



Bivalves and gastropods of Tubbataha Reefs Natural Park, Philippines

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Abstract: in this study of marine bivalves and gastropods of Tubbataha Reefs Natural Park (TRNP), Palawan, Philippines, we photo-document 96 species, including 17 species of bivalves (in seven families), and 79 species of gastropods (in 29 families). Of these, 64 species (eight bivalves and 56 gastropods species) were new recorded from the park. The list also includes the seven species of giant clams which are protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and three nationally protected gastropod species (*Cassis cornuta*, *Charonia tritonis* and *Tectus niloticus*). Thirty-six species that were previously reported at the park were not found in this study, which suggests that there are at least 132 species of gastropods and bivalves at TRNP. Our observations were limited at intertidal and shallow subtidal reefs in the park, suggesting that the number of species in the list may rise with an extensive survey.

Key words: Mollusca; Bivalvia; Gastropoda; species inventory; Tubbataha Reefs Natural Park; Philippines

INTRODUCTION

The Tubbataha Reefs Natural Park (TRNP) in the middle of the Sulu Sea, the Philippines, is rich in biodiversity. in 1993 the park was named by the United Nations, Educational, Scientific and Cultural Organization (UNESCO) as a World Heritage Site, and research has been done to document and protect the rich flora and fauna. Currently there are ca. 400 species of corals (85% of known coral species in the Philippines), nearly 700 species of fish, two species of marine turtles, seven species of breeding seabirds, 13 species of cetaceans, 79 species of algae and 10 species of seagrass (Dygico 2006; Songco 2012; TMO 2013).

Although many taxa have been inventoried in TRNP, not much is known about the park's molluscan fauna, which Yamaguchi (1996) first documented. Other studies did not extensively focus on mollusks but reported a few species (see Estacion *et al.* 1993; Dolorosa and Schoppe 2005; Dolorosa *et al.* 2011; Dolorosa and Jontila 2012; Dolorosa *et al.* 2013). We include previously published data, along our new observations made between May 2005 and June 2010, to provide an updated list of the mollusks of TRNP. Given such meager information,

this list of mollusks in TRNP is hoped to complement all other information about the rich and undocumented diversity in the Islands of Palawan, Philippines.

MATERIALS AND METHODS

This species list of mollusks of TRNP is based on photos made within TRNP, Palawan, Philippines ($08^{\circ}43'$ – $08^{\circ}57'$ N and $119^{\circ}48'$ – $120^{\circ}03'$ E), during annual biodiversity monitoring between May 2005 and June 2010. The TRNP is a no-take zone, and for this reason, no voucher specimens were collected. Photos of bivalves and gastropods were identified with the aid of various reference materials (Springsteen and Leobrera 1986; Aubry 1999; Abbott and Dance 2000; Laureta 2008; Terryn 2007; Poppe 2008a; Poppe 2008b; Poppe 2010a; Poppe 2010b). The species' taxonomy, including the species reported in prior publications, is according to the World Register of Marine Species (WoRMS 2014). Species are alphabetical within families. Also included in this list of species are those previously published in the literature but not encountered in our study.

RESULTS

We photo-document 96 species of mollusks from TRNP; 17 of these are bivalves belonging to seven families (Table 1; Figures 1 and 2). We newly record eight bivalves from the park (Table 1). We observed 79 species of gastropods, and 56 of these are new records at TRNP (Table 2; Figures 3–7).

DISCUSSION

The total number of species (96 species) recorded in this study is much higher compared with the previous record of Yamaguchi (1996) (Tables 1 and 2). However, 36 of the previously reported species were not found, implying that there are at least 132 species of gastropods and bivalves in TRNP.

Among the recorded species, seven bivalves (Tridacninae) are CITES protected (CITES 2014) and three gastropod species (*Charonia tritonis*, *Tectus niloticus*, and *Cassis cornuta*) are protected in the Philippines (Dolorosa and Jontila 2012; Dolorosa *et al.* 2013). These large mollusks species have high economic, ecological, aesthetic and scientific importance but are becoming rare in many parts of the country; thus, TRNP

can serve as significant seed source of these valuable species.

The number of species of gastropods and bivalves recorded from such a rich and protected area within the Coral Triangle, the world's center of marine biodiversity, is very low considering that Springsteen and Leobrera (1986) reported more than 1,600 species of mollusks from the Philippines. Previous studies were limited to intertidal areas (e.g., Batomalaque *et al.* 2010, who had reported 100 species). Our study was undertaken in intertidal and shallow subtidal coral reefs and sandy habitats and focused mainly on large-shelled species (over *ca.* 2 cm) and neglected smaller. The deeper water sandy areas inside the lagoon and the *ca.* 1000 m abyss surrounding the reefs remain unexplored. A deep sea expedition in Panglao, Bohol, Philippines found about 6,000 species (Richer de Forges *et al.* 2009), which include new species and new records for the Philippines. We anticipate that continued exploration of TRNP in both shallow and deep water habitats and with small-bodied species targeted may reveal new records for the park, Palawan, and the Philippines.

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Table 1. Bivalve species from Tubbataha Reefs Natural Park, Philippines; ● = recorded; ○ = previously recorded but not found this study; ★ = new records, this study.

Family	Species	Yamaguchi 1996	Estacion <i>et al.</i> 1993	Dolorosa and Schoppe 2005	Dolorosa and Jontila 2012	This study
Arcidae	<i>Anadara</i> sp.	○				
Cardiidae	<i>Fragum fragum</i> (Linnaeus, 1758)	○				
	<i>Hippopus hippopus</i> (Linnaeus, 1758)	●	●	●		●
	<i>Hippopus porcellanus</i> Rosewater, 1982		●		●	●
	<i>Tridacna crocea</i> Lamarck, 1819	●	●	●	●	●
	<i>Tridacna derasa</i> (Röding, 1798)		●			●
	<i>Tridacna gigas</i> (Linnaeus, 1758)		●			●
	<i>Tridacna maxima</i> Röding, 1798	●	●	●	●	●
	<i>Tridacna squamosa</i> Lamarck, 1819		●	●	●	●
Lucinidae	<i>Fimbria fimbriata</i> (Linnaeus, 1758)					★
	<i>Codakia tigerina</i> (Linnaeus, 1758)					★
	<i>Ctena bella</i> (Conrad, 1837)	○				
Mesodesmatidae	<i>Atactodea striata</i> (Gmelin, 1791)	●				●
	<i>Davila plana</i> (Hanley, 1843)	○				
Mytilidae	<i>Modiolus philippinarum</i> (Hanley, 1843)	○				
Ostreidae	<i>Lopha cristagalli</i> (Linnaeus, 1758)					★
	<i>Saccostrea mordax</i> (Gould, 1850)					★
Pinnidae	<i>Pinna muricata</i> Linnaeus, 1758	○				
Psammobiidae	<i>Asaphis violascens</i> (Forsskål in Niebuhr, 1775)					●
Tellinidae	<i>Tellina perna</i> Spengler, 1798	○				
	<i>Tellina scobinata</i> Linnaeus, 1758					★
	<i>Tellina</i> sp.					★
Veneridae	<i>Gafrarium pectinatum</i> (Linnaeus, 1758)	○				
	<i>Lioconcha castrensis</i> (Linnaeus, 1758)					★
	<i>Periglypta puerpera</i> (Linnaeus, 1771)					★
Total		12	7	4	4	17

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Table 2. Gastropod species from Tubbataha Reefs Natural Park, Philippines; ● = recorded; ○ = previously recorded but not found this study; ★ = new records, this study.

Family	Species	Yamaguchi 1996	Estacion et al. 1993	Dolorosa and Schoppe 2005	Dolorosa and Jontila 2012	This study
Angariidae	<i>Angaria delphinus</i> (Linnaeus, 1758)					★
Bursidae	<i>Tutufa bubo</i> (Linnaeus, 1758)			●	●	
	<i>Bursa lamarckii</i> (Deshayes, 1853)					★
	<i>Bursa granularis</i> (Röding, 1798)					★
Cancellariidae	<i>Scalptia</i> sp.	○				
Cassidae	<i>Cassis cornuta</i> (Linnaeus, 1758)	●			●	
	<i>Casmaria ponderosa</i> (Gmelin, 1791)					★
Cerithiidae	<i>Cerithium nodulosum</i> Bruguière, 1792					★
	<i>Cerithium</i> sp.	○				
	<i>Cerithium rostratum</i> A. Adams in G.B. Sowerby II, 1855	○				
	<i>Pseudovertagus aluco</i> (Linnaeus, 1758)	○				
Colubrariidae	<i>Colubraria muricata</i> (Lightfoot, 1786)					★
Columbellidae	<i>Euplica scripta</i> (Lamarck, 1822)	○				
	<i>Pyrene flava</i> (Bruguière, 1789)	○				
Conidae	<i>Conus arenatus</i> Hwass in Bruguière, 1792	○				
	<i>Conus coronatus</i> Gmelin, 1791	○				
	<i>Conus distans</i> Hwass in Bruguière, 1792					★
	<i>Conus ebraeus</i> Linnaeus, 1758					★
	<i>Conus eburneus</i> Hwass in Bruguière, 1792					★
	<i>Conus imperialis</i> Linnaeus, 1758					★
	<i>Conus leopardus</i> (Röding, 1798)					★
	<i>Conus litteratus</i> Linnaeus, 1758	●			●	
	<i>Conus lividus</i> Hwass in Bruguière, 1792		●		●	●
	<i>Conus marmoreus</i> Linnaeus, 1758					★
	<i>Conus miles</i> Linnaeus, 1758		●			●
	<i>Conus pulicarius</i> Hwass in Bruguière, 1792	○				
	<i>Conus</i> sp. 1	○				
	<i>Conus</i> sp. 2			○		
	<i>Conus sponsalis</i> Hwass in Bruguière, 1792	○				
	<i>Conus stercusmuscarum</i> Linnaeus, 1758					★
	<i>Conus striatus</i> Linnaeus, 1758					★
	<i>Conus tessulatus</i> Born, 1778	●				●
	<i>Conus planorbis</i> Born, 1778	○				
	<i>Conus pulicarius</i> Hwass in Bruguière, 1792					●
	<i>Conus virgo</i> Linnaeus, 1758	●		●		●
Costellariidae	<i>Vexillum exasperatum</i> (Gmelin, 1791)	○				
Cypraeidae	<i>Cypraea tigris</i> Linnaeus, 1758		●	●	●	●
	<i>Esoraria erosa</i> (Linnaeus, 1758)					★
	<i>Lyncina lynx</i> (Linnaeus, 1758)					★
	<i>Lyncina vitellus</i> (Linnaeus, 1758)					★
	<i>Mauritia arabica</i> (Linnaeus, 1758)					★
	<i>Monetaria annulus</i> (Linnaeus, 1758)	●				●
	<i>Monetaria moneta</i> (Linnaeus, 1758)	●				●
	<i>Monetaria caputserpentis</i> (Linnaeus, 1758)					★
	<i>Ovatipsa chinensis</i> (Gmelin, 1791)					★
	<i>Talparia talpa</i> (Linnaeus, 1758)					★
Fasciolariidae	<i>Latirolagena smaragdulus</i> (Linnaeus, 1758)					★
	<i>Pleuroloca trapezium</i> (Linnaeus, 1758)			●		●
Haliotidae	<i>Haliotis asinina</i> Linnaeus, 1758					★
Hipponicidae	<i>Cheilea cepacea</i> (Broderip, 1834)					★
Littorinidae	<i>Littoraria scabra</i> (Linnaeus, 1758)					★
Mitridae	<i>Mitra mitra</i> (Linnaeus, 1758)					★
	<i>Mitra papalis</i> (Linnaeus, 1758)			○		
	<i>Neocancilla papilio</i> (Link, 1807)		○			
Muricidae	<i>Chicoreus brunneus</i> (Link, 1807)					★
	<i>Drupa ricanus</i> (Linnaeus, 1758)					★

Table 2. Continued.

Family	Species	Yamaguchi 1996	Estacion et al. 1993	Dolorosa and Schoppe 2005	Dolorosa and Jontila 2012	This study
	<i>Drupella cornus</i> (Röding, 1798)					★
	<i>Drupella margariticola</i> (Broderip, 1833)	○				
	<i>Drupina grossularia</i> (Röding, 1798)					★
Nassariidae	<i>Nassarius albescens</i> (Dunker, 1846)	○				
	<i>Nassarius coronatus</i> (Bruguière, 1789)					★
	<i>Nassarius gaudiosus</i> (Hinds, 1844)	○				
	<i>Nassarius papillosus</i> (Linnaeus, 1758)					★
Naticidae	<i>Notocochlis gualteriana</i> (Récluz, 1844)					★
	<i>Mammilla sebae</i> (Récluz, 1844)					★
Neritidae	<i>Nerita polita</i> (Linnaeus, 1758)					★
	<i>Smaragdia</i> sp.	○				
Olividae	<i>Oliva annulata</i> Gmelin, 1791					★
	<i>Oliva carneola</i> (Gmelin, 1791)	○				
	<i>Oliva miniacea</i> (Röding, 1798)					★
	<i>Oliva reticulata</i> (Röding, 1798)					★
Personidae	<i>Distorsio anus</i> (Linnaeus, 1758)					★
Pyramidellidae	sp. 1	○				
Ranellidae	<i>Charonia tritonis</i> (Linnaeus, 1758)					★
Strombidae	<i>Canarium labiatum</i> (Röding, 1798)					★
	<i>Canarium mutabile</i> (Swainson, 1821)	○				
	<i>Canarium urceus</i> (Linnaeus, 1758)	○				
	<i>Conomurex luhuanus</i> (Linnaeus, 1758)	●			●	●
	<i>Euprotomus bulla</i> (Röding, 1798)					★
	<i>Gibberulus gibberulus gibbosus</i> (Röding, 1798)					★
	<i>Harpago chiragra</i> (Linnaeus, 1758)		●		●	●
	<i>Lambis lambis</i> (Linnaeus, 1758)	●				●
	<i>Lambis millepeda</i> (Linnaeus, 1758)					★
	<i>Lambis scorpius</i> (Linnaeus, 1758)					★
	<i>Lambis</i> sp.		○			
	<i>Lambis sowerbyi</i> (Mörch, 1877)					★
	<i>Lentigo lentiginosus</i> (Linnaeus, 1758)					★
Tegulidae	<i>Tectus fenestratus</i> (Gmelin, 1791)					★
	<i>Tectus niloticus</i> (Linnaeus, 1767)		●		●	●
	<i>Tectus pyramis</i> (Born, 1778)		●		●	●
	<i>Trochus maculatus</i> Linnaeus, 1758		●			●
Terebridae	<i>Hastula lanceata</i> (Linnaeus, 1767)					★
	<i>Hastula solida</i> (Deshayes, 1857)	○				
	<i>Myurella affinis</i> (Gray, 1834)	●				●
	<i>Oxymeris areolata</i> (Link, 1807)					★
	<i>Oxymeris crenulata</i> (Linnaeus, 1758)					★
	<i>Oxymeris dimidiata</i> (Linnaeus, 1758)					★
	<i>Oxymeris felina</i> (Dillwyn, 1817)					★
	<i>Oxymeris maculata</i> (Linnaeus, 1758)					★
	<i>Terebra argus</i> Hinds, 1844	○				
	<i>Terebra casta</i> Hinds, 1844	○				
	<i>Terebra guttata</i> (Röding, 1798)	●				●
	<i>Terebra subulata</i> (Linnaeus, 1767)	●				●
Tonnidae	<i>Malea pomum</i> (Linnaeus, 1758)					★
	<i>Tonna canaliculata</i> (Linnaeus, 1758)					★
Turbinellidae	<i>Vasum turbinellus</i> (Linnaeus, 1758)	●				●
Turbinidae	<i>Turbo chrysostomus</i> Linnaeus, 1758		●	●	●	●
Total		37	15	8	79	

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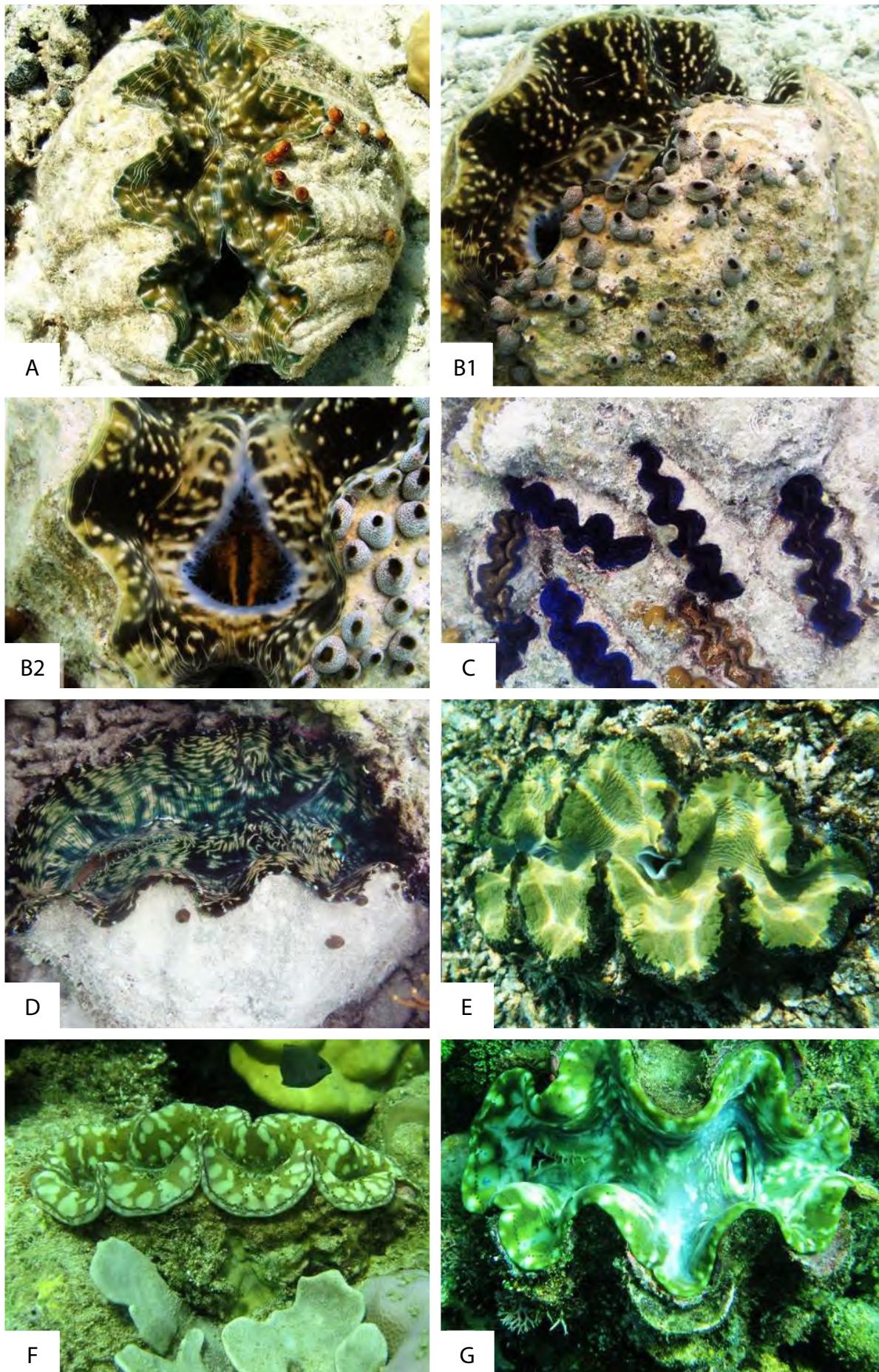


Figure 1. The giant clams of Tubbataha Reefs Natural Park. A) *Hippopus hippopus*, B1-2) *Hippopus porcellanus*, C) *Tridacna crocea*, D) *Tridacna derasa*, E) *Tridacna gigas*, F) *Tridacna maxima*, G) *Tridacna squamosa*.

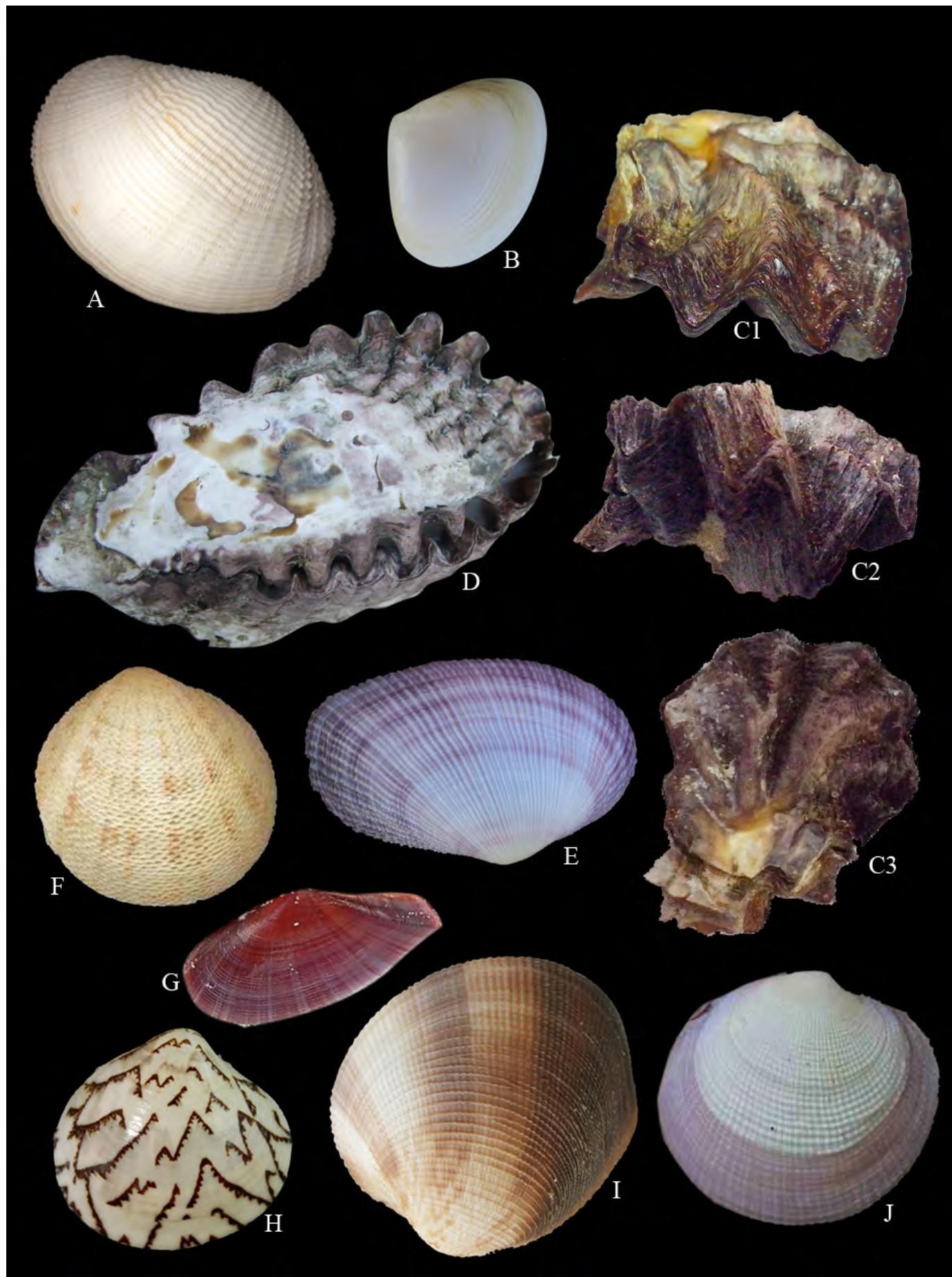


Figure 2. Some bivalve species from Tubbataha Reefs Natural Park. A) *Fimbria fimbriata*, B) *Atactodea striata*, C1-3) *Lopha cristagalli*, D) *Saccostrea mordax*, E) *Asaphis violascens*, F) *Tellina scobinata*, G) *Tellina* sp., H) *Lioconcha castrensis*, I) *Periglypta puerpera*, J) *Codakia tigerina*.

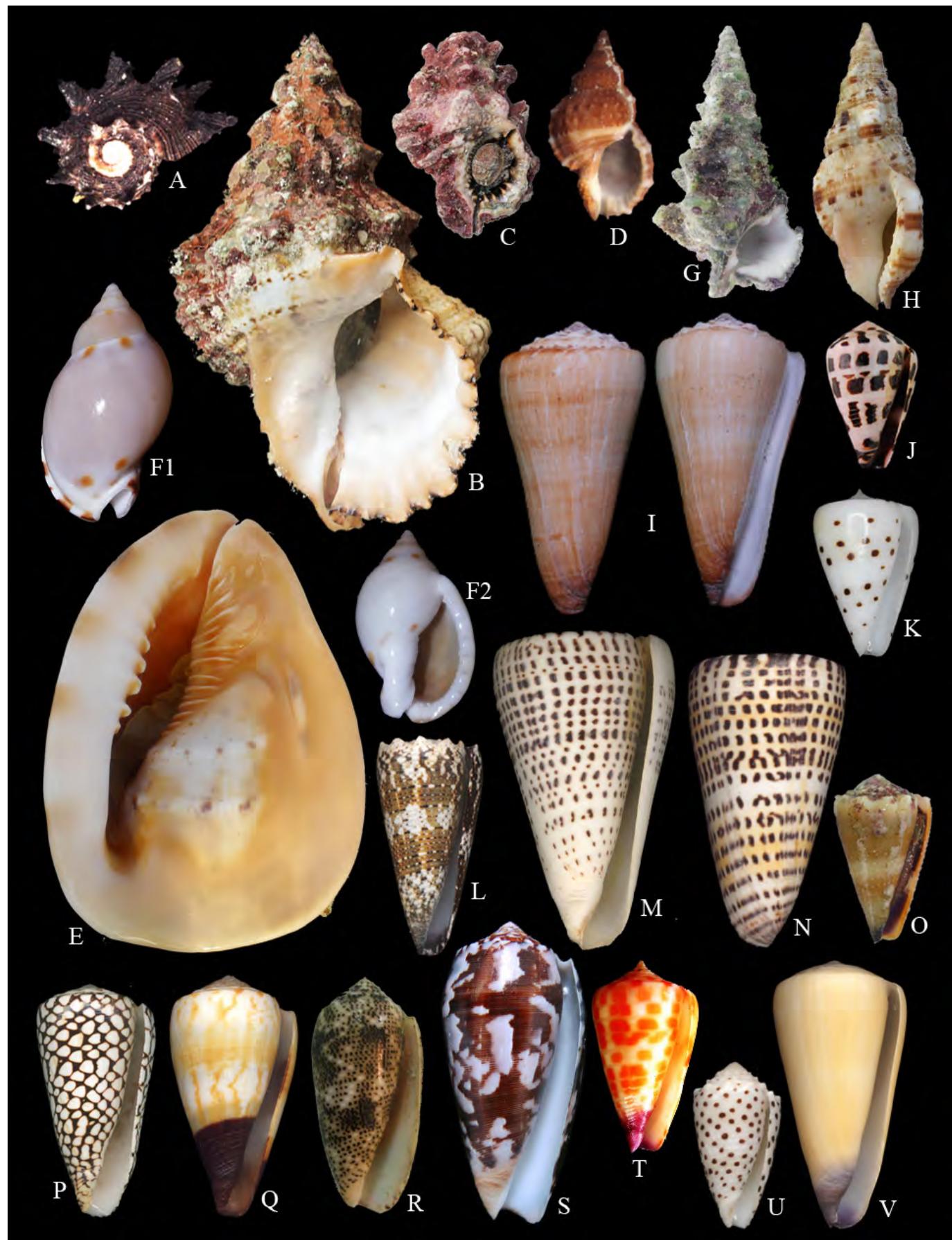


Figure 3. Some gastropod species at Tubbataha Reefs Natural Park. A) *Angaria delphinus*, B) *Tutufa bubo*, C) *Bursa lamarckii*, D) *Bursa granularis*, E) *Cassis cornuta*, F1-2) *Casmaria ponderosa*, G) *Cerithium nodulosum*, H) *Colubraria muricata*, I) *Conus distans*, J) *Conus ebraeus*, K) *Conus eburneus*, L) *Conus imperialis*, M) *Conus leopardus*, N) *Conus litteratus*, O) *Conus lividus*, P) *Conus marmoreus*, Q) *Conus miles*, R) *Conus stercusmuscarum*, S) *Conus striatus*, T) *Conus tessulatus*, U) *Conus pulicarius*, V) *Conus virgo*.



Figure 4. Some gastropod species at Tubbataha Reefs Natural Park. A) *Cypraea tigris*, B) *Esoraria erosa*, C) *Lyncina lynx*, D) *Lyncina vitellus*, E) *Mauritia arabisca*, F) *Monetaria annulus*, G) *Monetaria moneta*, H) *Monetaria caputserpentis*, I) *Ovatipsa chinensis*, J) *Talparia talpa*, K) *Latirolagena smaragdulus*, L) *Pleuroploca trapezium*, M) *Haliotis asinina*.



Figure 5. Some gastropod species from Tubbataha Reefs Natural Park. A) *Cheilea cepacea*, B) *Littoraria scabra*, C) *Mitra mitra*, D) *Chicoreus brunneus*, E) *Drupa ricanus*, F) *Drupella cornus*, G) *Drupina grossularia*, H) *Nassarius coronatus*, I) *Nassarius papillosus*, J) *Notocochlis gualteriana*, K) *Mammilla sebae*, L) *Nerita polita*, M) *Oliva annulata*, N) *Oliva miniacea*, O) *Oliva reticulata*, P) *Distorsio anus*.



Figure 6. Some gastropod species from Tubbataha Reefs Natural Park. A) *Charonia tritonis*, B) *Canarium labiatum*, C) *Conomurex luhuanus*, D) *Euproctis bulla*, E) *Gibberulus gibberulus gibbosus*, F) *Harpago chiragra*, G) *Lambis lambis*, H) *Lambis millepeda*, I) *Lambis scorpius*, J) *Lambis sowerbyi*, K) *Lentigo lentiginosus*.



Figure 7. Some gastropod species from Tubbataha Reefs Natural Park. A) *Tectus fenestratus*, B) *Tectus niloticus*, C) *Tectus pyramis*, D) *Trochus maculatus*, E) *Hastula lanceata*, F) *Myurella affinis*, G) *Terebra subulata*, H) *Oxymeris crenulata*, I) *Oxymeris felina*, J) *Oxymeris maculata*, K) *Oxymeris dimidiata*, L) *Terebra guttata*, M) *Oxymeris areolata*, N1–2) *Malea pomum*, O) *Tonna canaliculata*, P) *Vasum turbinellus*, Q) *Turbo chrysostomus*.