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# Recruitment of hard coral after coral bleaching in Krueng Raya Water, Aceh Besar

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**Abstract.** Krueng Raya waters is an area that has a distribution of coral reef ecosystems. This study aims to determine the recruitment of hard corals after coral bleaching Krueng Raya waters, Aceh Besar District. This research was conducted in April 2017 in Krueng Raya, Aceh Besar. Data were collected at three observation stations using a systematic sampling method using a 1x1 m quadratic transect. Based on the study results, coral recruitment was obtained from eight families and 13 genera (*Acropora*, *Cetenactis*, *Diploastrea*, *Favia*, *Favites*, *Galaxea*, *Goniastrea*, *Helliopora*, *Leptastrea*, *Montastrea*, *Pavona*, *Pocillopora*, and *Porites*). Where the most abundant coral genus found was from the genus *Pocillopora* and *Porites* (16 coloni/10m<sup>2</sup>). while the station with the highest colony abundance was at station 3 with 28 colonies/10m<sup>2</sup>.

## 1. Introduction

The condition of coral reefs in Indonesia is currently very concerning due to human activities such as industrial waste or pollution, garbage disposal, tourism activities, and caused by natural conditions such as global warming and high sedimentation [1]. Currently, coral reefs are facing an increasing threat due to the impact of global climate change. Global ocean temperatures are estimated to have increased by 0.6°C between the mid-1950s – 1990s. Furthermore, several studies predict an increase in ocean temperatures to reach 1.4-5.8°C in 2100 [2].

The increase in temperature can cause coral bleaching phenomena if there is an anomaly in sea surface temperature 1-2°C above the average summer temperature. Researchers also predict that coral bleaching events will become a more frequent phenomenon in the future [3]. Krueng Raya is located in Mesjid Raya Sub-District, Aceh Besar District, Aceh Province, Indonesia. It has three stations which are areas where there are several distributions of coral reef ecosystems. This area is one of the northern coasts of Aceh, which is affected by coral bleaching, so that it will affect the growth of coral reefs due to global warming.

Information on recruitment of corals after coral bleaching is crucial in restoring coral reef ecosystems in the waters of Krueng Raya, Aceh Besar. However, the spread of coral recruitment after coral bleaching is limited and depends on water conditions and other inhibiting factors. Furthermore, not

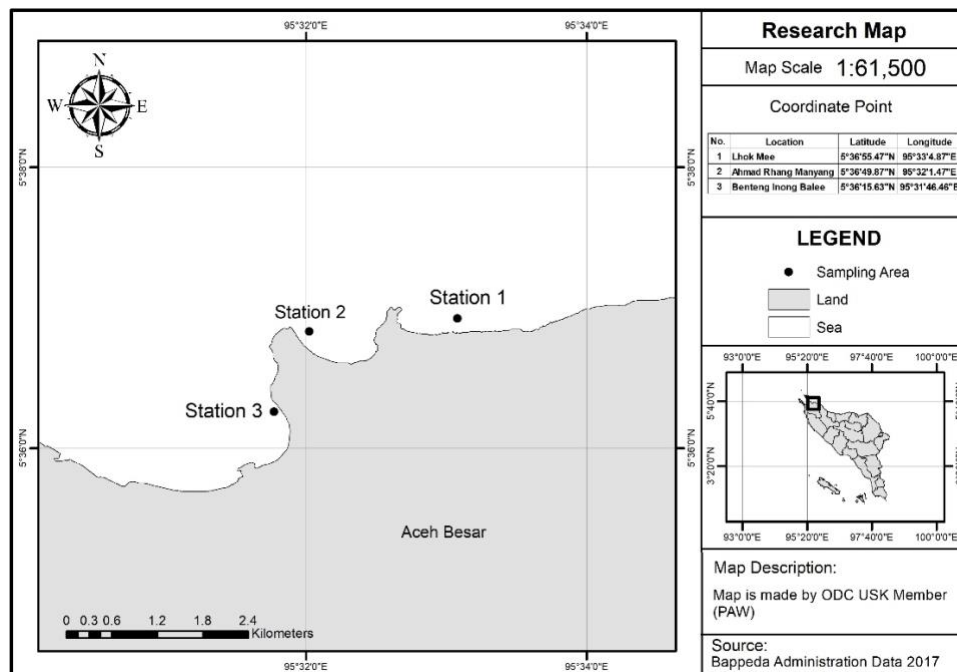


much is known about coral recruitment after coral bleaching, so information about the type and structure of coral recruiting communities in these waters is still lacking. Therefore, this research is vital to see how much impact coral bleaching has on coral reef recruitment in Krung Raya waters, Aceh Besar.

## 2. Material and Methods

### 2.1. Study Site

This research was conducted in April 2017. The location of this research includes three stations in the waters of Krung Raya, Aceh Besar, namely Inong Balee (Station 1), Ahmad Rhamayang (Station 2), and Lhok Mee (Station 3).



**Figure 1.** Map showing the research location

### 2.2. Sampling method

This research was conducted using a systematic sampling method, with quadratic transects placed along with the meter roller with the distance (interval) of each transect squared every 10 m. The quadratic transect that was used is 1x1 m with ten repetitions. A caliper was used to measure the diameter of the coral recruit colony. In each repetition, there was the type and number of recruits growing.

The data taken include the type of coral recruits attached, the diameter, and the number of colonies. Identification of coral recruitment was carried out up to the genus level [4]. It will then be identified based on the Coral Finder manual according to the category of lifeforms. The coral recruits obtained on the transect were recorded for species and counted. The colonies recorded were coral recruit colonies measuring <10 cm [5]. As supporting data, the physical-chemical parameters of the waters that will be carried out include temperature, salinity, pH of the waters.

### 2.3. Data Analysis

The formula can calculate the abundance of the selected community:

$$Xi=ni/A$$

Information:

$Xi$  = Abundance of the  $i$ -th young coral (colonies/m<sup>2</sup>)

$n_i$  = Number of coral recruitments to- $i$  at the observation station (colony)

$A$  = Observation transect area ( $m^2$ )

### 3. Result and Discussion

#### 3.1. Abundance of Coral Recruitment

The research results in Krueng Raya waters, Aceh Besar District, after coral bleaching that coral recruitment found eight families and 13 genera. The coral genera found included: (*Acropora*, *Cetenactis*, *Diploastrea*, *Favia*, *Favites*, *Galaxea*, *Goniastrea*, *Helliopora*, *Leptastrea*, *Montastrea*, *Pavona*, *Pocillopora*, and *Porites*).

**Table 1.** Total genera recruitment of corals (coloni/10m<sup>2</sup>).

No.	Family	Genera	Stasion 1	Stasion 2	Stasion 3	Total
1.	Acroporidae	<i>Acropora</i>	2	4	3	9
2.	Fungidae	<i>Cetenactis</i>	0	0	1	1
		<i>Diploastra</i>	2	2	0	4
3.	Faviidae	<i>Favia</i>	1	2	2	5
		<i>Favites</i>	0	3	0	3
		<i>Goniastrea</i>	2	1	0	3
		<i>Leptastea</i>	1	0	0	1
		<i>Montastrea</i>	0	2	0	2
4.	Oculinidae	<i>Galaxea</i>	2	0	2	4
5.	Helioporidae	<i>Helliopora</i>	0	3	0	3
6.	Agariciidae	<i>Pavona</i>	0	0	1	1
7.	Pocilloporidae	<i>Pocilopora</i>	2	2	12	16
8.	Poritidae	<i>Porites</i>	6	3	7	16
Total			18	22	28	68

From the results of Table 1, coral recruitment found as many as 68 coral colonies. The highest number of coral colonies found in *Pocillopora* and *Porites* was 16 coral colonies. The emergence of *Porites* and *Pocillopora* is most likely because this coral genus can adapt to the environment and substrate factors in Krueng Raya waters, Aceh Besar. The substrate is dominated by rubble and is suitable for the recruitment process of this type of coral. Coral recruitment is closely related to the presence of a good substrate for successful coral recruitment. Substrates with a high level of stability are substrates that have undergone coating algae biofilms or former coral debris [6]. In addition, this coral genus is one of the corals that reproduce by brooding. This type of coral already has septa and zooxanthellae algae that contribute as energy producers for the larvae during the attachment process [7].

In addition, water quality factors also support the growth of this genus where the temperature in these waters has a value ranging from 29°C -30°C, pH has a value of 8, and salinity has a value of 31‰-34‰. Thus, the condition shows that the water quality in these waters is categorized as standard for the sustainability of coral recruitment. In Krueng Raya waters, the least coral recruitment found was *Pavona*, *Leptastrea*, and *Cetenactis* with one colony. At least the recruitment of these three corals is due to several factors. One of the factors that caused these three coral genera to be found little was high waves, where *Pavona*, *Leptastrea*, and *Cetenactis* were only able to live in calm waters [8].

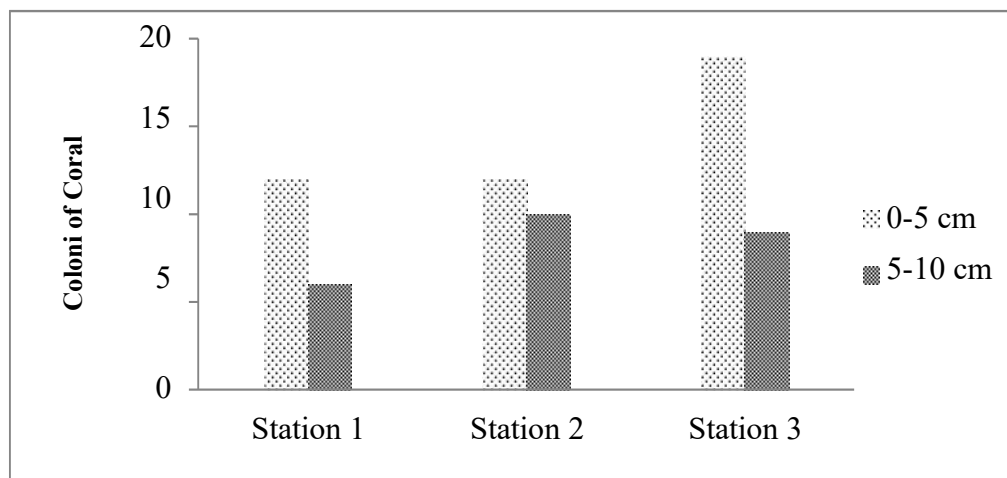
The results showed that there was a significant difference in coral recruitment between the three research sites. The highest genus was *Porites*, with six colonies; this is because this type of coral has a massive form of life and can live in sandy mud contours. Station 1 has a sandy mud substrate and a slightly sloped contour type. The genus that is massive and has large polyps can live on sandy mud substrates and is more resistant to sedimentation in waters, and can even dominate waters [9].

While at Station 2, the most dominant genus was *Acropora*, with four colonies. The high recruitment of corals of this genus is because the substrate is suitable for the attachment of *Acropora* coral larvae without having to choose a suitable substrate for the coral recruitment process. The substrate at station 2 consists of rock and coral fractures (rubble) so that it is suitable for the coral recruitment process. This follows the characteristics of the *Acropora* coral species, where this type of coral *Acropora* can be superior in accelerating the growth and colonization of a new substrate. Besides that, the coral colonization factor also affects the frequency of coral presence [8, 10 ], branching coral species such as *Acropora* and *Pocillopora* also have a 6-8 cm/year growth, allowing this genus to dominate coral recruitment. Thus, it can be explained that the genus *Acropora* has more opportunities to dominate the waters at station 2.

Station 3, the highest number of species of the coral genus, was *Pocillopora* with 12 colonies. The high coral of the *Pocillopora* genus is because this type of coral has a sub-massive form where this life form is easier to grow, and the substrate factor also supports where former dead corals dominate the substrate at station 3. This genus can also live as soon as possible to form new colonies, so this genus is one type of genera that paves the way for coral life [6, 11]. In addition, *Pocillopora* can spawn throughout the year, so its presence in adult coral communities often dominates [12,13].

### 3.2. Coral Recruitment Size

The grouping of coral sizes is divided into sizes 0-5 cm and 5-10 cm. The genus of corals identified by counting and recording the maximum diameter of coral 0-5 cm is a benchmark for the size of young corals (juvenile). Corals whose size is 5-10 cm in the waters are called recruits of mature corals (old recovery) because it has passed the recruitment period [14].



**Figure 2.** Total coloni of coral recruitment sizes.

Based on Figure 2, each station has a different number of coral recruitment sizes. Each station with a size of 0-5 cm has a value, namely Station 1 as many as 12 colonies, Station 2 as many as 12 colonies, and Station 3 as many as 19 colonies. While corals measuring 5-10 cm were found at station 1 as many as 6 colonies, station 2 as many as 10 colonies, and station 3, as many as 9 colonies. At the three stations found the most coral size 0-5 cm, the dominant coral recruitment was the type of coral genus *Acropora* and *Pocillopora*. This indicates that this type of coral grows faster and is easy to live in waters. *Acropora* or branched corals have a 7 cm/year growth while the massive ones are 0.5 cm/year [15,16].

The results of observations of coral recruitment at the three stations have different sizes ranging from 1 cm to 10 cm. According to Abrar et al. [5] stated that what is said to be coral recruitment is coral that is under 10 cm in size. The total number of genus sizes found at the observation location in the waters of Krueng Raya, Aceh Besar is 13 genera, as presented in (Table 2). The most commonly found was

*Porites*, while the size of the genus with a colony diameter of  $6 \geq 10$  cm was most commonly found in *Porites*.

**Table 2.** Size of the genus.

Genus	Size	Plot										Total
		1	2	3	4	5	6	7	8	9	10	
Acropora	< 3 cm	1	0	0	0	1	1	0	2	0	1	6
	3-6 cm	1	0	0	0	0	1	0	0	0	2	
	$6 \leq 10$ cm	0	0	0	0	1	0	0	0	0	1	
Cetenactis	< 3 cm	0	0	0	0	0	0	0	0	0	0	
	3-6 cm	0	1	0	0	0	0	0	0	0	1	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Diploastra	< 3 cm	0	0	1	0	0	0	0	0	0	1	
	3-6 cm	0	0	1	0	0	0	1	0	1	3	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Favia	< 3 cm	1	0	0	0	0	0	0	0	0	1	
	3-6 cm	0	0	0	0	0	0	0	1	1	3	
	$6 \leq 10$ cm	0	1	0	0	0	0	0	0	0	1	
Favites	< 3 cm	0	0	0	0	0	0	0	0	0	0	
	3-6 cm	1	0	0	2	0	0	0	0	0	3	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Galaxea	< 3 cm	0	0	0	0	0	0	0	0	0	0	
	3-6 cm	1	1	0	1	1	0	0	0	0	4	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Goniastrea	< 3 cm	0	0	0	0	0	0	0	0	0	0	
	3-6 cm	0	1	0	0	0	0	0	0	1	2	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	1	1	
Helliopora	< 3 cm	0	0	0	0	0	0	0	0	0	0	
	3-6 cm	0	0	0	1	0	0	0	0	0	1	
	$6 \leq 10$ cm	0	0	0	2	0	0	0	0	0	2	
Leptastrea	< 3 cm	0	0	0	0	0	0	0	0	1	1	
	3-6 cm	0	0	0	0	0	0	0	0	0	0	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Montastrea	< 3 cm	0	0	0	0	0	0	0	0	0	0	
	3-6 cm	1	0	0	1	0	0	0	0	0	2	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Pavona	< 3 cm	0	0	1	0	0	0	0	0	0	1	
	3-6 cm	0	0	0	0	0	0	0	0	0	0	
	$6 \leq 10$ cm	0	0	0	0	0	0	0	0	0	0	
Pocilopora	< 3 cm	1	1	0	0	0	0	0	0	1	4	
	3-6 cm	0	3	1	2	0	0	1	0	1	8	
	$6 \leq 10$ cm	1	0	1	0	0	0	1	0	1	4	
Porites	< 3 cm	0	0	0	2	0	0	0	0	0	2	
	3-6 cm	1	0	2	1	0	1	2	0	1	9	
	$6 \leq 10$ cm	0	2	1	0	0	0	0	1	0	5	
Total		9	9	8	12	3	3	6	4	8	6	68

#### 4. Conclusion

The conclusion that can be drawn from this research is the number of coral recruitment families found in the waters of Krueng Raya, Aceh Besar, as many as eight families, and the genus found as many as 13 genera. The genera found included *Acropora*, *Cetenactis*, *Diploastrea*, *Favia*, *Favites*, *Galaxea*,

*Goniastrea*, *Helliopora*, *Leptastrea*, *Montastrea*, *Pavona*, *Pocillopora*, and *Porites*. The highest recruitment of corals in these waters was *Porites*, and the least was *Pavona*, *Leptastrea*, and *Cetenactis*.

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