Taxonomy of Indonesian giant clams (Cardiidae, Tridacninae)

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ABSTRACT

Hernawan E. 2012. Taxonomy of Indonesian giant clams (Cardiidae, Tridacninae). Biodiversitas 13: 118-123. A taxonomic study was conducted on the giant clam’s specimens deposited in Museum Zoologicum Bogoriense (MZB), Cibinong Indonesia. Taxonomic overviews of the examined specimens are given with diagnostic characters, remarks, habitat and distribution. Discussion is focused on specific characters distinguishing each species. From seven species known to distribute in Indonesian waters, there are six species, Tridacna squamosa Lamarck, 1819; T. gigas Linnaeus, 1758; T. derasa Roding, 1798; T. crocea Lamarck, 1819; T. maxima Roding,1798; and Hippopus hippopus Linnaeus, 1758. This study suggests the need for collecting specimen of H. porcellanus Rosewater, 1982. Important characters to distinguish species among Tridacninae are interlocking teeth on byssal orifice, life habits, presence of scales and inhalant siphon tentacles.

Key words: Tridacninae, taxonomy, Museum Zoologicum Bogoriense

INTRODUCTION

Giant clams, the largest bivalve in the world, occur naturally in association with coral reefs throughout the tropical and subtropical waters of the Indo-Pacific region. From the southeast Pacific westwards to East Africa, its distribution extends up north to the Red Sea (bin Othman et al. 2010). They can generally be found in marine shallow water habitats (1-20 m) and are restricted in only clear waters due to their phototrophic characteristic (Jantzen et al. 2008). Their strong requirement of photosynthetic light is a consequence of their symbiotic relationship with zooxanthellae of the genus Symbiodinium (Hirose et al. 2006). Scientifically, there has been an increasing interest to the clams for more than the last four decades because their high commercial value has led the natural population to extinction. Vulnerable status, or even local extinction, for some species has been reported in Indonesia (Raymakers et al. 2003), Malaysia (Shau-Hwai and Yasin 2003) and several regions in Pacific (UNEP-WCMC 2010).

Recently, there are ten described species of the living giant clams, in only two genera, Tridacna and Hippopus (bin Othman et al. 2010). Three sub-genera are within Tridacna, Tridacna sensu stricto, consisting only T. gigas (Linnaeus, 1758); Persikima consisting T. derasa (Roding, 1798) and T. tevorou (Lucas, Ledua and Braley 1990); and Chametraacea comprising T. squamosa (Lamarck, 1819), T. crocea (Lamarck, 1819), T. maxima (Roding, 1798), T. rosewateri (Sireenko and Scarlato 1991) and T. costata (Richter, Roa-Quiaioit, Jantzen, Al-Zibdah, and M. Kochzius 2008). The genera Hippopus comprises of two species, H. hippopus (Linnaeus, 1758) and H. porcellanus (Rosewater 1982). There has been much discussion as to whether the giant clams should be placed still on their own family (Tridacnidae) or revised to be subfamily Tridacninae, included in family Cardiidae. Recently, based on sperm ultrastructure and molecular phylogenetic studies, the clams are belonging to family Cardiidae, subfamily Tridacninae (Schneider and Foighil 1999; Keys and Healey 2000).

Globally, various studies focusing on many aspects of the clams have been done, from biological experiments to mariculture and conservation strategy, for example Keys and Healy (2000), Buck et al. (2002), Kinch (2002), Harzhauser et al. (2008), and Teitelbaum and Friedman (2008). In context of Indonesia, taxonomic notes of giant clams are rare although Indonesian waters are the habitat for most of giant clams species in the world (bin Othman et al. 2010). This paper reports a taxonomic study of giant clams specimens deposited in Museum Zoologicum Bogoriense, Cibinong, Bogor, Indonesia.

MATERIALS AND METHODS

The study was conducted in June 2009 as a part of Workshop on Marine Taxonomy 2009, organized by Research Center for Oceanography. The giant clams specimens were observed from the dry collection of Museum Zoologicum Bogoriense (MZB), Cibinong Indonesia. All specimens were personally described, re-identified and determined based on Braley and Healy (1998), Newman and Gomez (2002), Dharma (2005), and ter Porten (2007). An overview of the examined specimens was given with diagnostic characters, remarks, habitat and distribution. Discussion is focused on specific characters distinguishing each species.
RESULTS AND DISCUSSION

Results
From the ten extant giant clams, seven species are known to inhabit Indonesian waters, i.e. Tridacna squamosa Lamarck, 1819; T. gigas Linnaeus, 1758; T. derasa Roding, 1798; T. crocea Lamarck, 1819; T. maxima Roding, 1798; Hippopus hippopus Linnaeus, 1758 and H. pallinarum Rosewater, 1982 (Newman and Gomez 2002; bin Othman et al. 2010). However, the specimen collection of giant clams in MZB is obviously not complete since only six species are deposited (Figure 1). None of the specimens is H. pallinarum Rosewater, 1982. Here is the taxonomic overview.

Class Bivalvia Linnaeus, 1758
Subclass Heterodonta Neumayr, 1884
Order Veneroida H. and A. Adams, 1856
Superfamily Cardioidea Lamarck, 1809
Family Cardiidae Lamarck, 1809
Subfamily Tridacninae Goldfuss, 1820

Genus Hippopus

Hippopus hippopus (Linnaeus, 1758) (Figure 1A)


Material examined. No. Lam 1327; Figure 1 (1); 7 specimens, paired valves (height : length; 6,05 : 8,10 cm; 6,62 : 9,25 cm; 5,85 : 8,12 cm; 5,95 : 7,05 cm; 5,00 : 8,10 cm; 5,72 : 8,18 cm; 5,27 : 7,35 cm; 5,82 : 8,05 cm); Loc. Laratuka Strait, Flores; Date 1953; Coll. Fr. L. Vianay, Det. U. E. Hernawan (22 June 2009)

Diagnostic characters. Solid shell, thick and heavy; equivalve, inequilateral, inflated and longer than high (maximum length 40 cm, commonly 20 cm). Umbo position is in midline. Outline of shell fan-shape; posterior and ventral margin meet at an angle less than 90°; anterior and ventral margin meet an angle less than 90°; posteroventral and anteriocentral margin meet at an angle more than 90°. Hinge with 1 ridge-like cardinal tooth, 2 lateral teeth on right valve, 1 lateral tooth on left valve. Pallial line presence but no pallial sinus; 1 adductor muscle scar. Outer surface sculptured with 2 to 3 small rib-like at each interstices; no scales and spines on the fold; anteriadorsal margin with non-interlocking crenulations, byssal orifice presence on anteriodorsal area with small byssal-gape (less than a half of anteriodorsal margin length). Inner margin with distinctively crenulations, correspond to the small rib-like sculpture at the interstices. Coloration on outer surface white, inner surface porcelaneous white. The inhalant siphon with tentacles.

Remarks. This species has outer surface without scales or spines, smoother than the others.

Habitat. Found in coral reefs, shallow water to a depth of 20 m.

Distribution. Tropical western Pacific, from western Indonesia to eastern Melanesia; north to the Philippines and south to New South Wales.

Tridacna (Tridacna) gigas (Linnaeus, 1758) (Figure 1C)

Syn. Chama gigas Linnaeus, 1758.

Material examined. No. Lam 899; Figure 1(3); 1 specimen, paired valves (13.44 cm in height and 22.5 cm in length); Loc. Maluku; Date (?); Coll. Rykschroeff, Det. U. E. Hernawan (22 June 2009)

Diagnostic characters. Shell solid, thick and heavy; equivalve, equilateral, inflated and longer than high (maximum length 60 cm, commonly 50 cm). Umbo position posterior. Outline of shell fan-shaped; rounded margin. Hinge with 1 ridge-like cardinal tooth, 2 lateral teeth on right valve, 1 lateral tooth on left valve. Pallial line presence but no pallial sinus; 1 adductor muscle scar. Outer surface sculptured with 7 to 12 large radial fold with 7 to 12 small rib-like at each interstices; no scales and spines on the fold; anteriadorsal margin with non-interlocking crenulations, byssal orifice presence on anteriodorsal area with small byssal-gape (less than a half of anteriodorsal margin length). Inner margin with indistinguishably crenulations. Coloration on outer surface white, inner surface porcelaneous white. The
inhalant siphon without tentacles.

**Remarks.** The specific characters are deep radial folds forming V-shape projection in ventral view. Outer surface relatively smooth and extremely large shell.

**Habitat.** Found in sand, coral reefs, shallow water to a depth of 20 m.

**Distribution.** Eastern Indian Ocean and tropical western Pacific, from southwestern Myanmar and western Indonesia to Micronesia and eastern Melanesia; north to southern Japan and south to Queensland and New Caledonia.

**Tridacna (Chametraechea) crocea** (Lamarck, 1819) (Figure 1D)

**Syn.** Tridacna crocea Lamarck, 1819: 106; Tridacna cumingii Reeve, 1862: pl. 7, fig. 7a (part); Tridacna ferruginea Reeve, 1862: pl. 8, fig. 8a-b.

**Material examined.** No. Lam. 443; Figure 1(4); 2 specimens, paired valves (6,65 cm in height and 8,05 cm in length); Loc. (?); Date (?); Coll. Duwens, Det. U. E. Hernawan. (22 June 2009).

**Diagnostic characters.** Shell solid, thick; equivaIve, inequilateral, inflated and longer than high (not exceeding 15 cm in length, commonly 11 cm). Umbo position posterior. Outline of shell fan-shaped; rounded margin. Hinge with 1 ridge-like cardinal tooth, 2 lateral teeth on right valve, 1 lateral tooth on left valve. Pallial line presence but no pallial sinus; 1 adductor muscle scar. Outer surface sculpture with 6 to 8 low radial fold with scales, closely spaced, near free ventral margin; no spines; no small rib-like at each interstices; anteriodorsal margin with non-interlocking crenulations; byssal orifice presence on anteriodorsal area in medium byssal-gape (about a half of anteriodorsal margin length). Inner margin with distinctively crenulations. Coloration of outer surface, white; inner surface, porcelaneous, white, pale yellowish tinge near the inner margin. The inhalant siphon with tentacles.

**Remarks.** The elongate giant clam. Shell growth widely elongated in anterior position. The scales presence only near the upper margin.

**Habitat.** Found in coral reefs, coral burrower partially embedded into a coral boulder on the reef top, sandy bottoms, firmly attached to coral head, in shallow and clean waters with majority living at less than 7m.

**Distribution.** Widespread in the Indo-West Pacific, from East Africa, including Madagascar, the Red Sea and the Persian Gulf to eastern Polynesia; north to Japan and south to New South Wales and Lord Howe Island.

**Tridacna (Chametraechea) squamosa** (Lamarck, 1819) (Figure 1F)

**Syn.** Tridacna squamosa Lamarck, 1819: 106; Chama squamata Rumphius 1705; female Littoralis*, pl. 42, fig. A.

**Material examined.** No. Lam. 890; Figure 1(6); 3 specimens, 2 paired valves, 1 right valve (9,15 cm in height and 12,7 cm in length); Loc. (?); Date (?); Coll. Rykschoerff; Det. U. E. Hernawan. (22 June 2009)

**Diagnostic characters.** Shell solid, thick; equivaIve, inequilateral, inflated and longer than high (not exceeding 40 cm in length, commonly 30 cm). Outline of shell fan-shaped; rounded margin. Umbo position midline. Hinge with 1 ridge-like cardinal tooth, 2 lateral teeth on right valve, 1 lateral tooth on left valve. Pallial line presence but no pallial sinus; 1 adductor muscle scar. Outer surface sculptured with 5 to 6 low radial fold with more than 6 small rib-like at each interstices. Scales presence; no spines. Anteriodorsal margin with non-interlocking crenulations; byssal orifice presence on anteriodorsal area in medium byssal-gape (about a half of anteriodorsal margin length). Inner margin with distinctively crenulations. Coloration of outer surface, white; inner surface, porcelaneous, white; often pinkish. The inhalant siphon with tentacles.

**Remarks.** The specific characters are deep radial folds forming V-shape projection in ventral view. Outer surface relatively smooth and extremely large shell.

**Habitat.** Found in coral reefs, shallow water to a depth of 20 m, live not embedded into a coral boulder, attached by the byssus to the substrate.
Figure 1. Giant clams specimens deposited in MZB; outer surface view; L (left valve), R (right valve). A. *Hippopus hippocus* (Linnaeus, 1758), L; B. *Tridacna (Persikima) derasa* (Roding, 1798), R; C. *Tridacna (Tridacna) gigas* (Linnaeus, 1758), L; D. *Tridacna (Chametrachea) crocea* (Lamarck, 1819), R; E. *Tridacna (Chametrachea) maxima* (Roding, 1798), R; F. *Tridacna (Chametrachea) squamosa* (Lamarck, 1819), R.
Distribution. Widespread in the Indo-West Pacific, from East Africa, including Madagascar, the Red Sea, but not the Persian Gulf, to eastern Melanesia; north to southern Japan and south to Queensland and New Caledonia.

Discussion

The fact that specimens of only six species of the giant clams are deposited in the MZB suggests the need for collecting specimens of H. porcellanatus Rosewater, 1982. The distribution of H. porcellanatus is the smallest among distribution of six other species. It is distributed in eastern part of Indonesian waters. In a larger scale, it can be found also in Philippine (Braley and Healy 1998; Newman and Gomes 2002).

Tridacninae can be easily distinguished from other bivalves based on its large shell with a strong radial fold in a few number and brightly colored mantle. Each shell has only one adductor muscle scar where a pedal retractor muscle attached, but no pallial sinus. The shell ligament is external with hinge teeth. One character easily separating Tridacna and Hippopus is the teeth on byssal orifice of opposed valves. Hippopus has interlocking teeth, while Tridacna does not. In turn, Tridacna bears a byssal gape which is not present in Hippopus. Additionally, because of the shell character, mantle character can also be used to differentiate living Hippopus and Tridacna. When it fully opens, Tridacna’s mantle expands laterally beyond the ventral margin shell. On the contrary, Hippopus’s mantle expands without passing through the ventral margin shell.

Phylogenetically, T. squamosa, T. maxima, and T. crocea are grouped in a single clade taxonomically known as subgenus Chametraea (Benzie and Williams 1998) because of the character of their life habit attaching and boring coral substrate. T. squamosa is unique for its spoon-like scales. T. crocea embeds totally its shell into coral substrates, whilst only half part of T. maxima shell is embedded into coral substrate. Subgenus Tridacna sensu stricto and Persikima do not attach to their substrate. They are separated each other based on the presence of tentacles in the inhalant siphon. T. derasa has low and weak radial folds on its shells. In contrast, T. gigas is specific for its remarkable large, smooth shell and strong U-shape radial folds.

CONCLUSION

Despite many field observations reporting that seven species of the giant clams inhabit Indonesian waters, the MZB deposits specimens of six species (Tridacna squamosa Lamarcq, 1819; T. gigas Linnaeus, 1758; T. derasa Roding, 1798; T. crocea Lamarcq, 1819; T. maxima Roding, 1798 and Hippopus hippopus Linnaeus, 1758), suggesting the need for collecting specimen of H. porcellanatus Rosewater, 1982. Important characters to distinguish species among Tridacninae are interlocking teeth on byssal orifice, life habits, presence of scales and inhalant siphon tentacles.

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