

## 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. tevoroa* (Lucas, Ledua and Braley 1990); and *Chametrachea* comprising *T. squamosa* (Lamarck, 1819), *T. crocea* (Lamarck, 1819), *T. maxima* (Roding, 1798), *T. rosewateri* (Sirenko and Scarlato 1991) and *T. costata* (Richter, Roa-Quiaoit, 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. porcellanus* 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. porcellanus* 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)

**Syn.** *Chama hippopus* Linnaeus, 1758: 691; *Hippopus maculatus* Lamarck, 1801: 117.

**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. Viannay, Det. U. E. Hernawan (22 June 2009)

**Diagnostic characters.** Solid shell, thick and heavy; equivalve, inequilateral, strongly 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 at an angle less than 90°; posteroventral and anteroventral 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 9 to 14 large radial fold with 2 to 3 small rib-like at each interstices; anteriodorsal margin with interlocking crenulations, byssal orifice presence on anteriodorsal area but without byssal gape. Inner margin with irregular crenulations correspond with the sculpture of outer surface. Coloration on outer surface whitish, irregular reddish blotches arranged in irregular concentric bands; inner surface porcelaneous white. Inhalant siphon without tentacles.

**Remarks.** This species is easily distinguished to the other giant clams by the presence of irregular semi-tubular spines and numerous riblets on the principal ribs and interstices. Irregular reddish blotches arranged in irregular concentric bands are the other specific character.

**Habitat.** Found on sandy areas in coral reefs, sometime on seagrass beds adjoining reefs; not attached by a byssus to the substrate.

**Distribution.** Tropical eastern Indian Ocean to western Pacific, from Andaman Islands to eastern Melanesia; north to southern Japan and south to Queensland

### Genus *Tridacna*

*Tridacna (Persikima) derasa* (Roding, 1798) (Figure 1B)

**Syn.** *Tridacna serrifera* Lamarck, 1819; *Persikima whitleyi* Iredale, 1937

**Material examined.** No. Lam 899; Figure 1(2); 1 specimen, paired valves (11 cm in height and 16,5 cm in length); Loc. Maluku; Date (?); Coll. Rykschroeff, Det. U. E. Hernawan (22 June 2009)

**Diagnostic characters.** Shell solid, thick and heavy; equivalve, inequilateral, 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; anteriodorsal 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 137 cm, commonly 80 cm). Umbo position midline. 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 4 to 6 deep radial fold; forming distinctively elongate-triangular projections on ventral free margin (V-shape) with 7 to 12 small rib-like at each interstices; no scales and spines on the fold; anteriodorsal 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 indistinctively 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 (Chametrachea) 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; equivalve, 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 crenulation; byssal orifice presence on anteriodorsal area with wide byssal-gape (more than a half of anteriodorsal margin length). Inner margin with indistinctly crenulations. Coloration on outer surface creamy white; inner surface: porcelaneous, white; often pinkish. The inhalant siphon with tentacles.

**Remarks.** The smaller species with wide byssal gape. Outer surface with fingernail-shape scales, closely spaced, undulate, arranged regularly on radial fold, but only near free ventral margin.

**Habitat.** Found in coral reefs, burrower, totally embedded, burrowed into a coral boulder on the reef top, only shell margin and mantle are visible to the diver.

**Distribution.** Tropical eastern Indian Ocean to western Pacific, from Andaman Islands to Fiji Islands; north to Japan and south to New Caledonia and Queensland.

*Tridacna (Chametrachea) maxima* (Roding, 1798) (Figure 1E)

**Syn.** *Tridachnes maxima* Röding, 1798: 171, no. 184; *Tridacna elongata* Lamarck, 1819: 106; *Tridacna rudis* Reeve, 1862: pl. 5, fig. 4a-c; *Tridacna compressa* Reeve, 1862: pl. 6, fig. 5; pl. 7, fig. 5b; *Tridacna cumingii* Reeve, 1862: pl. 7, fig. 7b (part); *Tridacna acuticostata* Sowerby, 1912: 30-31, fig.

**Material examined.** No. Lam 1301; Figure 1(5); 1 specimen, right valve (6,79 cm in height and 13,22 cm in length); Loc. (?); Date (?); Coll. (?), Det. U. E. Hernawan. (22 June 2009).

**Diagnostic characters.** Shell solid, thick; equivalve, inequilateral, inflated and longer than high (not exceeding 35 cm in length, commonly 25 cm). Outline of shell fan-shaped; rounded margin; anterior about twice in length than posterior. Umbo position posterior. 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 fingernail-shape scales, closely spaced, arranged regularly on radial fold, near free ventral margin; anteriodorsal margin with non-interlocking crenulations; byssal orifice presence on anteriodorsal area with 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 (Chametrachea) squamosa* (Lamarck, 1819) (Figure 1F)

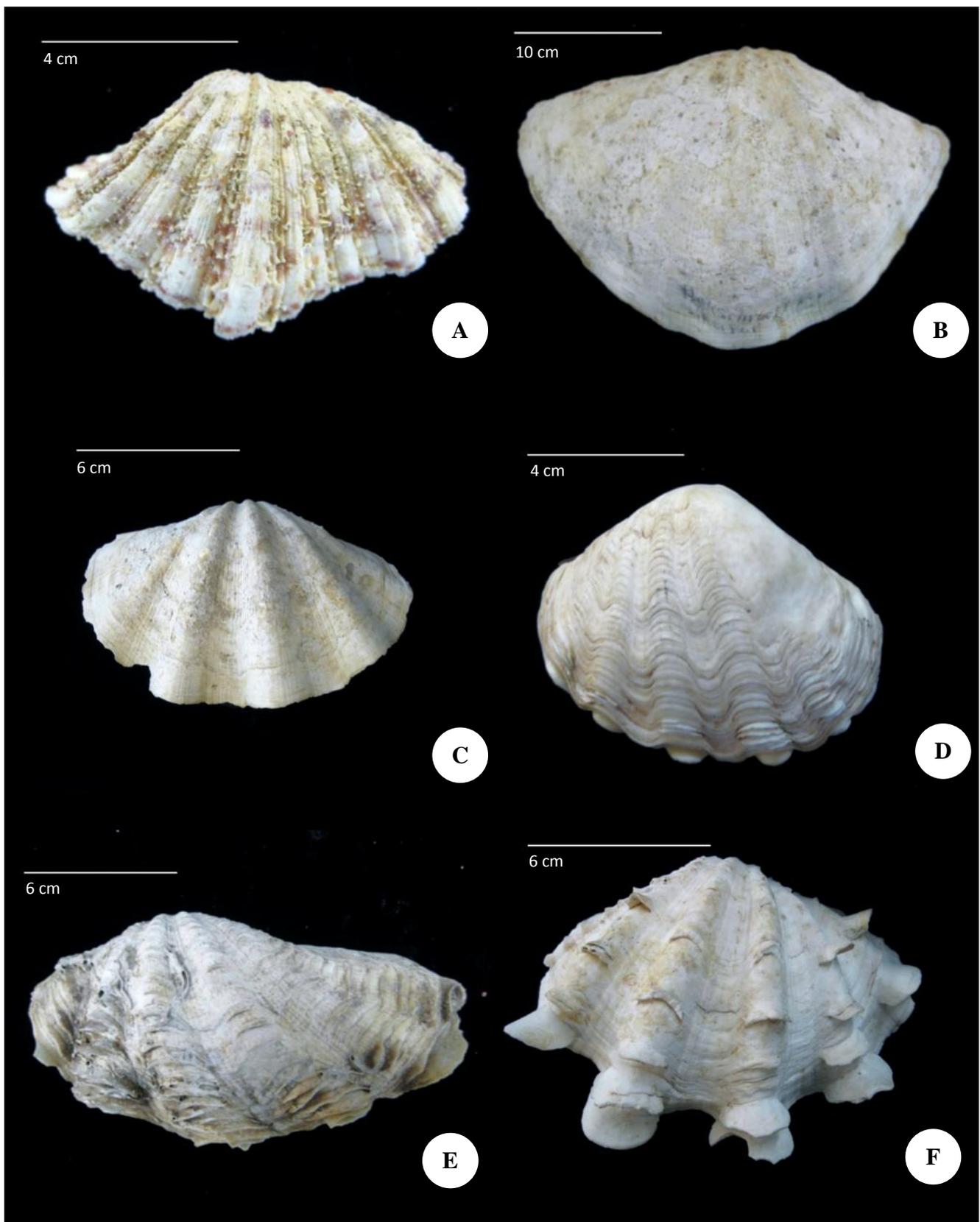
**Syn.** *Tridacna squamosa* Lamarck, 1819: 106; *Chama squammata* Rumphius 1705; female *Littoralis*, pl. 42, fig. A.

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

**Diagnostic characters.** Shell solid, thick; equivalve, 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 with medium byssal-gape (about a half of anteriodorsal margin length). Inner margin with distinctively crenulations. Coloration of outer surface, white; inner surface, porcelaneous, white. The inhalant siphon with tentacles.

**Remarks.** This species have specific character, viz. blade-like, spoon-shape scales, arranged regularly on radial fold. The scales still presence near the umbo, but being smaller.

**Habitat.** Found in coral reefs, littoral and 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 hippopus* (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. porcellanus* Rosewater, 1982. The distribution of *H. porcellanus* 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 to 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 *Chametrachea* (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* Lamarck, 1819; *T. gigas* Linnaeus, 1758; *T. derasa* Roding, 1798; *T. crocea* Lamarck, 1819; *T. maxima* Roding, 1798 and *Hippopus hippopus* Linnaeus, 1758), suggesting 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.

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