Coral diversity in the Kepala Madan District Reefs, South Buru Regency, Maluku

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Abstract. The abundance of coral genera is crucial for the coral reefs and determines biodiversity. The Kepala Madan district, located in the southern part of Buru Island, is isolated and far from human activities due to limited transportation access and a balanced approach to community resource utilization. In this observation, we aim to assess the abundance and diversity of coral genera in the waters of Kepala Madan to enhance conservation efforts by the Maluku government. The observation of coral reefs in the waters of Kepala Madan District, South Buru Regency, took time in September – October 2024. At each observation point, a 50m of Underwater Photo Transect with three repetitions was laid along reef contours at 8-10 m depth, to determine coral diversity. The observations found that there are in total 85 coral genera that have been observed, of which 67 genera are hard corals and 18 others are soft corals. The genus Porites is the most commonly found type of hard coral, while Sinularia dominates soft corals.

Keywords: coral reef, coral biodiversity, coral genera, Buru Island

1 Introduction

Healthy coral reefs are essential for sustaining marine biodiversity and human livelihoods. Coral reef ecosystems are highly complex and rich in biodiversity; the complexity of coral reefs can be seen in the high level of biological diversity present within these ecosystems. [16]. These ecosystems are habitats for many marine biota such as reef fish and many macrofauna. One of the important functions is their ecological function. Coral reefs play a crucial ecological role as nursery grounds, spawning grounds, and feeding grounds for various marine biota [13]. In addition to their important ecological functions, coral reef ecosystems also have significant economic functions such as contributing to the fisheries sector, as sustainable fishing around coral reefs can provide livelihoods for local fishermen, support the economy of coastal communities, and maintain food security. By conserving the habitats, the abundance of fish stocks in the ecosystem will hopefully be sustainably maintained, as the abundance of reef fish is also influenced by the abundance of coral reef species and the complexity of coral cover [6]. However, recent years have seen coral reefs

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facing significant challenges such as rising sea temperatures, ocean acidification, and uncontrolled anthropogenic activities [16]. The waters of Maluku are renowned for their beauty and rich marine biodiversity. The Kepala Madan district, located in the southern part of Buru Island, Maluku, has successfully attracted governmental interest in establishing conservation areas due to its abundant fisheries and marine resources. Limited transportation access has isolated the coral reef in the Kepala Madan from many direct human interactions with the ecosystem. The presence of rare species such as the leatherback turtle, orca, dugong, and numerous crocodiles reinforces this assertion. Consequently, the hypothesis is that marine biodiversity in Kepala Madan is well preserved. Given that there are only a few studies conducted in the waters surrounding Kepala Madan, the aim is to thoroughly find out whether area has a high abundance of coral genera biodiversity, thereby optimizing conservation efforts in Kepala Madan.

2 Method

2.1 Study sites

The coral reefs in the waters of Kepala Madan District, South Buru Regency, Maluku Province, were surveyed in September – October 2024. Observation points selected based on the highest coral cover in the area with 8-10m. In total 15 observation points were distributed fairly around Kepala Madan District Waters (Fig. 1).

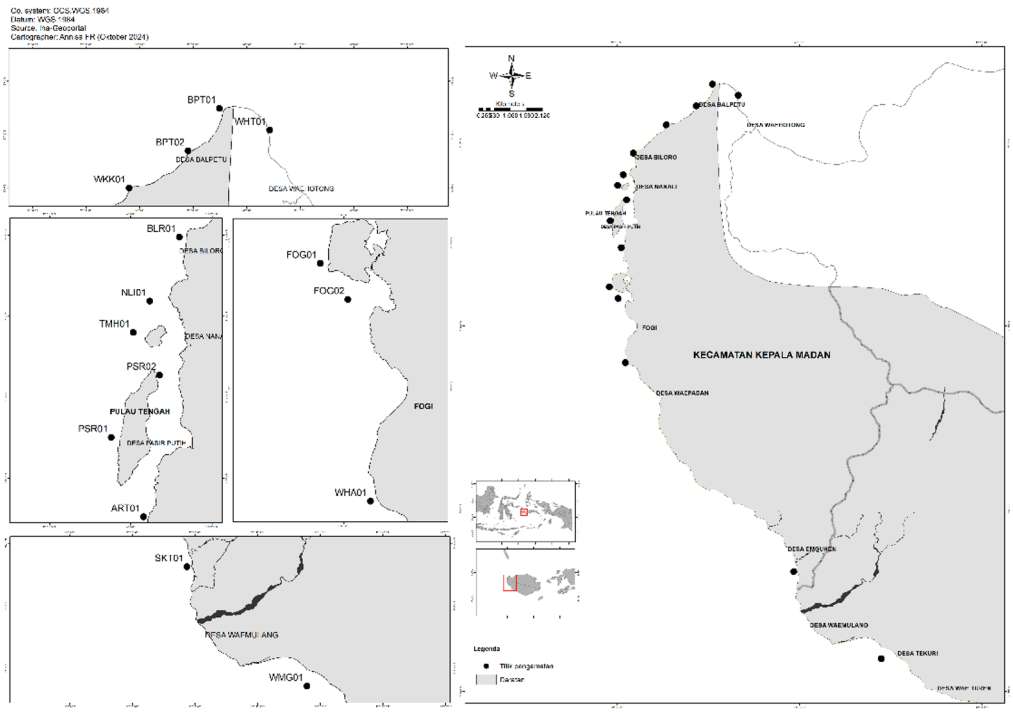


Fig. 1. Observation points map around Kepala Madan District Waters, South Buru Regency, Maluku.

Tab. 1. Each observation point details.

No.	Location	Point code	Latitude	Longitude
1	Waehotong Village	WHT01	-3,16468	126,14053
2	Balpetu Village 1	BPT01	-3,10961	126,09014
3	Balpetu Village 2	BPT02	-3,13665	126,07091
4	Waekeka Village	WKK01	-3,15605	126,04010
5	Biloro Village	BLR01	-3,17563	126,01495
6	Nanali Village	NLI01	-3,19535	126,00587
7	Tomahu Village	TMH01	-3,21000	126,00875
8	Pasir Putih Village 2	PSR02	-3,25046	126,00049
9	Pasir Putih Village 1	PSR01	-3,24184	125,99398
10	Air Ternate Village	ART01	-3,25541	126,00530
11	Fogi Village 1	FOG01	-3,30324	125,99859
12	Fogi Village 2	FOG02	-3,31658	126,00543
13	Waeha Village	WHA01	-3,36832	126,00795
14	Sekat Village	SKT01	-3,54215	126,15878
15	Waemulang Village	WMG01	-3,62074	126,21880

2.2 Data collection

Observations and identifications are done by laying 50 m of Underwater Photo Transect (UPT) with three repetitions at each observation site along reef contours at 8-10 m depth, to identify the coral genera. The identification of corals are based on the *Coral Finder* book by Russell Kelley, *Soft coral and Sea Fans* by Fabricius and Alderslade 2001, and *Corals of The World* by Veron 2000.

2.3 Data analysis

The abundance and diversity of hard coral and soft coral are then analysed by using Microsoft Excel and CPCE 4.1 (Coral Point Count with Excel) application. The coral ecological indexes are then classified based on the Shannon-Wiener Ecological Index [10]. The indexes calculated are the diversity index, uniformity index, and dominance index with the following criteria:

Diversity Index (H'):

$$H' = -\sum_{i=1}^{n} Pi \ln Pi$$

Explanation:
H' = Diversity Index
Pi = Comparison between individual (species-i) with total
n = The number of individual
i = 1, 2, 3, … n

H' < 1 = Low Diversity
1 ≤ H' ≤ 3 = Moderate Diversity
H' > 3 = High Diversity

Uniformity Index (E):

$$E = \frac{H'}{H'max}$$

Explanation:
E = Uniformity Index
H' = Diversity Index
H' max = Maximum Uniformity Index (ln S)
S = The number of total species

0 < E ≤ 0,4 = Low Uniformity, under pressured community
0,4 < E ≤ 0,6 = Moderate Uniformity, quite stable community
0,6 < E ≤ 1 = High Uniformity, stable community

Dominance Index (C):

$$C = -\sum_{i=1}^{n} Pi^2$$

Explanation:
C = Dominance Index
Pi = Comparison between individual (species-i) with total
n = The number of individual
i = 1, 2, 3, … n

0 < C ≤ 0,3 = Low Dominance
0,3 < C ≤ 0,6 = Moderate Dominance
0,6 < C ≤ 1 = High Dominance

3 Results and discussion

Overall, there were 85 coral genera recorded from observations conducted at 15 observation locations. The results showed that there were 67 types of hard coral genera and 18 types of soft coral genera spread across the waters of Kepala Madan District. These locations are generally dominated by corals of the genus Porites and also Sinularia when referring to soft corals.

3.1 Dominant genera of hard coral

There are 67 hard coral genera recorded in the Kepala Madan District Waters, with genus Porites being the most (40.83% ± 3.77) (Fig. 2a), and 4 other genera that are commonly found, including genus Acropora (14.76% ± 2.36), Montipora (7.24% ± 1.08), Millepora (6.14% ± 1.49), and Pocillopora (3.74% ± 0.49). While the remaining genera have a mean percentage below <3% in Kepala Madan District Waters. The observation result shows that the genus Porites dominate 12 out of 15 observation points with the highest percentage recorded in the waters of Waekeka (WKK01) with a percentage of 88.63% ± 0.71 (Fig. 2b), and the other three observation points are dominated by genus Acropora with the highest mean percentage in observation point Nanali (NLI01) (31.40% ± 12.32).

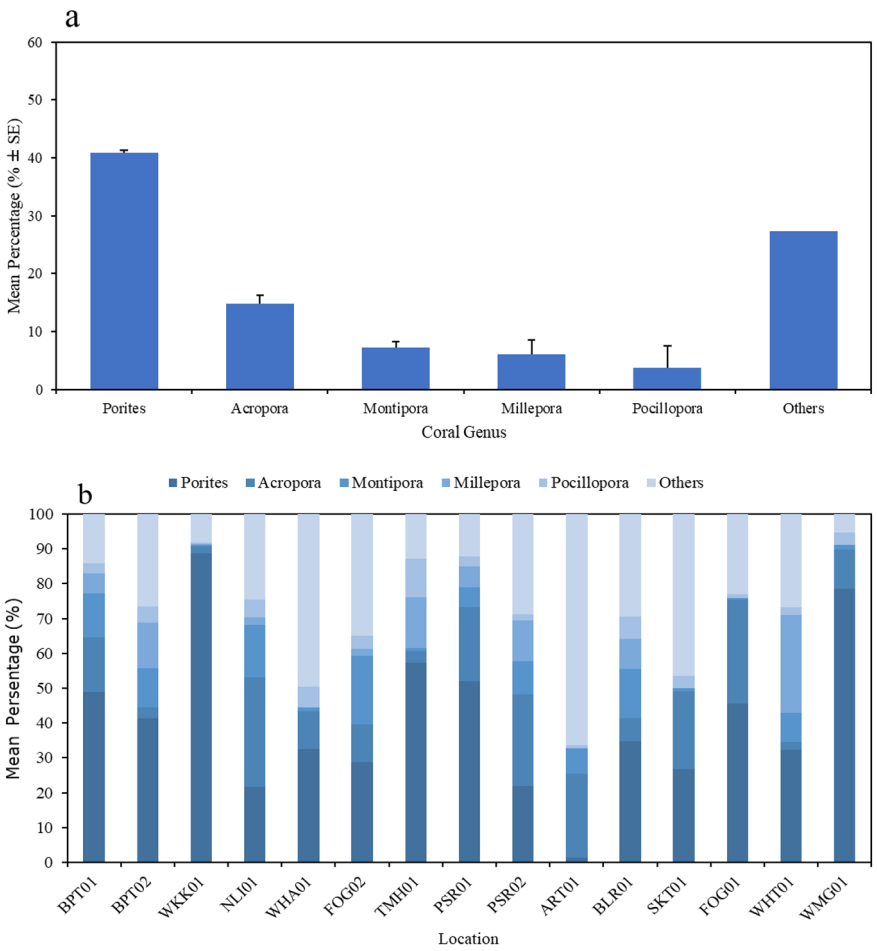


Fig. 2. Mean percentage of hard corals in Kepala Madan District overall (a) and each observation location (b).

The genus Porites is a primary type of Reef-building coral in the Indo-Pacific waters, particularly in shallow waters considered to have extreme environments [13]. Porites generally grow in a massive (CM) form, which gives it high resilience against various disturbances [7]. Although its growth rate is relatively slow, around 1–2 cm per year [15], Porites has a rapid recovery ability when exposed to stress, especially in its massive form [13], indirectly helping to maintain coral cover against natural and Human-induced damage. Besides Porites, the genus Acropora is also a significant reef builder, though it thrives best in clear shallow waters [12]. Given the high exposure waters characteristics of Kepala Madan, shallow water corals, including Acropora, are frequently exposed to sedimentation impacts, such as suspended particles carried by strong currents. Unlike the genus Porites, Acropora has low resilience to environmental changes [11, 14], but it compensates with a fast growth rate [1]. The dominance of Acropora is largely due to strong interspecies relationships that enable it to successfully compete for space and nutrients [5]. Meanwhile, Porites, with a morphology suited to host symbiotic organisms, benefit from associated organisms living around them, which help maintain their health and mitigate risks from environmental stress [3, 13].

3.2 Dominant genera of soft coral

The observation indicated that there were 18 genera of soft coral recorded, with Sinularia as the most dominant soft coral genus in the waters of Kepala Madan District, Buru Island. Sinularia dominates the soft coral genera with a percentage of 53.08% ± 4,49 (Fig. 3a). The soft coral genus Rumphella ranks second with a percentage of 13.18% ± 3,19, followed by Sarcophyton (9.36% ± 1,41), Xenia (7.88% ± 3,29), and Clavularia (5.14% ± 2,06).

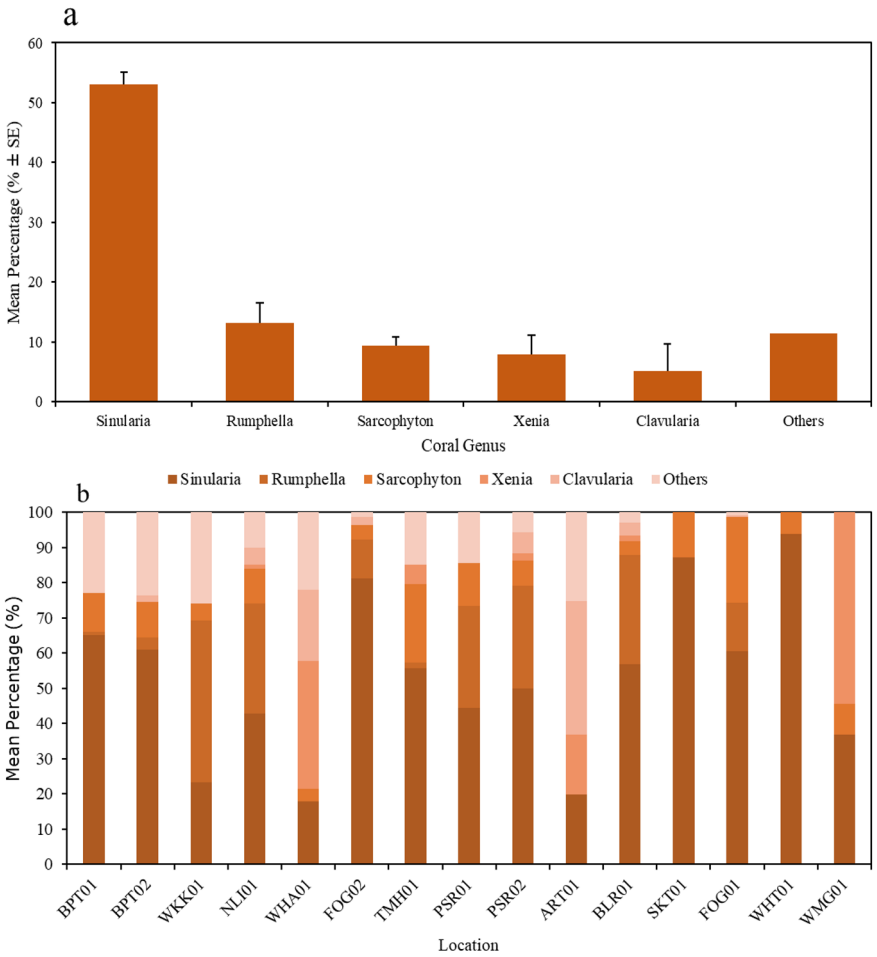


Fig 3. Mean percentage of soft corals in Kepala Madan District overall (a) and each observation location (b).

The genus Sinularia dominates 14 out of 15 observation points in the soft coral category. Sinularia is most commonly found in the waters of Waehotong Village at the observation point WHT01, with an average percentage of 93.86% among soft corals. The only location dominated by another soft coral genus is at the observation point of WKK01 in Waekeka Village, with Rumphella dominating the soft corals. The genus Sinularia is a type of coral that symbiotically associates with zooxanthellae and can live at temperatures between 25°C and 32°C [2]. The soft coral Sinularia has a creeping or encrusting growth type, allowing it to survive in high-wave waters [17]. Sinularia grows rapidly in warm waters and will slow down or stop in cold waters [8]. Some of the soft corals, including Sinularia, can release toxic chemical compounds when they feel threatened by predation or other competitors. [4].

3.3 Coral ecology index

To support sustainable ecosystem monitoring, there are efforts being made to provide coral ecological index data. Therefore, an analysis of diversity index, uniformity index, and dominance index was carried out in the Kepala Madan District reef ecosystem (Tab. 2). The average value of the coral reef diversity index in the waters of the Kepala Madan district was 2,05 and the uniformity index was 0,57 each. This shows that the diversity and uniformity of coral reefs in those waters are still classified as moderate category. Meanwhile, the dominance index in the reefs of the Kepala Madan district is relatively low, with an average value of 0,26 showing that no particular coral genus fully dominates in those waters. This is in line with the fact that the overall coral diversity index is still classified as moderate.

Tab. 2. Shannon-Wiener ecological index [10].

No	Location	Diversity Index		Uniformity Index		Dominance Index	
		H	Criteria	E	Criteria	C	Criteria
1	WHT01	2,26	Moderate	0,64	High	0,21	Low
2	BPT01	2,39	Moderate	0,71	High	0,16	Low
3	BPT02	1,82	Moderate	0,31	Low	0,35	Moderate
4	WKK01	0,83	Low	0,23	Low	0,73	Tinggi
5	BLR01	2,54	Moderate	0,69	High	0,14	Low
6	NLI01	2,69	Moderate	0,71	High	0,13	Low
7	TMH01	1,59	Moderate	0,41	Moderate	0,44	Moderate
8	PSR02	2,67	Moderate	0,77	High	0,11	Low
9	PSR01	1,75	Moderate	0,50	Moderate	0,38	Moderate
10	ART01	2,05	Moderate	0,59	Moderate	0,22	Low
11	FOG01	1,91	Moderate	0,55	Moderate	0,23	Low
12	FOG02	2,34	Moderate	0,66	High	0,16	Low
13	WHA01	2,33	Moderate	0,68	High	0,15	Low
14	SKT01	2,11	Moderate	0,61	High	0,21	Low
15	WMG01	1,56	Moderate	0,47	Moderate	0,38	Moderate
Kepala Madan		2,05	Moderate	0,57	Moderate	0,26	Low

The location Waekeka (WKK01) was the only location with a low diversity index and a high dominance index (Tab. 2). In contrast to the NLI01 location, which has the highest diversity index and low dominance index. This is in line with a high uniformity index of the NLI01 location, thus affected by the low dominance index. The high dominance index of WKK01 location affects the low uniformity index. The high dominance index of WKK01 is strongly suspected to be caused by the dominance of Porites in the area. As can be seen (Fig. 2b), porites are dominating the location by 88,63%. The genus Porites is a primary type of reef-building coral in the Indo-Pacific waters, particularly in shallow waters considered to have extreme environments [13]. According to [10], these ecological index can measure the stability of an ecosystem. In this case study, the coral reefs in the waters of the Kepala Madan district have a uniformity index that falls into the moderate category ($0,4 < E \leq 0,6$). This also shows that the coral reefs in those waters still have sufficient stability according to the quality standards. The higher the diversity of coral reef species, the complexity of substrate

and coral forms in the ecosystem, because each type of coral has different kinds of coral lifeforms. Meanwhile, according to [9], the more complex the substrate type, the higher the biodiversity in the waters.

4 Conclusion

The observations results of coral reef diversity in the waters of Kepala Madan District shows that there are a total of 85 types of coral genera recorded, with 67 types of hard coral genera and 18 types of soft coral genera found in those waters. From all types of coral genera, Porites is the most dominant genus of hard coral, because of its resilience against various disturbances, while Sinularia is the most commonly found genus of soft coral. In addition, the overall coral reef ecology index shows that the coral reef community in those waters is still considered to have a sufficient stability. This can be seen from the overall uniformity index of those waters which is classified as the moderate category. Meanwhile, the location WKK01 is different from other locations because it is the only location that has a high dominance index and low diversity index. The high dominance index of WKK01 is strongly suspected to be caused by the dominance of the genus porites in the area, with a percentage of 88,63%. The overall diversity index is categorized as moderate, indicating that the coral reef biodiversity in this ecosystem is still quite good.

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