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AND ITS TRADE IN PUERTO PRINCESA CITY,  
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# ATOLL RESEARCH BULLETIN

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**Atoll Research Bulletin No. 595 ♦ 14 November 2013**



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Published by SMITHSONIAN INSTITUTION SCHOLARLY PRESS  
P.O. Box 37012, MRC 957  
Washington, D.C. 20013-7012  
[www.scholarlypress.si.edu](http://www.scholarlypress.si.edu)

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ISSN: 0077-5630 (online)

## STATUS OF HORNED HELMET *CASSIS CORNUTA* IN TUBBATAHA REEFS NATURAL PARK, AND ITS TRADE IN PUERTO PRINCESA CITY, PHILIPPINES

ROGER G. DOLOROSA<sup>1</sup>, SEGUNDO F. CONALES<sup>2</sup>, and NOEL A. BUNDAL<sup>2</sup>

### ABSTRACT

The horned helmet *Cassis cornuta*, a protected species in some countries, is one of the largest reef gastropods that had been traditionally collected for food and for its shells as ornaments. In the Philippines, this protected species is rarely seen in habitats close to human settlement. However, in a protected area like the Tubbataha Reefs Natural Park (TRNP), *C. cornuta* are commonly encountered at the vicinity of the Ranger Station. With a dearth of information about this giant reef gastropod, notes on marked-recaptured *C. cornuta* in TRNP were taken from December 2009 until January 2011; and its trade was noted through surveys of some souvenir shops in Puerto Princesa City. Most of the sampled *C. cornuta* were large, suggesting the absence of exploitation at the study site. Regression analyses suggest that the shell's dimensions are significant determinants of body weight. Growth rates declined as shell size increased. Although exploitation of *C. cornuta* is prohibited under the Philippine law, their shells were openly displayed for sale in a number of souvenir shops in Puerto Princesa City. Given the limited area covered in this study, a nationwide survey is needed to fully document its status in the wild and the extent of its trade. Information on population, growth, survival, other aspects of its biology and its exploitation are needed in proposing a more relevant conservation measure for this vanishing giant reef gastropod.

**Keywords:** *Cassis cornuta*, shell dimension-weight relationship, size structure, trade, Tubbataha Reefs Natural Park, Palawan

### INTRODUCTION

Located in the centre of the Coral Triangle, the Tubbataha Reefs Natural Park (TRNP) and United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site (8° 41' 33" to 9° 06' 05" N and 119° 45' 46" to 120° 03' 30" E) is an offshore marine protected area (MPA) in the middle of the Sulu Sea, Philippines, with astounding biodiversity, and a popular destination for divers and researchers from around the globe (Arquiza and White, 1999; Subade, 2005; Dygico, 2006; TMO, 2011). Covering an expanded area of nearly 100,000 ha (about 3 times greater than its former size) through Presidential Proclamation 1126 series of 2006, the park now includes the Jessie Beazley Reef in addition to the North and South Atolls (TMO, 2011). Home to a diverse marine life, this off-shore no-fishing park remained attractive to illegal fishermen in spite of an active park enforcement system. Between 2002 and 2011, there were 85 apprehensions in TRNP involving 794 local and foreign fishermen; 34 % of these apprehensions and 28 % of all fishermen are Filipinos involved only in harvesting the reef gastropod *Trochus niloticus*. The rest were either local or foreign fishermen whose targets were sharks, the endangered humphead wrasse, marine turtles, giant clams and other marine life, but not *T. niloticus* (TMO, unpublished data).

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To promote an effective park management, the World Wildlife Fund for Nature (WWF) – Philippines has been collaborating with the Tubbataha Management Office (TMO) in the annual monitoring of TRNP since 1997. Between 1998-1999, about 17.5 % decline in live hard cover was recorded because of the El Niño bleaching effects (Dygico, 2006; Ledesma *et al.*, 2008). An outbreak of crown-of-thorns sea stars *Acanthaster planci* had been reported between 2007 and 2010, bringing large impacts on the reefs of Tubbataha (Ledesma *et al.*, 2008; Bos, 2010; Pan *et al.*, 2010). Ledesma *et al.* (2008) reported that between 1997 and 2008, yearly estimates of fish biomass in TRNP were much higher compared with the projected fish yield biomass from slightly fished and protected reefs, suggesting that conservation effort in TRNP is working. By contrast, little is known about the gastropod resources in Tubbataha Reefs. Notably, there are a number of large macrobenthic molluscs at the park (Dolorosa and Schoppe, 2005; Dolorosa *et al.*, 2011), yet it was not until in 2006 that monitoring of the large reef gastropod *T. niloticus* had begun (Dolorosa *et al.*, 2010). In 2008, except for areas proximate to the Ranger Station of TRNP, massive decline in *T. niloticus* abundance in areas distantly located from the Ranger Station had been linked with high incidence of poaching at the park (Ledesma *et al.*, 2008; Jontila *et al.*, 2011).

One of the largest reef gastropods commonly encountered in TRNP is the horned helmet *Cassis cornuta*. They can reach a maximum shell length of 35 cm and have been reported to feed on the crown-of-thorns sea star *A. planci* (Poutiers, 1998), a coral predator that when in large numbers can cause considerable damage to coral reefs (Salvat, 1992; Gawel, 1999; Pratchett *et al.*, 2009). Because of their ecological importance, the exploitation of *C. cornuta* is totally prohibited in Queensland, Australia (Poutiers, 1998; Weis *et al.*, 2004), in Fiji (Minter, 2008) and may be in most of its distribution range. In the Philippines, Fisheries Administrative Order (FAO) 158 series of 1986 prohibits any person from gathering or possessing the shells under the genera *Triton* or *Charonia* and *Cassis* (Floren, 2003; BFAR, 2012). In 2001, FAO 208, otherwise known as the conservation of rare, threatened and endangered fishery species, listed *Cypraea cassis rufa* or Bullmouth helmet under the “rare species” category among 25 other gastropods species. Nothing has been mentioned about *C. cornuta* at all as to whether it is rare, threatened or endangered (DA, 2001; Floren, 2003).

The exploitation of *C. cornuta* began during prehistoric times. Their shells, fashioned as adzes and ornaments, had been found in archaeological assemblages in Micronesia and Southeast Asia (Weisler, 1999; Szabó *et al.*, 2007). In recent times, they are traditionally collected for food and their shells are locally sold as souvenir items, home decors and other ornaments (Poutiers, 1998; Floren, 2003). In Mozambique, each horned helmet shell would fetch a price of 15,000 meticals (Barnes *et al.*, 1998), almost US\$ 600 based on the exchange rate of 1 US\$ = 26.95 meticals (Google Currency Converter, 14 March 2012). However, depending on size, an online Hawaiian shell dealer is selling horned helmet shells at much lower prices, ranging between US\$ 12.99 – 48.99 (Anonymous, 2012a).

In Kenya, the low abundance of *C. cornuta* in both protected and unprotected areas had been attributed by McClanahan (1989) to continued harvesting and slow population recovery along with many other factors. The volume of harvest for *C. cornuta* is not known, but harvest estimates for another crown-of-thorns sea star (*A. planci*) predator, the triton (*Charonia tritonis*) from the Great Barrier Reef was at about 10,000 individuals per year in the 1960s, resulting in a massive decline of its population (Hodgson and Liebler, 2002). In TRNP, poaching of reef gastropods, mainly *T. niloticus*, had been rampant in 2007-2008, causing its abundance to decline sharply in permanent monitoring stations located distantly from the Ranger Station (Ledesma *et al.*, 2008; Dolorosa *et al.*, 2010). *Trochus niloticus* are omnivores (Rao, 1937; Nash, 1993; Lambrinidis *et al.*, 1997; Soekendarsi *et al.*, 1998), whose diet may include the settling larvae of crown-of-thorns sea stars, which may explain their outbreak in parts of TRNP where *T. niloticus* population had been greatly reduced by poaching (pers. obs.).

The collection and trade of shells from the Philippines has been a global business (Springsteen and Leobrera, 1986; Floren, 2003; BFAR, 2008; Cuyos, 2011) wiping out vast areas and bringing many species to the brink of extinction (DA, 1998; 2001; 2006; BFAR-NFRDI-PAWB, 2005). While *C. cornuta* are now relatively uncommon in shallow areas close to coastal communities in Palawan (pers. obs.), and possibly in many parts of the country, one or more *C. cornuta* were sometimes noted at the intertidal area proximate to the Ranger Station of the TRNP. Given that very little information is known about *C. cornuta* in the Philippines and in its distribution range, the notes we gathered about the species is hoped to create and raise awareness about their status and encourage researchers to conduct further studies and help promote for the conservation of this vanishing and less known giant reef gastropod.

## MATERIALS AND METHODS

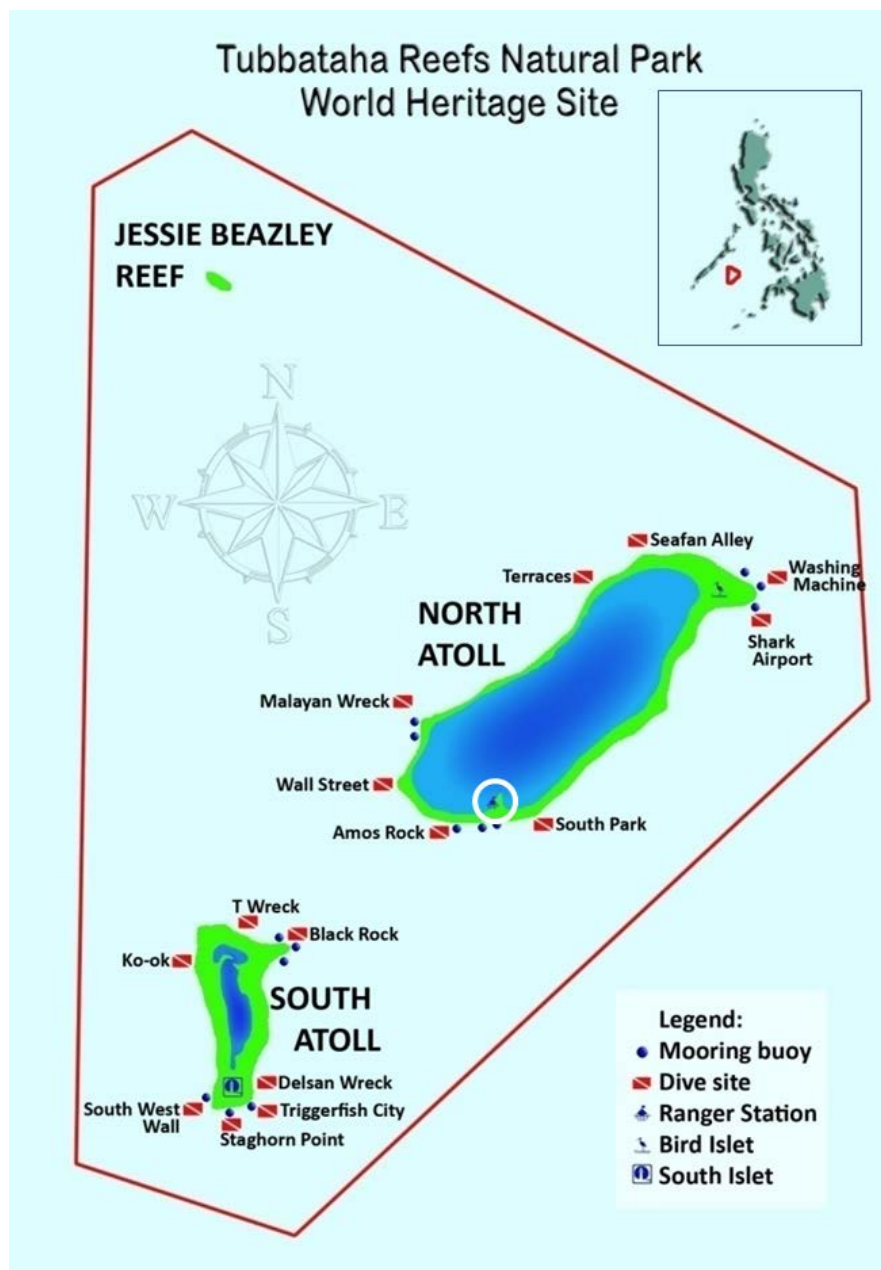
### Study Site

The study site, located at the vicinity of the Ranger Station (Fig. 1) in the southern tip of the North Atoll, TRNP (08° 51' 05.4" N and 119° 55' 02.0" E) was characterized by an unstable sand bar of about 100 m in length; mostly submerged during high tide. In December, part of the sand bar was right in front of the Ranger Station, but the Northeast monsoon can move the sand bar up to about 40 m south away from the Ranger Station (see Dolorosa *et al.*, 2011). The substrate surrounding the sand bar that was exposed at low tide was generally sandy and bare with increasing patches of rubble and coral rocks towards the constantly submerged area (Fig. 2). Home to a variety of invertebrates such as shelled molluscs, echinoderms and polychaetes, the sand flat when submerged at high tide was notably an important feeding ground for sting rays, sharks, and trigger fishes (Dolorosa *et al.*, 2011) and a resting/feeding area for marine turtles. Several incidents of marine turtle nesting have also been noted on the sand bar.

### Sampling

Notes on encountered *C. cornuta* at the vicinity of the Ranger Station of TRNP were taken from December 2009 to January 2011, with samplings having been conducted during the months of December 2009, January, April, June, August, September and December 2010, and January 2011. These were done when the first author stayed at the park or when the second and third authors were assigned at the park as rangers. Exposed and shallow (~30 cm deep) areas at low tide around the Ranger Station during early morning and or late afternoon low tides were surveyed by random walk for about 1-2 hours. Encountered *C. cornuta* were taken to the Ranger Station and marked using a pre-numbered dymo tag. Tagging was done by firstly cleaning the shells from marine growth before gluing a tag on each shell with marine epoxy. To minimize or avoid tag damage when *C. cornuta* crawls on sandy areas with some branching corals or when burrowing in sand or rubble, the tag was glued on the flattened spire or ventral-posterior part of the shell (Fig. 3). In some cases, a double tag was added and glued on the dorsal-posterior part of the body whorl, right below the central and largest knob on the shoulder. To avoid stress while allowing the resin to harden, *C. cornuta* were kept in a shaded sandy area under the Ranger Station. Because of their large size, locally made wooden callipers were used to measure the shell dimensions such as basal length, basal width, body length, body width and body heights (Fig. 3), while the live weight was measured with a spring balance. *Cassis cornuta* were returned to their natural habitat at dusk or in the evening to avoid excessive exposure to sunlight. Trade of *C. cornuta* in Puerto Princesa City was documented by visiting 136 souvenir shops to record the prices and numbers of *C. cornuta* on display.



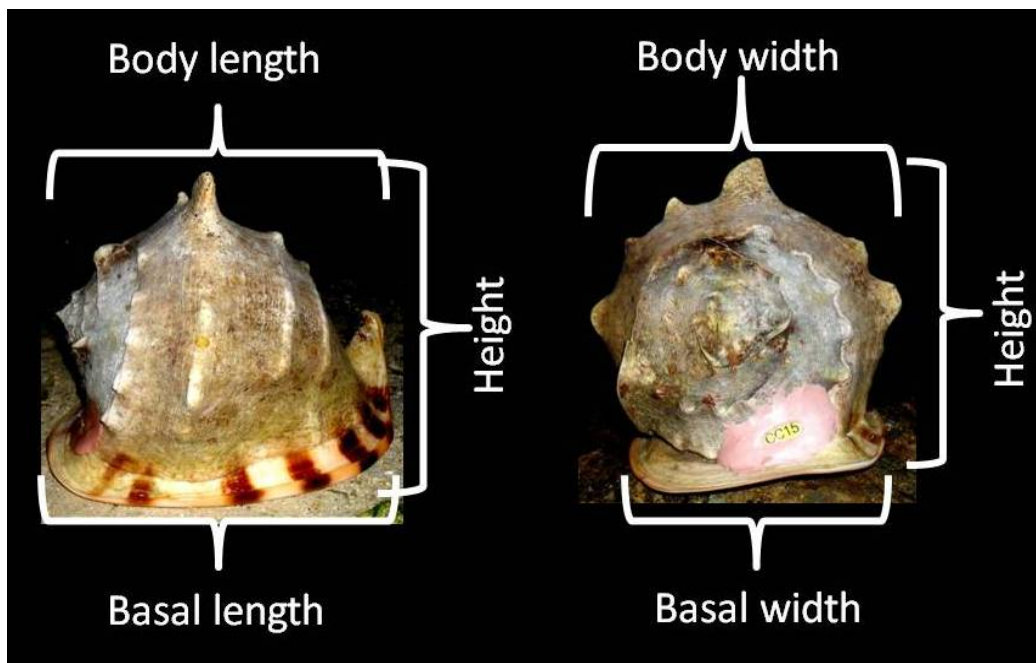


**Figure 1.** The study site (white circle around the Ranger Station) in Tubbataha Reefs Natural Park; inset at the upper right margin is the map of the Philippines with TRNP marked “red” at the middle of the Sulu Sea (map credit: Tubbataha Management Office).



**Figure 2.** The shallow subtidal areas at the southern side of the Ranger Station.





**Figure 3.** The marked *Cassis cornuta* ready for release, with shell dimensions indicated. Basal length was measured from the tip of the posterior lip to the tip of siphonal canal. Body length was measured from the apex to the tip of siphonal canal. Body width was measured as the widest part of the body including the tip of the tubercles. The height is the tallest part of the shell when in crawling position, measured from the base or aperture to the tip of the central tubercle on the shoulder. Note the tag on the ventral-posterior part of the shell (right photo).

### Statistical Analysis

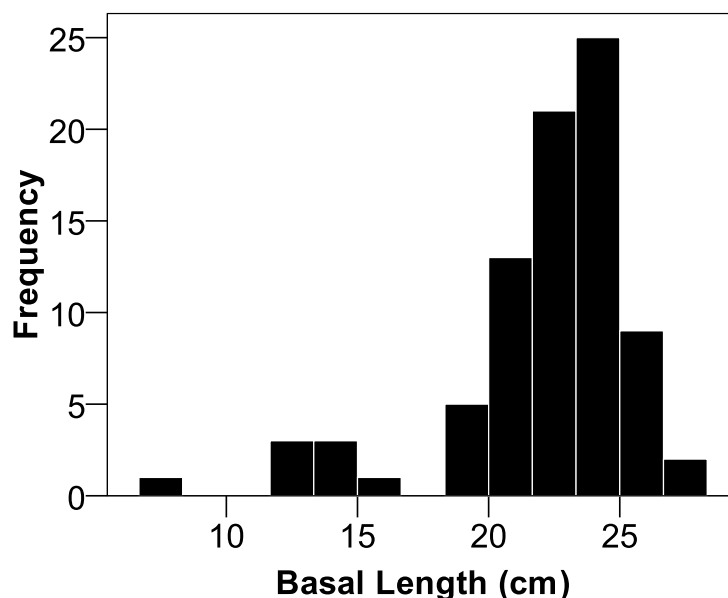
Descriptive and regression analyses were conducted on gathered data using SPSS software version 16 (Field, 2009). In performing the regression analyses between any of the four shell dimensions (X; cm) and weight (Y; kg), both independent (shell dimension) and dependent (weight) variables were log transformed to obtain linear trends. Analysis of variance was used to determine the significance of the regression models in predicting the live weight of the animals. Growth rates based on recaptured marked individuals were obtained by dividing the size increment by the number of days between marking and recapture.

## RESULTS

In total, 83 individuals were marked, one of which was recaptured twice, approximately 3 and 8 months from the date of tagging. Five other individuals were recaptured once. The interval between the date of tagging and incidence of recapture of marked individuals ranged between 2 to 8 months, with an average of 4.85 months.

Most (93 %) of the samples were large, with basal lengths greater than 15 cm (Fig. 4). The sizes ranged between 7.7 cm and 27.6 cm basal length (Fig. 5), with an average of 22.1 cm. As most samples were large and with flanged and produced lip over the spire, the average basal length is longer than the body length. The mean live weight was 2.27 kg (Table 1); No weight measurement was taken for the largest individual but the second largest sample with 26.3 cm basal length weighed 3.75 kg. Sexes were not recorded for all samples but a 1:1 sex ratio was noted on a total of six individuals (encountered in 2 days) whose sexes were noted.

The relationship between the shell dimension ( $X$ ) and live weight ( $Y$ ) is expressed by the equation:  $Y = aX^b$ . As the parameters  $a$  and  $b$  were calculated from the log transformed values of  $X$  and  $Y$ , thus the resulting equation is:  $\text{Log}_{10} Y = \text{Log}_{10} a + b \log_{10} X$ . All regression models can predict the live weight of *C. cornuta* significantly well ( $P < 0.001$ ), but basal length appeared to be the best predictor with  $R^2 = 0.975$ ,  $F\text{-ratio} = 747$ ,  $\text{df}=1,19$ ,  $P < 0.001$  (Fig. 6, Table 2). Growth rates declined with size and were undetected for large individuals (Fig. 7).

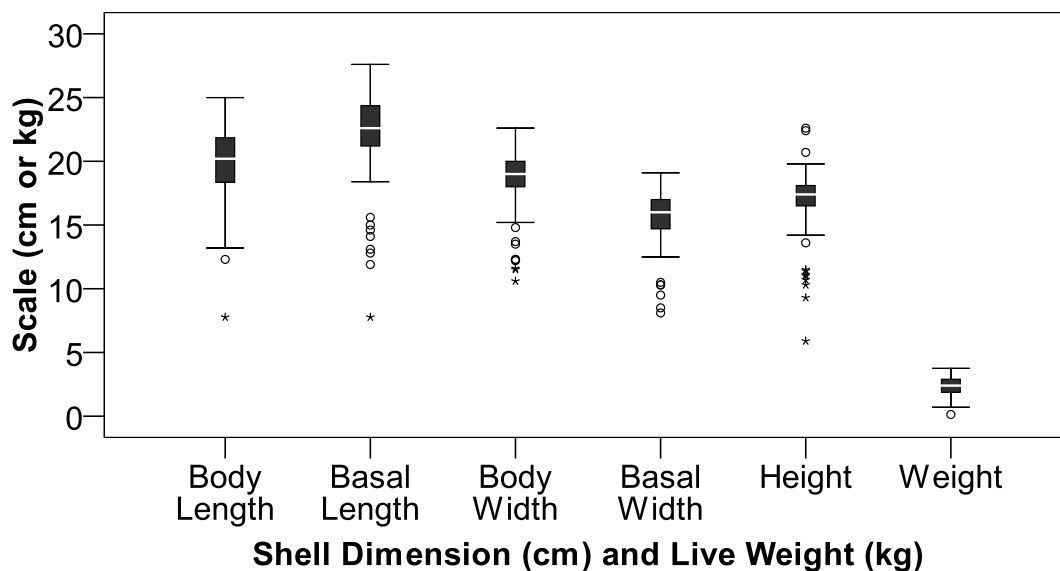


**Figure 4.** Basal length frequency distribution of *Cassis cornuta* (n=83) sampled at TRNP between 2009 and 2011.

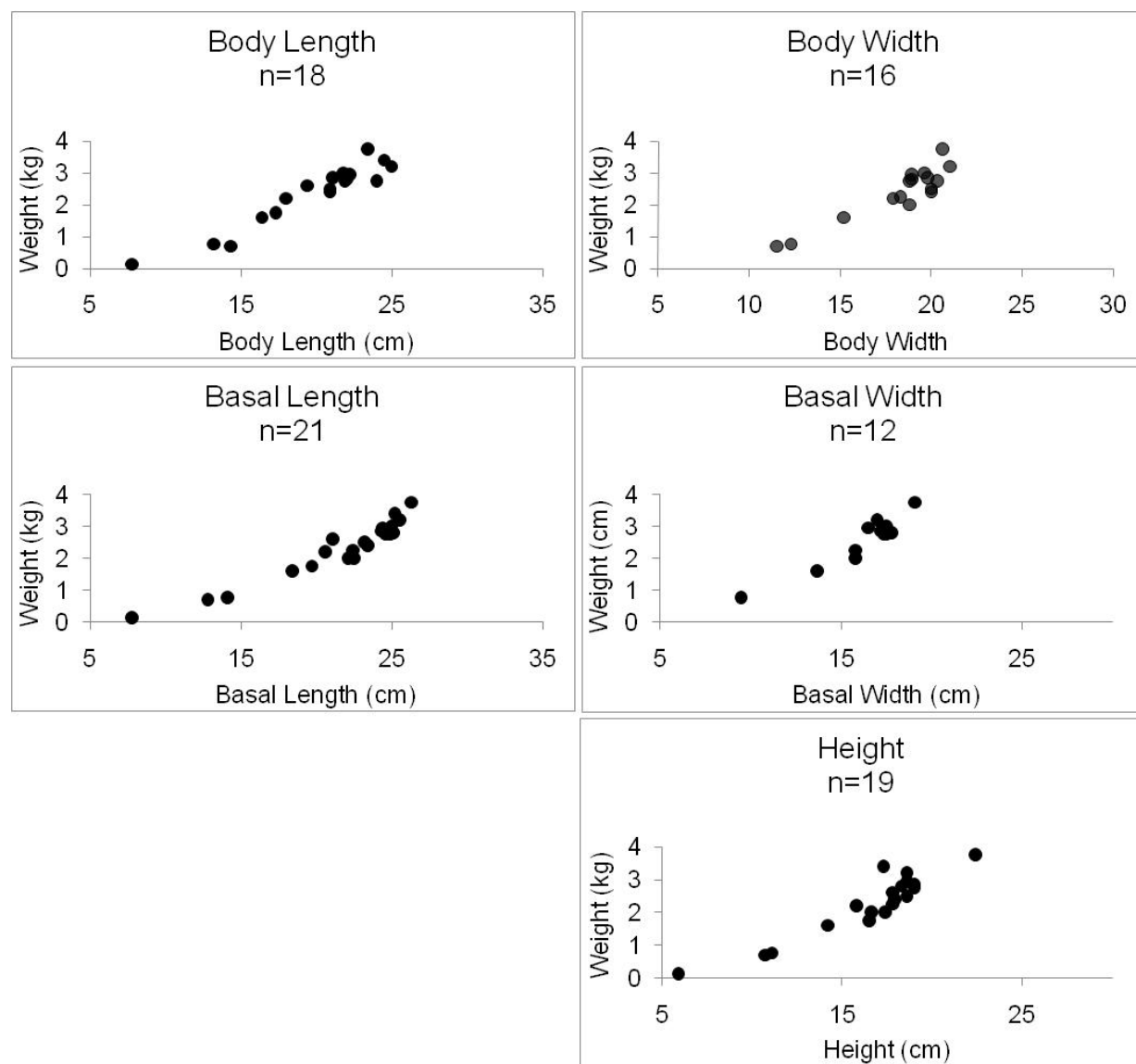


**Table 1. Mean ( $\pm$ SE) shell dimensions obtained from sampled *Cassia cornuta*.** Variations in the number of samples (n) between shell measurements was due to failure to measure either one or two of the shell's dimensions in some samples. Only *C. cornuta* encountered from December 2009 – June 2010 had their weights taken during the sampling. Data from recaptured individuals were excluded.

Shell Dimension and Live Weight	n	Mean	$\pm$ SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Body length (cm)	80	19.78	0.320	19.156	20.414
Basal length (cm)	83	22.10	0.314	21.484	22.720
Body width (cm)	78	18.59	0.324	17.949	19.223
Basal width (cm)	74	15.58	0.333	14.922	16.230
Height (cm)	81	16.88	0.318	16.254	17.504
Weight (kg)	19	2.27	0.657	0.975	3.556



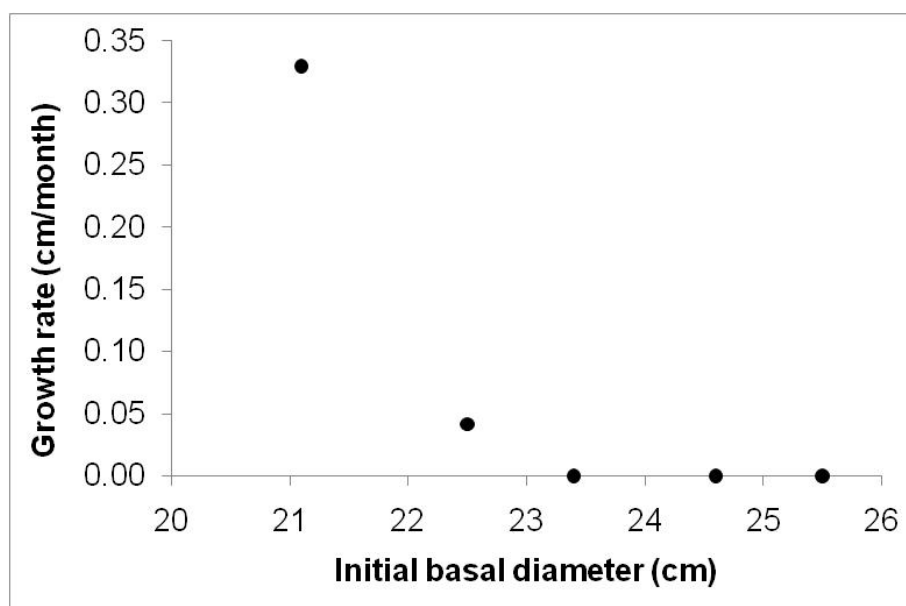
**Figure 5.** Box plots for body measurements of *Cassia cornuta* from TRNP. o and \* are outliers. Data from recaptured individuals were excluded.



**Figure 6.** Scatter plots between the shell dimensions and live weights of *Cassis cornuta* from TRNP. The variation in number of samples was a result of incomplete set of measured shell dimension in some individuals. Data from recaptured individuals were included.

**Table 2. Shell dimension-weight regression coefficients for *C. cornuta* from TRNP.** Values for the intercept ( $a$ ) and the slope ( $b$ ) were obtained from the log transformed  $X$  (shell dimension; cm) and  $Y$  (weight; kg) values resulting to an equation:  $\text{Log}_{10} \text{Weight} = \text{Log}_{10} a + b \cdot \text{Log}_{10} \text{Shell Dimension}$ . The variation in number of pairs was a result of having incomplete data for some individuals.

Shell Dimension	n	Slope “ $b$ ”	Intercept “ $a$ ”	$R^2$	df	$F$ -ratio	$P$
Body length	18	2.772	-3.260	0.955	1,16	340.00	<0.001
Basal length	21	2.522	-3.037	0.975	1,19	747.00	<0.001
Body width	16	2.576	-2.888	0.935	1,14	200.03	<0.001
Basal width	12	2.252	-2.334	0.956	1,10	214.19	<0.001
Body height	19	2.562	-2.806	0.968	1,17	509.29	<0.001



**Figure 7.** Growth rates of *Cassia cornuta* based on recaptured individuals. The negative growth in one of the 6 recaptured *C. cornuta* (basal length: 18 cm) which we presumed a sampling error was not included in this graph.

Market surveys revealed some *C. cornuta* shells displayed for sale (Fig. 8) in a number of souvenir shops in Puerto Princesa City. Between May and June 2012, six (4.41 %) of the 136 souvenir shops we visited were selling a piece of *C. cornuta* shell at a price ranging between PhP150-350 (US\$3.4-8.0). In total, 11 pieces of *C. cornuta* shells were noted among those shops. When asked about the danger of transporting a protected species, the sellers replied that airport facilities cannot detect the shells of *C. cornuta* once carefully packed, further adding that in the past, many tourists bought the shells from them and had transported the same without having been caught by airport authorities.





**Figure 8.** *Cassis cornuta* along with other souvenir items displayed for sale in one of the surveyed shops in Puerto Princesa City. Note the variations in the shape of the shell for female (left) and male (right) helmet conches.

## DISCUSSION

Most of the sampled helmet conch had 3 – 4 prominent knobs on the shoulder (see Fig. 3), distinguishable body shape for either male or female (Poutiers, 1998; Coleman, 2012), and the basal length longer than the body length (Fig. 5) because of the well developed flanged lip which protruded beyond the apex of the shell. The large knobs common to helmet conch with > 15 cm basal length were less developed in one small individual (having both the body and base of equal length at 7.77 cm) which we presumed juvenile. The variation in sizes of large *C. cornuta* with 3 – 4 prominent knobs on the shoulder could be sex related, with males being smaller than females (Poutiers, 1998), and/or due to differential growth rate and age. Variation in growth rates of other gastropods such as *T. niloticus* (Nash, 1993) and conches (Ray and Stoner, 1995) are location- and food-availability related. A flanged lip suggests sexual maturity and cessation of growth among humped conch *Strombus gibberulus* (Giovas *et al.*, 2010). For the reef gastropod *T. niloticus*, it appeared that occurrence of flanged lip is associated with age instead of sexual maturity. Flanged lip is well developed among captive and stunted 3-year old *T. niloticus* (> 5 cm basal shell diameter), while it only occurred among large individuals in the wild. An aggregate (3-5 individuals per group) of *T. niloticus* (7 – 9 cm basal shell diameter) at an intertidal area of TRNP had flanged lip, while such shell formation appeared only on much larger individuals collected from the deeper parts of the reef (Dolorosa, 2011). For *C. cornuta*, flanged lip is developed every 270

degrees of shell growth. Examination of four shell samples in our university revealed that large *C. cornuta* with 3 – 4 prominent knobs on the shoulder could have developed 8 – 9 flanged lips.

The skewness (-1.64) of the frequency distribution in favour of large individuals suggests the absence of exploitation. This is likely true, but near absence of smaller individuals < 10 cm (Fig. 4) also suggests a sampling bias skewed toward findings individuals over a certain size. Since sampling was conducted over a period of just over a year, it is unlikely that the 3 size groupings in Figure 3 represent cohorts. The growth rates obtained from recaptured helmet conch declined with size. Reduced growth rate as shell size increases is normal for animal growth as had been reported for other molluscs (Perron, 1983; Nash, 1993; Helidoniotis *et al.*, 2011). *Cassis cornuta* can occur from 2 – 30 m deep (Poutiers, 1998), but in TRNP they appear to favour shallow water, sandy habitats and sandy areas with small patches of rubble and live corals. There were no reports of any *C. cornuta* in deeper and outer parts of TRNP (see Dolorosa and Schoppe, 2005; Ledesma *et al.*, 2008). Encountered *C. cornuta* on exposed sand flats during low tides were either setting on or partly buried beneath the sand or rubble. Individuals encountered in inundated environment were often fully emerged. They seem abundant at intertidal area when there was a wide low tide before sunrise, suggesting nocturnal activities at the intertidal area during spring tide.

The absence of sightings of *C. cornuta* in deeper parts of the reef in TRNP may be related to their nocturnal habit and tendency to remain dormant while partly buried on sand during the day; their population is low, or they do not prefer seaward drop-off reef areas where all permanent monitoring transects for corals and fishes are established. They possibly occur abundantly in the lagoon, which is generally sandy, but has not been surveyed yet. However, if *C. cornuta* favour shallow habitats in TRNP, such a pattern of distribution is similar to that of *Terebra maculata* (Dolorosa *et al.*, 2011) and *T. niloticus* (Dolorosa and Schoppe, 2005; Ledesma *et al.*, 2008). To determine whether *C. cornuta* are widely distributed and are still abundant in other areas distantly located from the Ranger Station, a park-wide survey of its abundance is suggested.

The average basal length of sampled *C. cornuta* (22.1 cm) in TRNP coincided with the reported common size within its natural geographic range (Poutiers, 1998). Other large reef gastropods recorded at the park are *T. niloticus*, measuring 16 cm in maximum basal shell diameter, but commonly 7 cm (Ledesma *et al.*, 2008), and *C. tritonis* having a shell length and weight of 34.7 cm and 2.75 kg (Dolorosa, unpublished data).

The high  $R^2$  values (> 0.9) in all regression analyses suggest that at least 90 % of the variation in live weight is accounted for by variations in any of the shell dimensions. All tests were significant ( $P < 0.001$ ), thus any of the derived equations is a good estimator of live weight for *C. cornuta* in TRNP. Length-weight relationship can allow life history and morphological comparisons between populations of a species from different habitats and regions. Most studies on length-weight relationships were on fishes (e.g. Gonzales *et al.*, 2000; Stergiou and Moutopoulos, 2001; Loh *et al.*, 2011). Very few length-weight relationship studies have been done for shelled molluscs (e.g. Gimin *et al.*, 2004; Suja and Mohamed, 2012). Length-weight relationship may vary with sex (see Loh *et al.*, 2011) but this has not been determined in this study.

*Cassis cornuta* may find it hard to recover once overly exploited. In the past, before the declaration of Tubbataha Reefs as a National Park, there was large scale extraction of fish and other marine life in the area (Arquiza and White, 1999). Also, even after its declaration as a National Park and with the presence of park rangers, entry of both local and foreign poachers remained a problem (TMO, unpublished data; Jontila *et al.*, 2011). *Cassis cornuta* are difficult to spot when partly buried on sand, but their large size and tendency to form a colony (Poutiers, 1998) make them vulnerable to exploitation. Unlike fishes, the populations of large reef gastropods and invertebrates are difficult to revive when overly exploited.

Recovery of fishes in long term well-protected reefs (>20 years) in the Philippines, like the Apo Reef sanctuary, had been reported (Alcala, 1998; Abesamis and Russ, 2005), but there is limited information on the recovery of reef invertebrates. Raymundo (2003) suggested that recruitment limitation and very low numbers of the breeding populations explain the absence of coral reef health indicators such as giant clams, pencil urchins and tritons in spite of the lack of poaching at Apo Reef sanctuary.

Despite that *C. cornuta* is a Philippine protected species, poaching and trading continues. In 2011, confiscated shells ready for export from Cebu, Philippines included among others at least 1,377 and 25 shells of the protected species *C. cornuta* and *Charonia tritonis* (Cuyos, 2011). In May 2012, the value of 139 confiscated boxes of horned helmet shells and 20 boxes of turtle carapaces from Cebu was estimated at about PhP 5 million (Anonymous, 2012b). Also, in April 2012, an unspecified number of horned helmet shells, top shells and white lip oysters, 24 dead green sea turtles and 19 hawksbill turtles had been confiscated from 12 Vietnamese poachers in Palawan (Marcaida and Ponce de Leon, 2012). Surprisingly, *C. cornuta* (Fig. 8) and the other protected reef gastropod *Charonia tritonis* (Fig. 9) are continuously displayed for sale in some souvenir shops and even along a sidewalk in Puerto Princesa City.



**Figure 9.** Shells including the protected *Charonia tritonis* are openly displayed for sale in a sidewalk in Puerto Princesa City.

Population studies of *C. cornuta* in other parts of the country are needed to determine areas with healthy populations which could become a focus of conservation. A well-designed sampling method that minimizes bias towards finding large individuals, estimation of sex ratios, reproductive biology and natural predators would be needed to develop an accurate estimate of the size and health of *C. cornuta* populations. Permanent markings engraved on the shells as what Kosuge *et al.* (2009) has done on Auger



shells *Terebra maculata* which allowed long term growth and survival studies for up to 10 years or even longer might be applied among *C. cornuta*. Such markings may be also used to trace the origins of *C. cornuta* sold in some souvenir shops. To put an end to its harvesting and trade in Palawan and other parts of the country, stringent law enforcement is needed.

## ACKNOWLEDGMENTS

The authors are indebted to the assistance of the Rangers of TRNP during the data collection; and to the comments and suggestions of Mr. Joie D. Matillano, Dr. Lota A. Creencia and Dr. Leo L. Lactuan on the early draft of the manuscript.

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