The community structure of giant clam in the waters of Morella village, Leihitu region, Central Mollucas Regency

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Abstract. Kima (giant clams) are molluscs that inhabit the ocean floor on the reef and sand substrate. There are 7 species found in the waters of Indonesia namely Tridacna maxima, T. squamosa, T. gigas, T crocea, T derasa, Hippoppus hippoppus and H. porcelanus. Kima are included among the protected biota, both nationally and internationally. This research was conducted on the waters of Morella Village, Leihitu Region, Central Mollucas Regency. The study sites are divided into two stations; Station 1 is the waters of Mahiwa Bay and Station 2 is the waters of Tihlepuai Bay. Station 2 is a Kima farm established in December 2016 by the Minister of Marine Affairs and Fisheries. Samples were collected by using the belt transect method. The results obtained are as follows. In Station 1, the 2 species found are T. maxima and T. squamosa, while the 4 species found in Station 2 are T. maxima, T. squamosa, T crocea and H. hippoppus. The highest value, abundance, density, and frequency of occurrence were represented by T. squamosa. The diversity and homogeneity indexes in the waters of Morella village were in the high and medium levels, respectively. The result of this research will add data contribution in determining strategies for kima conservation in Mollucas.

1. Introduction

Kima (giant clams) are molluscs that inhabit the ocean floor on the reef and sand substrate. There are 7 species found and scattered in the waters of Indonesia, namely, Tridacna maxima, T. squamosa, T. gigas, T crocea, T derasa, Hippoppus hippocampus and H. porcelanus [1]. In 2011, the T. kimaboe was found on Toli-toli waters, South East Sulawesi, which means there are already 8 species of kima found in Indonesia [2]. Kima is included among the protected biota, both nationally and internationally. Kima is one of the international trading commodities with high economic value as food, building, and handicraft materials. The kima have tillers also become one of the seawater ornamental aquarium trading commodities [3, 4]. The high market value and demand from all over the world inflict overexploitation. Kima are included in Appendix II CITES [5] and the UICN Red List of Threatened Species [6]. A similar regulation has been issued by the Indonesian Government through Forestry Ministerial Decree No.12/Kpts-II/1987 and Government Regulation No.7/1999 which state that kima are protected biotas. All types of kima have been included in Appendix II CITES since 1985. Nationally, kima is protected by Government Regulation No.7/1999 concerning the preservation of plants and animal, which included all 7 types of kima found in Indonesia as protected species, whereby all form of exploitation (capture and trade) are prohibited, with the exception given to farm products and after being declared as hunting creatures as regulated in Government [7].

The Wahiwa Bay waters in Negeri Morella, Central Maluku Regency are currently being developed for coastal ecotourism activities. The ocean floor of this area is that of a substrate consisting of sand, dead coral fragments, and coral reefs. One of the most abundant biotas found in this coral reef ecosystem is kima. That kima has both potential for development and threats to its existence shows that there is a need for an improved management of marine areas which in turn can be linked to fisheries management in Indonesia. Fisheries management in Indonesia based on UU No. 45/2009 and
UU No. 1/2014, mandates that as a measure for the management of coastal areas and small islands along with the management of fish resources, it is necessary to take actions in ecosystems conservation, fish species conservation, and fish genetics conservation. The enactment was issued through Government Regulation No. 60/2007 and Minister of Marine and Fisheries Regulation [8] regarding the rules for determining marine conservation areas.

With the development of Wahiwa bay and Tilepuwai bay in Morella Village as ecotourism areas, it is necessary to conduct research on the density and distribution patterns of Kima in these locations as a foundational data for the development of kima conservation and as an evaluation material for ecotourism management.

2. Materials and Method

2.1. Time and location of research

This research was conducted from July to August 2020, in Morella Village waters, Leihitu district, Central Maluku Regency (Figure 1). The research location consists of 2 stations: Station 1 is Mahiwa Coast (near the residential areas), and Station 2 is Tilepeuw Coast (no residential areas). The Belt Transects method was used for Kima sampling. The location was divided into two stations, each station with five transect line, with a length of 50 meters and width 10 meter starting from the shoreline parallel to the coastline. The distance between transect is 10 meters. The area of observation for each station is 2,500 m².

Figure 1. The research location in Morella.

2.2. Data analysis

2.2.1. Relative abundance. Relative Abundance is calculated by the following formula:

\[ KR = \frac{ni}{N} \times 100\% \]

where: KR : Species Relative Abundance, ni : The number of the individual species i, N : Total individual.

2.2.2. Species density. The quality of the waters environment can be described by the structure of the community which is analyzed using a species density distribution model. This model can describe the
process that occurs in the community that involves the use of natural resources and the stability of the
waters environment [9]. Density analysis of Kima species in Negeri Morella waters can be calculated
by the following formula:

\[ D_1 = \frac{n_i}{A} \]

where: \( D_1 \): \( i \)th individual species density,
\( n_i \): The amount of the \( i \)th individual,
\( A \): Sampling plot area.

2.2.3. Frequency of occurrence. The species frequency is obtained from the ratio of the square of the
\( i \)th species found and the sum of the square of the \( i \)th species found. This species frequency of
occurrence can be calculated by the following formula [10]:

\[ F = \frac{p_i}{\sum p} \]

where: \( F \): The species frequency of occurrence,
\( p_i \): Number of plots where \( i \)th species was found,
\( \sum p \): The total number of plots observed.

2.2.4. Diversity index. The diversity of an aquatic biota can be determined using the Shannon-Wiener
diversity index (\( H' \)). The main purpose of this theory is to measure the level of order and irregularities
in a system [9]. The diversity index can be calculated by the following formula:

\[ H' = -\sum (p_i \ln(p_i)) \]

where: \( H' \): Diversity Index,
\( p_i \): \( ni/N \), ratio between the amount of \( i \)th species and total number of individual,
\( \ln \): Natural Logarithm,
\( n_i \): The amount of the \( i \)th species individual,
\( N \): Total of the counted individual.

2.2.5. Uniformity Index. The Evenness uniformity index value is used to describe the individual
components of each species contained in a community which is calculated according to the guidelines.
The following formula is to calculate the uniformity index:

\[ E = \frac{H'}{H_{\text{max}}} \]

where: \( E \): Uniformity index,
\( H' \): Shannon-Wiener diversity index,
\( H_{\text{max}} \): \( \ln(S) \),
\( S \): Number of species.

3. Result and Discussion

3.1. Species composition of kima in Morella coastal waters.
The species of Kima obtained at stations 1 and 2 are presented in Table 1 and Figure 2. There are
different species found, where at station 1 there are only two species, while at Station 2 there are four
species. This happens because Station 1 is located nearby the residential area so it is suspected that
there has been overexploitation of species \( T. crocea \) and \( H. hippopus \). In addition, the coral exposure at
Station 1 has experienced degradation compared to Station 2. [11] and [12]) found 5 species of kima in
Negeri Morella waters, i.e. \( T. maxima, T. squamosa, T. crocea, T. gigas, and H. hippopus \). In contrast,
in this research only 4 species were found; the species that were not found is \( T. gigas \), this happens
because the areas of sampling are different.
Table 1. Number of species and number of individual of kima found in Morella coastal waters

| Family    | Genus | Species  | Station 1 | Station 2 | Σ individual | Proportion (%) |
|-----------|-------|----------|-----------|-----------|--------------|----------------|
| Tridacnidae | Tridacna | T. maxima | 15        | 24        | 39           | 34.2           |
|           |       | T. squamosa | 21        | 29        | 50           | 43.9           |
|           |       | T. crocea | 0         | 22        | 22           | 19.3           |
| Hippopus  |       | H. hippopus | 0         | 3         | 3            | 2.6            |
| Total     |       |           | 36        | 78        | 114          | 100            |

The cause of the high number of individuals of the *T. squamosa* species is closely related to its way of life, in which it uses its strong byssus to submerge its entire body/shell in the crevices of coral reef (coral massive), making this species difficult to extract. According to [13], *T. squamosa* is a small type Kima, which needs a hard substrate to submerge its shell. *T. maxima* and *T. crocea* live submerged inside the coral massive, that only the edge of valves were visible from the outside. While Station 1 has coral massive and branching, Station 2 has massive, branching, and submassive coral.

After *T. squamosa*, the next type of kima that was found the most is *T. maxima*. This is because *T. maxima* have a similar life with *T. crocea* that lives in the reef surfaces where this species either entirely or partially submerge its shell.

![Figure 2](image-url)

*Figure 2.* (a) *T. maxima*, (b) *T. squamosa*, (c) *T. crocea*, and (d) *H. hippopus*.

3.2. Community structure of kima in Morella waters

3.2.1. Relative abundance. Based on the calculation of kima relative abundance at both stations in Morella waters, the species with the highest relative abundance at station 2 is the *T. squamosa* with 25.4%. The other species that has high enough relative abundance are the *T. maxima* with 21.1%, *T. crocea* with 19.3%. The species with low relative abundance is the *H. hippopus* with only 2.6%. At Station 1, *T. squamosa* has high relative abundance with 18.4% while *T. maxima* has low relative abundance with 13.2%. The Relative Abundance of the different species of kima in the observation area per station is presented in Figure 3.
The high abundance of \textit{T. squamosa} is due to the substrate type found in both stations that is almost dominated by the type of live coral substrate and coral fragments. According to [14], \textit{T. squamosa} live mostly on coral reef substrate and coral fracture substrate. \textit{H. hippopus} is the Kima type with low relative abundance with 2.6\%. The low relative abundance is affected by the type of substrate, in that species mostly live on sandy substrate. According to [15], the relative abundance of kima is influenced by the waters quality (biological, physical, and chemical). The most influential parameters are depth, salinity, and brightness.

3.2.2. \textit{Species density}. Based on the kima species density calculation (Figure 4), the highest kima species density in Station 1 is \textit{T. squamosa} with 0.0084 ind/m\textsuperscript{2} and the lowest species density is \textit{T. maxima} with 0.006 ind/m\textsuperscript{2}. The highest Kima species density in Morella waters found in Station 2 is \textit{T. squamosa} with 0.006 ind/m\textsuperscript{2}, followed by \textit{T. maxima} with 0.0096 ind/m\textsuperscript{2}, \textit{T. crocea} with 0.0088 ind/m\textsuperscript{2}, and the lowest species density is \textit{H. hippopus} with 0.0012 ind/m\textsuperscript{2}.

The low species density in Station 1 is due to its location that is near the residential area. Interviews with the locals tell us that the utilization of kima is often done to meet daily needs. Moreover, the locals' lack of knowledge about protected organism like kima also causes the high exploitation. The high species density in Station 2 is because this station is located far from the residential area (1-2 km). [16], mentioned that substrate is one of the important parameters to survive. \textit{T. squamosa}, \textit{T. maxima}, \textit{T. crocea} live on the coral reef substrate by clinging or submerging its shell on the substrate using their byssus while \textit{H. hippopus} live on the sandy substrate and coral fracture [17, 18].

![Figure 3. Relative abundance of kima in Morella coastal waters](image-url)
3.2.3. Frequency of occurrence. Based on the frequency of occurrence calculation, kima with the highest frequency of occurrence in the Morella waters at Station 2 is *T. squamosa* with 3.8. Other species with high enough frequency are *T. crocea* with 3.6, *T. maxima* with 3.4. While species with the lowest frequency at Station 2 is *H. hippopus* with 0.6. The highest frequency of occurrence at Station 1 is *T. squamosa* with 3.2 and the lowest frequency of occurrence is *T. maxima* with 2.4.

The Frequency of occurrence of Kima in the observation area per station is presented in Figure 5. According to Figure 5, *Tridacna* with highest frequency of occurrence in both station in Negeri Morella waters in *T. squamosa* with 3.8 and the lowest frequency of occurrence is *H. hippopus* with 0.6.

The difference in frequency of occurrence is suspected to be caused by the locals’ consumption level and the dissimilarity in the waters quality parameters on each location. The frequencies of occurrence of three *Tridacna* types, *T. squamosa*, *T. maxima*, and *T. crocea*, are not that high, because the condition of the substrate that fits these three types is the substrate consisting of coral reef and coral fragments.
3.2.4. Diversity index and uniformity Index. The Kima diversity Index ($H'$) in Station 1 is 0.67, which means that the diversity index of Station 1 in Morella waters is on the low category. The diversity index in Station 2 is 1.21, which means that the diversity index of Station 2 in Morella waters is on the medium category. The species that live in that area of a limited number and the individuals occupying this habitat are distinctive. The diversity index is affected by a few things, such as the amount or the type of individual, dominance by certain species, and the limited amount of homogeneous and coral-filled substrate that can serve as a shelter and foraging food, causing only certain species can survive.

The uniformity index ($E$) of Station 1 is 0.49, which shows that kima uniformity index in Negeri Morella waters is on the low category. The uniformity index of Station 2 is 0.87, which means on this station the uniformity index is on the high category. The uniformity index determine the stability of a community. A community is said to be stable if the uniformity index is close to 1. A small uniformity index indicates uneven distribution of species. A high uniformity index indicates relatively even distribution of species [19]. Distribution of species is closely related to dominance, and hence, a small uniformity index indicates that there is a dominance from certain types.

3.3. Kima distribution pattern based on depth
Kima distribution based on depth is obtained by total number of each Kima type found on two types of depth, as seen in Figure 6. Based on the result of the survey, the depth of the location is divided into two parts: the first is less or equal 2 meters deep, and the second is more than 2 meters deep.

*T. squamosa* has the widest distribution area in all observation areas. The distribution at Station 2 is found to be the highest in depth type 2 compared to Station 1. This is because the condition of the ocean floor profile that is slanted or cliff-like. Additionally, during the low tide, exploitation activity is high because swallow water become accessible and only small tools and little efforts are needed.

![Figure 6. Comparison of the number of kima found at the research location.](image)

4. Conclusion
The kima resources in Negeri Morella coastal area was found to amount to 114 individuals consisting of 2 genera, 1 family, and 4 species. The kima species with high relative abundance, species density, and frequency of occurrence is *Tridacna squamosa*. The diversity index and uniformity index in Negeri Morella waters are classified as high and medium category respectively. The dominance index shows that certain species has the highest abundance.
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