Species identification, density, and type of substrate of clam (Tridacnaidae) in Kali Lemon coastal water - Kwatisore, Cenderawasih Bay, Papua, Indonesia

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Abstract. The giant clam is one type of invertebrate biota in the mollusks phylum group widely used by the coastal community in Papua as food and whiting. However, as time passed, the use of clams by the coastal community became more excessive and thus threatened the survival of clams. This study aimed to determine the species, density, and substrate in the coral reef ecosystem in the Kali Lemon coastal water. The clam was observed using the cruise method by pulling the measuring tape meter and forming a 100m x 100m quadrant in a predetermined area between 5 and 10 m depth during high tide. The location observation results showed that the Kali Lemon coastal area has six species of clams: *Tridacna crocea*, *Tridacna squamosa*, *Tridacna gigas*, *Tridacna maxima*, *Hippopus hippopus*, and *Hippopus porcellanus*, wherein this case, each individual and species of clam grows on different types of substrate. Furthermore, based on the density analysis, Kwatisore waters have a low density of clams with a value of 0.0073 ind m^{-2}). *T. crocea* had the highest density based on the results, while *T. gigas* had the lowest density among all the species found.

Key Words: density, giant clam, Kali lemon, species, substrate types.

Introduction. Cenderawasih Bay National Park (CBNP) is the largest national park in Indonesia with 1,453,000 ha, divided into a sea area of 1,385,300 ha and a land area of 68,000 ha. Geographically, CBNP is located on the inner edge of the Bird's Head region of Papua bordering the Pacific Ocean, which is also the meeting point between the Pacific Plate and the Australian continent at coordinates 134°06′–135°10′E and 01°43′–03°22′S (TNTC 2020). Based on its strategic position, this area is endowed with high biodiversity. The CBNP area consists of five terrestrial and marine ecosystems, including tropical forest ecosystems, coastal forest ecosystems, mangrove forest ecosystems, coral reef ecosystems, and seagrass ecosystems (Rahayu et al 2016). One part of the waters within the CBNP that has a complex marine ecosystem is Kwatisore, wherein this area is found mangrove, seagrass, and coral reef ecosystems. These three aquatic ecosystems support the high productivity of the seas for the biota that live around them (Wake 2021).

The Kwatisore waters, especially on the Kali Lemon coast, have several protected biota species such as turtles, dugongs, various species of sharks and clams. Clams or giant clams are a type of invertebrates included in the mollusk phylum (Amjad et al 2017). This marine biota is one of the widely used resources by the coastal communities of Papua as food and whiting (Rahayu et al 2016). It is noted that in the world, there are nine types of clams, whose existence is protected in all parts of the world's waters (Copland & Lucas 1988). Determination of the types of clams is generally identified based on the shape of the outer shell that protects the internal organs (Asni 2014). The clam species in genus *Tridacna* can live in various types of substrates, some of which are found living attached to coral, sand, or mud in coral reef ecosystems (Amjad et al 2017).

Although clams on the coast of Kali Lemon are quite diverse, research on this biota is still very rarely carried out. Therefore, this research was conducted to identify the species, density, and substrate in coral reef ecosystems, especially in the Kali Lemon coastal waters. The data obtained would contribute to the management and conservation of clams in the area.

Material and Method

Description of the study sites. This research was conducted on 9-12 January 2021 in the tidal zone of Kali Lemon coast, Kwatisore, Nabire Regency, Papua Province, Indonesia (Figure 1).

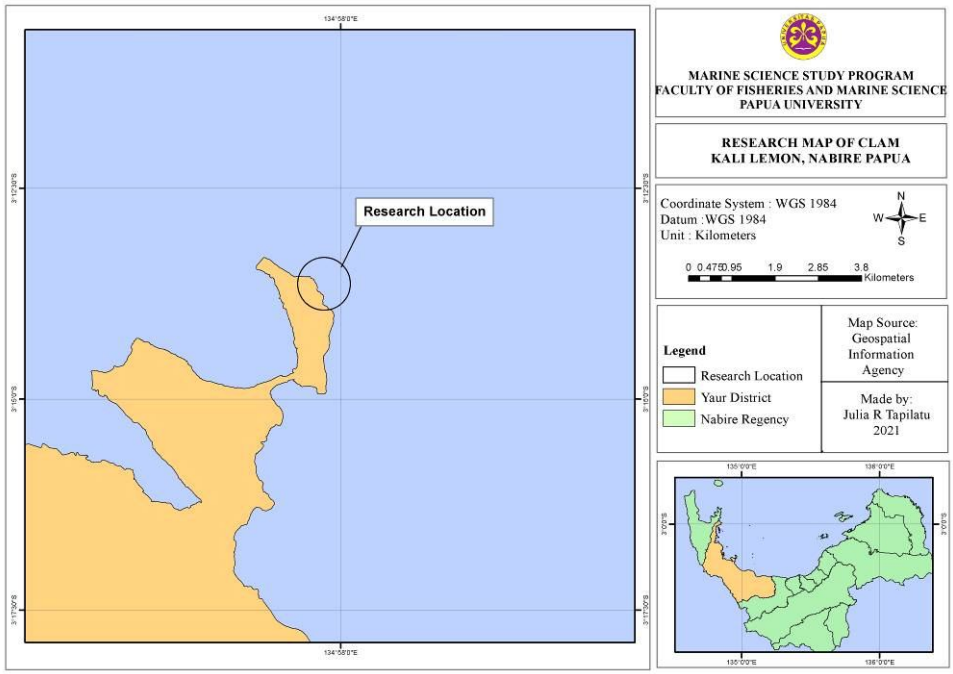

Figure 1. The location of giant clam distribution, Nabire Regency, Indonesia.

Data collection. Observational data were divided into two parts, namely primary and secondary data. Primary data include observations of the type and substrate of clams. Meanwhile, secondary data were in the form of parameters of the marine environment such as pH, temperature, oxygen, and water brightness.

The method used when collecting primary data is the cruise method (Rugayah & Pratiwi 2004) in four dive trips directly from shoreline. The application of this method was carried out by determining the point of location for the climax observation, then making a quadrant with a length and width of each quadrant of 100 meters. Furthermore, climatic parameters and observations were carried out in the quadrant area. There are also data taken during the observation documentation type of clam and type of substrate where clams are attached in the study site. The determination of the substrate was conducted visually and recorded using a code according to Baker et al (1997) with the following details:

- coral cover (CC). It is a characteristic of the habitat for clams that live in dense coral cover areas;
- dead coral algae (DCA). It is a characteristic of clam habitats that live on dead coral substrates and have overgrown with algae;
- Faviidae (FAV). It is a characteristic of the habitat for clams that live in massive coral reef areas with a monocentric shape. Placoid coral, or meanodroidin;
- Porites (POR). It is a characteristic of the habitat for clams that live immersed in small coral reefs;

- rubble (RB). It is a characteristic of the habitat for clams that live on coral fragments.

Furthermore, secondary data related to the quality of Kwatisore waters were obtained through the latest literature study (research not more than five years) associated with the physical and chemical parameters of Kwatisore waters.

Data analysis. The data analysis carried out in this study looked at the density of clams on the coast of Kali Lemon, Kwatisore. The following formula was used for density analysis (Odum & Srigandono 1993):

$$D = \frac{N}{A}$$

where: D = specific density (ind m^{-2});
N = number of individuals in each species (individuals);
A = the sampled area (m^2).

Results. Water quality in a location is one of the most important components to be determined because water quality is one of the main factors that impacts the life of aquatic biota (Gaol et al 2017). According to Nontji (2007), the water temperature range suitable for marine organisms ranges from 27 to 31°C. While the standard pH value of the waters that are ideal for life ranges from 7 to 8.5. The environmental parameters data utilized in this study were based on secondary data collected at 11 sample stations in Kwatisore waters by Prihadi et al (2017) (Table 1).

Table 1
Mean and standard deviation water quality parameter in Kwatisore waters (Prihadi et al 2017)

Parameter	*Unit*	*Mean±StDev*
Temperature	°C	30.6±0.2
Salinity	‰	29.5±0.3
Clarity	cm s^{-1}	14.5±0.5
pH	-	8.0±0.0

Furthermore, environmental parameter data is then juxtaposed with the water quality standards listed in the Ministerial Decree. No. 51/2004. In addition, there is an opinion expressed by Ellis (1999) that the criteria for parameters suitable for clam's growth have the following details: temperature ranges from 25 to 32°C, water salinity 32-35‰, and pH ranged between 7.5 and 8.1. Based on these results, it can be concluded that the water quality per day of Kwatisore has parameters following quality standards and is suitable for the life of clam (Prihadi et al 2017). Besides that, this statement is also supported by other related research, which states that the quality of the waters in Cendrawasih Bay is included in the category above the quality standard (Ardania et al 2019).

Identification of Tridacna species in Kwarisore waters. According to Romimohtarto et al (1987) in Pasaribu (1988), seven clam species are found in Indonesia. Based on our research results in the coastal waters of Kali Lemon Kwatisore, six species of clams live in tidal areas. The clam classifications and descriptions in question are as follows:

Tridacna crocea
Classification:
Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroidae
Family: Tridacnaidae
Genus: *Tridacna*
Species: *Tridacna crocea* (Lamarck, 1819) (Figure 2)

Figure 2. Specimen of *Tridacna crocea* in Kali Lemon Kwatisore (Original photo: Julia Tapilatu).

T. crocea or commonly known as hole clam is a type of clam that lives in the area of coral reef ecosystems. The term of hole clam comes from its habit of life, which implants almost all parts of its body on rocks or rocks. The shell color is generally white, orange, or yellow, and has a colored coat (Ellis 1999; KKP 2015).

Tridacna squamosa
Tridacna crocea
Classification:
Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroidae
Family: Tridacnaidae
Genus: *Tridacna*
Species: *Tridacna squamosa* (Lamarck, 1819) (Figure 3)

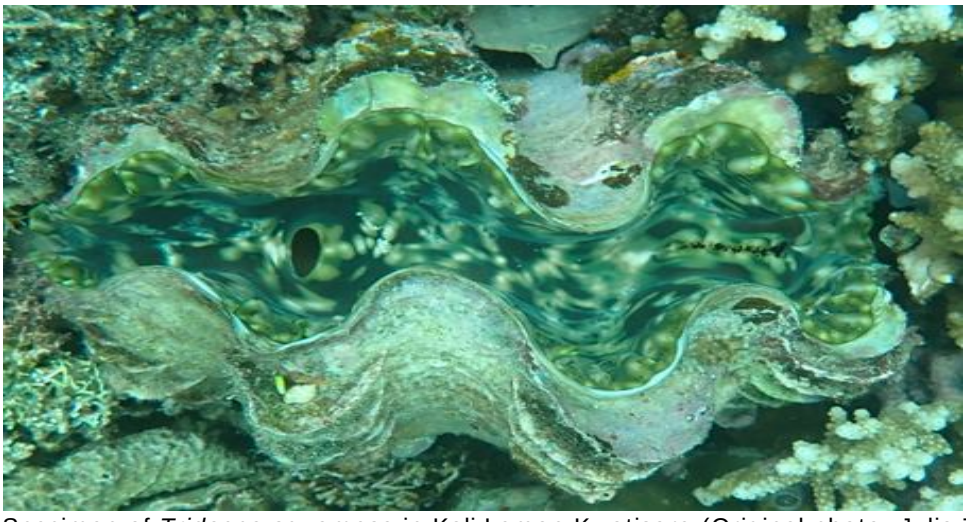

Figure 3. Specimen of *Tridacna squamosa* in Kali Lemon Kwatisore (Original photo: Julia Tapilatu).

T. squamosa, commonly known as clams of scales/thorns, are clams that live attached to rocks and have a size that would reach more than 40 cm. This clam species is very easy to recognize because of its equilateral shell shape with the scales getting broader and broader, and the mantle is generally speckled with blue, brown, and green (Ellis 1999; KKP 2015).

Tridacna gigas
Classification:
Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroidae
Family: Tridacnaidae
Genus: *Tridacna*
Species: *Tridacna gigas* (Lamarck, 1819) (Figure 4)

Figure 4. Specimen of *Tridacna gigas* in Kali Lemon Kwatisore (Original photo: Julia Tapilatu).

T. gigas, commonly known as the giant clam, is the largest clam species and has a size of up to 1.4 meters with a 200-500 kg weight range. In general, the clam's shell is white and has a brown or green coat that exceeds the tip of the surface so that it cannot be tightly closed (Ellis 1999; KKP 2015).

Tridacna maxima
Classification:
Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroidae
Family: Tridacnaidae
Genus: *Tridacna*
Species: *Tridacna maxima* (R & Jing, 1798) (Figure 5)

Figure 5. Specimen of *Tridacna maxima* in Kali Lemon Kwatisore (Original photo: Julia Tapilatu).

T. maxima, commonly known as the giant clam, is a type of clam with a habit of living attached to coral substrates and can grow to 25-35 cm. Its morphology is almost similar to *T. crocea*. The difference is it does not immerse all parts of its body in the coral. In addition, the clam has fine scales at the end of the shell (Ellis 1999; KKP 2015).

Hippopus hippopus
Classification:
Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroidae
Family: Tridacnaidae
Genus: *Hippopus*
Species: *Hippopus hippopus* (Linnaeus, 1758) (Figure 6)

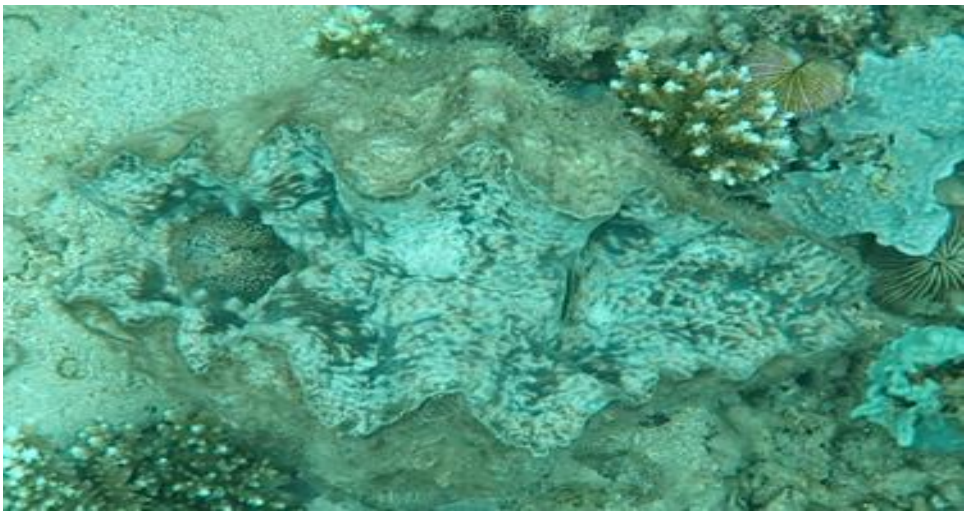

Figure 6. Specimen of *Hippopus hippopus* in Kali Lemon Kwatisore (Original photo: Julia Tapilatu).

H. hippopus, commonly known as horseshoe clams, generally live in coral reef ecosystems and seagrass meadows on sandy substrates. Morphological characteristics of this clam have a small notched shell and patches of strawberry and a yellow, brown, green, or gray coat that does not cross the shell boundaries (Ellis 1999; KKP 2015).

Hippopus porcellanus
Classification:
Kingdom: Animalia
Phylum: Mollusca
Class: Bivalvia
Order: Veneroidae
Family: Tridacnaidae
Genus: *Hippopus*
Species: *Hippopus porcellanus* (Rosewater; 1982) (Figure 7)

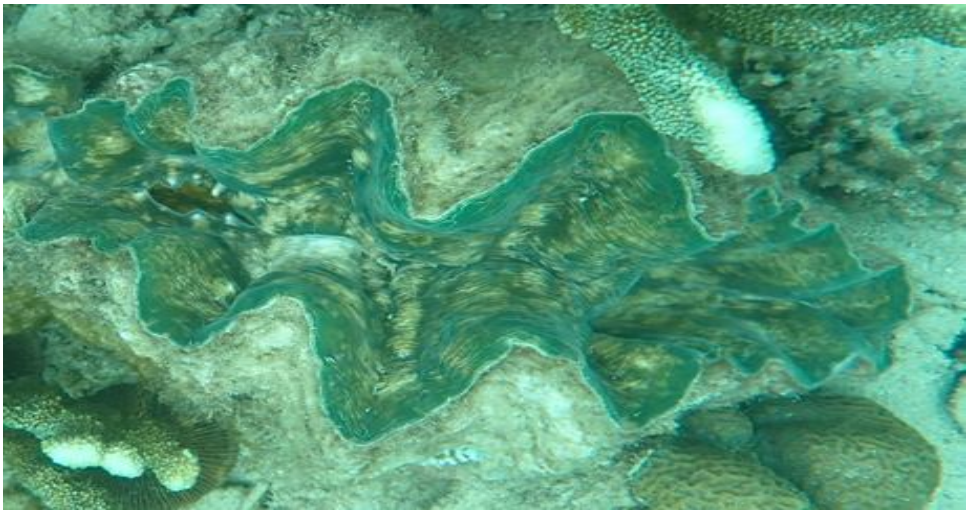

Figure 7. Specimen of *Hippopus porcellanus* in Kali Lemon Kwatisore (Original photo: Julia Tapilatu).

H. porcellanus is a species of clam that lives in coral reef ecosystems. The morphological shape of this clam is almost like the clam species *H. hippopus*, but has a larger size and can grow up to 60 cm (KKP 2015).

Number of individuals and density of clam. Based on the research results in the coastal tidal area of Kali Lemon Kwatisore, 73 individuals and six species of clams were found. The six species of clams consist of *T. crocea*, *T. squamosa*, *T. gigas*, *T. maxima*, *H. hippopus*, and *H. porcellanus*, with detailed data in Table 2.

Table 2

Data on the number of individuals and species of clams

Genus	*Species*	*Total number of individuals and proportion (%)*
Tridacna	*Tridacna crocea*	24 (32.9)
	Tridacna squamosa	11 (15.1)
	Tridacna gigas	4 (5.5)
	Tridacna maxima	23 (31.5)
Hippopus	*Hippopus hippopus*	5 (6.8)
	Hippopus porcellanus	6 (8.2)
	Total	73

The results of the species inventory carried out on an area of 10,000 m^2 (100 x 100 m) showed that *T. crocea* was the most common species of clam found on the Kali Lemon coast, with 24 individuals (32.9%), while *T. gigas* was the clam species with the least number of individuals, a total of 4 individuals (5.5%).

The density of clams is the total number of clams in a particular measured area (Suzana et al 2011). Overall, the total density in the Kali Lemon coastal area is 0.0073 ind m^{-2}) with a relatively small density value (Figure 8). When viewed based on the value of clam density, the values that are less than one are in the low-density category (Planes et al 1993). However, the clam density in the area has a higher value when compared to the total density of clams in Manokwari waters, which only has a density value of 0.0056 (ind m^{-2}) in an area of 389.286 m^2 (Iriansyah et al 2021). In general, the high- and low-density values of clam species at a location are strongly influenced by adaptation factors and the type of habitat for clams living in an environment (Ode 2017).

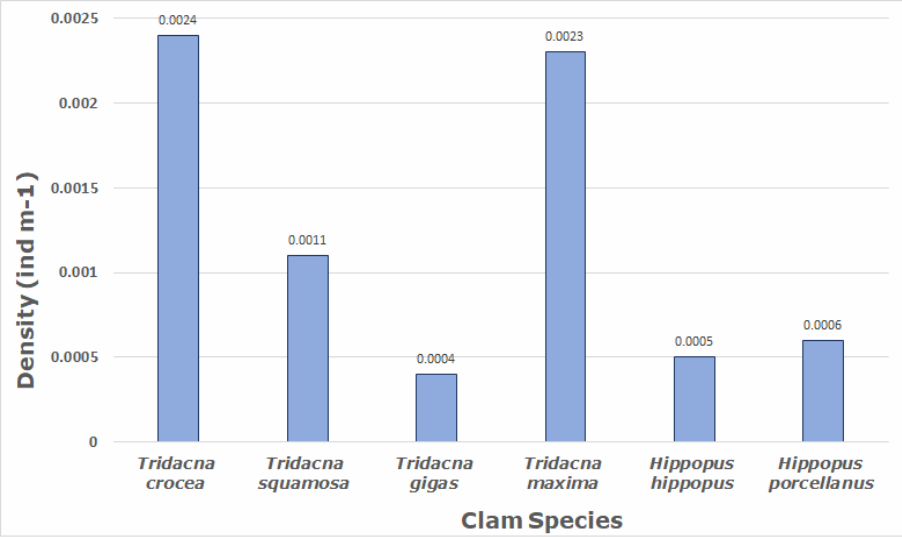

Figure 8. Species density of clam species in Kali Lemon.

Substrate types. The substrate is one of the essential parameters that support the survival of clams (Padilah et al 2015). There are several types of substrates for growing clams that can be found along the coast of Kali Lemon, Kwatisore, such as coral reefs (CC), dead corals (DCA), massive corals (FAV), coral reefs (POR), and coral fragments (RB). However, not all types of clams occupy the same kind of substrate; wherein this case, every kind of clam has a relationship with certain substrate conditions based on its life habits (Rizkifar et al 2019). Table 3 below showed the distribution of types of the substrate where clams were found.

Table 3

Distribution of Kima species by substrate types

Species	*Substrate type*				
	CC	*DCA*	*FAV*	*POR*	*RB*
Tridacna crocea	-	-	+	+	-
Tridacna squamosa	+	+	-	-	+
Tridacna gigas	+	-	-	-	-
Tridacna maxima	-	-	+	+	-
Hippopus hippopus	+	-	-	-	+
Hippopus porcellanus	+	-	-	-	+

Discussion. Based on the density data analysis results, *T. crocea* is the type of clam with the highest density value, which is 0.0024 (ind m^{-2}). The habit of living in groups of *T. crocea* species is thought to be due to the availability of food and the method of reproduction of this clam which causes the high-density value of the species *T. crocea* in a water location (Oktapyani et al 2020; Triska 2020). Besides, a type of clam with the lowest density is *T. gigas*, with a value of 0.0004 (ind m^{-2}). The low-density value of *T. gigas* in this area is because it has a random growth pattern and is not in groups. This result is also supported by research conducted by Ode (2017) in the waters of Nitanghahai Bay, Central Maluku, which shows that the distribution of *T. gigas* is random. On the other hand, according to Usher (1984), the low density of *T. gigas* clams in the waters is thought to be because this species has a high selling value and has been over-exploited in most of Indonesia's territorial waters.

Based on the observations the result of this study may suggest that *T. crocea* and *T. maxima* generally live attached to massive coral substrate habitats. This was due to their habit of living by digging into massive corals (especially *Porites* sp.) and rocks (Hardy & Hardy 1969). In addition, *T. squamosa*, *T. gigas*, *H. hippopus*, and *H. porcellanus* clams are species that generally live in association with coral reefs and are

scattered in coral rubble areas. This is also supported by Harry & Hardy (1969), which states that these types of clams are generally widely distributed in shallow water areas and are associated with stretches of hard coral reefs.

Conclusions. Based on the research, there are six species of clams on the coast of Kali Lemon, Kwatisore, namely: *T. crocea*, *T. squamosa*, *T. gigas*, *T. maxima*, *H. hippopus* and *H. porcellanus*. In addition, the total density value of clams on the Kali Lemon coast was in a low category, which was 0.0073 (ind m^{-2}). *T. crocea* is a clam species with the highest density value of 0.0024 (ind m^{-2}). In contrast, the type of clam with the lowest density value is *T. gigas* with a value of 0.0004 (ind m^{-2}). Furthermore, each type of clam generally lives on a particular type of substrate based on its life habits. The results showed that *T. crocea* and *T. maxima* generally lived attached to massive coral substrate habitats. *T. squamosa*, *T. gigas*, *H. hippopus*, and *H. porcellanus* generally lived on dead coral substrates, and among coral reefs.

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