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Analyze the Finding and implications on Coral Fish Distribution and Its Relationship in the Lhok Seudu Sea Area, Layeun Village, Aceh Besar

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ABSTRACT

Research on coral fish distribution and coral cover relationship in the Lhok Seudu Sea Area, Layeun Village, Aceh Besar was conducted. This study aimed to determine the diversity of reef fish and the factors that influence coral fish diversity in the Lhok sea area Seudu, Layeun Village, Aceh Besar District. The method used in this research is purposive sampling which is divided into 3 research stations. Data retrieval is done using the Visual Census Technique method. Parameters used are biological, physical and chemical parameters. The results of this study found 44 species of reef fish belonging to the 13 families with the most species found in the family Pomacentridae. The highest abundance was obtained at Lhok Keutapang station as much as 0.58 individuals / m2, while the lowest abundance was obtained at Batee Itam station as much as 0.29 individuals / m2. The highest diversity index was obtained at Lhok Keutapang station with a value of 3.23, while the lowest diversity index was obtained at Batee Itam station with a value of 2.47. The category of reef fish diversity in the Lhok Seudu Sea starts from moderate to high. Dominance index value (C) of reef fish ranged from 0.05 to 0.09, included in the category of small dominance. The relationship between coral cover and reef fish at the research station has a close relationship. The conditions of the physical and chemical factors of the waters in the research location support the survival of reef fish and coral reefs.

ABSTRAK

Telah dilakukan penelitian mengenai sebaran ikan karang dan hubungan tutupan karang di Kawasan Laut Lhok Seudu, Desa Layeun, Aceh Besar. Penelitian ini bertujuan untuk mengetahui keanekaragaman ikan karang dan faktor-faktor yang mempengaruhi keanekaragaman ikan karang di perairan Lhok Seudu Desa Layeun Kabupaten Aceh Besar. Metode yang digunakan dalam penelitian ini adalah purposive sampling yang dibagi menjadi 3 stasiun penelitian. Pengambilan data dilakukan dengan metode Teknik Sensus Visual. Parameter yang digunakan adalah parameter biologi, fisika dan kimia. Hasil penelitian ini menemukan 44 spesies ikan karang yang termasuk dalam 13 famili dengan spesies terbanyak terdapat pada famili Pomacentridae. Kelimpahan tertinggi diperoleh di stasiun Lhok Keutapang sebanyak 0,58 individu/m2, sedangkan kelimpahan terendah diperoleh di stasiun Batee Itam sebanyak 0,29 individu/m2. Indeks keanekaragaman tertinggi diperoleh di stasiun Lhok Keutapang dengan nilai 3,23, sedangkan indeks keanekaragaman terendah diperoleh di stasiun Batee Itam dengan nilai 2,47. Kategori keanekaragaman ikan karang di Laut Lhok Seudu dimulai dari sedang hingga tinggi. Nilai indeks dominasi (C) ikan karang berkisar antara 0,05 hingga 0,09 termasuk dalam kategori dominasi kecil. Hubungan tutupan karang dengan ikan karang di stasiun penelitian mempunyai hubungan yang erat. Kondisi faktor fisik dan kimia perairan di lokasi penelitian mendukung kelangsungan hidup ikan karang dan terumbu karang.

1. INTRODUCTION

Coral fish is one of the marine organisms associated with coral reefs and their entire lives in coral reef ecosystems. Reef fish need to live a habitat for nesting and foraging (Hastuty and Adrianto, 2014). Generally reef fish have low mobility, hence the nest as a place to survive and

shelter is very important for the sustainability of its function in the area that it has maintained (Edrus et al., 2016). All the needs of reef fish have been provided by coral reefs as an ecosystem that has co-evolved together with reef fish. The association of coral fish with coral reefs is very close so that the existence of reef fish in a coral reef area is very fragile when habitat destruction occurs (Hartati & Edrus, 2005). Lhok Seudu Sea is surrounded by community settlements, most of the people work as fishermen. Community activities that often take place around the Lhok Seudu sea are fishing, the fishing harbor, fishing, octopus fishing and others (Yuliani, 2016). These activities are thought to affect the abundance and diversity of reef fish (Taofiqurohman, 2013). This research can be information about coral fish diversity and the factors that influence the diversity of reef fish in the Lhok Seudu marine area.

2. MATERIALS AND METHODS

Time and Location

This research was conducted from September 2014 to January 2015 in the Lhok Seudu sea area of Layeun Village, Leupung District, Aceh Besar District (Figure 1). The tools used are swimming equipment (snorkel, mask, and fins), boat for transportation, refractometer, DO meter, waterproof stationery (2B pencil and mica plywood), meter, GPS, observation table, underwater camera (Canon Ixus 145), Secchi disk and thermometer. The material used is aquadest.

The determination of the station is done by using purposive sampling. Stations are differentiated based on coral reef conditions. Then the sampling location consisted of 3 research stations (Figure 1).

- The Batee Itam Station, located at coordinates 5 ° 21'22.72 "N 95 ° 14'25.86" E. The distance is close to residential areas. Coral reefs in this location suffered a lot of damage, abiotic cover and high dead coral.
- The Bleut Station, located at coordinates 5 ° 21'32.07 "N 95 ° 14'08.77" E. To go to the station using a motorboat, this station has a better coral cover than Station I and still found abiotic cover and a little dead coral.
- The Lhok Keutapang Station, located at coordinates 5 ° 21'37.76 "N 95 ° 13'56.07" E. To go to the station must use a motorboat, this station has a good coral cover and is better than other stations.

Methods for collecting reef fish data using the Visual Census method, using a transect line with a length of 80 meters per research station. Each transect is divided into 4, with a length of 20 meters each and a distance between 5 meters transects that are installed parallel to the coastline at a depth of 3 meters. Observation of reef fish species diversity was carried out by tracing a transect of 400 m2 for each transect slowly for 10 minutes with visibility of 2.5 meters to the left and 2.5 meters to the right from the transect line. For each transect observed, the data recorder traces the transect with a view that the deep sea is on its right. All fish species seen were recorded and counted for the number of individuals.

The research parameters used are the parameters of biology, physics, and chemistry. Biological parameters consist of species abundance, diversity index, dominance index and percentage of coral cover. Physical parameters measured include temperature and brightness. While the chemical parameters measured are salinity, degree of acidity (pH) and dissolved oxygen (DO).

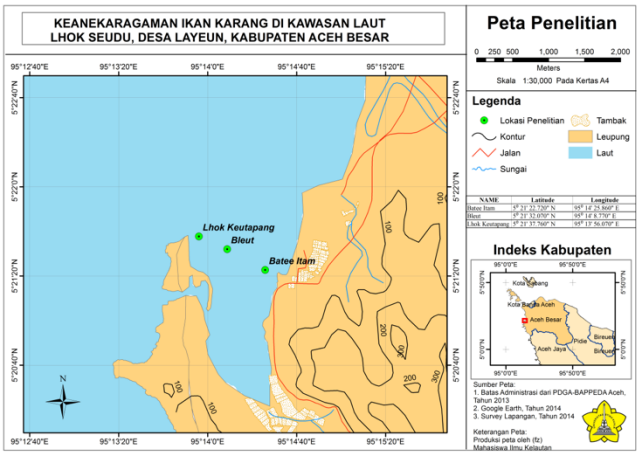

Figure 1. Map of sampling locations in the Lhok Seudu Reefs, Layeun Village, Aceh Besar

Local Distribution, Diversity and dominance Indices

Fish abundance is defined as the number of individuals of large unity fish. The Shannon-Wiener diversity index was utilized to evaluate the diversity of coral fish as follows:

$$H' = -\sum pi.\ln.pi$$

Where, H '= Shannon-Wiener Diversity Index, ni = Number of individuals of all species I, and N = Number of individuals of all species. According to Odum and Barret (2004), the Shannon Wiener diversity index is classified into three levels, low (H<2), moderate (2<H<4), and high (H>4).

The Simpson dominance index was calculated to assess the dominance of the fish species in the community as follow:

$$C = \sum (ni/N)^2$$

Where C = Dominance Index, ni = Number of individuals of the species to-i, and N = a total number of individuals. Type Dominance Index (C) ranges from 0-1, where value tends to 0 is an indication no predominant species, while the value tends to 1 indicates the presence of predominant species in the community (Muchlisin and Siti Azizah, 2009). Correlation analysis is used to determine the relationship between parameters that affect the diversity index (H ') and fish abundance. Pearson correlation analysis (r) is calculated using the Excel Computerized Method.

3. RESULTS AND DISCUSSION

The abundance of reef fish obtained in the Lhok Seudu sea varies. The abundance and composition of reef fish, coral cover, and physical and chemical parameters can be seen in Table 1. The highest abundance was found at Lhok Keutapang station with a value of 0.58 individuals / m2. This is because in the area the condition of coral reefs is better compared to other stations. High live coral cover (88.62%),

Table 1. Abundance and composition of reef fish, coral cover, and physical and chemical parameters in the Lhok Seudu sea area, Village, Layeun, Aceh Besar district.

No	Family/species	Station			Number of individuals
		Batee Itam	Bleut	Lhok Keutapang	
	Acanthuridae				
1	*Acanthurus lineatus*	4	8	6	18
2	*Acanthurus triostegus*	5		4	9
3	*Acanthurus blochii*			3	3
4	*Acanthurus Leucosternun*	3	4	5	12
5	*Paracanthurus phyropherus*	8	4		12
6	*Acanthurus nigrofuscus*	3	5		8
7	*Ctenochaetus striatus*	2		5	7
	Apogonidae				
8	*Cheilodipterus macrodon*		3		3
	Chaetodontidae				
9	*Chaetodon citrinellus*			4	4
10	*Chaetodon collare*	7	4	13	24
11	*Chaetodon falcula*		6		6
12	*Chaetodon meyeri*		9	7	16
13	*Chaetodon trivascialis*	12	5		17
14	*Chaetodon trivasciatus*		17	19	36
15	*Chaetodon triangulum*			3	3
16	*Chaetodon vagavundus*	9		16	25
17	*Heniochus singularius*			3	3
18	*Heniochus pleurotaenia*			6	6
	Haemulidae				
19	*Plectorhinchus vittatus*			5	5
	Labridae				
20	*Gomphosus varius*	4	4	4	12
21	*Halichoeres hotulanus*		2		2
22	*Halichoeres marginatus*			3	3
23	*Labroides dimidiatus*			6	6
	Lutjanidae				
24	*Lutjanus decussatus*			2	2
25	*Ocyurus crysurus*			13	13
	Monachantidae				
26	*Amanses scopas*		3	5	8
27	*Oxymonacanthus longirostris*		2		2
	Nemipteridae				
28	*Scolopsis binileata*			4	4
29	*Scolopsis lineata*			3	3
	Pempheridae				
30	*Pempheris vanicolensis*			8	8
	Pomacentridae				
31	*Abudefduf vaigenensis*		15	20	35
32	*Chrysiptera caeruleolineata*		11		11
33	*Chromis dimidiata*		8	12	20
34	*Chromis atripectoralis*		11		11
35	*Chromis viridis*		12		12
36	*Chromis atripes*	5			5
37	*Neopomacentrus azysron*	13	16	14	43
38	*Plectroglyphidodon dicki*	21		4	25
39	*Plectroglyphidodon lacrymatus*	13			13
40	*Pomacentrus moluccensis*			8	8
	Scariadae				
41	*Chlorurus sordidus*			3	3
	Serranidae				
42	*Cephalopholis argus*	3		11	14
43	*Epinephelus quoyanus*	5	8		13
	Zanclidae				
44	*Zanclus cornutus*		6	12	18
	Number of individuals / stations	117	163	231	511
	Fish Abundance (individual / m2)	0,29	0,41	0,58	
	Number of Species (S)	16	22	31	44
	Diversity Index (H ')	2,47	2,92	3,23	
	Dominance index (C)	0,09	0,06	0,05	
	Live Coral Cover (%)	59,66	76,10	88,62	
	Dead Coral Cover (%)	13,45	5,62	7,07	
	Abiotic Cover (%)	26,89	18,27	4,31	
	Temperature (°C)	30	30	29	
	pH	8,1	8,2	7,9	
	DO (mg/l)	7,5	7,7	7,5	
	Salinity (ppt)	33,1	33	32,6	
	Brightness (m)	>3	>3	>3	

where this condition is very beneficial for reef fish due to the availability of places for the survival of reef fish such as shelter, foraging, and spawning. Community activities also rarely take place in this area, because the location of the station is far from the settlement and to reach it must use a boat. The physical chemistry parameters of the waters in the study location are still in the optimal range for reef fish.

The lowest abundance was found at Batee Itam station with a value of 0.29 individuals / m2. This is presumably because this area has a low coral cover than other stations (59.66%). Its location is close to residential areas so that community activities often take place in this area. This is thought to affect the physical condition of the aquatic environment that affects coral reefs so that the coral cover in this area is low and coral fish abundance decreases.

The results of the study also reported that fish diversity has a positive relationship with the diversity of coral reefs (Ilyas et al., 2017; Yanuar and Aunurohim, 2015; Harahap et al., 2019). Diversity is also related to the physical chemistry parameters of the waters (Putra and Widyorini, 2015). Fish communities tend to be negatively correlated with the sand substrate (Luckhurst and Luchhurst, 1978). Fish density is also influenced by the presence of predators (Hackradt et al., 2020), conservation areas (McClure et al., 2020).

Coral Fish Species in the Lhok Seudu Sea

Species of reef fish with the highest number of individuals were found in the Lhok Seudu sea, from the species *Plectroglyphidodon dicki* with a total of 21 individuals at Batee Itam station. *Chaetodon trivasciatus* with 17 individuals at Bleut station and *Abudefduf vaigenensis* species totaling 20 individuals at Lhok Keutapang station. The species of reef fish that have the most individuals at each station can be seen in Figure 2.

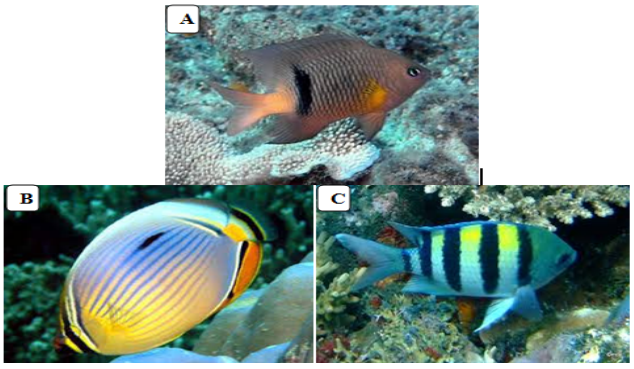

Figure 2. Coral fish species that have the most individuals in each station. (a). *Plectroglyphidodon dicki*; (b) *Chaetodon trivasciatus*; and (c) *Abudefduf vaigenensis*

The high number of individuals of the Plectroglyphidodon species in the Batee Itam station allegedly due to the availability of food and habitat suitability at the study site for these fish. This fish is an omnivorous fish that usually eats benthic algae, small fish and zoobenthos. The condition of the substrate at this station is also dominated by broken coral overgrown with algae. The high number of individuals of the Chaetodon trivasciatus (kepe-kepe) species at Bleut station is because this fish is the fish that is most closely associated with corals. After all, these fish eat coral polyps.

Kepe-kepe fish live in areas of fertile coral cover, this is because kepe-kepe fish generally eat coral polyps (Rizka et al., 2018; Okemwa et al., 2019; Emslie and Cheal, 2018), although there are other types eating combinations with small invertebrate animals at the bottom of waters and algae (Nur, 2018; Santos and Sikkel, 2019).

The high number of individuals of the Abudefduf vaigiensis species found at Lhok Keutapang Station is presumably due to habitat suitability and the availability of food for these fish at the station. Abudefduf vaigiensis is often found on flat reefs and coral slopes. These fish are also found in groups and belong to the omnivorous fish group (Wibowo et al., 2018). The parameters of water physics chemistry in all research stations are still in the optimal range for reef fish (Brown et al., 2017).

Composition of the Coral Fish Family in the Lhok Seudu Sea

The composition of reef fish found in the Lhok Seudu Sea can be seen in Figure 3. The composition of the largest reef fish found in the Lhok Seudu Sea is from the family Pomacentridae, ranging from 25% to 45%. The Chaetodontidae family ranges from 24% to 31%. Family Acanthuridae 10% to 21%. Other fish families have the lowest composition at the research station ranging from 1% to 8%. The reef fish that had the largest composition found during the study in the Lhok Seudu sea was from the family Pomacentridae (38.33%). This is thought to have a close relationship with the nature of life and the morphology of the fish. This reef fish family is often seen clustered and found at each research station even though the number of species found at each station is different.

The second-largest composition of reef fish found in the Lhok Seudu sea is from the family Chaetodontidae (26.67%). The Chaetodontidae family has a close relationship with the condition of coral reefs. This fish is an indicator of coral health because the food from this fish is coral polyps. The presence of the Chaetodontidae family indicates the healthy condition of the coral reefs at the study site. According to Romimohtarto and Juwana (2001), butterflyfish (Family Chaetodontidae) can be used as indicators of coral reefs, the main food is coral polyps and this family is often present when there are healthy corals.

The third-largest composition of reef fish found in the Lhok Seudu sea is from the family Acanthuridae (14.66%). Species from this family were found at all research stations. This is thought to be related to the diet of this family following environmental conditions at each research station. Acanthuridae family is looking for food during the day and most of this family are herbivores by eating benthic algae, and some others are eating zooplankton and detritus.

Other reef fish families are very small in the Lhok Seudu Sea, such as the reef fish from the Family Apongidae, Haemulidae, Labridae, Lutjanidae, Serranidae, Monachantidae, Nemipteridae, Pempheridae, Scaridae and Zanclidae. This is presumably because there is a close relationship with the habits of life of most of the fish from these families that is solitary, not clustered and generally has a large body size. According to the view of its function, most of the fish from these families function as ornamental fish and target fish that are caught by many local people (Luthfi et al., 2016; Arifin et al., 2017). Fish from these families are

mostly active at night (nocturnal) (Syakur and Wiadnyana, 2017), during the day hiding in coral reefs and some who have a small body will fall prey to larger fish such as fish from the family Serranidae (Astuti and Kamal, 2016). Some of them function as target fish such as the Lutjanidae Family which are used by the community as consumption fish (Prihatiningsih et al., 2017; Sumiono et al., 2017)

Coral Fish Community Structure

The condition of the structure of reef fish communities at the research station can be determined from the value of the diversity index (H ') and the dominance index (C). The diversity index and dominance index of reef fish can be seen in Table 2. The observations showed that the highest diversity index of reef fish in the Lhok Seudu sea was found at Lhok Keutapang station with a value of H '= 3.23 because the number of species and number of individual reef fish obtained at this station was evenly distributed. This is also because live coral cover at the research station is good and suitable for the survival of reef fish, it was also said by Nugraha et al., (2019) that there is a relationship between the percentage of live coral cover with the index value of fish species diversity and abundance. The higher the percentage value of live coral cover, the higher the index value of species diversity and fish abundance.

Table 2. Diversity Index (H '), Dominance Index (C).

No	Research Station	H' Index/ Category	C Index/ Category
1	Station Batee Itam	2.47/ medium	0.09/ low
2	Station Bleut	2.92/ medium	0,06/ low
3	Station Lhok Keutapang	3.23/ medium	0.05/ low

The lowest diversity index was obtained at Batee Itam station with a value of H '= 2.47. This value is lower compared to other stations because the number of species and the number of individuals found is uneven. This is because the live coral cover at the study site is low when compared to other stations. Community activities, such as fishermen who fish in the coral reef area, catching octopus in the area of coral reefs will damage coral fish habitat which can affect the diversity index of reef fish in the Lhok Seudu sea.

Coral cover and community activities can affect reef fish diversity (Dala-Corte et al., 2019). The effect of fishing activity on the decline in the total wealth of fish species (Beguinot, 2019; Lefcheck et al., 2019). The existence of cages and ponds in a location also affects the structure and diversity of fish communities (Amadi et al., 2019). Deforestation, rubbish, and wastewater from land will change the structure of reef fish communities (Turgeon et al., 2019; Elguata et al., 2019)

The dominance index of reef fish obtained in the Lhok Seudu sea during the study was included in the low dominance category because the results were close to zero. This low dominance means that no reef fish species or individuals dominate certain fish communities at the research station. This is supported by Yui et al., (2019) which states that the availability of food for reef fish in their habitat greatly affects the level of competition between fellow species of fish and also of different types of fish. While the low dominance index value is thought to be due to the factor of abundant food availability for reef fish (Viviani et al., 2019). Reef fish can grow and live well, therefore the dominance of reef fishes is low (McClanahan, 2019).

Percentage of Coral Cover

The percentage of coral cover between stations in the Lhok Seudu sea area, Layeun, Aceh Besar has different values. This percentage is used to find out what percentage of coral cover is at each research station. The percentage of live coral cover, dead coral cover and abiotic cover can be seen in Figure 4.

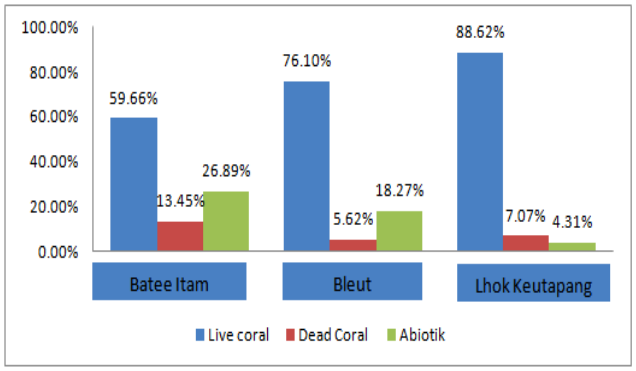

Figure 4. Percentage of live coral cover, dead coral cover and abiotic cover at the research station

Based on the data obtained from the results of the study it can be explained that the highest live hard coral cover is at Lhok Keutapang Station which is 88.62% (Very good). This is because this area still has natural habitats, community activities rarely take place in this area, and the waters are also clear, so that sunlight can penetrate directly to the bottom of the water. This condition is very suitable for the growth of coral reefs. This is also following the research of Ahmad et al., (2019) which said that the high percentage of live coral cover is suspected because the area has an unspoiled habitat. Clear waters (Tribot et al., 2019) and sufficient light intensity (Hess et al., 2019). This condition is needed for good coral reef growth.

The lowest percentage of live coral cover from other stations was found at Batee Itam station, which was 59.66% (Good). It is suspected that the damage to coral reefs in this region is higher than in other stations, both naturally and caused by human activities. Besides that, the area also has sloping and calm waters and is close to residential areas. This area is often used by people and tourists to swim, fish, snorkel, catch octopus and park motorboats which are thought to affect the physical-chemical conditions of the waters. This was also said by Nasir (2012), the low percentage of live coral cover was due to a large amount of sand. Also, the area is often used as a boat landing for tourists who want to snorkel (diving) so that it can disrupt coral recruitment.

Relationship of Coral Cover with Coral Fish

To see the relationship between coral cover and reef fish, quadratic regression can be used. Seeing the relationship of live coral with an abundance of reef fish can be seen in Figure 5. Correlation analysis shows that there is a high positive relationship between live coral and the

amount of coral abundance. The influence of the percentage of live coral cover on the abundance of reef fish in Lhok Seudu has a positive effect. The greater the percentage of coral cover the higher the coral abundance (Pearson Correlation r = 0.768).

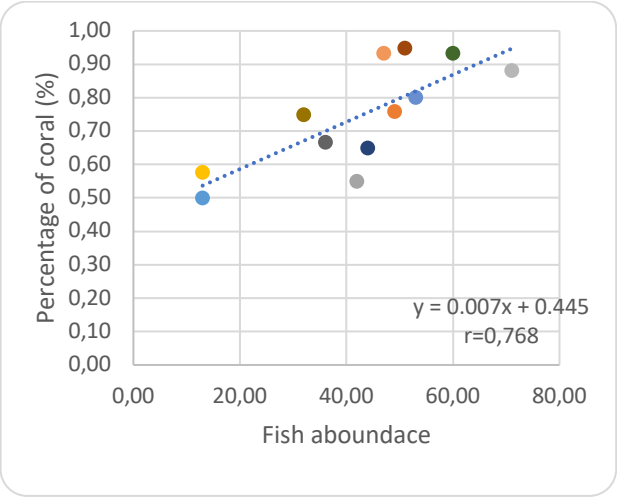

Figure 5. Relationship between abundance of fish and percentage of live coral cover

The abundance of fish Chaetodontidae, Pomacentridae, Labridae, Scaridae. Acanthuridae and Gobiidae rise together to increase live coral cover (Bell and Galzin, 1984). Habitat complexity also influences fish abundance (Roberts and Ormond, 1987; Gouhier and Pillai, 2019)

The relationship of abiotic cover with coral fish abundance can be seen in Figure 6. Correlation analysis shows that there is a negative relationship between abiotic cover and the amount of fish abundance. The effect of the percentage of abiotic substrate cover on the abundance of reef fish in Lhok Seudu has a negative effect. The greater the percentage of abiotic cover, the coral abundance decreases (Pearson Correlation r = -0.793).

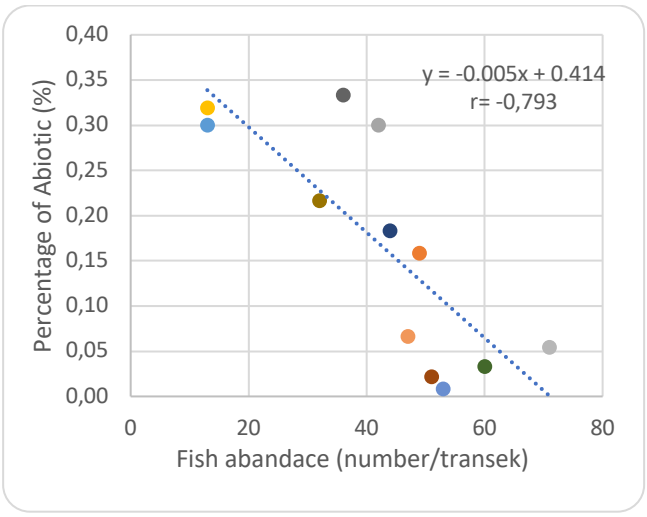

Figure 6. Relationship between Fish Abundance and Abiotic Cover Percentage

Coral mortality can cause an increase in abiotic covers such as algae, dead coral, coral fragments and sand (Masucci et al., 2019), causing a reduction in coral fish abundance. In addition to increasing substrate cover, the presence of reef fish predators also has the potential to reduce fish abundance (South et al., 2019; Herlily et al., 2020).

Correlation analysis between coral cover and diversity index also shows that there is a close relationship between coral fish and coral reefs. The diversity of reef fish and abundance of reef fish will increase with increasing live coral cover. While the diversity of reef fish and coral fish abundance will decrease along with the increase in abiotic cover.

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Aquatic Environment Conditions at the Research Location

The results showed that the condition of the aquatic environment can affect the life of reef fish. The results of water quality measurements can be seen in Table 3. Seawater temperature obtained at the study site ranged from 29-30 ° C. Based on Romimohtarto (1985) said that the optimum temperature for the survival of seawater fish is 25-32 ° C. As for the optimal temperature of coral reefs according to (Tomascik et al. 1997), corals generally require warm water temperatures, which is between 25-32 ° C. The pH range obtained is from 7.9 to 8.2. Based on KLH (2004) that the pH needed by marine biota is 6.5-8.7. Then Stark and Langdon (2019) also said that the optimum pH would support the life of coral biota.

Seawater salinity obtained at the study site ranged from 33 to 32.6 ppt. According to Sunyoto and Mustahal (2002), the salinity of seawater suitable for seawater fish ranges from 30-35 ppt. Then Nybakken (1992) said that good salinity conditions for coral animal growth ranged from 32-35 ppt. The DO range obtained ranged from 7.5-7.7 mg / l. Based on KLH (2004), that the DO quality standard for seawater for the survival of marine biota is> 6. The condition of the physical and chemical parameters of the waters obtained in the Lhok Seudu marine area is still in the optimal range and is suitable for the survival of coral and reef fish coral.

Table 3. Aquatic Physics and Chemical Parameters

Station	Temperature (°C)	pH	DO (mg/l)	Salinity (ppt)	Brightness (m)
Batee Itam	30	8,1	7,5	33,1	>3
Bleut	30	8,2	7,7	33	>3
Lhok Keutapang	29	7,9	7,5	32,6	>3
Optimal Conditions for Coral Fish	25-32	6,5-8,7	>6	30-35	Bright
Optimal Conditions of Coral Reefs	25-32	6,5-8,5	>6	30-35	Bright

4. CONCLUSIONS

The results of the study in the Lhok Seudu Sea found 511 individual fish consisting of 44 species belonging to 13 families. The highest abundance of reef fish was found at Lhok Keutapang Station (0.58 individuals / m2) and the lowest abundance was found at Batee Itam Station (0.29 individual / m2). The highest diversity index is found in Lhok Keutapang station H '= 3.23, while the lowest diversity index is found in the Bate Itam station H' = 2.47. The dominance index (C) value of reef fish ranges from 0.05 to 0.09, included in the small dominance. The condition of physical and chemical factors in the waters of the study site supports the survival of coral fish and coral reefs. Abundance and diversity of reef fishes are closely related to the percentage of live coral cover.

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