A large new *Wareniccona* (Bivalvia: Vesicomydidae) from a Pliocene methane seep deposit in Leyte, Philippines

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**ABSTRACT**

A new species of the genus *Wareniccona*, *W. mercenarioides*, belonging to the chemosymbiotic bivalve subfamily Pliocardinae (family Vesicomydidae), is described from a Pliocene methane-seep deposit at Liog-Liog on Leyte Island, Philippines. With a length of almost 12 cm, this species is significantly larger than the six extant species currently considered as belonging to *Wareniccona*. In addition to being very large, *W. mercenarioides* is more inflated and has a considerably more rounded shell outline compared to the oval shells of other *Wareniccona* species. This is the first fossil record of *Wareniccona*. Considering the overall similarity of the Leyte seep fauna to species living at vents and seeps in the vicinity of southern Japan, we anticipate that similarly large, and closely related species, might still be extant in the Indo-West Pacific region.

**Additional Keywords:** Indo-Pacific Ocean, hydrothermal vents, shell size, deep-sea

**INTRODUCTION**

Vesicomyd bivalves are a major component of faunal communities around many deep-sea hydrothermal vents, methane-seeps, and sunken whale carcasses (Boss and Turner, 1980; Paull et al., 1984; Smith et al., 1989; Kojima et al., 2004; Krylova and Sahling, 2010; Johnson et al., 2017). They thrive in these environments because they live in symbiosis with sulfur-oxidizing bacteria from which they obtain most, if not all, of their nutrients (Arp et al., 2014). Although vesicomyd bivalves do not show the diversity of symbiotic associations as bathymodiolids do, vesicomyd clades show a diversity of sulfide-binding affinities that enable (or restrict) them to colonize distinct niches within methane seep sites related to sulfate flux and availability (Barry and Kochevar, 1999; Goffredi and Barry, 2002; Decker et al., 2001). Future studies of shell size and sulfide-binding affinities could provide new insights into the long-term evolution of these traits through Earth’s history.

**MATERIALS AND METHODS**

Several methane-seep deposits have been discovered in deep-water strata of the Visayan back-arc basin along the northwestern coast of the island of Leyte in the Philippines (Majima et al., 2007; Majima et al., 2010). These massive mudstones were mapped as Bata Formation and initially considered late Miocene in age (Corby et al., 1951; Porth et al., 1989; Mines and Geosciences Bureau, 2010). The
specimens reported here were obtained from a giant calcareous concretion packed with chemosynthetic bivalves, found exposed at Liog-Liog Point between Tabango and Campano bays, at 11°17'37.7" N, 124°21'57.5" E (Majima et al., 2007). Ongoing stratigraphic and micropaleontologic work indicates that the Bata Formation exposed around the Liog-Liog Point ranges in age from late Pliocene to early Pleistocene, and the giant concretion is likely to have been derived from the upper Pliocene part of the Bata Formation. The type material is deposited at the National Museum of Nature and Science, Tsukuba, Japan (NMNS PM 28168, PM 28169) and the National Museum, Manila, Philippines (NMP-2148).

To observe the hinge structure, we performed non-destructive analysis using an X-ray microfocus CT system (TESCO TXS320 ACTIS) at the National Museum of Nature and Science, Tokyo, at experimental conditions of 247 kV and 240 μA. The resolution of the square slice CT was 97 mm per 1024 pixels, and the spacing between each CT slice was 0.1 mm. Analysis and surface rendering were performed using the software OsirX version 3.9.2 32-bit (an open-source DICOM viewer for Macintosh).

SYSTEMATICS

Family Vesicomyidae Dall and Simpson, 1901

Genus Wareniconcha Cosel and Olu, 2009

**Type Species:** Vesicomya guineensis Thiele and Jaeckel, 1931; Recent, from ca. 2500 to 4000 m depth on the West African continental margin (Cosel and Olu, 2009).

**Remarks:** Cosel and Olu (2009) included only the type species in Wareniconcha. In a subsequent review of vesicomyid species, Krylova and Sahling (2010) considered also the following species as belonging to Wareniconcha: Vesicomya compressa Prashad, 1932, Vesicomya cretacea Smith, 1906, Vesicomya lepta Dall, Vesicomya mercenarioides new species; holotype (NMNS PM 28168). 1. Left valve. 2. Right valve. 3. Dorsal view. 4. Hinge and ligament nympha of left valve, micro-CT scan. 5. Hinge and ligament nympha of right valve, micro-CT scan.
1895, *Vesicomya ovalis* Dall, 1895, and *Vesicomya winckworthi* Prashad, 1932.

**Wareniconcha mercenarioides** new species (Figures 1–9)

**Diagnosis:** Large and inflated *Wareniconcha* species that is about as high as wide, with a broad ligament nymph plate.

**Description:** Large, inflated shell, up to 12 cm long, slightly longer than high; umbones large, blunt, strongly prosogyrate; shell surface sculpture by fine, regular growth increments; anterior part short, somewhat pointed; posterodorsal margin broadly and evenly rounded, with angular transition to the equally broadly and evenly rounded ventral margin. Right valve with strong cardinal 1 radiating anteriorly, positioned anterior of umbo, cardinal 3a thin and short, positioned just anterior of umbo, cardinal 3b short, moderately strong, pointing posteriorly. Left valve with strong and elongate cardinal 2a subparallel to dorsal margin, cardinal 2b strong, quadrate, just beneath umbo, cardinal 4 thin, elongate, pointing posteriorly; nymph plate long and broad.

**Type Locality:** The Liog-Liog seep deposit.

**Type Material:** Holotype: NMNS PM 28168, articulated specimen (length 11.3 cm, height 9.7 cm, width 6.5 cm); Paratype 1: NMP-2148, articulated specimen (length 11.3 cm, height 10.1 cm, width 5.7 cm); Paratype 2: NMNS PM28169, disarticulated specimen (length ca. 12 cm, height, ca. 10 cm) consisting of incomplete right valve.

**Distribution and Habitat:** Pliocene methane-seep carbonates at Liog-Liog Point, Tabango municipality in Leyte, Philippines.
Etyymology: For its shell shape resembling the venerid  
genus Mercenaria.

Remarks: Wareniconcha mercenarioides differs from all  
species assigned to Wareniconcha (see list above in the  
remarks about Wareniconcha.) by being larger, more  
inflated, and being roughly as wide as high, whereas all  
other Wareniconcha species are oval in an anterior-  
posterior direction. Furthermore, W. guineensis, W.  
compressa, and W. lepta have a narrower hinge plate than  
W. mercenarioides.

Many of the accompanying bivalve species at the type  
locality belong, or are very similar to, extant species from  
vents and seeps in Japanese waters and especially in the  
Okinawa Trough (including, for example, Bathymodiolus  
securiformis (Okutani et al., 2004), Archivesica soyae  
(Okutani, 1957), Archivesica similis (Okutani et al.  
1997), Archivesica kawamurai (Kuroda, 1943), and  
Pliocardia kuroshimana (Okutani et al. 2000); TK and SK,  
unpublished). Therefore, we anticipate that Wareniconcha  
mercenarioides or a very closely related species may still  
be extant somewhere around the Indo-West Pacific.

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Notice

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