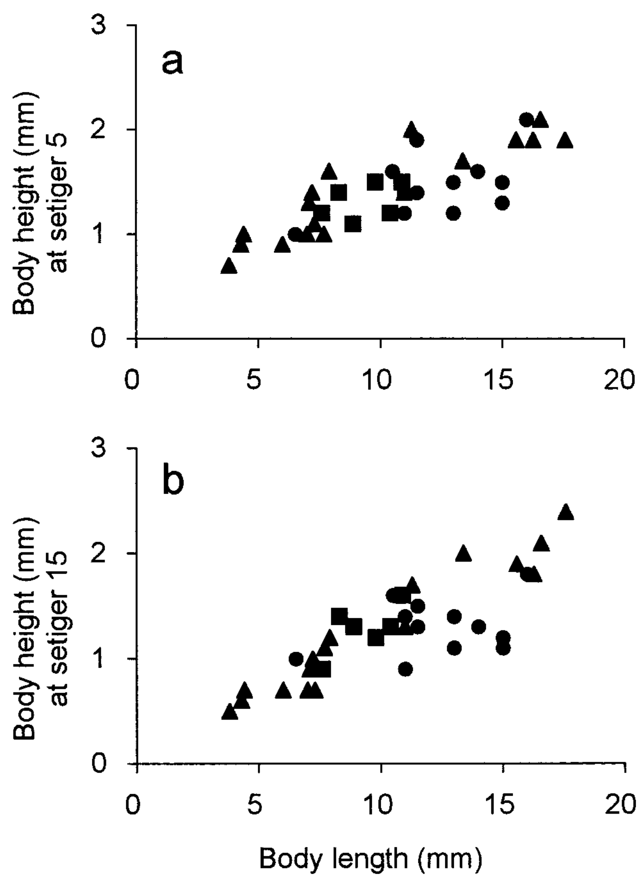

Fig. 4. *Euzonus japonicus* sp. nov. Relationships between body length and (a) body height at setiger 5 and (b) body height at setiger 15. Circles: 12 specimens collected from Izu Peninsula (Oura Bay, Shimoda and off Yumigahama Beach, Minami-izu). Triangles: 17 specimens collected from off Yura Beach, Miyazu. Squares: 6 specimens collected from Tomioka Bay, Amakusa-Shimoshima Island.

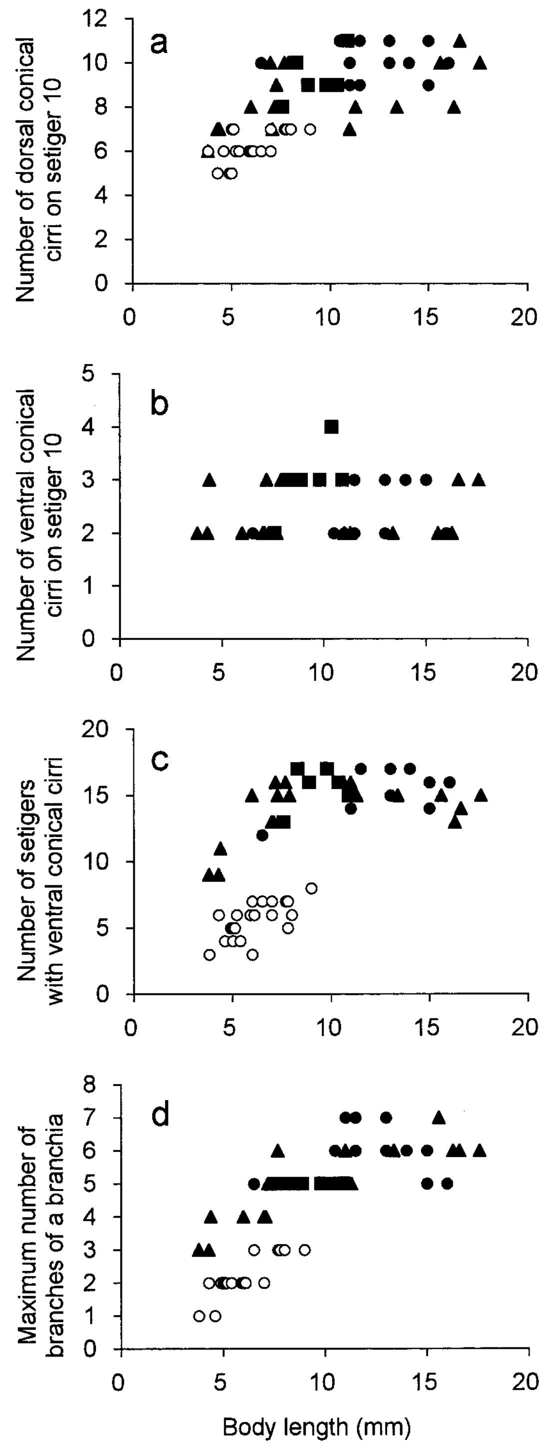

Fig. 5. *Euzonus japonicus* sp. nov. (solid symbols) and *E. flabelliferus* (open ones). Relationships between body length and (a) number of dorsal conical cirri on setiger 10, (b) number of ventral conical cirri on setiger 10, (c) number of setigers with ventral conical cirri, and (d) maximum number of branches of a branchia. Solid circles: 12 specimens collected from Izu Peninsula (Oura Bay, Shimoda and off Yumigahama Beach, Minami-izu). Solid triangles: 17 specimens collected from off Yura Beach, Miyazu. Solid squares: 6 specimens collected from Tomioka Bay, Amakusa-Shimoshima Island. Open circles: data shown by Ziegelmeier (1955, Tabelle 2) for 22 specimens of *E. flabelliferus* collected from the North Sea.

Table 1. Comparison of morphological characteristics in two subtidal *Euzonus* species

Species (Locality)	*E. japonicus* sp. nov. (Japan)	*E. flabelliferus* (North Sea)	*E. flabelliferus* (White Sea)
Maximum body length (mm)	18	9	16
Total number of setigers	31–32	31 or 32*	?
No. of dorsal conical cirri on setiger 10	6–11	5–7	?
No. of ventral conical cirri on setiger 10	2–4	1	?
First / last setiger with ventral cirri (No. of setigers with ventral cirri)	9 / 17–25 (9–17)	9 / 11–16 (3-8)	?
First / last branchiate setiger (No. of branchiate setigers)	12 / 26 (15)	12 / 25 (14)	12 / 24 (13)
Maximum number of branches of a branchia	3–7	1–3	2
No. and form of cirri on each lateral lobe of pygidium	7–12 tapering	7 round	?
Form of midventral anal cirrus	round, often obscure	round	?
References	Present study	Ziegelmeier, 1955 *Hartmann-Schröder, 1996	Tzetlin, 1978

nus species. They are also unique in lacking a triangular midventral anal plate that is common to most *Euzonus* species.

E. japonicus sp. nov. differs from *E. flabelliferus* in some characteristics (Table 1): *E. japonicus* sp. nov. has palmatifid branchiae with 3–7 finger-shaped branches, while *E. flabelliferus* has trifid, bifid or unbranched branchiae (Ziegelmeier, 1955). In comparison using individuals with corresponding BL of 3.8–9.0 mm (values for *E. flabelliferus* are based on data shown in Ziegelmeier, 1955), maximum number of branches in a branchia was significantly larger in *E. japonicus* sp. nov. (range: 3–6, average±SD: 4.5±0.9, n=14) than in *E. flabelliferus* (1–3, 2.2±0.6, n=22) (Mann-Whitney U-test: P<0.0001) (Fig. 5d). Number of dorsal conical cirri on setiger 10 was significantly larger in *E. japonicus* sp. nov. (6–10, 8.5±1.4, n=14) than in *E. flabelliferus* (5–7, 6.2±0.7, n=22) (P<0.0001) (Fig. 5a). Number of ventral conical cirri on setiger 10 was larger in *E. japonicus* sp. nov. (2–3, 2.4±0.5, n=14) than *E. flabelliferus* (1, variation not shown in Ziegelmeier, 1955). Number of setigers with ventral conical cirri was significantly larger in *E. japonicus* sp. nov. (9–17, 13.6±2.6, n=14, from setiger 9 to setiger 17–25) than in *E. flabelliferus* (3–8: 5.6±1.4, n=22, from setiger 9 to setiger 11–16) (P<0.0001) (Fig. 5c).

All the specimens of *E. japonicus* sp. nov. were collected from subtidal zones up to 15 m in depth. Similarly, *E. flabelliferus* has been reported from subtidal zones in the North Sea and the White Sea (Ziegelmeier, 1955; Tzetlin, 1978; Hartmann-Schröder, 1996). The subtidal habitats for *E. japonicus* sp. nov. and *E. flabelliferus* are in contrast with the intertidal habitats mainly restricted within upper to midtidal zones for most *Euzonus* species (Okuda, 1934; McConnaughey and Fox, 1949; Dales, 1952; Probert, 1976; Kemp, 1988; Buzhinskaja, 1991; Jaramillo *et al.*, 1993; Jaramillo, 1994; Hartmann-Schröder and Parker, 1995; Souza and Gianuca, 1995; our unpublished data).

We re-examined ten specimens, which were collected from off Yura Beach, Miyazu in 20 August 1973 and reported as *E. ezoensis* by Yokoyama and Hayashi (1980), and judged them as *E. japonicus* sp. nov. Horikoshi and Tamaki (1978) and Sakurai *et al.* (2001) also reported the occurrence of "*E. ezoensis*" from subtidal zones up to 19 m in depth in northern Japan. Their specimens also may be *E. japonicus* sp. nov. though we have not examined them.

ACKNOWLEDGEMENTS

We are grateful to Isao Hayashi (Kyoto University), Tetsuya Kato (Hokkaido University), Rei Ueshima (University of Tokyo) and Akio Tamaki (Nagasaki University) for kindly providing materials, and Masahiro Ueno (Kyoto University), staff of Fisheries Research Station of Kyoto University and staff of Shimoda Marine Research Center of University of Tsukuba for their help in collection of materials. We also thank Alexander Tzetlin (State University of Moscow) and Mary E. Petersen (Zoological Museum, Copenhagen) for their help with literature information, and two referees for their helpful comments.

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(Received October 10, 2002 / Accepted June 20, 2003)