BIODIVERSITAS
Volume 26, Number 4, April 2025
Pages: 1891-1897

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d260438

Community status of giant clam (Tridacnidae) on Bira of Seribu Islands, Indonesia

RATNA KOMALA[1,♥], DIANA VIVANTI SIGIT[2,♥♥], EKA PUTRI AZRAI[3,♥♥♥]

[1]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta. Jl Rawamangun Muka, East Jakarta 13220, Jakarta, Indonesia. Tel.: +62-214-894909, ♥email: ratna_komala08@yahoo.co.id.

[2]Graduate Program of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta. Jl Rawamangun Muka, East Jakarta 13220, Jakarta, Indonesia. Tel.: +62-214-894909, ♥♥email:dianavivanti@yahoo.com

[3]Department of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta. Jl Rawamangun Muka, East Jakarta 13220, Jakarta, Indonesia. Tel.: +62-214-894909, ♥♥♥email:ekaputri@unj.ac.id

Manuscript received: 29 September 2024. Revision accepted: 17 April 2025.

Abstract. *Komala R, Sigit DV, Azrai EP. 2025. Community status of giant clam (Tridacnidae) on Bira of Seribu Islands, Indonesia. Biodiversitas 26: 1891-1897.* The Tridacnidae family, commonly referred to as giant clams, has a comparatively high ecological and commercial potential but is vulnerable to environmental shifts and human activities. The study aims to identify species of Tridacnidae, ascertain their abundance, diversity, and dominance, and examine the correlation between environmental factors and the population abundance of giant clams on Bira of Seribu Islands, Indonesia. The location of the observation is determined purposefully based on the coral reef existence. Data collection was carried out using the line Transect method, which involves measuring 10 transects over 100 meters from the shore to the reef edge. The Underwater Photo Transect (UPT) sample collection technique was employed at a depth of between 3 and 4.5 meters. The Mantel test was used to examine the relationship between environmental parameters and the abundance of giant clams. In contrast, the abundance, biodiversity, and dominance index formulas were used to interpret the data. The result identified three species of giant clams from the genera *Tridacna* and *Hippopus*, with *T. maxima* showing the highest abundance, followed by *T. gigas* and *H. hippopus*. The diversity encompassed the low to middle criteria with low criteria dominance. Environmental parameters remained within a range favorable for the growth of giant clams, but there is no significant correlation between the environmental parameters with the abundance of Tridacnidae.

Keywords: Bira Island, giant clam, population, Tridacnidae

Abbreviations: UPT: Underwater Photo Transect

INTRODUCTION

Bira Island, part of the Seribu Islands, Indonesia, possesses great biodiversity, especially in marine biota that compose coral reef ecosystems. One of the most important ecological and economic classes is the bivalve (Komala et al. 2024). The Tridacnidae family of bivalves, also known as giant clams, have the highest and fastest growth rate among Bivalvia classes (Al-Howiti et al. 2020). Population growth of giant clams is a crucial component of Indo-Pacific coral reef communities (Al-Howiti et al. 2020; Lee et al. 2024). The coral reef habitat is an accumulation of limestone skeletons created by a group of coral polyps that secrete calcium carbonate (Lin et al. 2021; Asner et al. 2022), serves as a habitat for bivalves and plays a significant role in both ecologically and economically. In the Indo-Pacific, giant clams are both ecologically vital as habitats and economically significant as food and trade items for their shells (Waters et al. 2013; Purcell et al. 2020). There are 12 species of giant clams known to exist, with two in the genus *Hippopus* and 10 in the genus *Tridacna* (Neo et al. 2015; Lee et al. 2024). Eight of the eleven clam species that have been identified worldwide are found in Indonesian waters, namely *T. crocea* (Lamarck, 1819), *T. maxima* (Röding, 1798), *T. squamosa* (Lamarck, 1819), *T. derasa* (Röding, 1798), *T. gigas* (Linnaeus, 1758), *H. hippopus* (Linnaeus, 1758), *H. porcellanus* (Rosewater, 1982). The existence of giant clams is affected by various natural and human-induced factors. Climate change and global warming have significant impacts on Earth, particularly on marine ecosystems like coral reefs in Indonesia (Maynard et al. 2015; Hoegh-Guldberg et al. 2019). The majority of coral reef ecosystems are less resilient now due to environmental stressors like sedimentation, eutrophication, overfishing, substrate damage, and other physical activities that affect marine resources (Schönberg et al. 2017).

All giant clam species are on the CITES Appendix II and IUCN Red List, needing conservation to prevent extinction (Purcell et al. 2020). According to the IUCN, Tridacninae faces a high risk of extinction, emphasizing the necessity for current data (Rossbach et al. 2021). Environmental disturbances significantly affect biota populations, and changes in abundance, diversity, or dominance can indicate environmental issues like pollution, climate change, or habitat loss. Despite being protected, Indonesia's giant clam population is declining due to food consumption, and habitat vulnerability and

exploitation (Purcell et al. 2020). To overcome the drastic decline in giant clam populations, the Indonesian Government enacted Forestry Minister Regulation No. 12/Kpts-II/1987, trengthened by Government Regulation No. 7 of 1999, protecting eight giant clam species from exploitation. These clams are found in Indonesian waters, including the Seribu Islands. However, current studies indicate significant damage to Bira Island's coral reef ecosystem, negatively impacting its biodiversity, including giant clams, based on low percentage of live hard coral (Komala et al. 2024). Bira Island is a privately-owned island that has long been unmanaged, consequently impacting the surrounding waters which are a conservation area.

Research on giant clams in the Seribu Islands, specifically in Kayu Angin Bira, found two species: *T. crocea* and *T. squamosa*. The distribution indicates a uniform pattern, with a low diversity index and high uniformity criteria., while in Belanda Island has a higher abundance and species richness of giant clams compared to Pramuka Island (Gumilar et al. 2023).

The species diversity influences both the variety and dominance of life within an ecosystem, and conversely, diversity and dominance impact the abundance of species. Healthy ecosystems typically exhibit high diversity and low dominance. Changes in abundance, diversity, or dominance can indicate environmental problems like pollution, climate change, or habitat loss. Understanding environmental parameters and their complex interactions is essential for protecting and restoring Earth's ecosystems.

Due to the the limited information on the Tridacnidae specifically on bira island in the seribu islands. The study is crucial to assess the potential of these giant clams and develop effective conservation strategies by investigating their resources, community structure in terms of abundance, diversity, dominance and the correlation between environmental factors and their abundance. The novelty of this study lies in observing samples around the Island from the shore to the reef edge for obtaining the most current data to inform conservation efforts.

MATERIALS AND METHODS

Study area

Data collection was carried out using the line transect method. The species observed was the giant clam population from the Tridacnidae family. The research was conducted in the coral reef ecosystems around Bira Island, the farthest island in the Seribu Islands, Indonesia. There are no sources of freshwater or river flows into Bira Island. The sampling location is shown in Figure 1.

Procedures

Determine observation station and transects

Ten observation stations were determined around Bira Island, purposefully based on the coral reef existence. Each station has a transect that extends 100 meters from the shore to the reef edge, with the distance between each station or transect being approximately 200 meters from the shore. A 1 × 1m² plot is laid out along the transect with a 5-meter spacing between plots. Subsequently, the data on Tridacnidae is recorded in each plot.

Collection of Tridacnidae samples

Data collection was carried out using the Underwater Photo Transect (UPT) technique at a depth of 3-4 meters in the coral reef ecosystem. The photos were then used to identify species based on shell morphology, scales, color, size, and habitat, as described by the CITES Management Authority Australia in Little (2005). Samples were collected in three replicates, with an observation period of one month between each sampling event on 22 June, 27 July, and 24 August 2024.

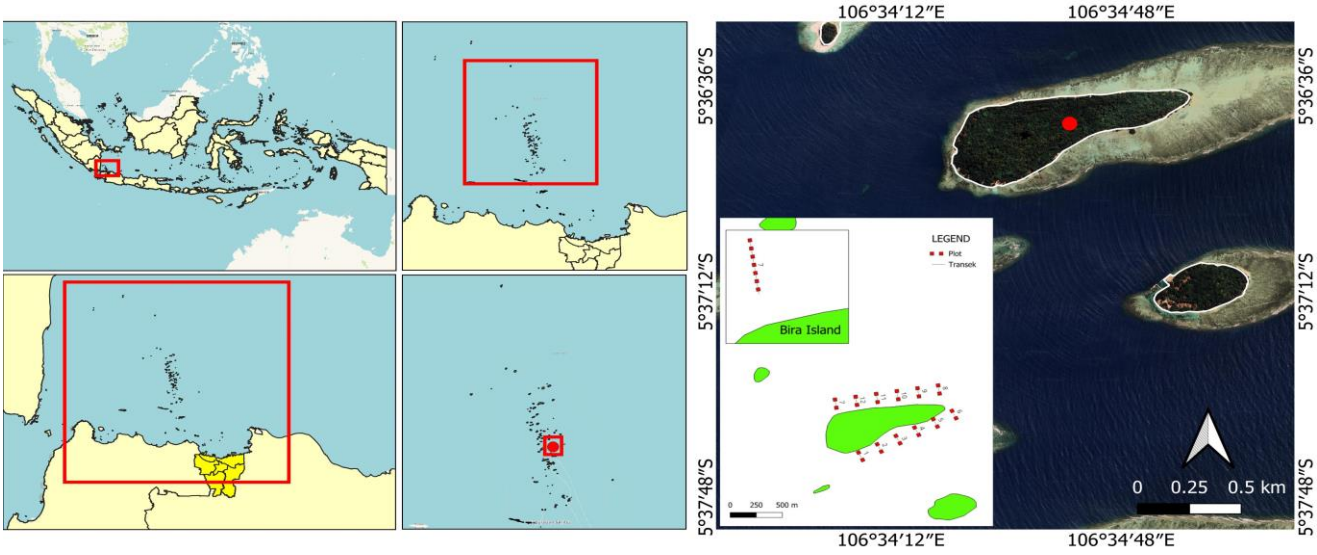

Figure 1. Sampling location at Bira Island, Seribu Islands, Jakarta, Indonesia

Measuring environmental parameters

The measurement environmental parameters include. Physical parameters such as temperature, and light penetration, as well as chemical parameters such as pH, dissolved oxygen, air velocity, and salinity, are measured during the research.

Data analysis

Next, to understanding the community structure, data was analyzed using formulas for abundance, diversity index, and dominance index. In comparison, the Mantel test was used to analyze the correlation of environmental parameters with *Tridacna* abundance. Abundance provides an overview of the species composition in a community, the diversity index displays the balance in the distribution of the number of individuals within each species, as well as the richness of species within a community, calculated using the Shannon-Wiener Index. Three criteria are used to evaluate species diversity: low if $H' \leq 2$, medium if $2 < H' \leq 3$, and high if $H' \geq 3$. The dominance index indicates which species are more prevalent in the water. The Simpson Dominance Index is used to calculate species dominance. The Dominance Index value ranges from 0-1. The dominance category is based on the index value criteria Simpson Dominance (D), namely as follows: Low if $0.00 < D \leq 0.50$, and High if $0.50 < D \leq 1.00$.

RESULTS AND DISCUSSION

Abundance and composition of Tridacnidae

In Bira Island, the Seribu Islands, 118 individuals from the Tridacnidae family were found, comprising three different clam species, namely *T. maxima* 58 individuals, *T. gigas* 40 individuals, and *H. hippopus* 19 individuals and identified species of Tridacnidae shown in Figure 2. At the same time, the number of individuals in each transect is shown in Figure 3.

Tridacna maxima species had the highest abundance, while *H. hippopus* had the lowest. Species abundance varied per transect, as shown in Table 1. Based on the total number of Tridacnidae, *T. maxima* has the largest composition (49.57%), followed by *T. gigas* (34.19%), and *H. hippopus* (16.24%) has the lowest.

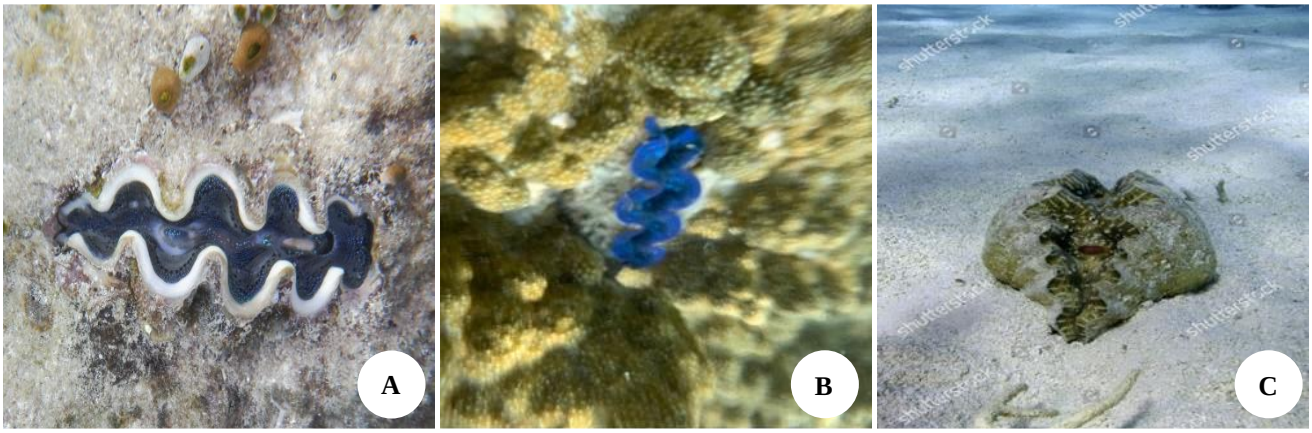

Figure 2. Identified species of Tridacnidae. A. *Tridacna maxima*; B. *Tridacna gigas*; C. *Hippopus hippopus*

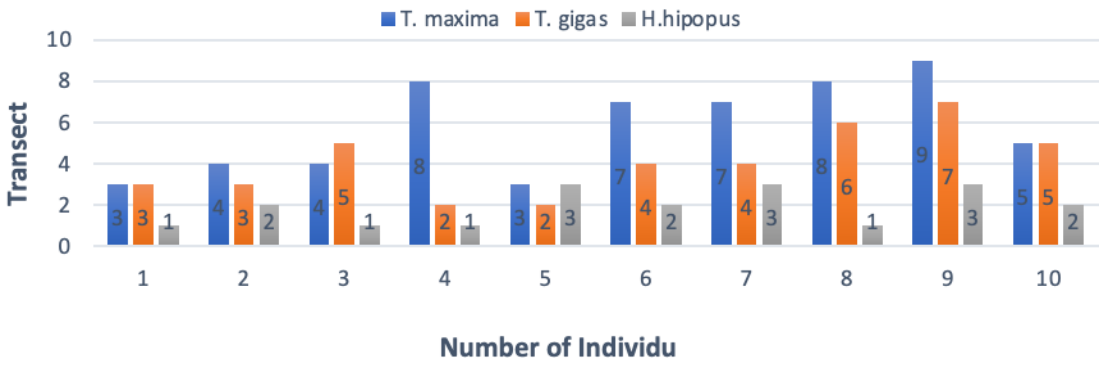

Figure 3. The number of Tridacnidae species in each transect

Diversity index and dominance index species of Tridacnidae

The diversity index value for each transect ranges from 0.76 to 1.11, indicating moderate diversity (60%) and low diversity (40%). The dominance index ranges from 0.34 to 0.58, with criteria for low dominance (80%) and high dominance (20%) shown in Table 2.

Correlation and influence of environmental parameters on the Tridcanidae community

The result of the Mantel test obtains the correlation coefficient value (r = 0.07363) and significance value (p = 0.3359). This value indicates that there is no correlation and no significant effect between environmental factors with Tridacnidae abundance. Environmental parameter values are generally still within the normal range for living clams compared with the standard requirement (Kepmen LH 51/2004). The average of environmental factors is shown in Table 3.

Discussion

Hippopus and *Tridacna* are the two genera that make up the gigantic clam family Tridacnidae. Out of the eight species found in Indonesia, only three Tridacnidae species have been identified in Bira Island that are *T maxima, T gigas,* and *H. hippopus*, but several other species are reported to be found in Indonesian waters, such as in Batu Bilis Island, Riau Islands, Tanjung Bilik National Park Baluran, Pramuka Island and Belanda Island in Seribu Islands and Supermonde Island identified *T. crocea, T. squamosa,* and *T. derasa*. Several factors, such as environmental suitability and the geographical location of the waters, greatly influence the distribution of Tridacnidae. The emphasis on the role of environmental suitability and the geographical position of waters underlines the complexity of factors influencing their distribution. Each observation station has a different number of clam species; however, those with sand and coral bottoms tend to have more clam species overall. Tridacnidae giant clams are vital components of Indo-Pacific coral reefs, serving various functions in these communities (Rossbach et al. 2021).

With an average abundance of 4.915 ind/m^2,at all transecst *T. maxima* had the highest abundance at all observation stations. This species is found on various types of coral substrates by immersing its body. *Tridacna maxima* is primarily found on rock substrates, although it can also be found on large coral and dead coral substrates (Lee et al. 2024). This species attaches itself to coral reefs by burrowing, making it challenging to remove from nature. If taken by force, it could harm the coral reefs where the *T. maxima* attach or submerge.

Table 1. Abundance of Tridacnidae from 10 observation transects on Bira Island, Seribu Islands, Indonesia

Transect	Abundance (ind/m^2)			Average
	T. maxima	*T. gigas*	*H. hippopus*	
1	2,542	2,542	0,847	1,977
2	3,390	2,542	1,695	2,542
3	3,390	4,237	0,847	2,825
4	6,780	1,695	0,847	3,107
5	2,542	1,695	2,542	2,260
6	5,932	3,390	1,695	3,672
7	5,932	3,390	2,542	3,955
8	6,780	5,085	0,847	4,237
9	7,627	5,932	2,542	5,367
10	4,237	4,237	1,695	3,390
Average	4,915	3,475	1,610	

Table 2. Diversity and dominance species of Tridacnidae in each transect

Index	Transect									
	1	2	3	4	5	6	7	8	9	10
H'	1.00	1.06	0.94	0.76	1.08	0.98	1.03	0.88	1.11	1.04
D	0.39	0.36	0.42	0.57	0.34	0.41	0.38	0.45	0.58	0.47

Table 3. Average values of environmental parameters at each station

Transect	Environment parameter						
	Temperature (°C)	pH	Salinity (ppt)	Light penetration (m)	Current (m/s)	Dissolved oxygen (mg/L)	Turbidity (NTU)
1	28	6	33.5	4.0	0.05	6.52	0.35
2	29	7.5	33.5	4.3	0.07	6.72	0.38
3	30	7.5	34.0	4.1	0.09	6.61	0.38
4	30	7.5	34.5	4.2	0.07	6.53	0.45
5	30	8.0	34.3	3.8	0.06	6.67	0.58
6	32	8.0	34.7	3.2	0.07	6.47	0.55
7	32	8.0	33.9	4.3	0.08	6.55	0.56
8	31	7.5	34.5	4.1	0.08	6.91	0.57
9	31	8.0	35.3	3.9	0.06	6.92	0.66
10	31	7.5	34.7	3.8	0.08	6.83	0.66
Average	30.40	7.55	34.29	3.97	0.071	6.67	0.51
Standard	30-34	7-8.5	33-34	3-6	-	>5	-

Tridacna maxima in Bira Island, found in the surrounding waters of Bira Island, lives and grows on massive coral substrates, both living and dead, during observation. Several environmental conditions and biogeographical factors are thought to influence the variation in Tridacnidae abundance. Sunlight is a crucial component for these clams and is not just a source of energy, but it also supports their symbiotic association with dinoflagellates belonging to the Symbiodiniaceae family (Rossbach et al. 2021; Massei et al. 2023). This delicate balance in nature is a testament to the intricate web of life in our oceans.

Several factors, including overexploitation, habitat loss, pollution, and climate change, have threatened the existence of giant clams (Maynard et al. 2015). Giant clams are highly sensitive to stock levels during reproduction and spawning, which impacts fertilization success and subsequently slows population recruitment (Zhou et al. 2022; Sayco et al. 2024). The small number of giant clams on Bira Island is suspected to be due to intensive fishing by fishermen in this area, or predation by predators like sea stars, as well as development on nearby private islands. Excessive sedimentation buries the coral reefs that the clams inhabit. Climate change further harms the habitat of coral reef ecosystems (Adyasari et al. 2021). According to Komala et al. (2024), the coral reefs of Bira Island are in the moderately damaged category.

Based on the total number of Tridacnidae, *T. maxima* has the largest composition (49.57%), followed by *T. gigas* (34.19%), and *H. hippopus* (16.24%) has the lowest. *Tridacna maxima* is a species of bivalve mollusk that inhabits the waters of the Indo-Pacific region. This species, which is larger than *H. hippopus* but smaller than *T. gigas*, has a medium body size and is more frequently seen in shallower waters (Al-Howiti et al. 2020; Lee et al. 2024). *Tridacna maxima* was colored bright blue, green, or brownish, typically measuring between 5 and 15 cm, and can grow up to 20 cm in length. Although it is typically embedded in hard substrates, it can also be found on sandy bottoms (Waters et al. 2013; Vogel and Hoeksema 2024). *Tridacna maxima* is the most widely distributed species. At the same time, the distributions of *Hippopus porcellanus*, *T. ningaloo* (Penny & Willan, 2014), *T. noae* (Röding, 1798), *T. rosewateri* (Sirenko & Scarlato, 1991), *T. mbalavuana* (Ladd, 1934) (previously known as *T. tevoroa* (Lucas, Ledua & Braley, 1990)), and *T. squamosina* (Sturany, 1899) are significantly more limited (Lee et al. 2024).

Tridacna gigas is found at various depths, from shallow to deep. This species has a very bright and striking appearance with beautiful patterns. The shell is very thick and strong, often with scales in varying colors, from green to dark blue. The fact that all the discovered *T. gigas* on Bira Island were still modest in size indicates that the species is still developing (Hawkins and Klumpp 1995; Wen et al. 2024). *Hippopus hippopus* is a member of the Tridacnidae family. Although the three species found look similar, *H. hippopus* has a few unique traits, such as a smoother and thinner shell, no scales, a paler color, and a coat that is typically white or cream. It also has a maximum size smaller than the other two types of *Tridacna* (Purcell et al. 2020; Lee et al. 2024).

Hippopus hippopus presented the lowest composition and abundance. This is assumed to be because the species favors deeper and more protected waters, making it somewhat difficult to find. This species inhabits coral-sand environments dispersed across Indonesia's coastal seas and does not adhere to the substrate (Neo et al. 2018; Lee et al. 2024). *Hippopus hippopus* is characterized by an elongated triangular shell that grows up to 40 cm in length, irregular reddish spots patches, strong radial ribs, and strawberry-like nodules. The *Hippopus* mantle has a short byssal aperture and does not extend over the edge of the shell-like *Tridacna* species (Mills et al. 2024).

Based on the criteria of clam diversity on Bira Island, the criteria range from low to medium. Only three different kinds of clams were found. The number of species present in the community significantly impacts the biota's variety in a body of water. Diversity increases with the number of species, but this value is highly dependent on the quantity of individuals in each species. The greater the number of individual members and the more evenly distributed they are, the higher the diversity index will be (Kohler and Gill 2006; Maasri et al. 2022; Handayani et al. 2023).

Clam diversity is a measure of how well an ecosystem is functioning; low diversity suggests stress or disturbance in the ecosystem. The health and stability of the ecosystem can be negatively impacted by various factors, such as habitat degradation, anthropogenic pressure, changes in ecological functions, and environmental health (Lin et al. 2021). Giant clams play an important role in coral reef ecosystems as stabilizers of the substrate and water filters. Declining clam numbers may hamper these ecological processes. A significant indicator of ecosystem health is a reduction in the diversity of clam species (Vercammen et al. 2019). Due to their accessibility, particularly on shallow coral reefs, giant clam populations are highly vulnerable to anthropogenic overexploitation worldwide. For the past few decades, local fishermen in some areas have overfished giant clam populations to obtain their meat for consumption and their shells for decoration (Roué et al. 2016; Van Wynsberge et al. 2017).

The number of individuals of one species exceeding the number of individuals of other types, the state of the substrate, and the ecosystem as the habitat of the identified species, among other factors, can affect the high and low values of species diversity (Gumilar et al. 2023). Species diversity is determined not just by the number of species found but by the nature of the community, which is influenced by the wide variety of species, the stability of the habitat, and the evenness and abundance of individuals of each species in a community. As a result, a habitat in a better or more stable state will support a greater diversity of species and a richer biota (Lin et al. 2021).

The Dominance Index value in Bira Island waters is generally low. This index value indicates that there are no dominating clam species in that particular area (Massei et al. 2023). These findings provide further evidence that the environmental conditions in Bira Island's waters are generally uniform, allowing all varieties of bivalves,

including clams, to survive there. In an ecosystem, a low dominance index means that no single species controls the majority of the population. This indicates that the number of individuals of each species in the ecosystem is relatively balanced. The abundance of species affects diversity and dominance, which in turn can affect the abundance of species. Healthy ecosystems tend to have high diversity and low dominance. Changes in abundance, diversity, or dominance can be indicators of environmental problems, such as pollution, climate change, or habitat loss.

Overall, environmental conditions are still within the normal range for clam life. The impact of the environmental matrix and the community matrix (abundance) was assessed using the Mantel test. The correlation coefficient value ($r = 0.07363$) and significance value ($p = 0.3359$) ($p<0.5$) indicate that the giant clam community is minimally affected by the environmental matrix and are displayed in the result. This indicates that the giant clam community with little correlation is unaffected by the environmental matrix. Various environmental conditions can influence clam density in the shallow waters of lagoons and coral reefs. For instance, a decrease in water exchange might lead to decreased oxygenation (Hughes et al. 2017). Each species has a distinct range of sensitivity and tolerance to environmental changes. Tolerance, activity, and susceptibility to environmental changes are important factors that influence diversity and abundance (Mwadzombo et al. 2023).

Temperature significantly impacts metabolic processes, organism distribution and abundance, spawning and hatching, activity, and growth. Clams can survive at temperatures from 28 to 32°C (Apte et al. 2019; Liu et al. 2020). The ideal temperature range for clam growth is from 25 to 35°C, making the research location's temperature ideal for both clam growth and survival (Liu et al. 2020). The salinity on Bira Island varies from 33.5 to 34.7 ppt, which is still suitable for clam growth.

A suitable salinity range for clam growth is 25 to 40 ppt (Enochs and Glynn 2017). The role of salinity on aquatic biota in nature is directly related to the regulation of ions in the body, inappropriate salinity can impact physiological processes, causing clam death (Mariani et al. 2002). Clams and other macrobenthos are supported by water with a pH of 5.8 to 8.3. Waters with a pH between 6 and 9 are considered productive, have high fertility, and have the potential to promote the breakdown of organic waste into minerals. The pH of the waters on Bira Island, which ranges from 6 to 8, is still normal for clam life. In general, there is no significant difference between pH and salinity between the transects because the observation location is far from the mainland; there is no source of freshwater or river flow that enters the waters around Bira Island. According to observations, the physical and chemical parameters in the waters surrounding Bira Island suggest that the conditions remain conducive to the survival and growth of clams. These parameters can vary naturally at any time, depending on the day or night conditions and season, and each has different tolerances for these variations (Apte et al. 2019; Mwadzombo et al. 2023). Environmental factors affect almost every organism, yet the Mantel test results do not show a relationship or influence of environmental factors on clam population abundance. The lack of clam species is assumed to be caused by other factors, such as habitat degradation or exploitation, as all environmental parameters are still within the usual range. Therefore, monitoring is required to maintain their habitat (Neo et al. 2018). To maintain the giant clam population, ongoing research, and comprehensive conservation efforts are essential to address this issue.

From this research, it can be concluded that only three species of Tridacnidae have been identified on the waters surrounding Bira Island, with *T. maxima* being the most abundant and *H. hippopus* being the least abundant. Overall, the diversity in moderate criteria and the dominance in low criteria. Environmental parameters remained within a range favorable for the growth of giant clams. However, they did not show a significant correlation with giant clam abundance.

ACKNOWLEDGEMENTS

Thank you to the Indonesian Ministry of Education, Culture, Research and Technology, Indonesia, for funding this research in accordance with the main contract number: 064/E5/PG.02.00.PL/VI/2024 dated 11 June 2024, and the derivative contract number: 2/UN39.14/PG.02.00.PL/PFR/VI/2024 dated 13 June 2024.

REFERENCES

Adyasari D, Pratama MA, Teguh NA, Sabdaningsih A, Kusumaningtyas MA, Dimova N. 2021 Anthropogenic impact on Indonesian coastal water and ecosystems: Current status and future opportunities. Mar Pollut Bull 171: 112689. DOI: 10.1016/j.marpolbul.2021.112689.

Al-Howiti NS, Ben Othmen ZO, Ben Othmane A, Chaffai AH. 2020. Use of *Tridacna maxima*, a bivalve in the biomonitoring of the Saudi Arabian Red Sea coast. Mar Pollut Bull 150: 110766. DOI: 10.1016/j.marpolbul.2019.110766.

Apte D, Narayana S, Dutta S. 2019. Impact of sea surface temperature anomalies on giant clam population dynamics in Lakshadweep reefs: Inferences from a fourteen years study. Ecol Indic 107: 105604. DOI: 10.1016/j.ecolind.2019.105604.

Asner GP, Giardina SF, Balzotti C, Drury C, Hopson S, Martin RE. 2022. Are sunken warships biodiversity havens for corals? Diversity 14 (2): 139. DOI: 10.3390/d14020139.

CITES Management Authority Australia in Little. 2005. *Tridacna gigas* Linnaeus, 1758. AC22 Doc. 10.2. https://cites.org/sites/default/files/eng/com/ac/22/E22-10-2-A8e.pdf

Enochs IC, Glynn PW. 2017. Trophodynamics of Eastern Pacific coral reefs. In: Glynn P, Manzello D, Enoch I (eds). Coral Reefs of the Eastern Tropical Pacific. Coral Reefs of the World, vol 8. Springer, Dordrecht. DOI: 10.1007/978-94-017-7499-4_9.

Gumilar I, Fauzi M, Riyantini I, Sunarto. 2023. Biodiversity and distribution patterns of Clams (Tridacninae) on coral reefs in Kayu Angin Bira Island, Indonesia. Asian J Fish Aquat Res 25 (4): 117-126. DOI: 10.9734/ajfar/2023/v25i4689.

Handayani S, Widhiono I, Widyartini DS. 2023. Macroalgae diversity and its relationship with environmental conditions in polluted waters of Seribu Islands, Jakarta Bay, Indonesia. Biodiversitas 24 (11): 6279-6286. DOI: 10.13057/biodiv/d241151.

Hawkins AJS, Klumpp DW. 1995. Nutrition of the giant clam *Tridacna gigas* (L.). II. Relative contributions of filter-feeding and the ammonium-nitrogen acquired and recycled by symbiotic alga towards

total nitrogen requirements for tissue growth and metabolism. J Exp Mar Biol Ecol 190 (2): 263-290. DOI: 10.1016/0022-0981(95)00044-R.
Hoegh-Guldberg O, Pendleton L, Kaup A. 2019. People and the changing nature of coral reefs. J Reg Stud Mar Sci 30: 100699. DOI: 10.1016/j.rsma.2019.100699.
Hughes TP, Barnes ML, Bellwood DR et al. 2017. Coral reefs in the Anthropocene. Nature 546 (7656): 82-90. DOI: 10.1038/nature22901.
Keputusan Menteri Negara Lingkungan Hidup (Kepmen LH) No. 51. 2004. Baku Mutu Air Laut. Kementerian Lingkungan Hidup, Jakarta. [Indonesian]
Kohler KE, Gill SM. 2006. Coral Point Count with Excel extensions (CPCe): A visual basic program for the determination of coral and substrate coverage using random point count methodology. Comput Geosci 32 (9): 1259-1269. DOI: 10.1016/j.cageo.2005.11.009.
Komala R, Noer MI, Miarsyah M, Widyartini DS, Handayani. 2024. Assess the level of damage to the coral reef ecosystem based on substrate coverage on Bira Island, Kepulauan Seribu, Indonesia. Biodiversitas 25 (3): 971-977. DOI: 10.13057/biodiv/d250309.
Lee LK, Neo ML, Hii KS, Gu H, Chen CA, Lim PT, Leaw CP. 2024. Vanishing giants: An assessment on the population status of giant clams across Malaysia. Reg Stud Mar Sci 74: 103546. DOI: 10.1016/j.rsma.2024.103546.
Lin T-H, Akamatsu T, Sinniger F, Harii S. 2021. Exploring coral reef biodiversity via underwater soundscapes. Biol Conserv 253: 108901. DOI: 10.1016/j.biocon.2020.108901.
Liu C, Yan H, Fei H et al. 2020. Dynamic of *Tridacna* spp. population variability in northern SCS over past 4500 years derived from AMS ^{14}C dating. Sci Total Environ 748: 141359. DOI: 10.1016/j.scitotenv.2020.141359.
Maasri A, Jähnig SC, Adamescu MC et al. 2022. A global agenda for advancing freshwater biodiversity research. Ecol Lett 25 (2): 255-263. DOI: 10.1111/ele.13931.
Mariani S, Piccari F, De Matthaeis E. 2002. Shell morphology in *Cerastoderma* spp. (Bivalvia: Cardiidae) and its significance for adaptation to tidal and non-tidal coastal habitats. J Mar Biol Assoc UK 82 (3): 483-490. DOI: 10.1017/S0025315402005751.
Massei K, Souza MCS, da Silva RM et al. 2023. Analysis of marine diversity and anthropogenic pressures on Seixas coral reef ecosystem (northeastern Brazil). Sci Total Environ 905: 166984. DOI: 10.1016/j.scitotenv.2023.166984.
Maynard JA, McKagan S, Raymundo L et al. 2015. Assessing relative resilience potential of coral reefs to inform management. Biol Conserv 192: 109-119. DOI: 10.1016/j.biocon.2015.09.001.
Mills K, Muir DD, Oldroyd A, John EH, Santodomingo N, Johnson KG, Hussein MAS, Sosdian S. 2024. Microstructure and crystallographic texture data in modern giant clam shells (*Tridacna squamosa* and *Hippopus hippopus*). Data Brief 52: 109947. DOI: 10.1016/j.dib.2023.109947.
Mwadzombo NN, Tole MP, Mwashimba GP. 2023. Ecological risk assessment on nutrient over-enrichment in water quality: A case study of the Kenyan coral reef ecosystems. Reg Stud Mar Sci 67: 103216. DOI: 10.1016/j.rsma.2023.103216.
Neo ML, Eckman W, Vicentuan K, Serena LM, Teo B, Peter A, Todd. 2015. The ecological significance of giant clams in coral reef ecosystems. Biol Conserv. DOI: 10.1016/j.biocon.2014.11.004
Neo ML, Liu L-L, Huang D, Soong K. 2018. Thriving populations with low genetic diversity in giant clam species, *Tridacna maxima* and *Tridacna noae*, at Dongsha Atoll, South China Sea. Reg Stud Mar Sci 24: 278-287. DOI: 10.1016/j.rsma.2018.09.001.
Purcell SW, Gossuin H, Ceccarelli DM. 2020. Fishery management and spatial variation of giant clam stocks: Lessons from New Caledonia. Ocean Coast Manag 193: 105243. DOI: 10.1016/j.ocecoaman.2020.105243.
Rossbach S, Anton A, Duarte CM. 2021. Drivers of the abundance of *Tridacna* spp. giant clams in the Red Sea. Front Mar Sci 7: 592852. DOI: 10.3389/fmars.2020.592852.
Roué M, Darius HT, Picot S, Ung A, Viallon J, Gaertner-Mazouni N, Sibat M, Amzil Z, Chinain M. 2016. Evidence of the bioaccumulation of ciguatoxins in giant clams (*Tridacna maxima*) exposed to *Gambierdiscus* spp. cells. Harmful Algae 57 (Pt A): 78-87. DOI: 10.1016/j.hal.2016.05.007.
Sayco SLG, Pomares AA, Cabaitan PC, Kurihara H. 2024. Reproductive consequences of thermal stress-induced bleaching in the giant clam *Tridacna crocea*. Mar Environ Res 193: 106280. DOI: 10.1016/j.marenvres.2023.106280.
Schönberg CHL, Fang JKH, Carreiro-Silva M, Tribollet AG, Wisshak M. 2017. Bioerosion: The other ocean acidification problem. J Mar Sci 74 (4): 895-925. DOI: 10.1093/icesjms/fsw254.
Van Wynsberge S, Andréfouët S, Gaertner-Mazouni N, Wabnitz CCC, Menoud M, Le Moullac G, Levy P, Gilbert A, Remoissenet G. 2017 Growth, survival and reproduction of the giant clam *Tridacna maxima* (Röding 1798, Bivalvia) in two contrasting lagoons in French Polynesia. PLoS One 12 (1): e0170565. DOI: 10.1371/journal.pone.0170565.
Vercammen A, McGowan J, Knight AT et al. 2019. Evaluating the impact of accounting for coral cover in large-scale marine conservation prioritizations. Divers Distrib 25 (10): 1564-1574. DOI: 10.1111/ddi.12957.
Vogel ML, Hoeksema BW. 2024. The role of aquaculture in the international trade of giant clams (Tridacninae) for the aquarium industry (2001-2019). Aquaculture 583: 740563. DOI: 10.1016/j.aquaculture.2024.740563.
Waters CG, Story R, Costello MJ. 2013. A methodology for recruiting a giant clam, *Tridacna maxima*, directly to natural substrata: A first step in reversing functional extinctions?. Biol Conserv 160: 19-24. DOI: 10.1016/j.biocon.2012.12.036.
Wen H, Yan H, Liu C, Zhao N, Liu S, Dodson J, Han T, Geng J, Zhou P. 2024. Seasonal to interannual variations of daily growth rate of a Tridacna shell from Palau Island, western Pacific, and paleoclimatic implications. Palaeogeogr Palaeoclimatol Palaeoecol 647: 112258. DOI: 10.1016/j.palaeo.2024.112258.
Zhou Y, Li Y, Liao Q, Gongpengyang S, Qin Y, Zhang Y, Ma H, Li J, Yu Z. 2022 Examination of the role of the forkhead box L2 (Foxl2) in gonadal and embryonic development in the boring giant clam *Tridacna crocea*. Aquaculture 560: 738554. DOI: 10.1016/j.aquaculture.2022.738554.