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Kondisi dan Variasi Bentuk Pertumbuhan Terumbu Karang di Area Pesisir Bandara Rendani, Manokwari, Indonesia

Variations and Condition of Coral Lifeforms in the Coastal Area of Rendani Airport, Manokwari, Indonesia

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ABSTRAK

Terumbu karang merupakan ekosistem yang unik dan hanya ditemukan didaerah tropis. Keanekaragaman, distribusi, dan pertumbuhan karang dipengaruhi oleh faktor lingkungan. Morfologi koloni karang atau bentuk pertumbuhan sangat bervariasi antara spesies dan antara faktor lingkungan. Penelitian ini bertujuan untuk mengetahui variasi karang keras berdasarkan bentuk pertumbuhannya; dan menilai kondisi terumbu karang dengan mengukur persen tutupan karang di wilayah pesisir Bandara Rendani. Pengumpulan data tutupan karang dan kerusakan karang menggunakan metode *Point Intercept Transect* (PIT). Hasil penelitian menunjukkan variasi bentuk pertumbuhan karang di wilayah pesisir Rendani relatif rendah, seperti yang ditunjukkan dengan tidak ditemukannya beberapa bentuk pertumbuhan karang di lokasi studi. Bentuk pertumbuhan yang paling bervariasi ditemukan pada kedalaman 7m dengan lima bentuk pertumbuhan, sedangkan yang terendah ditemukan pada kedalaman 3m dengan tiga bentuk pertumbuhan. Tutupan karang hidup mencapai 77,66% di stasiun 1 dan 75,00% di stasiun 2, dan presentase terendah 11,33% di stasiun 3. Patahan karang tertinggi di stasiun 1 sebesar 4,33% dan karang mati dengan alga tertinggi ditemukan di stasiun 3 sebesar 8,00%.

Kata kunci: *Tutupan karang, bentuk pertumbuhan, Manokwari, Rendani*

ABSTRACT

Coral reefs are unique ecosystems and only occur in the tropics area. Diversity, distribution, and coral growth are influenced by environmental factors. Coral colonies morphologies or coral lifeform rates vary significantly between species and between environmental factors. This study aimed to determine the variations of hard coral based on their lifeform; and assess the condition of reefs by measuring the percent cover of live coral in the coastal area of Rendani Airport. Coral cover and coral damage data gathering used a survey approach with Point Intercept Transect (PIT) method. The results showed the variations of coral lifeform in the coastal area of Rendani was relatively low, as indicated by the absence of some coral lifeforms in the study site. The most variation lifeform was found at 7m depth with five lifeforms, while the lowest was found at 3m depth with three lifeforms. The live coral cover reached 77,66% at station 1 and 75,00% at station 2, and the lowest coverage was 11,33% at station 3. The highest average of rubble at station 1 at 4.33% and dead coral with algae was found to be highest at station 3 at 8.00%.

Keywords: *Coral cover, lifeform, Manokwari, Rendani*

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INTRODUCTION

Coral reefs are unique ecosystems and only occur in the tropics area. Noted as many as 600,000 species of coral reefs in the world and centralized in the Indo-Pacific region (Plaisance et al, 2011). Indonesia accounts for about 18% of the total world's coral reefs that area 284.300 km^2, and the total area of coral reefs in Indonesia reached approximately 51.000 km^2 (Burke et al, 2002). The condition of coral reefs in Indonesia is currently experiencing changes that are mainly in the category broken (Carter, 2018, Peck et al, 2021). The average coral cover of life that his condition is still very good and good only about 5.5% and 27% (Hadi et al, 2018).

Diversity, distribution, and coral growth influenced by environment factors. Light intensity, level of exposure, water temperature, current, water turbidity, salinity, and suspended solid were the physic-chemical factor that affected corals life. Some common forms of coral lifeform, such as *globose*, *branching*, *digitate plate*, *compound plate*, *fragile branching*, *encrusting*, *plate*, *foliate* and *micro atol*. Certain coral lifeform was able to dominate in a kind of habitat, it depends on environmental condition or habitat. The various corals colony morphologies provide the physical complexity that characterizes coral reefs (Saptarini et al, 2017).

Coastal areas as a reef habitat today face high pressure from infrastructure development in coastal areas. Such is the case with the Manokwari coast, which is one of the distributions of coral reef ecosystems in the Bird's Head Seascape (BHS), West Papua. Damage to coral reefs on the Manokwari coast is caused by destructive fishing, such as the use of blast fishing or refraction and tuba root anesthesia (Iriansyah et al, 2021; Algutomo et al, 2022). On the other hand, due to sedimentation and garbage originating from activities on land. Several coral reef studies in Manokwari waters, generally describe the occurrence of degradation of living coral areas (Pattiasina et al, 2019; Dasmasela et al, 2019; Thovyan et al, 2017).

Coral colonies morphologies or coral life form rates that vary greatly between species and between environments factor. The purpose of the present study was to determine the diversity of hard coral based on their lifeform, and to assess the condition of reefs by measuring percent cover of live coral in the coastal area of Rendani Airport.

RESERACH METHOD

Area Study

Data observations were made at three stations, and each station had 3 sub-stations, enclosed in the Rendani Airport area, Manokwari. The determination of the station point was carried out by an initial survey, namely direct observation with diving aimed at obtaining an overview of the distribution of coral lifeform on the Rendani coast (Figure 1).

Methods

The research was a visual survey with Point Intercept Transect (PIT) used to collect data (Santavy et al, 2012). Observation of cover and composition of lifeform was carried out in June-July 2020. PIT method was used because it is fast, efficient, and provides a reasonable estimate for the cover of benthic communities (Hill & Wilkinson, 2004). The PIT method is one of the methods developed to monitor the condition of live corals and other supporting organisms at a coral reef location. Observations were made by stretching a measuring tape with a length of 50m drawn horizontally (parallel to the coastline) at each station observation point. Transects were placed at three different depths, namely 3, 5 and 7 meters. Observations were made along the transect line by recording all categories of growth forms (lifeform), each distance of 0.5 m with three repetitions.

Data collection of the aquatic environment parameters such as dissolved

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oxygen, current, water transparency, pH, salinity, and temperature were done *in-situ* at the same station with coral data collection.

Data Analysis

Description of benthic categories used the category of level 2 (Facon et al, 2016): Algal assemblage (AA), branching *Acropora* (ACB), digitate *Acropora* (ACD), *Acropora* encrusting (ACE), submassive *Acropora* (ACS), table *Acropora* (ACT), Coralline algae (CA), coral branching (CB), encrusting (CE), foliose (CF), *Heliopora* (CHL), massive (CM), Millepora (CME), mushroom (CMR), submassive (CS), *Tubipora* (CTU), Dead coral (DC), Recently killed coral (RCK), Dead coral with algae (DCA), Fleshy macroalgae (FMA), *Halimeda* (HA), Nutrient indicator algae (NIA), Others (OT), Rubble (R), Rock (RCK), Sand (S), Soft coral (SC), Silt (SI), Sponges (SP), Turf algae (TA), Water (WA), and Zoanthids (ZO). The percentage of live coral cover was obtained by the following equation (Facon et al, 2016):

Percent cover = 100 × Number of points where the category is recorded/Total number of points on the transect

The benthic category cover values, especially life form, and the percentage criteria were obtained from the above equation, categorized by referring to Minister of Environment Decree No. 04/2001; Gomez & Yap (1988), namely the percentages of 0-24.9% (poor), 25-49.9% (fair), 50-74.9% (good), and 75-100% (excellent).

Coral conditions were obtained from the comparison between the percentage of live coral cover with abiotic components consisting of sand, rubble, and dead corals.

RESULT AND DISCUSSION

Aquatic water and environments condition

Temperature is a limiting factor that determines coral growth. Nontji (1987) explains that coral growth will peak in the temperature range between 25-30°C, but each coral colony has specific adaptability in temperature changes (Duckworth *et al*, 2012). The temperature range found between 30 and 30.6ºC. Suharsono (1998) states that the temperature range that can still be tolerated by corals ranges between 26-34°C. Corals that live in the tropics are constantly faced with relatively fixed temperatures, so that changes in temperature that are only 1-3°C will disrupt the metabolic processes of corals (Muhlis, 2011). Corals that have high metabolic rates and high growing speeds will be more sensitive to temperature increases compared to corals that have slow metabolism and low growth rates (Schoepf et al, 2015). Increased damage to coral reefs caused by increased temperature (Yee *et al*., 2011; McClanahan *et al*., 2003; Baird and Marshall, 2002; dan Kushmaro *et al*., 1998).

Ideal salinity for coral reefs ranges from 25-40 ppt (Wilkinson & Buddemeier, 1994). Corals are very sensitive to salinity, which determines the distribution and abundance of coral reefs (Goreau & Hayes, 2008). The range of salinity found was between 28-31 ppt (Table 1). The low salinity at station 3 might be affected by the flow of the river facing directly with this station (Figure 1).

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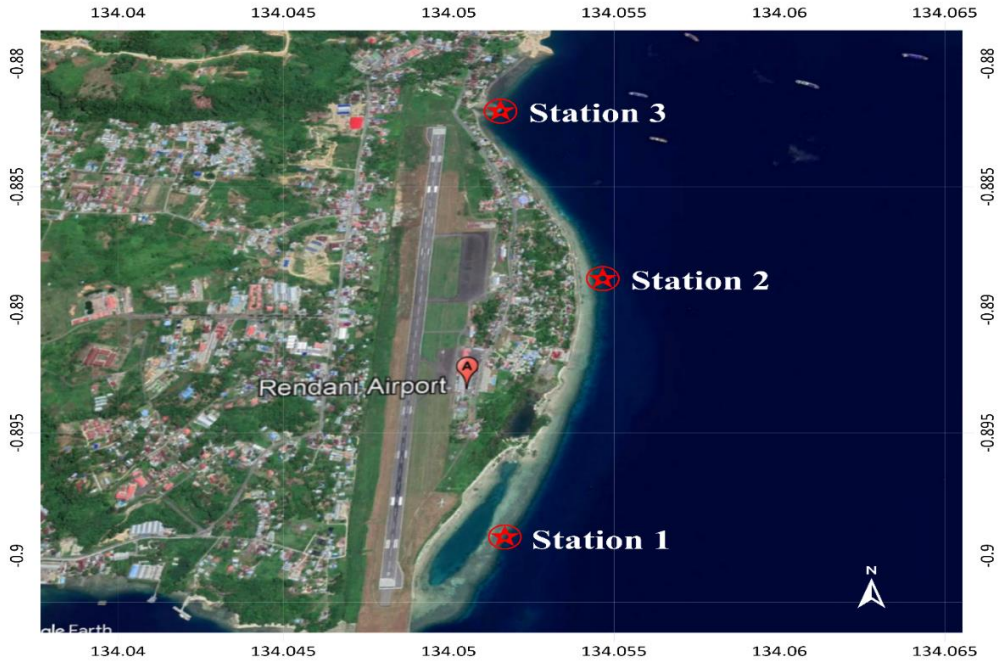

Figure 1. Research Map Location

Table 1. Environmental parameter condition

Station	*Temperature (°C)*	*Salinity (ppt)*	*Dissolved Oxygen (mg/l)*	*pH*	*Current velocity (m/s)*	*Water transparency (%)*
Station 1	30.6	31	8.2	7.9	0.16	100
Station 2	30	31	6.2	7.7	0.14	100
Station 3	30	28	6.1	6.7	0.11	70
Overall	30.2±0.35	30±1.73	6.8±1,18	7.4±0.64	0.10±0.03	90±17.3

Dissolved oxygen is one of the important parameters to describe the quality of a water. Marine organisms require dissolved oxygen for their metabolic activities. The oxygen is used in the body's metabolic processes for growth and breeding of corals (Haas et al, 2014). The range of dissolved oxygen found is between 6.1-8.2 mg/l. In general, the measurements of dissolved oxygen found still supported the growth of coral reefs. Coral reefs grow well in the dissolved oxygen range from 5.08-5.2 mg/l (Paulangan et al, 2019; Thovyan et al, 2017). Furthermore, corals could tolerate reduced oxygen concentrations, but only until a given threshold determined by a combination of exposure time and concentration (Haas et al, 2014).

The degree of acidity (pH) water describes the concentration of hydrogen ions in particular water (Roger et al, 2001). pH measurement results range between 6.7 and 7.9. In general, this observation is a common condition in the Indonesian waters (tropical), so it can be assumed that this pH range is still very supportive for the lives of coral reefs. Atkinson et al (1995) revealed good coral growth in pH (7.6-8.3) and a high nutrient.

The hydrodynamic process (current) affects coral growth, reducing the rate of coral-eating biota attacks (Lenihan et al, 2015). Current measurement results at the study site ranged from 0.11 to 0.16 m/s.

Water transparency in water strongly supports the growth of coral reefs for life. The water transparency value found is 100%, meaning that light can still penetrate to the bottom of the waters. However, at station 3 the water

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transparency value is slightly low, with a value of 70%. Water transparency is very closely related to light penetration, which is very important for zooxanthella and coral animals, especially in the process of photosynthesis (Rogers et al, 1994).

Condition of Coral Reef Ecosystem

The highest coral cover conditions in Rendani waters are at station 1 of 77.66% and station 2 of 75%, categorized as "excellent". The lowest percentage at station 3 is 11.3% which is categorized as "poor". The highest percentage of coral cover at station 1 is thought to be due to ideal water conditions for coral growth, and relative is not affected by a residential activity because it is at the end of the Rendani airport runway zone which is prohibited for any activity. Meanwhile, the low coral cover at station 3 is due to its position near the Rendani river mouth. The location of water where coral reefs grow is relatively shallow and adjacent to rivers, and run-offs certainly experience extreme temperature and salinity fluctuations. In addition, pressure from land close to the source of sedimentation is carried by rivers carrying material from the mainland. Sediments carried by river flows from the mainland cause turbidity and reduce the sunlight penetration into the water column. In addition, the sediment will settle and cover coral polyps so that it would cause death in corals (Barus et al, 2018; Burke et al, 2002).

The highest average of rubble at station 1 at 4.33%, followed by station 2 at 3.00%, and lastly station 3 at 2.00%. The percentage of rubble cover illustrates the magnitude of damage to coral reef ecosystems in water. The threat of damage to coral reefs can originate from nature and result from human activity. Wilkinson (2004) explains that natural damage is usually caused by waves, storms, tsunamis, and rising temperatures due to climate change. Threats originating from human activity are sedimentation, eutrophication, fishing methods that are not environmentally friendly (using bombs or poisons), construction of bridges and ports, waste disposal, and tourism (Willoughby et al. 1997; Munoz-Chagin 1997; Ress et al. 1999; Burke et al. 2002; Raymundo et al. 2007; Larsen et al. 2018; Paulangan et al, 2019; Littaqwa & Side, 2022).

Table 2. Percentage of coral cover per station

Station	Live coral (%)			Component average (%)	Category (%)*
	Depth 3 m	Depth 5 m	Depth 7 m		
Station 1	49,00	86,00	98,00	77,66	Excellent
Station 2	71,00	71,00	83,00	75,00	Excellent
Station 3	34,00	-	-	11,33	Poor

*Gomez and Yap (1988); Minister of Environment Decree (2001)

Table 3. Percentage of rubble and dead coral / dead coral with algae

Station	Rubble (%)			Dead Coral / Dead coral with algae (%)			Average of Rubble (%)	Average of Dead Coral / Dead coral with algae (%)
	Depth			Depth				
	3m	5m	7m	3m	5m	7m		
Station 1	13,00	-	-	16,00	7,00	-	4,33	7,66
Station 2	-	3,00	-	10,00	10,00	2,00	3,00	7,33
Station 3	6,00	-	-	24,00	-	-	2,00	8,00

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The highest average dead coral with algae was found at station 3 at 8.00%, followed by station 1 (7.66%), and lastly station 2 (7.33%) (Table 3). Birkeland (1997) explained that coral death can be caused by physical and chemical aspects, on the physical aspect of death or damage to coral reefs that occur due to being hit by large waves that can destroy coral reefs, while from the chemical aspect is the presence of pollutants from human activities on land that cause eutrophication, sedimentation, pollution and excessive influx of freshwater from land due to erosion through run off. Muttaqin et al, (2014) added that coral death had provided room for the growth of algae as competitors of coral reefs. The highest average of dead coral with algae found in Rendani coastal is comparable with the average of dead corals in the Jayapura, Papua (Paluangan et al, 2019); i.e., 8.67%. However, the mean value is lower than that found in several other coral reef ecosystems in Papuan, i.e., Pasir Putih waters, Dampier strait, Mansinam island, and Lemon Island (Thoviyan et al, 2017; Yuanike et al, 2019; Dasmasela et al, 2019; Sitanala et al, 2021).

Various composition of Coral Lifeform

There were two coral lifeforms found for Acropora (branching-ACB, digitate-ACD) and amount four non-Acropora (branching-CB, massive-CM, sub massive coral-CS, and mushroom-CMR) (Figure 3). Either Acropora or non-Acropora distinguished from axial corallite presence. Non-Acropora hadn't axial corallite but had both axial and radial corallites (Suharsono, 1998).

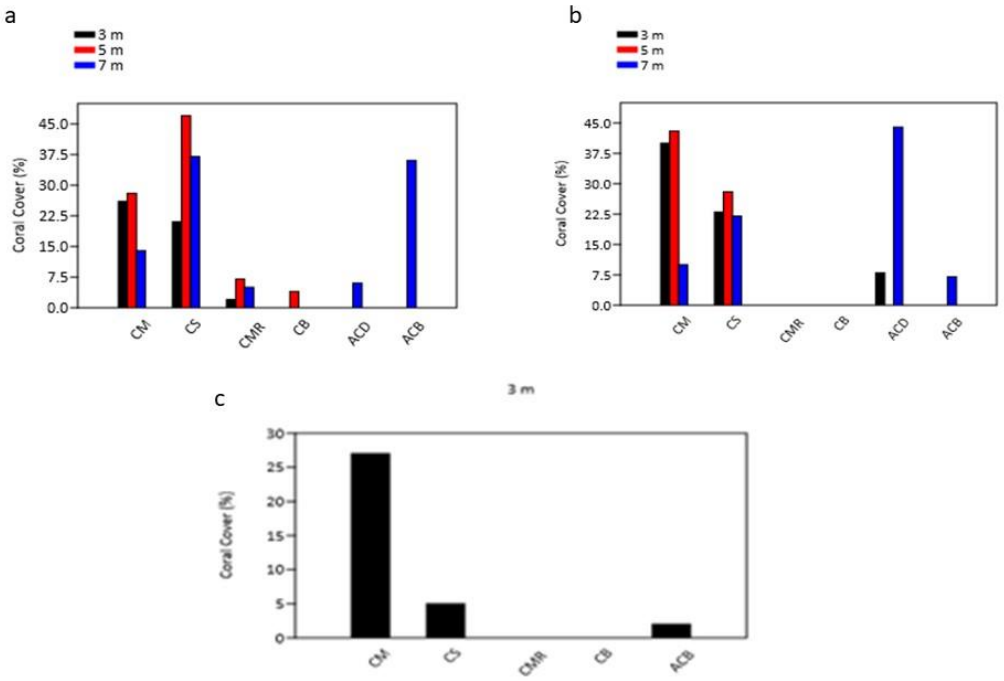

Figure 2. Lifeform composition at Rendani coastal of Manokwari, Indonesia. a. Station 1, b. Station 2, and c. Station 3

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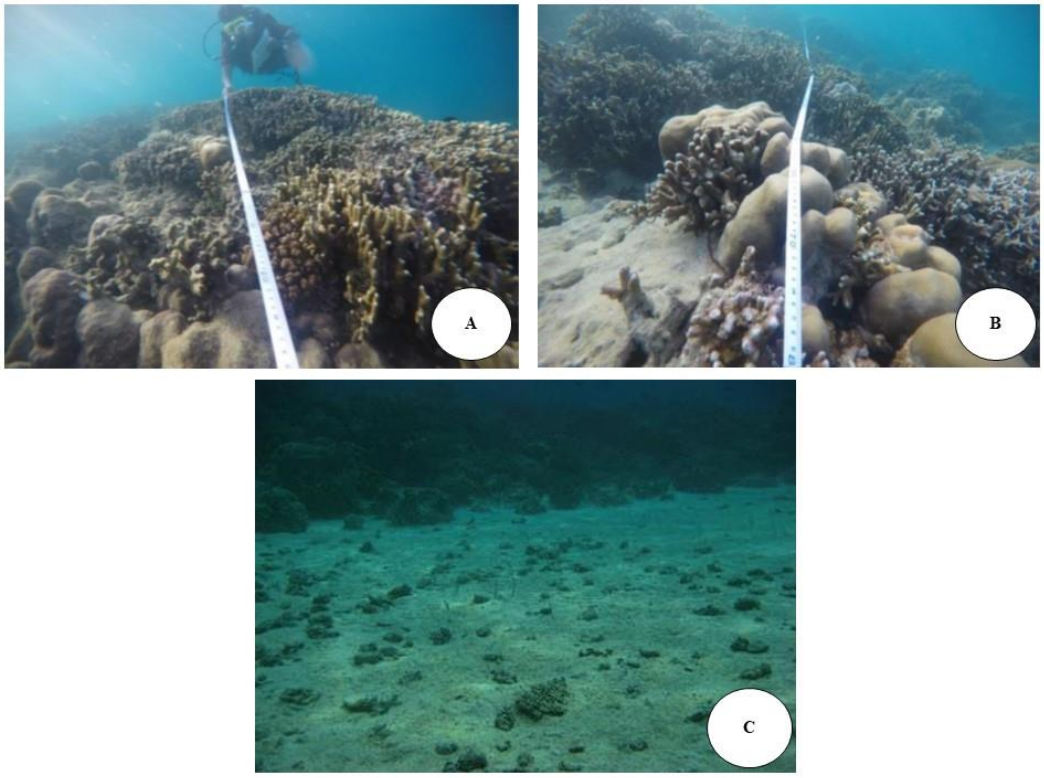

Figure 3. Coral diversity and lifeform variation in the coastal area of Rendani. A. Station 1, B. Station 2, and C. Station 3

There are various compositions of coral lifeforms in all three locations. Hard corals (non-Acropora) dominate the percentage of cover. The highest coral lifeform was found at station 1, six types and mostly is non-Acropora types: massive, sub-massive, branching, and mushroom. In contrast, the type of Acropora including branching and digitate are only found at a depth of 7m. Station 2 coral lifeform were found in as many as four types, with 2 types of non-Acropora: massive and sub-massive found at all depths. Acropora including branching and digitate are only found at a depth of 7m. This condition provides an overview of the distribution of corals that are affected by environmental conditions in Rendani waters, where the morphology of corals formed is an adaptation to local conditions. Environmental factors in this case temperature, depth, and currents, are thought to have an important influence on these variations. Fluctuations in environmental conditions will affect growth rates, forms of growth, and coral reproductive abilities (Kleypas et al., 1999), finally exerting influence on the abundance, composition, and diversity of corals (Baker et al., 2008). This is in line with Nakano (2004) who stated that healthy corals play an important ecological role in shaping the structure of their communities.

Station 3 has the lowest percentage of coral cover and lifeform. The lifeform that dominates at station 3 is massive. This station has low water transparency and salinity compared to other stations; thus it is suspected that local environmental conditions have a significant influence on the form of coral growth. This station is characterized by a predominantly sandy substrate. This is then strengthened by the absence of branching coral species at depths of 3 and 5m. Branching coral is only found at a depth of 7m but with a very low percentage of cover. As is known that this type of coral branching is a lifeform that is quite sensitive to changes in environmental conditions. Corals generally have a massive form in shallow

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coral reefs lament with high turbidity and sediment resuspension (Barus et al, 2018). Ecomorph forms such as massive benefit corals to rid themselves of sediment accumulation with the help of current movements (Barus et al, 2018; Saptarini et al, 2017; Rani, 2001). Of the various types of coral lifeforms, branched coral types are a type that is known to tend to be sensitive to changes in environmental temperature so that changes in temperature above ordinary or average conditions can be immediately known (Rani 2001). The presence of sand and mud is not a favorable substrate for planula (Thamrin, 2006).

CONCLUSION

The variation of corals on the Rendani waters was low, indicated by the occurrence of all coral lifeforms. The highest coral variation was observed at 7 m depth with five lifeforms, and the lowest was at 3m deep with three lifeforms. The live coral cover reached 77,66% at station 1 and 75,00% at station 2, both indicating an "excellent" coral reef health. The highest average of rubble at station 1 at 4.33%, followed by station 2 at 3.00%. On the other hand, dead coral with algae was found to be highest at station 3 at 8.00%, and followed by station 1 at 7.66%.

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