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Diseases prevalence of *Acropora* corals: Study on Semak Daun Island, Seribu Islands, Jakarta

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ABSTRACT

Coral reefs have undergone significant degradation as a result of the impact of human disturbance and natural factors on biodiversity and ecosystem function. The impacts ranged from an increase in the appearance of coral bleaching, coral disease, to coral death. Especially for coral disease, it is confirmed that it has contributed to the reduction of live coral cover and the productivity of coral reef ecosystems. The coral disease can be epidemic due to environmental pressures, both anthropogenic and natural, as well as infection from pathogenic microbes. Recently in several places, including Semak Daun Island, Seribu Islands-Jakarta, it was reported that the condition of coral reef cover had increased. However, a high percent of coral cover can increase disease prevalence and abundance. *Acropora* coral is a type of coral that is commonly found on Semak Daun Island. However, these corals are very susceptible to stress so that the threat of disease is high. So it is necessary to conduct a study that aims to determine the type and prevalence of diseases that disturb *Acropora* coral in Semak Daun Island, Seribu Islands, Jakarta. The field survey was carried out for coral observation using the line transect method at four stations. Coral disease identification refers to the Coral Disease Handbook and Underwater Cards for Assessing Coral Health. Observation objects, both coral species, and signs of disease were documented using underwater cameras. The study results indicate that 15 types of *Acropora* corals were dominated by *A. humilis*. Meanwhile, two groups of diseases were found, namely *Tissue loss - Predation* caused by the COTS and *Drupella*, while those from the *Compromised Health* group included RFA, SD, and *Sponges*.

Keywords: *Acropora*, compromised health, coral disease, corallivorous, prevalence, Semak Daun Island

1. INTRODUCTION

In recent years, coral reefs have experienced significant degradation as a result of the impact of human disturbance and natural factors on biodiversity and ecosystem function [1–8]. In this case, coral reefs become unstable, even though there is plenty of space for coral reefs to attach and grow but they are very sensitive and vulnerable to stress triggers [9, 10]. The impacts ranged from an increase in the appearance of coral bleaching, coral disease, to coral death [11–14].

In particular, outbreaks of coral disease have had a significant negative impact on the condition of coral reefs and have contributed to decreased live coral cover and productivity of coral reef ecosystems [15–18]. The health of coral reefs around the world is being threatened by several diseases caused by biological and environmental factors [8, 14, 19–21]. Coral disease is defined as an abnormal condition of a coral organism that impairs organism function systems, or organs, associated with specific symptoms and signs [22, 23]. Symptoms and signs arise due to the combination and interaction of corals as hosts, the medium of transmission, and pressure from the environment. Biotic factors that cause disease in corals can come from infection with viruses, bacteria, fungi, and protists, while abiotic factors include environmental stresses such as temperature, sediment, toxins, and ultraviolet radiation [24].

Global monitoring of coral disease caused by pathogenic microbial infections shows the highest prevalence in Caribbean waters [25]. Meanwhile, disturbances in coral health in the Indo-Pacific region are more caused by environmental pressures. However, infection by pathogenic microbes has been shown to increase temporally at several sites [26]. Following [12, 25, 27], most coral diseases occur in higher than normal seawater temperatures (warm temperature anomalies) which can facilitate the emergence and spread of pathogens or other stress agents. Furthermore, [28] mentions that disease attack generally occurs when coral communities are in vulnerable conditions such as during competition with rapid algae growth and in weak physiological conditions after bleaching.

In Indonesia, the area of coral reefs released based on the results of remote sensing image data analysis is around 2.5 million hectares or 18% of the world's coral reefs [29]. According to [30], generally, the status of Indonesian coral reefs, from 1153 reefs there are about 33.82% categorized poor, 37.38% categorized fair, 22.38% categorized good and only 6.42% categorized excellent. The condition of the coral reef is determined by the percentage of live coral cover. In the study area of Semak Daun Island, based on a report by the TERANGI Foundation, the percentage of hard coral cover had decreased in 2007, which was only around 24.7% [11].

Furthermore, it is quite encouraging in the last ten years, the condition of the coral reefs of Semak Daun Island has increased. This is of course due to natural coral recruitment patterns [31], [32] and also can not be separated from the efforts of conservation and rehabilitation activities by elements of society and the government [33]. Based on research results from [34], the condition of the coral reefs in Semak Daun Island ranged from 29.67% to 77.66%. Related to this, [35] indicates that the contribution of the percent of coral cover can increase the prevalence and abundance of diseases where the higher the live coral cover, the higher (number) of diseases and health problems of coral.

Hard corals of the order Scleractinia are important components of coral reef ecosystems that can produce calcium skeletons in building reef structures. [36, 37]. *Acropora* is one of the genera from the Scleractinian group with the most widespread distribution [38] because it has

a large survival rate and a high growth rate [39]. However, this coral is especially susceptible to bleaching when stressed [40], so that it is included in the threatened coral species [41].

Based on the background that has been presented, this study aims to determine the types and prevalence of diseases that disturb *Acropora* corals in Semak Daun Island, Seribu Islands, Jakarta. The study of coral disease is very important to continue because of the limited knowledge and understanding of the composition and dynamics of the natural microbial communities that live with most corals, environmental factors that influence infection and disease progression, mechanisms of transmission, and the possibility of developing resistance. Without understanding the interactions between causative agents, corals and their environments, management of these diseases in the field will be almost impossible [42].

2. MATERIALS AND METHODS

2. 1. Location of observation and data collection

The study location is in the waters around Semak Daun Island, Seribu Islands, Jakarta. Geographically it is located at position 5°57'21" South, 106°34'33" East. Observation and data collection were carried out at four stations which were considered to meet ecological criteria, area representation, and ease of accessibility (**Table 1** and **Figure 1**). The field survey was carried out in January 2014 to observe and collect coral condition data from the *Acropora* genera.

Table 1. The position of the geographic coordinates of the observation station and an overview of the location

Station	Geographical Coordinates (degree, minute, second)		Location Description
	Latitude (South)	Longitude (East)	
1	05° 43' 44.4"	106°34' 22.8"	This station is relatively close to the jetty, which is in the eastern part of Semak Daun Island. This area is very often used by tourists for snorkeling, diving, and throwing fishermen's anchors in the coral reef ecosystem.
2	05° 43' 51.5"	106° 34' 19.2"	This station is located in the northeast of Semak Daun Island. This station is quite close to the boat dock, in an area for snorkeling, fishing and is close to aquaculture activities.
3	05° 43' 51.5"	106° 34' 8.4"	This station is in the west of Semak Daun Island. Around this station, there still can be found the activity of taking sand and coral as a building material for houses.
4	05° 43' 40.8"	106° 34' 11.9"	This station is located in the southwest of Semak Daun Island close to the lagoon, this area is estimated to have very little human activity.

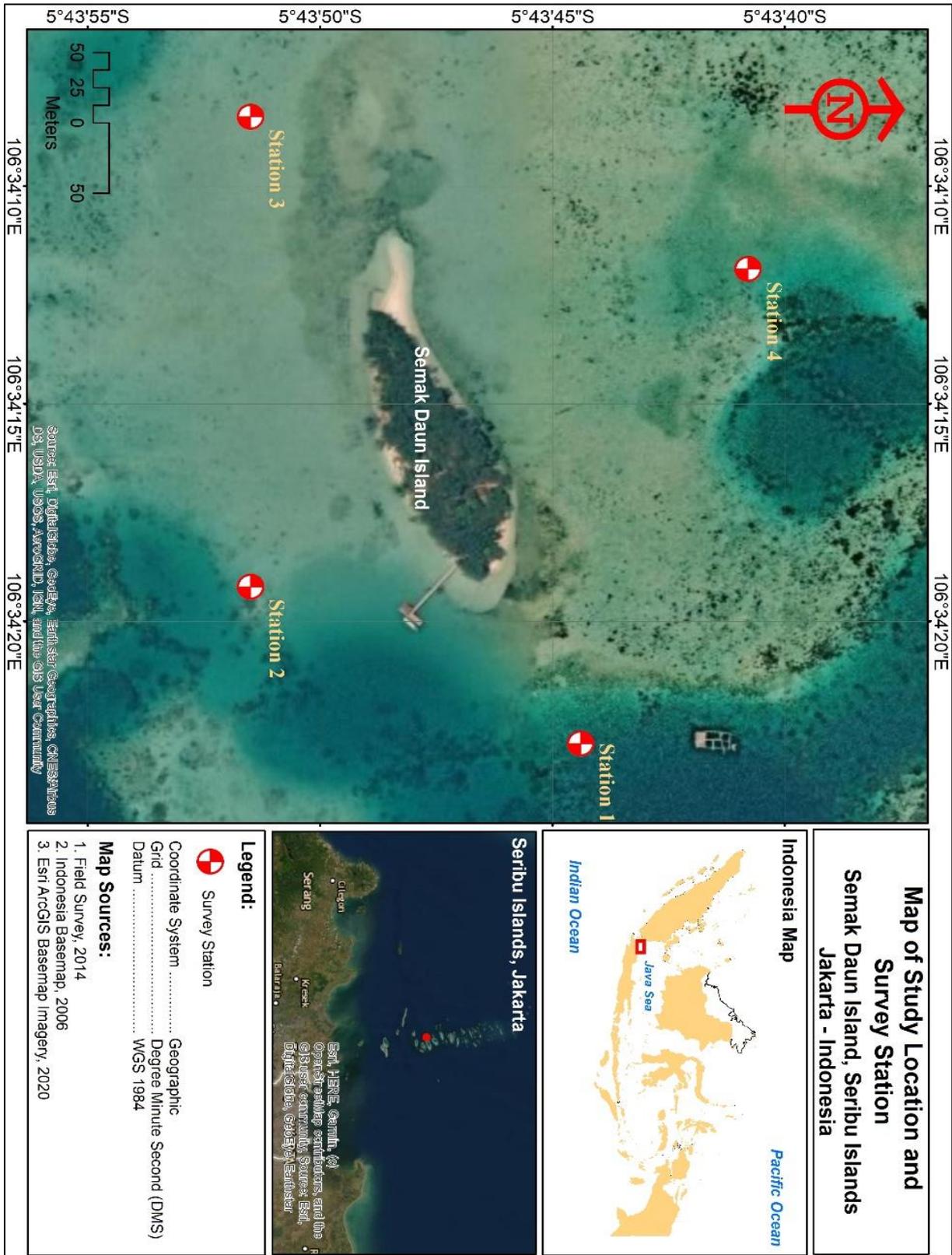


Figure 1. Map of the study location and the observation and data collection stations

2. 2. Coral observation and analysis

Coral observation in this study used the LIT (line intercept transect) method. The transect line is drawn parallel to the coastline, and the island or land area is on the left. Observations were made at a depth of between three to ten meters with a total length of line transect equaling to 100 meters (**Figure 2**).

Types of *Acropora* corals under the transect line were recorded based on the growth form, number of colonies, and seen for signs of coral disease.

Observation of coral disease was carried out by referring to the Coral Disease Handbook [24] and the Underwater Cards for Assessing Coral Health on Indo-Pacific Reefs [43]. Observation objects, both coral species, and signs of disease were documented using underwater cameras. To determine the health of coral, it is done by looking at the percentage of healthy corals which is calculated by as Equation 1 follows:

$$\text{Coral Health} = \frac{\text{Healthy corals}}{\text{Number of corals}} \times 100\% \dots\dots\dots \text{Equation 2}$$

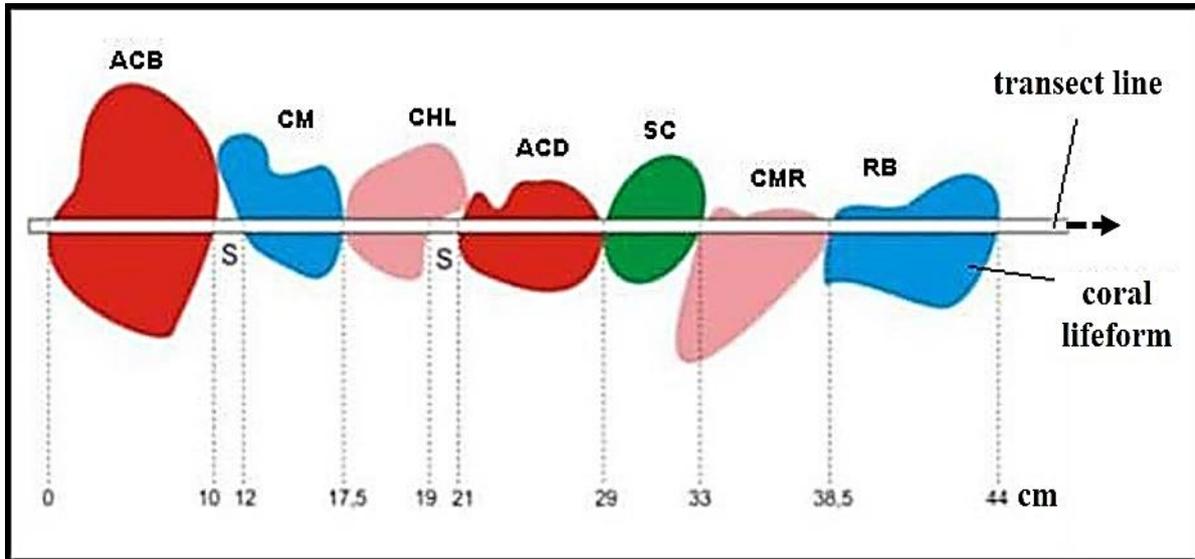


Figure 2. Illustration of an example diagram of measurement using the LIT method

3. RESULTS AND DISCUSSION

3. 1. Types and numbers of *Acropora* coral colonies

The genus *Acropora* has the characters of the family Acroporidae (synapticulotheca, simple septa, and no columella or dissepimenta) and is defined by its mode of growth, in which a central or *axial* corallite extends and buds off subsidiary or radial corallites [44]. From the results of the observations listed in **Table 2**, it can be seen that there are 15 types of *Acropora* corals found in the study site.

According to [45] *A. formosa* is the most common type of *Acropora* and is found in Indonesia. However, it was different in the study location, of the 91 coral colonies of the genus *Acropora*, the most common colony was *A. humilis*, with eighteen colonies (19.78%).

Corals of *A. humilis* are often found in shallow reef flat habitats [44, 45]. This is possible because Semak Daun Island has nearly 90% of its shallow waters which are reef flats [34].

The station that has high species diversity is station 3, with eleven species dominated by *A. humilis* with 26 colonies. The largest number of colonies was at station 4 with 27 colonies dominated by *A. humilis*, *A. hyacinthus*, and *A. pulchra* with five colonies each. Meanwhile, the least number of species was at station 1, namely seven species. At this station, *A. humilis* and *A. pulchra* dominate. The least coral species found were *A. carduus*, *A. digitifera*, *A. echinata*, *A. florida*, *A. prostrata*, *A. speciosa*, and *A. valenciennesi* with only one colony each. In general, the colony distribution of *Acropora* corals is very uneven and the factors that influence it are not known clearly [46].

Table 2. Types of coral at each station

No.	<i>Acropora</i> Coral	The Number of Colony per Station				Total Colony
		Station 1	Station 2	Station 3	Station 4	
1	<i>A. brueggemanni</i>	N/A	N/A	1	1	2
2	<i>A. carduus</i>	N/A	1	N/A	N/A	1
3	<i>A. cervicornis</i>	4	3	1	4	12
4	<i>A. digitifera</i>	N/A	1	N/A	N/A	1
5	<i>A. echinata</i>	N/A	N/A	1	N/A	1
6	<i>A. florida</i>	N/A	N/A	1	N/A	1
7	<i>A. formosa</i>	2	4	2	2	10
8	<i>A. humilis</i>	6	1	6	5	18
9	<i>A. hyacinthus</i>	4	2	1	5	12
10	<i>A. millepora</i>	N/A	1	4	2	7
11	<i>A. pulchra</i>	6	1	4	5	16
12	<i>A. prostrata</i>	N/A	N/A	1	N/A	1
13	<i>A. speciosa</i>	N/A	N/A	N/A	1	1
14	<i>A. valenciennesi</i>	1	N/A	N/A	N/A	1
15	<i>A. yongei</i>	1	N/A	4	2	7
No. of Coral Species		7	8	11	9	91

N/A: Not Available

3. 2. Coral health and disease

The results of observations held on Semak Daun Island in *Acropora* coral colonies found that there were five types of diseases, namely *Crown-of-Thorns Starfish* (COTS), *Drupella*, *Red Filamentous Algae* (RFA), *Sediment Damage* (SD), and *Sponges*. These diseases are included in *Tissue loss – Predation* and *Compromised Health* groups. These results are supported by studies conducted by [35] which revealed that the *Compromised Health* group was found on several islands in Jakarta Bay. The chart shown in **Figure 3** shows the percentage of these diseases in each station. It can be seen that the diseases that disturb the *Acropora* corals in the study sites are caused more by factors of human activity impact and corallivorous predators. If there is a change in water conditions such as an increase in seawater temperature, it can trigger pathogenic microbial infections [12, 27] and causes diseases that are included in the group of *Tissue loss – Non-Predation – Colored Band Disease* [47].

COTS attacks on *Acropora* corals in Semak Daun Island were only found at station 3 with a prevalence percentage of 8.33%. According to [43], COTS is predation that causes loss of coral tissue with white skeletons. This animal can remove large areas of tissue (10th-100th cm) in a single day [48]. COTS usually preys on corals on the edge of the colony, traces of predation are also usually seen around colonies near the colonies that are preyed on. A report from [49] reveals that COTS is one of the major causes of coral mortality in Indonesia. Research conducted in the Spermonde Islands [50] the impact of the COTS outbreak was devastating to the point of losing live coral cover by 20% monthly.

Apart from COTS, predation by *Drupella* was also found at the study site. *Drupella* is found in station 1 and station 3 with a prevalence of 8.34% and 5%, respectively. The outbreak of this coral predator is one of the factors affecting the growth of coral communities [51–53]. These animals usually take shelter under coral colonies or close to the bottom during the day [43]. As it turns out, *Drupella* prefers to be on branching corals of the genus *Acropora* [54] and will prey on coral polyps that are depressed or weak [52, 55]. Coral skeleton growth decreased linearly with the high density of these snails [56]. According to [53], if abundances of *Drupella* greater than 0.62 m^{-2} , sustained over sufficiently large temporal and spatial scales and predation in large numbers will cause damage to coral reefs.

RFA is a disease found at all observation stations. The highest prevalence of this disease is in station 2 which reaches 42.20%. RFA is a type of disease that is included in the *Compromised Health* group. This disease attacks by colonization and overgrowth of algae on live coral tissue with a large number of algae growing. The covered tissue usually dies leaving the skeleton. Algae disturbances can be caused by predation of fish bites because the wounds caused by fish bites will be overgrown by algae [24].

Interference by SD is quite high. It can be seen that the disease caused by this symptom occurs in the southern part of the island, namely station 2 and station 3, with a prevalence of 36.65% and 23.34%, respectively. It is known that there are still sea sand extraction activities around these two locations. Sediment damage is a symptom of coral health disturbance where the coral surface is covered by fine sediment, resulting in tissue loss [57]. In research conducted by [58] on Pramuka Island, this symptom is among the diseases with the highest prevalence. Heavy sediment will cover and clog the feeding structures on coral reefs. Suspended material and high organic matter in water cause photosynthetic light to decrease so that coral reef growth is reduced and even causes death [59, 60].

Coral disease caused by sponges was only found at station 1 with a prevalence of 16.67%. Overgrowing sponge on the coral surface makes a boundary with pale color between coral and

sponge [61] and usually at the peak of the reef [62]. It should be noted that patches of the sponge were mostly overgrowing branching corals, belonging to the Acroporidae species [63].

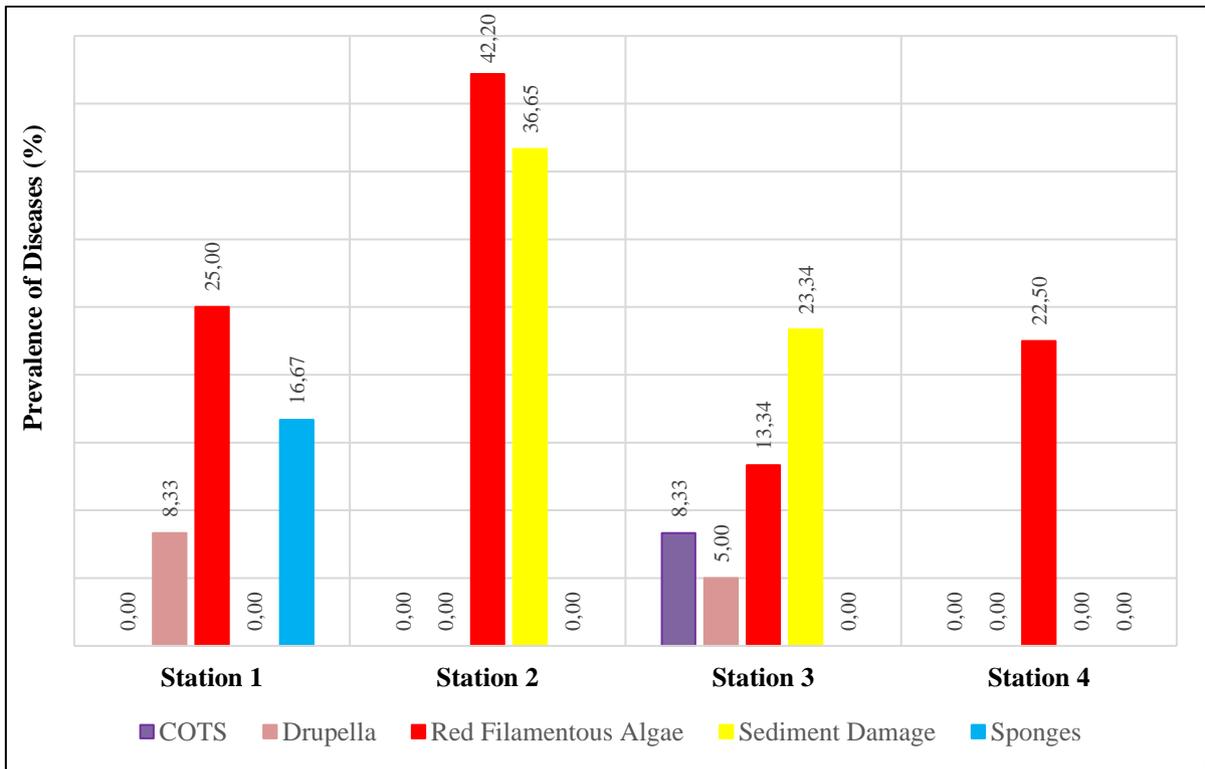


Figure 3. Disease prevalence in *Acropora* corals at each station on Semak Daun Island

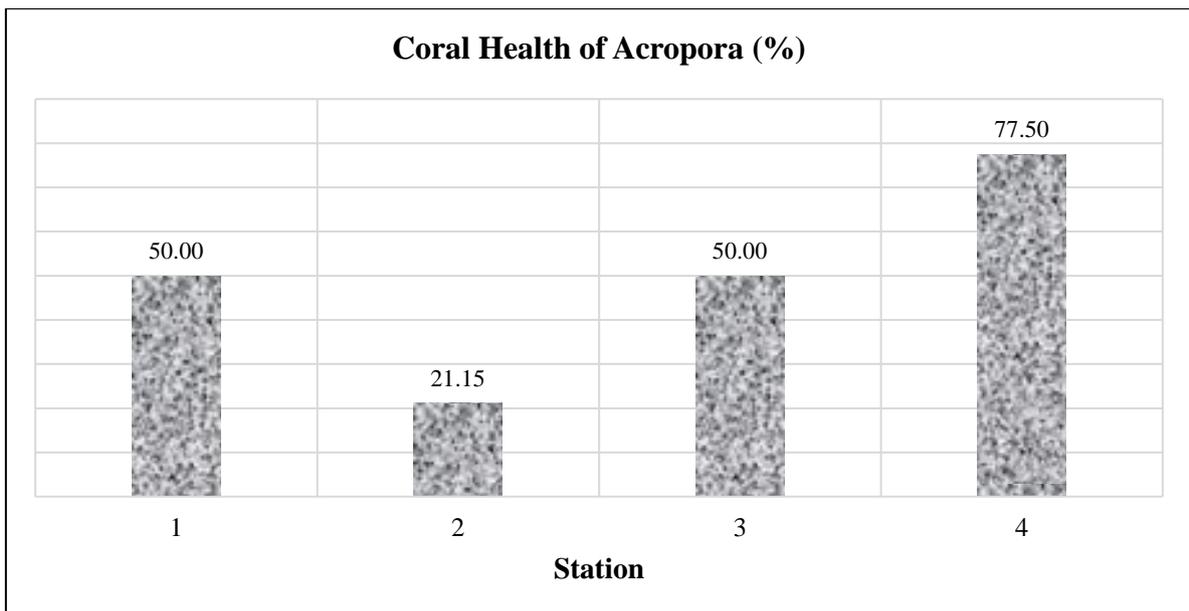


Figure 4. Percentage of the health of *Acropora* corals at each station

Based on the percentage of disease prevalence, a picture can be made related to the health of *Acropora* corals in Semak Daun Island. On the chart in **Figure 4**, it can be seen that the percentage of coral health ranged from 21.15 to 77.50%. The lowest coral health was at station 2, amounting to 21.15%. This shows that the disease attack is much higher than at other stations with the prevalence of disease reaching 78.85% caused by RFA and SD (**Figure 3**). It is known that this station is close to the jetty so that boat traffic is high. This location is also a snorkeling location and is close to aquaculture activities. As a result, water quality decreases with a large number of suspended materials and nutrients. This indicates clearly that at this station the influence of environmental pressure is quite high due to a large number of human activities [10]. Conditions like this are thought to have the potential to reduce coral populations and new impacts on local damage to reefs in the waters of Semak Daun Island. Meanwhile, the location with the highest coral health on Semak Daun Island was at station 4 with a health level of 77.50%. The disturbance experienced by coral colonies was only from RFA with a prevalence of 22.50%.

4. CONCLUSIONS

There are 15 types of *Acropora* corals found in the waters of Semak Daun Island, namely *A. brueggemanni*, *A. carduus*, *A. cervicornis*, *A. digitifera*, *A. echinata*, *A. florida*, *A. formosa*, *A. humilis*, *A. hyacinthus*, *A. millepora*, *A. pulchra*, *A. prostrata*, *A. speciosa*, *A. valenciennesi*, and *A. yongei*. The most common colonies were *A. humilis* with 18 colonies (19.78%). The dominance of *A. humilis* corals is thought to be related to the bottom topography of Semak Daun Island which is shallow water with a reef average of about 90%.

The coral health problems in Semak Daun Island consist of two groups, namely *Tissue loss - Predation* which consists of diseases caused by the *Crown of Thorns Starfish* (COTS) and *Drupella*, while those from the *Compromised Health* group include *Red Filamentous Algae* (RFA), *Sediment Damage* (SD), and *Sponges*. RFA is a health disorder found in all observation stations with a dominant number in almost all of these stations. Sedimentation is also a prominent indication of the cause of coral disease in the study sites. From this description, it is confirmed that *Compromised Health* is the dominant disease prevalence group. The health condition of the *Acropora* corals in the waters of the northern part of Semak Daun Island is better when compared to the eastern, southern to western parts. This condition is thought to be related to the impact of community activities around the area.

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