

A new species of *Lepidozona* (Mollusca, Polyplacophora, Ischnochitonidae) from Okinawa Trough, East China Sea

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Abstract A new species of chiton, *Lepidozona* (*Tripoplax*) *alba* is described from Okinawa Trough, East China Sea, at the depth from 576–611 m. The new species is distinguishable from other congeneric species by the flat radiating ribs lacking of granular sculpture on the valves, smooth dorsal girdle scales with long apical spines, and the deep-sea habitat. The new species appears to inhabit a chemosynthetic environment.

Key words: chiton, new species, chemosynthetic environment, Minami-Ensei Knoll, Japan.

Introduction

The Minami-Ensei Knoll, northern Okinawa Trough has been known to have an active hydrothermal vent and a warm seepage at the depth from 670 to 710 m (Okutani *et al.*, 1992). From this vent site, two molluscan taxa, a turbinid gastropod, *Thermocolonia jamsteci* Okutani and Fujikura, 1990 [= *Cantrainea jamsteci* (Okutani and Fujikura, 1990) (fide Okutani, 2000)] and a vesicomyid bivalve, *Calyptogena solidissima* Okutani *et al.*, 1992 [= *Calyptogena kawamurai* (Kuroda, 1947) (fide Kojima *et al.*, 2006)] were described. During the survey cruise to the Ryukyu Islands area by R/V Hakuho-Maru of the Japanese Agency of Marine Science and Technology Center in 2005, a large number of molluscan shells, including living *Calyptogena kawamurai* were collected in the neighboring area of the Minami-Ensei Knoll, at the depth of 576–594 m (St. OT-6). Those molluscan samples included a small ischnochitonid chiton and three large disarticulated intermediate valves which were tentatively identified as a species of the genus *Lepidozona*. Subsequently, this area was surveyed several times by R/V Nagasaki-Maru of Naga-

saki University, and a chiton specimen was collected in the latest cruise in November 2012 close to St. OT-6. Examination of those chiton specimens revealed that all belong to a single new species of the genus *Lepidozona* (*Tripoplax*), which is described herein.

Material and Methods

For SEM observation, pieces of girdle and radula were dissected, and macerated with household bleach, rinsed with water, cleaned with an ultrasonic cleaner, dehydrated with ethanol series, then transferred to t-butyl alcohol, and freeze-dried with JEOL-JFD300 freeze drying device. Dried specimens were coated with gold-palladium. SEM images were taken with high vacuum mode with low accelerating voltage, 1.0 kV.

Terms for the gill arrangement follow Sirenko (2006).

All specimens were deposited in the molluscan collection of the Department of Zoology, National Museum of Nature and Science, Tsukuba (formerly National Science Museum, Tokyo: NSMT).

Systematics

Class Polyplacophora Gray, 1821

Order Chitonida Thiele, 1910

Family Ischnochitonidae Dall, 1889

Genus *Lepidozona* Pilsbry, 1892

Subgenus *Tripoplax* Berry, 1919

Type species: *Trachydermon trifidus* Carpenter, 1864, by original designation

Lepidozona (Tripoplax) alba sp. nov.

(Figs. 1–17)

Material examined. Holotype: NSMT-Mo 78478, body length 32 mm, near Minami-Ensei Knoll area, northern Okinawa Trough, R/V Nagasaki-Maru St. J6–1, 28°32.080'N, 127°01.894'E–28°34.126'N, 127°02.546'E, 605–611 m, on sunken wood, 16 Nov. 2012. Paratypes: 1 small individual, NSMT-Mo 78479, body length 9.8 mm, near Minami-Ensei Knoll, Okinawa Trough, R/V Hakuho-Maru St. OT-6, 28°32.22'N, 127°01.84'E–28°31.05'N, 127°01.49'E, 576–594 m, on dead shell, 13 May 2005; 3 intermediate valves, NSMT-Mo 78480, valve width 10.6 mm, 23.2 mm and 24.0 mm, same locality with another paratype, NSMT-Mo 78479.

Type locality. Minami-Ensei Knoll area, northern Okinawa Trough, 28°32.080'N, 127°01.894'E–28°34.126'N, 127°02.546'E, 605–611 m.

Description of holotype. Animal large, 32 mm in body length, 19 mm in body width, oval (Figs. 1, 2). Valves moderately elevated, carinated in dorsum, hardly beaked, slightly convex in side slopes. Dorsal elevation 0.35 in valve IV, which lowering towards tail valve (Figs. 5–8). Color of valves and girdle white, partially covered with blackish foreign deposit.

Head valve semicircular, with shallow apical notch, almost straight in anterior slope (Fig. 4). Intermediate valves broadly rectangular; anterior margin slightly convex at both sides of somewhat forwardly produced jugal area; side margin

weakly rounded, hind margin nearly straight or slightly concave; apices weakly protruding; lateral areas raised (Figs. 5–7). Tail valve less than semicircular, narrower than head valve, which length is nearly half the width; mucro well defined, located slightly behind centre (Fig. 8); postmucronal slope slightly concave.

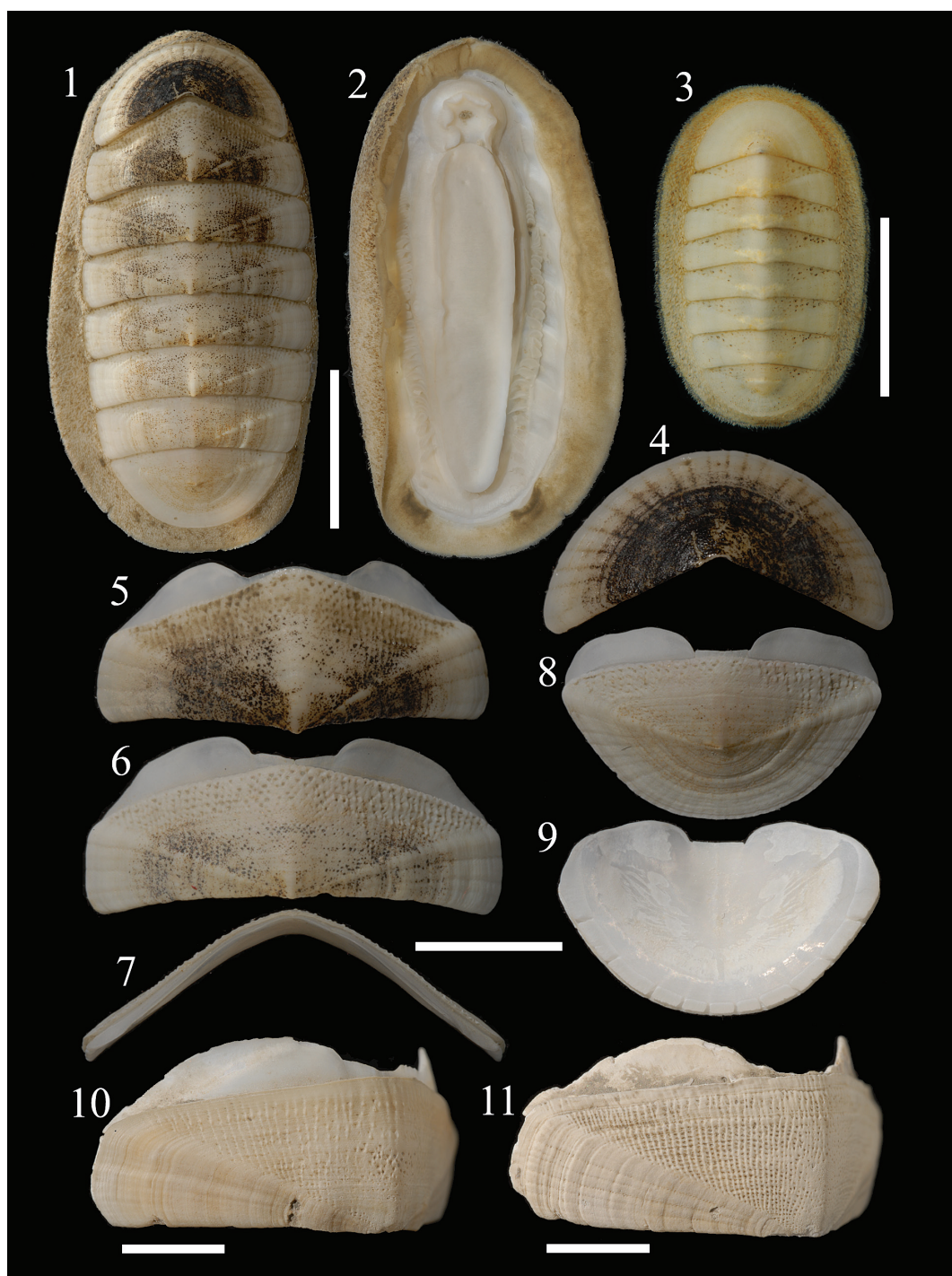
Head valve, lateral areas of intermediate valves and posterior area of tail valve cut by shallow sulci into low, flat, smooth radiating ribs: 24 in head valve, 3–4 in lateral areas, 26 in postmucronal area; sulci in posterior area very weak. Pleural areas sculptured with rather irregularly arranged longitudinal riblets, 18–20 in each side, and fine commarginal riblets; crossing points of both riblets often granularly raised. Sculpture of jugal area weak, finely reticulate with low oblique riblets (Figs. 4–6, 8).

Articulamentum white; sutural laminae wide, short, more or less rounded, connected across shallow sinus by short, slightly concave jugal plate, weakly notched at both sides (Figs. 5, 6, 8, 9). Insertion plates squarish, short, outer surface rough with minute grooves. Slit formula 16/2–3/10.

Girdle of moderate width (Fig. 1), covered with loosely imbricating, obliquely implanted, bent, almost smooth scales, up to 370 μ m in width, 300 μ m in length, with long, longitudinally grooved apical spine (Fig. 12). Surface of scales near girdle margin with numerous weak longitudinal riblets. Marginal fringe composed of long, slender, straight, blunt-topped, smooth needles, ca. 170 $\times$ 22 μ m, sheathed on a long chitinous stalk (Fig. 13), very small, rather coarsely grooved, also stalked spicules, 40–58 $\times$ 10 μ m, and wedge shaped, obliquely grooved, blunt-topped spicules, ca. 150 $\times$ 40–48 μ m (Fig. 14). Ventral side of girdle paved with partly overlapping rows of needles which are similar to the long stalked needle at the girdle margin, 160–190 $\times$ ca. 20 μ m (Fig. 15).

Gills holobranchial, adanal, with space, 38 ctenidia on each side. Posterior 7–10th ctenida largest (Fig. 2).

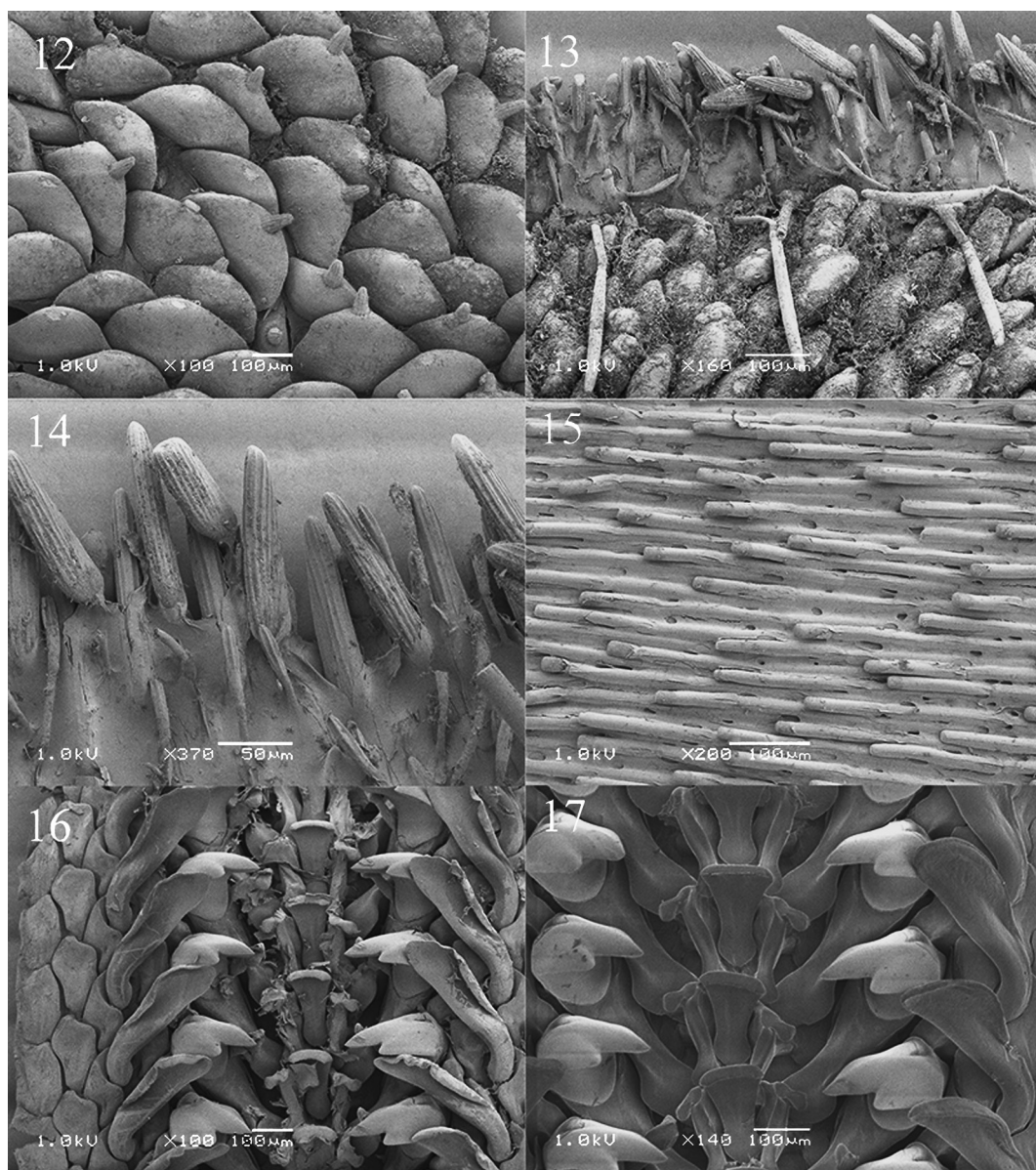
Radula 11 mm in length with 38 transverse



Figs. 1–11. *Lepidozona alba* n. sp. — 1, 2, 4–9, holotype, NSMT-Mo 78478; 3, paratype, NSMT-Mo 78479; 10–11, paratypes, NSMT-Mo 78480. — 1, 2, Intact animal, dorsal and ventral view. 3, Small animal, dorsal view. 4, Head valve, dorsal view. 5, Valve II, dorsal view. 6, 7, Valve IV, dorsal and frontal views. 8, 9, Tail valve, dorsal and ventral views. 10, 11, Sculpture of intermediate valves. Scales: 10mm for 1 and 2; 5 mm for 3–11.

rows of mineralized teeth. Central tooth narrow, weakly keeled at base, widening at top, with wide cutting edge. Centro-lateral (first lateral) teeth lower than central tooth, with small accessory plate at antero-dorsal corner, grooved at inner surface. Major lateral (2nd lateral) teeth

bicuspid; inner cusp much longer than outer one, pointed at tip; outer cusp blunt at tip. Shaft of major lateral with long petaloid process that is almost attaining near the tip of the inner cusp. Major uncinus teeth with fairly wide cusp (Figs. 16, 17).



Figs. 12–17. *Lepidozona alba* n. sp., holotype, NSMT-Mo 78478. — 12, Scales on perinotum. 13, Dorsal girdle margin. 14, Close up of dorsal girdle margin. 15, Spicules on hyponotum, inner surface. 16, Radula, anterior 16–20th rows. 17, Close up of central part of radula, anterior 10–12th rows. Scales: 100 μ m for 12, 13, 15–17; 50 μ m for 14.

Variation of valve sculpture. The three isolated intermediate valves exhibit considerable variation in the sculpture. Figure 10 shows a valve with a very weak sculpture, some parts are nearly smooth, whereas the valve in Figure 11 has a coarser reticulate sculpture. The sculpture of the third, smallest valve is intermediate between other two valves. Rather irregularly arranged longitudinal ribs with granular raises in the sides of pleural areas and the flat radial ribs without granules are common features shared in all specimens. In the smallest specimen (Fig. 3), the valve sculpture is much smoother than those of the larger specimen. Only a faint reticulation is found in the pleural areas.

Etymology. *alba*, Latin, meaning white, for the color of the animal.

Remarks. Among species of the subgenus *Tripoplax* occurring in the Northwestern Pacific area, the present species most resembles *Lepidozonia andrijaschevi* (Yakovleva, 1952) by having flat radiating ribs in the head valve, lateral areas of the intermediate valves and postmucronal area of the tail valve. However, the present species differs from *L. andrijaschevi* by absence of granules on flatter radiating ribs, and the deep-sea habitat. For the flat ribs without granules, the present species also resembles *Lepidozonia trifida* (Carpenter, 1864) and *Lepidozonia attuensis* Clark, 2000, but it can be distinguishable from either species by having long apical spine on the dorsal girdle scales, far distant distribution area, and the deep-sea habitat. *L. trifida* is distributed along the west coast of North America from Puget Sound, Washington, north to Shumagin Island, Alaska, in subtidal zone, and *L. attuensis* has been known only from Attu Island, Aleutian Islands, Alaska, in intertidal zone.

Schwabe and Sellanes (2004) described *Lepidozonia balaenophila* [= *Lepidozonia (Tripoplax) balaenophila* Schwabe and Sellanes, 2004] from whale bones at the depth of 240m off Concepcion, Chile. They suggested that *L. balaenophila* feeds on whale bones or is a potential member of a chemosynthetic community. They also reported *Tripoplax cowani* Clark, 2008 [= *Lepidozonia*

(*Tripoplax*) *cowani* (Clark, 2008)] from a methane seep area off Concepcion, Chile, at the depth of 922m (Schwabe and Sellanes, 2010). The present species also appears to live in a chemosynthetic environment, because all the specimens were collected together with a bivalve, *Calyplogena kawamurai* which is characteristic to chemosynthetic community. Okutani (2011) described a new large lucinid bivalve, *Elliptiolucina ingens* from the same site with the present paratypes, and suggested that it is associated with a chemosynthetic environment. Further investigations are needed for both cases of chitons to clarify their exact habitats and the relationships with the chemosynthetic communities. However, it should be noted that three species of the same subgenus have been found in such environments.

The deep-sea habitat of *Tripoplax* has been noted by Clark (2008). He raised *Tripoplax* as a full generic rank based on the deep-sea habitat together with the distribution range in northern, colder area and some morphology such like smaller dorsal scales and finer sculpture of the tegmentum other than the multiple slitting of the intermediate valves, which suggested the genus to be a natural (monophyletic) group. The features of the present new species may support his assertion, but as he remarked, further studies, especially molecular analysis, are needed to test his hypothesis and its relationship to *Lepidozonia* (*sensu* Clark, 2008).

Associated organisms on the sunken wood on which the holotype was attached included large number of acmaeid limpet, *Pectinodonta* sp. (T. Sasaki, pers. comm.) and teledinid bivalves, a few numbers of a small snail, probably a columbelliid and a small white galatheid (Crustacea), which can be seen in an image of the sunken wood taken onboard.

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