

The First Record of Noah's Giant Clam *Tridacna noae* (Röding, 1798) (Cardiidae: Tridacninae) with Notes on Population and Associated Giant Clam Species in Romblon, Philippines

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ABSTRACT

This study reports the first confirmed record of *Tridacna noae* (Röding, 1798) in Carmen Bay, Romblon, Philippines, expanding the known distribution of the species within the region. Field surveys were conducted from January to March 2021 using modified belt transect methods across four sites, comprising both protected (sites 1 and 2) and non-protected areas (sites 3 and 4). A total of 171 giant clams, representing three species, were identified: *Tridacna crocea* (n = 140), *T. maxima* (n = 31), and *T. noae* (n = 10). *Tridacna crocea* was the most abundant species, while *T. noae* exhibited the lowest abundance. Both *T. maxima* and *T. noae* were restricted exclusively to marine protected areas. Population densities were markedly higher in protected sites (580 and 527 individuals per hectare) compared to non-protected areas (20 and 13 individuals per hectare), highlighting the critical role of marine protected areas in conserving tridacnid populations. The limited distribution and low population density of *T. noae* and *T. maxima* within the study area suggest that they are potentially vulnerable to anthropogenic pressures and habitat degradation. These findings provide essential baseline data on the occurrence, abundance, and spatial distribution of *T. noae*, underscoring the need for enhanced conservation strategies to safeguard giant clam biodiversity in the Philippines.

Keywords: *abundance, Carmen Bay, density, non-protected area, protected area*

INTRODUCTION

Tridacna noae, commonly known as the Noah's Ark clam or the small giant clam, is a species of large marine clam that belongs to the family Cardiidae (Borsa et al., 2015). It is one of the several species of giant clams found in the Indo-Pacific region (Borsa et al., 2014; Marra-Biggs et al., 2022; Militz et al., 2015; Neo & Low, 2018). It is one of the smaller species of giant clams, typically reaching a maximum length of about 30 centimeters (12 inches). The shell of this species is elongated and symmetrical, with a slightly curved shape (Triadiza et al., 2019). Like other giant clams, the mantle of *Tridacna noae* exhibits a highly complex and intricate pattern, distinguishing it from other giant clam species (Su et al., 2014). It features a diverse range of colors,

including shades of blue, green, brown, and gold, often forming elaborate designs across its surface (Borsa et al., 2015). One of its most striking characteristics is the presence of large, dark ocelli (eye-like spots), which are more pronounced and well-defined compared to the more minor, scattered spots found in *T. maxima* (Ecube et al., 2019). These ocelli are typically surrounded by lighter or iridescent rings, creating a visually striking contrast (Su et al., 2014). Additionally, the mantle may display a network of fine, wavy lines, blotches, or intricate reticulations, contributing to its unique appearance (Borsa et al., 2015). These unique patterns aid researchers and marine biologists in field identification, reducing the likelihood of misidentification, which has been a common issue due to the species' close resemblance to *T. maxima* (Morejohn et al., 2023). This species is typically found in shallow, tropical marine habitats such as coral reefs and lagoons (Ecube et al., 2019, 2024). It requires clear and well-lit waters for its symbiotic relationship with the zooxanthellae algae (Soo & Todd, 2014). Along with other giant clam species, it has faced significant threats from overharvesting and habitat degradation (Watson &

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Neo, 2021). As a result, it is considered vulnerable and protected under various international agreements and conservation initiatives (Davila et al., 2017; Neo & Li, 2024). In the Philippines, all giant clams are protected under Republic Act 9147 or the Philippine Wildlife Act, Republic Act 10654 or the Amended Fishery Law, and Department of Agriculture-Department Administrative Order 208 series of 2001, also known as the conservation and protection of rare, threatened, and endangered aquatic species and updating the listed species. This small giant clam is primarily found in the Indo-Pacific region (Marra-Biggs et al., 2022). Its distribution range spans from the eastern coast of Africa and the Red Sea, across the Indian Ocean, to the western Pacific Ocean (Borsa et al., 2014). In the Philippines, *Tridacna noae* can be found in coral reef ecosystems and shallow marine habitats. Some specific locations where it has been reported in eastern Negros Island (Borsa et al., 2015; Marra-Biggs et al., 2022; Miltz et al., 2015; Neo & Low, 2018), San Vicente, Palawan (Ecube et al., 2019), and Culion Island, Palawan (Mecha, 2024).

This study aims to document the first recorded occurrence, population, and abundance of *Tridacna noae* (Röding, 1798) in Romblon, Philippines. It contributes to the understanding of local marine biodiversity, highlights conservation needs for this

potentially vulnerable species, and underscores the importance of giant clams in coral reef ecosystems. Additionally, it adds valuable data to the taxonomy and distribution of giant clams, supporting future research and conservation efforts.

METHODOLOGY

Sampling Site

The survey was conducted in the protected area of Carmen Bay, Romblon, Philippines, specifically in the Cabolutan Fish Sanctuary and non-protected areas, including the gleaning regions of barangay Carmen and Sugod, from January to March 2021. Carmen Bay is a small bay located in the north of Tablas Island, Romblon, Philippines (Figure 1). It is geographically located in the Municipality of San Agustin, Romblon, Philippines. This bay is bounded by three barangays of San Agustin, namely, Cabolutan, Carmen, and Sugod. In addition, the bay faces the Romblon Passage, an essential corridor for migratory species such as tuna, sea turtles, and other endangered and commercially important marine species, as well as a habitat for other marine organisms, including giant clams. It is also considered the most exploited fishing ground in the

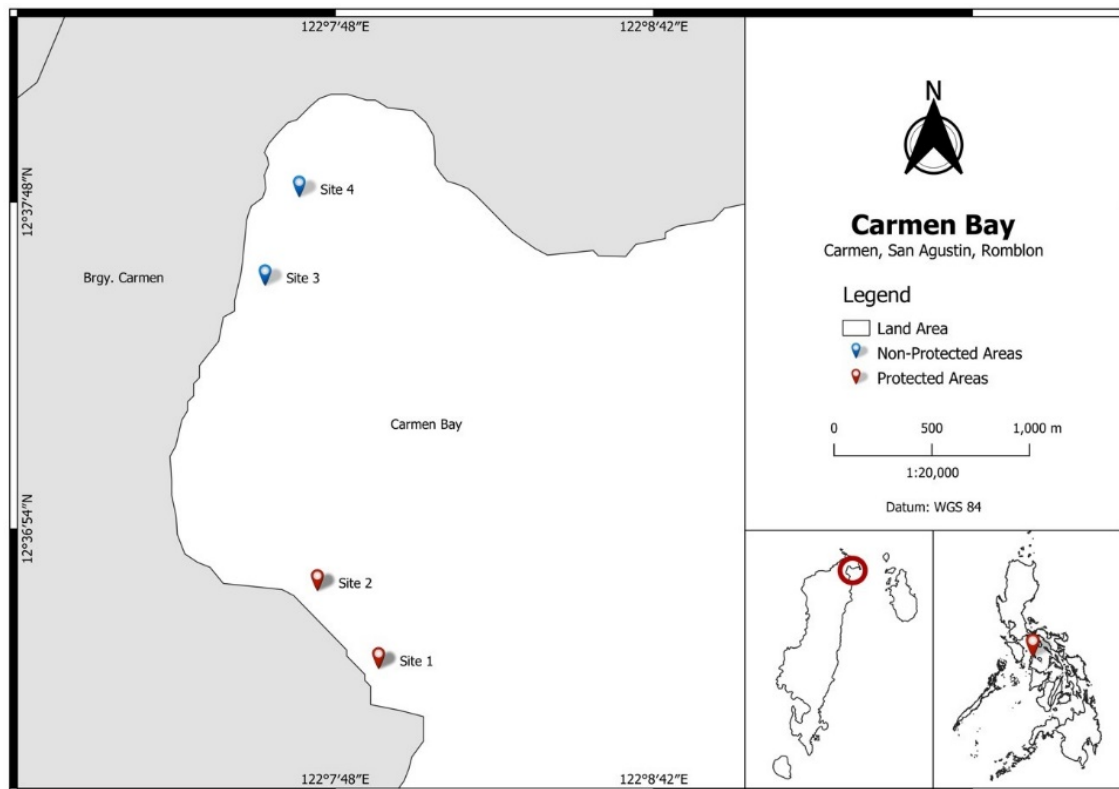


Figure 1. The map of Carmen Bay in San Agustin Romblon, Philippines. Red pins indicate the sampling sites in Cabolutan Fish Sanctuary, and blue pins indicate the location of the sampling sites in none protected area in the bay.



Figure 2. Photos of giant clams in Carmen Bay, Romblon, Philippines. *Tridacna crocea* (A), *T. maxima* (B), *T. noae*, (C), focus image mantle pattern of *T. noae* (D).

Country [Sentro Para sa Ikauunlad ng Katutubong Agham at Teknolohiya Inc (SIKAT), 2013].

Sampling Method

The survey of giant clams was conducted in the shallow waters (about 1 meter deep) of Carmen Bay, Romblon, Philippines. Researchers established four sampling sites, each with three transects perpendicular to the shore, for data collection. Each transect measured 50 x 10 meters.

Sampling Site

Sites 1 and 2 were located within the Cabolutan-Carmen Fish Sanctuary, a protected area, while sites 3 and 4 were outside the sanctuary. The team employed the modified belt transect method, as described by English et al. (1997), to guide the survey, which was conducted during daytime low tides.

Identification of Giant Clams

Identification was based on the morphological characteristics of giant clams, including their habits, mantle pattern, and photographs. An identification guide from the Fisheries Administrative Order (FAO) and the World Register of Marine Species (WORMS) was used

for species identification. Sending giant clam photos to the expert online was also done for further verification.

Survey on Abundance and Population Density

All giant clams found within the 50x10 meters transect were counted for population density and measured for shell dimension (Knop, 1996). All giant clam species identified were counted and analyzed using Microsoft Excel. Photography was done for future identification and documentation purposes. Sample photos that were not identified were sent to experts from other institutions.

Data Analysis

All identified giant clam species were counted to determine species composition. The collected data on giant clams were processed and analyzed using Microsoft Excel to assess their population and abundance. A two-tailed independent sample t-test was conducted to determine whether there were significant differences in abundance and population density between sites.

FINDINGS AND DISCUSSION

The Giant Clams in Carmen Bay, Romblon, Philippines

Three species of small giant clams, *Tridacna crocea* (Figure 2A), *Tridacna maxima* (Figure 2B), and *Tridacna noae* (Figure 2C&D) were found and identified in Carmen Bay, Romblon. Notably, this marks the first recorded occurrence of *T. noae* in Romblon province (Figure 2). Among these three species recorded, *T. crocea* was present in all sites, while *T. maxima* and *T. noae* were only found in the protected area of Carmen Bay, Romblon. Among three giant clams, *T. noae* has the highest mean shell length of 9.40 cm, followed by *T. maxima* with 6.96 cm mean shell length and *T. crocea* with 6.22 cm mean shell length. *Tridacna noae*, commonly known as Noah's giant clam, is often mistaken for *Tridacna maxima* due to their similar appearance, but several distinct morphological features differentiate the two (Su et al., 2014; Su et al., 2021). The shell of *T. noae* is elongated and roughly symmetrical, with prominent radial folds or ridges. It typically grows up to 40 cm in length, making it smaller than *T. gigas* but comparable in size to *T. maxima* (Ecube et al., 2019; Marra-Biggs et al., 2022; Su et al., 2021). The shell is generally white to cream-colored, often marked with brownish patterns, and features well-developed scutes along the ridges, a characteristic that helps distinguish it from *T. maxima* (Borsa et al., 2015; Marra-Biggs et al., 2022). The mantle of *T. noae* displays a striking variety of colors, including shades of black, brown, and gold, often adorned with intricate patterns of spots, white lines, or blotches (Su et al., 2014). One of the most distinguishing features is the presence of large, dark ocelli (spots) on the mantle, which are more defined compared to the more minor, scattered spots seen in *T. maxima* (Roszbach et al., 2020). Around the incurrent siphon, short, non-retractile siphonal tentacles are present. The hinge area of *T. noae* is relatively small, and its byssal opening is narrow, allowing the clam to attach firmly to rigid coral substrates (Su et al., 2014).

Tridacna noae, along with *T. crocea* and *T. maxima*, is primarily found in shallow tropical coral reefs, often nestled within coral crevices or growing attached to rocky surfaces. This type of habitat condition was also observed in the sampling sites in Carmen Bay, Romblon (Borsa et al., 2014; Lee et al., 2024; Roszbach et al., 2021). Its distribution spans across the Indo-Pacific region, including Southeast Asia, Australia, and the Pacific Islands (Borsa et al., 2015; Marra-Biggs et al., 2022; Militz et al., 2015; Neo & Low, 2018). In the Philippines, *Tridacna noae*, commonly known as Noah's giant clam, has been identified in several locations across the Philippines, with notable occurrences in Palawan (Ecube et al., 2019; Mecha, 2024). The first

Table 1. Abundance and population density of giant clams in Carmen Bay, Romblon, Philippines. Site 1 & 2 (protected area), Site 3 & 4 (non-protected area)

Site	Species	No. of giant clams	Density (giant clam/ha)
1	<i>T. crocea</i>	81	540
	<i>T. maxima</i>	12	80
	<i>T. noae</i>	7	47
	Total	87*	580
2*	<i>T. crocea</i>	55	367
	<i>T. maxima</i>	19	127
	<i>T. noae</i>	3	20
	Total	79*	527
3	<i>T. crocea</i>	2	13
	<i>T. maxima</i>		
	<i>T. noae</i>		
	Total	3	20
4	<i>T. crocea</i>	2	13
	<i>T. maxima</i>		
	<i>T. noae</i>		
	Total	2	13

Note * Significance difference (p-value 0.029)

report of *T. noae* in the country was from eastern Negros, based on mitochondrial DNA sequences retrieved from open-access databases (Viray-Mendoza, 2018). Subsequent observations have expanded its known distribution, particularly within Palawan. In 2019, a specimen measuring 4.5 cm in shell length was documented in Port Barton, San Vicente (Ecube et al., 2019). Later, in 2024, two juvenile specimens, each approximately 7.8 cm in shell length, were discovered partially buried in dead coral substrates at a depth of 2 meters in Barangay Malaking Patag, Culion (Mecha, 2024). These findings suggest a broader distribution of *T. noae* across the Philippines; however, comprehensive studies are still needed to understand its range and population status in the country fully. The unique combination of shell morphology, mantle coloration, and habitat preference helps distinguish *Tridacna noae* from other giant clam species, making it an essential species in marine biodiversity studies.

Abundance of Giant Clams in Carmen Bay, Romblon, Philippines

A total of 181 ± 27.51 giant clams were recorded in the shallow waters of Carmen Bay, Romblon. Among the three identified species, *Tridacna crocea* was the most abundant, with 140 ± 34.26 individuals. This was

followed by *T. maxima*, with 31 ± 3.5 individuals, and *T. noae*, with the lowest count of 10 ± 2.0 individuals. The two protected sites (Sites 1 and 2) exhibited significantly higher (p -value=0.029) in terms of abundance and densities of giant clams, with 667 clams/ha in Site 1 and 513 clams/ha in Site 2, compared to the non-protected sites (Sites 3 and 4), which recorded only 13 clams/ha for both sites (Table 1). These findings strongly suggest that marine protected areas (MPAs) play a critical role in sustaining giant clam populations by providing a safer environment with reduced human disturbances and better habitat conditions (Solandt et al., 2025).

Among the three identified species, *Tridacna crocea* was the most dominant, accounting for the majority of the recorded individuals across all sites. It was particularly abundant in the protected areas, with 81 individuals in Site 1 (540 clams per hectare) and 55 individuals in Site 2 (367 clams per hectare). This species was also found in non-protected areas, but in drastically lower numbers, with only two individuals each in Sites 3 and 4 (13 clams/ha per site). The ability of *T. crocea* to persist in lower numbers in non-protected areas may suggest that it has a higher tolerance to environmental stressors or human disturbances compared to other giant clam species (Liu et al., 2020). *Tridacna maxima* was found only in the protected sites, with 12 individuals in Site 1 (80 clams per hectare) and 19 individuals in Site 2 (127 clams per hectare). Its complete absence in non-protected areas suggests that this species may be more sensitive to environmental changes, overharvesting, or habitat degradation, making it highly dependent on protected areas for survival (Pulido-Chadid et al., 2023). *Tridacna noae* was the rarest species observed, with only 7 individuals in Site 1 (47 clams per hectare) and 3 individuals in Site 2 (20 clams per hectare). Its absence in non-protected areas further highlights its vulnerability and potential risk of local extinction due to external pressures (Ameca et al., 2024). The low numbers of *T. noae* could be attributed to its naturally lower population density or possible misidentification issues in past surveys, as it closely resembles *T. maxima* (Marra-Biggs et al., 2022; Neo & Low, 2018).

The dramatic decrease in population density from protected to non-protected areas suggests that human activities, including illegal harvesting, habitat destruction, and water quality degradation, may be key factors influencing the distribution of giant clams (Siburian et al., 2024). Overharvesting is a significant concern, as giant clams are highly valued for their meat, shells, and use in the aquarium trade (Gomez & Mingoa-Licuanan, 2006). Additionally, habitat degradation due to coastal development, pollution, and climate change may further contribute to the decline of these species in non-protected areas (Watson & Neo, 2021).

The results show the critical role of marine protected areas in conserving giant clam populations. The significantly higher densities observed in Sites 1 and 2 demonstrate that protection efforts have been effective in maintaining suitable conditions for the survival and recruitment of giant clams. However, the low numbers in non-protected areas emphasize the urgent need for stronger conservation measures, including the potential expansion of protected zones, stricter enforcement of fishing regulations, and active habitat restoration efforts in degraded areas.

CONCLUSION

The present study provides the first documented occurrence of *Tridacna noae* in Carmen Bay, Romblon, Philippines, alongside *Tridacna crocea* and *Tridacna maxima*. The findings demonstrate a clear disparity in giant clam abundance between protected and non-protected areas, with significantly higher densities observed within marine protected zones. The restricted presence of *T. noae* solely within protected areas, coupled with its low population density, indicates its heightened sensitivity to anthropogenic disturbances and potential risk of local decline. These results underscore the crucial role of marine protected areas (MPAs) in preserving tridacnid populations by mitigating threats such as overexploitation and habitat degradation. Furthermore, the study underscores the necessity for expanded conservation efforts, strict enforcement of protective regulations, and long-term monitoring programs to support the recovery and persistence of vulnerable giant clam species, particularly *T. noae*, within Philippine reef ecosystems. These baseline data contribute to the broader understanding of tridacnid distribution and population dynamics, supporting future biodiversity management and conservation initiatives.

AUTHORS' CONTRIBUTIONS

All authors are involved during the conceptualization, data collection, data processing and interpretation, write-up and revision.

CONFLICT OF INTEREST

The authors declare no competing interests.

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