

## A New Record of *Paramphichteis weberi* (Polychaeta: Terebellida: Ampharetidae) in Korean Fauna

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### ABSTRACT

An ampharetid polychaete, *Paramphichteis weberi* (Caullery, 1944), originally described from Indonesia, is newly reported from Korean waters. *Paramphichteis weberi* is characterized by the presence of the prostomial glandular ridges, nuchal ridges, pinnate buccal tentacles, four pairs of the foliose branchiae, and paleae in segment II. The mitochondrial cytochrome *c* oxidase subunit I (COI), 16S ribosomal DNA (16S rDNA), and nuclear 18S ribosomal DNA (18S rDNA) sequences from the Korean specimens of *P. weberi* were determined. The intra-specific genetic distance was 0.0–0.2% in COI and no variation was detected in 16S rDNA and 18S rDNA. The inter-specific genetic distances between several *Amphichteis* species were 20.0–22.0% in COI, 15.3–20.4% in 16S rDNA, and 1.3–3.1% in 18S rDNA. This is the first record of the genus *Paramphichteis* Caullery, 1944 in Korean fauna.

**Keywords:** *Paramphichteis weberi*, COI, 16S rDNA, 18S rDNA, Korea

### INTRODUCTION

*Paramphichteis* Caullery, 1944 is a small genus of the family Ampharetidae Malmgren, 1866 comprised of four species (Reuscher et al., 2015). The members of the genus are characterized by the following diagnostic features: the prostomium with paired longitudinal glandular ridges, presence of the paired nuchal ridges, pinnate buccal tentacles, and at least one pair of foliose branchiae (Jirkov, 2011; Reuscher et al., 2015). In East Asia, three *Paramphichteis* species, *P. angustifolia* (Grube, 1878), *P. sinensis* (Sui and Li, 2014), and *P. weberi* (Caullery, 1944), have been reported from China and Japan (Sui and Li, 2014; Reuscher et al., 2015). Among them, *P. weberi* was originally described as *Amphichteis weberi* from Indonesia, and later transferred to the genus *Paramphichteis* by the presence of the pinnate buccal tentacles based on an examination of Japanese specimens (Reuscher et al., 2015). The specimens previously considered *Amphichteis angustifolia* by von Marenzeller (1884) from southern Japan were identified as *P. weberi* by the presence of the paleae on segment II (Reuscher et al., 2015).

The sequences of mitochondrial DNA cytochrome *c* oxidase subunit I (COI), 16S ribosomal DNA (16S rDNA), and nuclear 18S ribosomal DNA (18S rDNA) are useful tools to

identify ampharetid polychaetes (Stiller et al., 2020). Because DNA barcoding information for the genus *Paramphichteis* is lacking, several *Amphichteis* polychaetes available in GenBank were used in this study. The *Amphichteis* species used were as follows: *A. dalmatica* Hutchings & Rainer, 1979, *A. gunneri* (M. Sars, 1835), *A. ninonae* Jirkov, 1985, *A. obscurior* Chamberlin, 1919, and *Amphichteis* sp. (Colgan et al., 2001; Eilertsen et al., 2017; Kongsrud et al., 2017; Stiller et al., 2020).

In this study, *P. weberi* is reported from Korean waters for the first time with its three partial DNA barcoding sequences. Based on the Korean specimens, the morphological description, illustrations, and photographs of the species are provided.

### RESULTS AND DISCUSSION

The specimens were collected from muddy sand in the intertidal zone using 500 µm mesh sieves. The morphological observation was carried out on live specimens anesthetized with a 10% magnesium chloride solution under a stereomicroscope (SZX12; Olympus, Japan). Dissected appendages were mounted onto temporary slides using glycerol and observed under an optical microscope (DM2500; Leica, Germany). The specimens were fixed in 4% formaldehyde for the morpho-

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**Table 1.** Pairwise genetic distances of three gene regions (COI, 16S rDNA, 18S rDNA) between Korean specimens of *Paramphicteis weberi* and several *Amphicteis* species mind from GenBank

Species	Accession No. (voucher No.)	1	2	3	Data source
COI (591 bp)					
1 <i>Paramphicteis weberi</i>	MW517800 (NIBRIV0000880690)				Present study
2 <i>Amphicteis obscurior</i>	MT166981 (SIO : BIC : A9431)	0.200			Stiller et al. (2020)
3 <i>Amphicteis dalmatica</i>	AF342678 (AMW199656)	0.220	0.200		Colgan et al. (2001)
16S (536 bp)					
1 <i>Paramphicteis weberi</i>	MW539050 (NIBRIV0000880690)				Present study
2 <i>Amphicteis ninonae</i>	KX513561 (ZMBN 95441)	0.153			Kongsrud et al. (2017)
3 <i>Amphicteis ninonae</i>	MG253077 (ZMBN 99270)	0.153	0.000		Eilertsen et al. (2017)
4 <i>Amphicteis gunneri</i>	MT166796 (SIO : BIC : A1107)	0.204	0.185	0.185	Stiller et al. (2020)
18S (1,435 bp)					
1 <i>Paramphicteis weberi</i>	MW539054 (NIBRIV0000880690)				Present study
2 <i>Amphicteis gunneri</i>	MG253150 (ZMBN 121368)	0.024			Eilertsen et al. (2017)
3 <i>Amphicteis</i> sp.	MG253160	0.031	0.013		Eilertsen et al. (2017)

logical study and 95% ethanol for genetic study. All voucher specimens were deposited at the National Institute of Biological Resources in Korea.

Genomic DNA was extracted from the ethanol-preserved *P. weberi* specimens (from branchia) using a DNeasy Blood & Tissue Kit (Qiagen, Hilden, Germany) according to the manufacture's protocol. The sequences of three gene regions were amplified by polymerase chain reaction according to the methods described by Kongsrud et al. (2017) using the following primer sets: LCO1490 and HCO2198 for COI (Folmer et al., 1994), 16Sar and 16Sbr for 16S rDNA (Kessing et al., 1989), and 18E/18R1843, 18F997 (internal) for 18S rDNA (Kongsrud et al., 2017). The newly determined sequences were registered in the GenBank under accession numbers MW517799–801 for COI, MW539049–51 for 16S rDNA, and MW539054 for 18S rDNA. The sequences of *P. weberi* were aligned with those of other *Amphicteis* species using Geneious v.8.1.9 (Biomatters, Auckland, New Zealand) and pairwise genetic distances (p-distance) were calculated by MEGA X (Kumar et al., 2018). The intra-specific genetic distances of Korean *P. weberi* ranged from 0.0 to 0.2% in COI, and no variation in 16S rDNA and 18S rDNA. The inter-specific genetic distances among several *Amphicteis* species available from GenBank were 20.0–22.0% in COI, 15.3–20.4% in 16S rDNA, and 1.3–3.1% in 18S rDNA (Table 1). The determined DNA sequences of *P. weberi* will be useful in future studies of ampharetid taxonomy.

Order Terebellida *sensu* Rouse & Fauchald, 1997  
Family Ampharetidae Malmgren, 1866

<sup>1</sup>\*Genus *Paramphicteis* Caullery, 1944

<sup>2</sup>\**Paramphicteis weberi* (Caullery, 1944) (Figs. 1–3)

*Amphicteis angustifolia*: von Marenzeller, 1884: 198, Pl. 2, fig. 5.

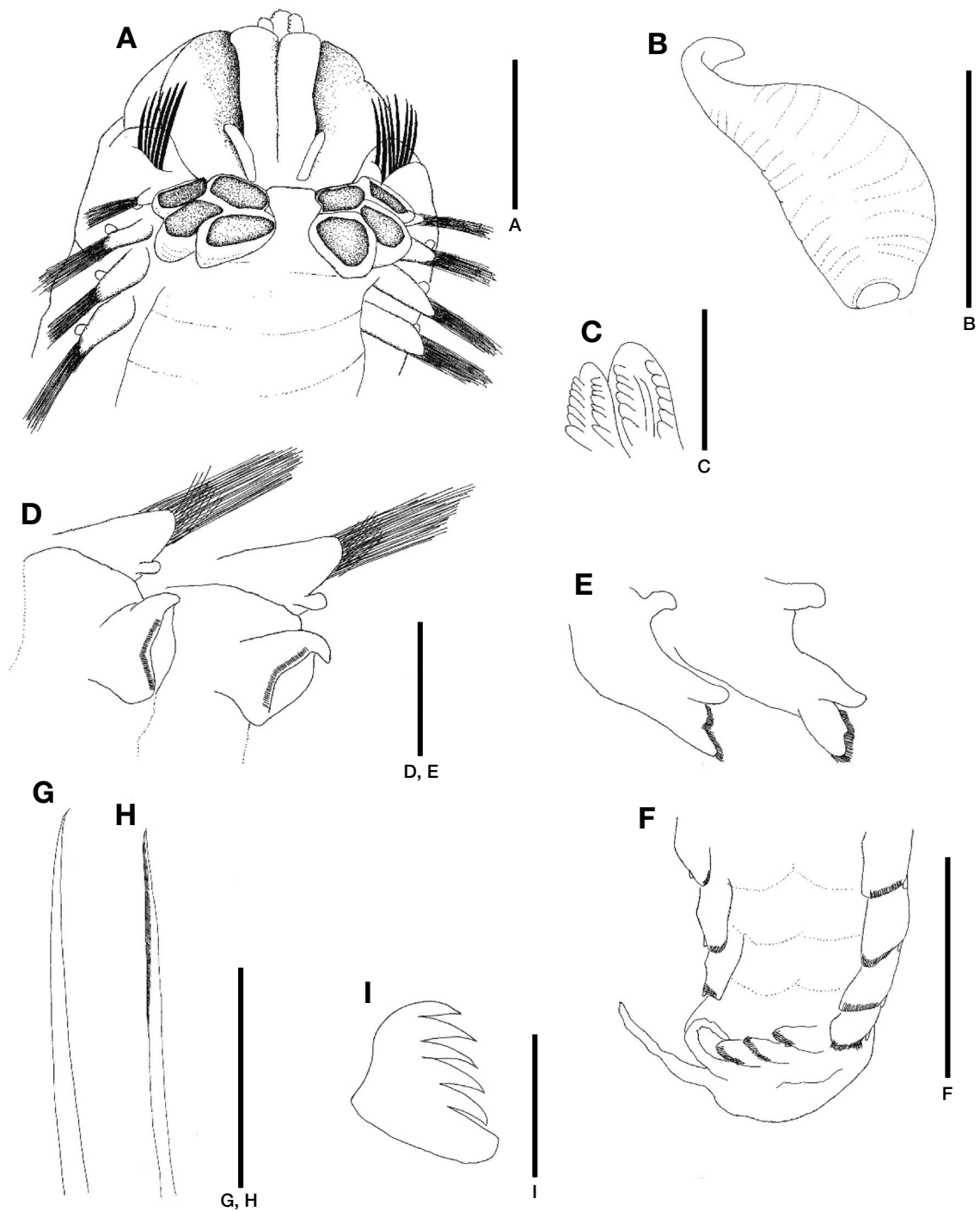
*Amphicteis weberi* Caullery, 1944: 76, fig. 62.

*Paramphicteis weberi*: Reuscher et al., 2015: 936, fig. 6.

**Material examined.** Korea: 4 inds., Jeollabuk-do: Buan-gun, Byeonsan-myeon, Mapo-ri (35°39'32"N, 126°29'22"E), 14 Aug 2018, intertidal, muddy sand (NIBRIV0000880692–4); 3 inds., same locality (35°39'34.5"N, 126°29'21.2"E), 19 Sep 2020, intertidal, muddy sand (NIBRIV0000879442, NIBRIV0000880690–1).

**Diagnosis.** Prostomium with paired longitudinal glandular ridges slightly curved anteriorly. Paired nuchal ridges separated by wide median gap, arranged at narrow-angle to each other. Eyespots absent. Buccal tentacles pinnate with digitiform filaments arranged in 2 vertical rows. Branchiae foliose, 4 pairs, arranged in 2 transverse rows separated by wide median gap on segments III and IV; first (inner) and second (outer) ones on anterior row, and third (inner) and fourth (outer) ones on posterior row (Figs. 1A–C, 2A, B, 3A, B). Paleae of segment II as long as following notochaetae but slightly thicker, numbering up to 9 per fascicle (Figs. 1A, G, 2A). Notopodia from segment III, with limbate capillaries arranged in 2 rows and tuberculate ventral cirri, present on 17 chaetigers. Neuropodial tori from segment IV with uncini and dorsal lobe, present on 14 chaetigers; thoracic uncini with 4–5 teeth above rostral tooth arranged in single row (Figs. 1D, H, I, 2C, F). Ventral

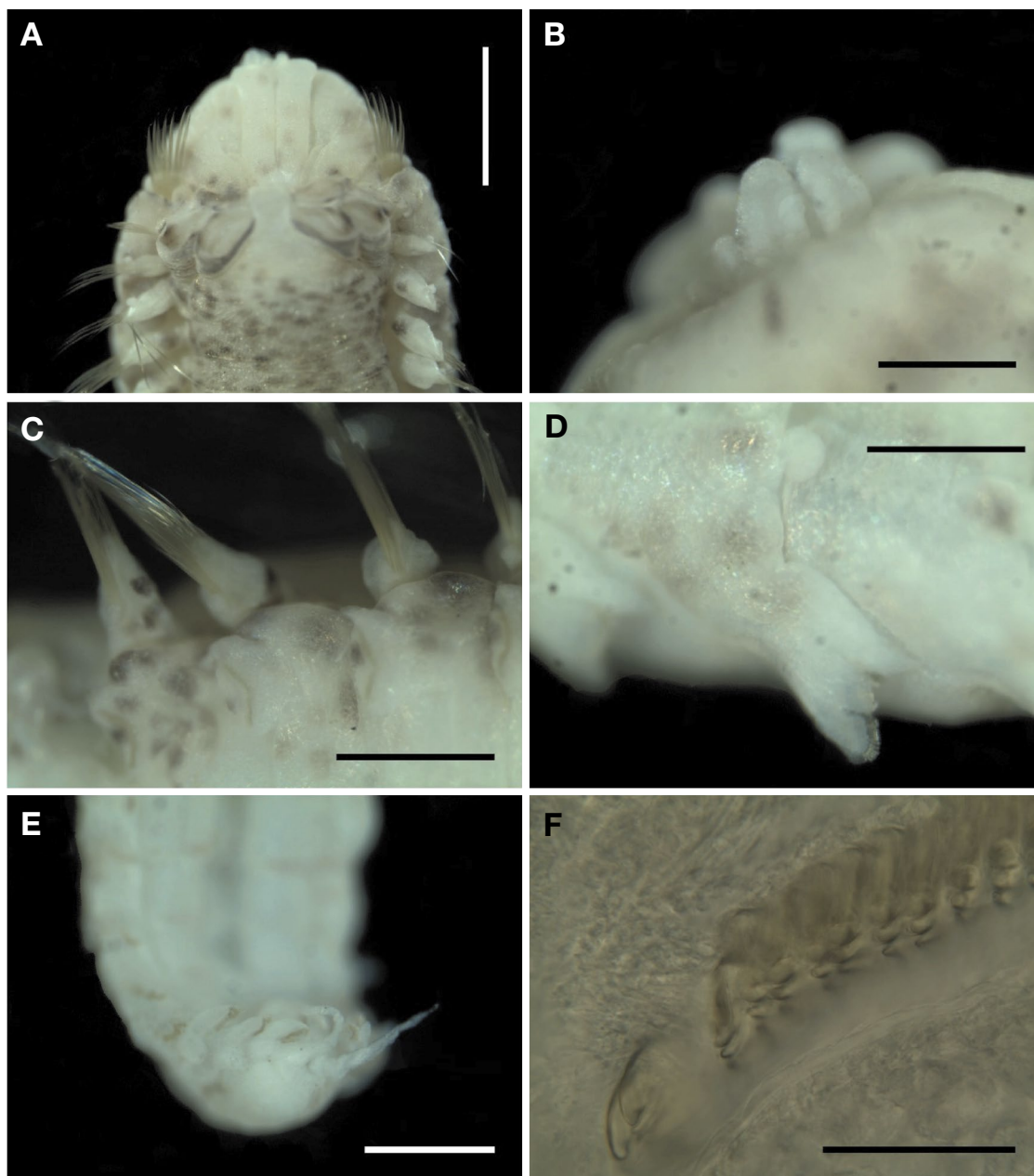
Korean name: <sup>1</sup>\*갯사슴갯지렁이속 (신칭), <sup>2</sup>\*갯사슴갯지렁이 (신칭)



**Fig. 1.** *Paramphicteis weberi* (Caullery, 1944) (NIBRIV0000880692). A, Anterior end without branchiae; B, Branchia; C, Buccal tentacles; D, Thoracic parapodia; E, Abdominal parapodia; F, Posterior end; G, Palea; H, Limbate notochoeta; I, Thoracic uncus. Scale bars: A, B, F=1.0 mm, C=0.3 mm, D, E=0.5 mm, G, H=0.8 mm, I=0.03 mm.

shields distinct to thoracic uncinger 10, becoming faint from thoracic uncingers 11. Modified notopodia and intermediate uncingers absent. Abdominal uncingers present on 15 chae-

tigers; pinnules each with digitiform dorsal cirrus (Figs. 1E, 2D). Pygidium with terminal anus and a pair of lateral cirri-form anal cirri (Figs. 1F, 2E).



**Fig. 2.** *Paramphicteis weberi* (Caullery, 1944) (NIBRIV0000880692), specimen fixed in alcohol. A, Anterior end without branchiae; B, Buccal tentacles; C, Thoracic parapodia; D, Abdominal parapodia; E, Posterior end; F, Thoracic uncini. Scale bars: A=1.0 mm, B=0.28 mm, C, E=0.5 mm, D=0.3 mm, F=0.04 mm.

**Remarks.** *Paramphicteis weberi* is characterized by the following characteristics combined: (1) presence of the prostomial glandular ridges and nuchal ridges, (2) pinnate buccal tentacles, (3) four pairs of foliose branchiae, (4) presence of the paleae on segment II, and (5) similar paleae length to the following notochaetae (Reuscher et al., 2015). A morphological difference between Indonesian (type locality) and East Asian

(Korean and Japanese) specimens of *P. weberi* is observed in the number of the abdominal uncini: 14 uncini in the Indonesian vs. 15 in East Asian specimens (Reuscher et al., 2015). *Paramphicteis weberi* is similar to *P. angustifolia* in having four pairs of foliose branchiae. However, the former can be distinguished from the latter by the presence of paleae on segment II which are as long as the following notochaetae



**Fig. 3.** *Paramphicteis weberi* (Caullery, 1944) (NIBRIV0000879442), specimen alive in seawater. A, Lateral view; B, Anterior end with branchiae, dorsal view. Scale bars: A=5.0 mm, B=1.0 mm.

(Reuscher et al., 2015).

**Habitat.** From intertidal to subtidal zones at 185 m depth (Reuscher et al., 2015). In this study, Korean specimens were collected from the muddy sand in the intertidal zone.

**Distribution.** Indonesia (type locality), Japan, Korea.

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## CONFLICTS OF INTEREST

Seong Myeong Yoon and Gi-Sik Min, contributing editors of the *Animal Systematics, Evolution and Diversity*, were not involved in the editorial evaluation or decision to publish this article. The remaining author has declared no conflicts of interest.

## ACKNOWLEDGMENTS

This study was supported by the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR202002204).

## REFERENCES

- Caullery M, 1944. Polychètes sédentaires de l'expédition du Siboga. Ariciidae, Spionidae, Chaetopteridae, Chlorhaemidae, Opheliidae, Oweniidae, Sabellariidae, Sternaspidae, Amphictenidae, Ampharetidae, Terebellidae. Siboga-Expédition, 24:1-204.
- Colgan DJ, Hutchings PA, Brown S, 2001. Phylogenetic relationships within the Terebellomorpha. Journal of the Marine Biological Association of the United Kingdom, 81:765-773. <https://doi.org/10.1017/S002531540100457X>
- Eilertsen MH, Kongsrud JA, Alvestad T, Stiller J, Rouse GW, Rapp HT, 2017. Do ampharetids take sedimented steps between vents and seeps? Phylogeny and habitat-use of Ampharetidae (Annelida, Terebelliformia) in chemosynthesis-based ecosystems. BMC Evolutionary Biology, 17:222. <https://doi.org/10.1186/s12862-017-1065-1>
- Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R, 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology, 3:294-299.
- Jirkov IA, 2011. Discussion of taxonomic characters and classification of Ampharetidae (Polychaeta). Italian Journal of Zoology, 78:78-94. <https://doi.org/10.1080/11250003.2011.617216>
- Kessing B, Croom H, Martin A, McIntosh C, Owen McMillian W, Palumbi S, 1989. The simple fool's guide to PCR. Department of Zoology, University of Hawaii, Honolulu, HI, pp. 1-47.
- Kongsrud JA, Eilertsen MH, Alvestad T, Kongshavn K, Rapp HT, 2017. New species of Ampharetidae (Annelida: Poly-

- chaeta) from the Arctic Loki Castle vent field. Deep-Sea Research Part II: Tropical Studies in Oceanography, 137:232-245. <https://doi.org/10.1016/j.dsr2.2016.08.015>
- Kumar S, Stecher G, Li M, Knyaz C, Tamura K, 2018. MEGA X: Molecular evolutionary genetics analysis across computing platforms. Molecular Biology and Evolution, 35:1547-1549. <https://doi.org/10.1093/molbev/msy096>
- Reuscher MG, Fiege D, Imajima M, 2015. Ampharetidae (Annelida: Polychaeta) from Japan. Part III: The genus *Amphicteis* Grube, 1850 and closely related genera. Journal of the Marine Biological Association of the United Kingdom, 95:929-940. <https://doi.org/10.1017/S0025315414001623>
- Stiller J, Tilic E, Rousset V, Pleijel F, Rouse GW, 2020. Spaghetti to a tree: a robust phylogeny for Terebelliformia (Annelida) based on transcriptomes, molecular and morphological data. Biology, 9:73. <https://doi.org/10.3390/biology9040073>
- Sui J, Li X, 2014. *Pseudoamphicteis sinensis* sp. nov., a new species of Ampharetidae (Polychaeta) from China. Zootaxa, 3872:376-380. <https://doi.org/10.11646/zootaxa.3872.4.4>
- von Marenzeller E, 1884. Südjapanische Anneliden II. Ampharetea, Terebellacea, Sabellacea, Serpulacea. Denkschriften der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften, 49:197-224.

Received March 2, 2021

Revised April 13, 2021

Accepted April 13, 2021