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## Reef fish community structure and its association with Lifeform coral in the core zone of the Anambas islands Marine Tourism Park (MTP)

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### Abstract

Reef fish are one of the biotas that live in coral reef ecosystems, and their lives depend on the condition of coral reefs. Reef fish communities have a close relationship with coral reefs as their habitat. Collecting data on reef fish and coral growth forms using the underwater visual census (UVS) method and methods point intercept transect (PIT). The results of the identification of coral growth forms found 10 growth forms. The most abundant group of fish in the core zone waters of the Anambas Islands was the omnivorous group of fish found as many as 14,924 ind/250m<sup>2</sup>. The uniformity index value is obtained by the criteria for a stable uniformity index. The cluster analysis results showed that the similarity index of 43% was found in three groups of entities. The correspondence analysis results found three groupings of reef fish based on their association with coral growth forms.

**Keywords:** Anambas islands, association with Lifeform Coral, core zone, reef fish

### 1. Introduction

Anambas Islands Regency is the outermost district which is composed of a group of small islands. In general, potential damage to habitat can occur on small islands, for example, damage to coral reef ecosystems. (Marasabessy *et al.* 2018) [26]. Management of marine conservation areas is needed to maintain the sustainability of coral reef ecosystems. Anambas Islands Regency has a Marine Tourism Park (MTP), which was established based on the Decree of the Minister of Marine Affairs and Fisheries Number 37 of 2014 concerning National Water Conservation Areas. One of the ecological potentials in the Anambas Islands MTP is the coral reef ecosystem and the various types of reef fish that live in it (LKKPN Pekanbaru 2014) [22].

Ecosystems in coastal areas and scattered in small islands are coral reefs, coral reefs function as a *spawning ground*, *nursery ground*, and *feeding ground* for most fish (Bengen 2013) [6]. Reef fish are one of the biotas that live in coral reef ecosystems, and their lives are highly dependent on the condition of coral reefs (Rodonuwu *et al.* 2013) [37]. The biophysical roles of coral reef ecosystems are very diverse, including a place to live, shelter, foraging, and breeding for various marine biota, including reef fish (Mardasin *et al.* 2011) [27]. Coral reef ecosystems can lead to high fishery productivity (reef fish) with high economic value (Bengen 2013) [5].

Reef fish communities have a close relationship with coral reefs as their habitat. It is essential to know the existence of reef fish communities on a reef, seeing their role and function naturally (Rondonuwu 2014) [38]. The concept of community plays a role in analyzing the condition of an aquatic environment. The composition and characteristics of the community are good indicators to show environmental conditions and the ecological status of fish communities related to ecosystem stability (Ungaro *et al.* 1998) [42].

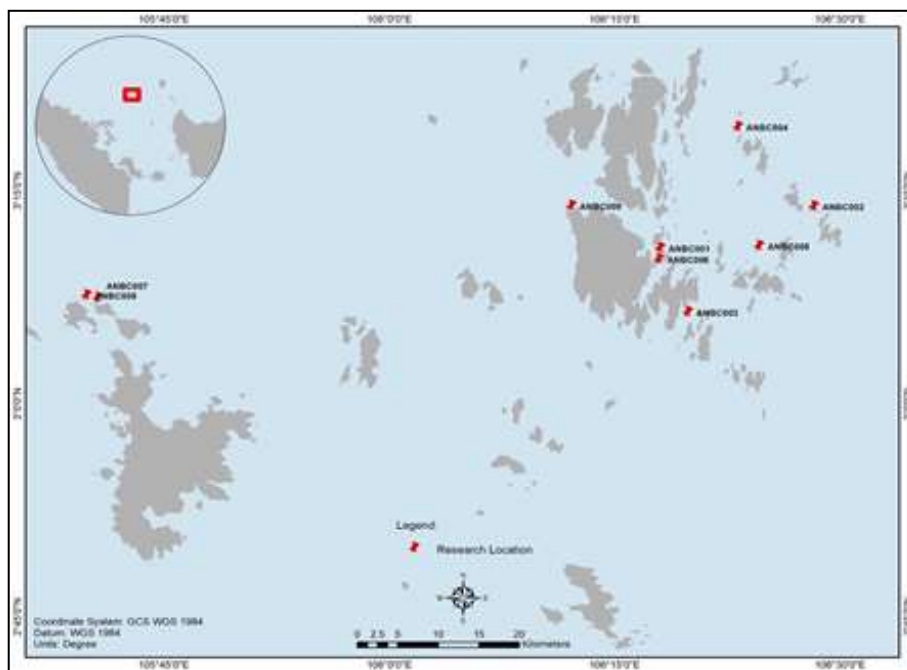
Reef fish are one of the groups of animals associated with coral reefs, and their presence is conspicuous and found in various micro-habitats on coral reefs (Muniah *et al.* 2019) [28]. Reef fish live permanently and forage for food in coral reef areas so that if coral reefs are damaged or destroyed, reef fish will also lose their habitat (Rani *et al.* 2010) [36]. The form of coral reef growth is closely related to the reef fish that inhabit it. The abundance of reef fish is highly dependent on the condition of coral reefs and the complexity of the existing habitats in the ecosystem (Allen *et al.* 2003) [2].

## 2. Materials and Methods

### 2.1 Time and Place

This research will be conducted in August 2020 in the Anambas Archipelago MTP Core Zone (Figure 1). Locations

The selected location is the Anambas Islands MTP Core Zone. The core zone is an area that has a functional purpose of improving habitat and reef fish stocks, with regulations prohibiting harvesting activities.



**Fig 1:** Sampling location in the core MTP zone of the Anambas Islands.

### 2.2 Data Collection Methods Data

The collection of reef fish species uses the method *visual census* (Dartnall and Jones 1986 in Rembet *et al.* 2011) [7, 35], a fast, accurate, effective, and environmentally friendly method. Benchmarks in data collection (following the technique Line Intercept Transect- LIT UNEP 1993) [43]. The data obtained are the number of species and the number of individuals of each species of fish. Reef fishes found inside the transect area were identified to the species level based on Kuitert and Tonozuka (2001) [20], Allen *et al.* (2003) [2] and Subhan *et al.* (2017) [40].

The Point intercept transect method (PIT) method measures sessile benthic cover, algae, and substrate type (hard coral, soft coral, sponge, and macroalgae) because it is fast, efficient, and provides a reasonable estimate of benthic community cover (Hill and Wilkinson 2004) [16]. Reef fish data were collected then analyzed to find data on species diversity, density (abundance). Furthermore, reef fish are grouped based on major fish, target fish, and indicator fish groups. The collection of reef fish data was followed by identifying reef fish groups based on trophic levels. It was found that four groups of reef fish were herbivores, carnivores, planktivores, and omnivores (Wibowo *et al.* 2016) [44].

Percentage cover calculates the percentage cover of each category of live coral and another benthic biota and abiotic category. The benthos categories calculated were LC: live coral (AC: Acropora and NA: Non-Acropora), DC: Dead coral, DCA: Dead coral with algae covering, SC: Soft coral, SP: Sponge, OT: Other fauna, R: Rubble, S: Sand, SI: Silt, RK: Rock. The percentage of cover for each category of coral reef growth forms was calculated using the formula according to English *et al.* (1997) [10]. The criteria for assessing the condition of coral reefs are based on the percentage of live coral cover (Kep. MENLH No. 4 2001) [19].

### 2.3 Analysis of Coral Fish Diversity and Its Association with Life form Coral

Collected reef fish data were composition of reef fish species is grouped according to the classification of reef fish (major, indicator, and target). Reef fish communities have a close relationship with coral reefs as their habitat. The form of coral reef growth is closely related to the reef fish that inhabit it. The association of reef fish with coral reef growth forms in the Anambas Islands TWP core zone can be analyzed using correspondent analysis. The correspondent analysis is a multivariable analysis based on the row I matrix as the fish families found and column J matrix as coral growth forms in the Anambas Islands MTP core zone. Measurements to characterize the similarity are carried out by measuring the chi-square distance (Bengen 2000) [4].

The level of grouping based on the similarity of reef fish species was used by the Bray-Curtis Index (Krebs 1989) [21]. The measurement of the Bray-Curtis similarity index can use the formula for the complement of the Bray-Curtis measurement index, which is 1.0-B (Krebs 1989) [21]. Data processing using software *Primer-e7*.

## 3. Results and Discussion

### 3.1 Composition of Growth Form and Percentage of Coral Reef Cover Coral reef

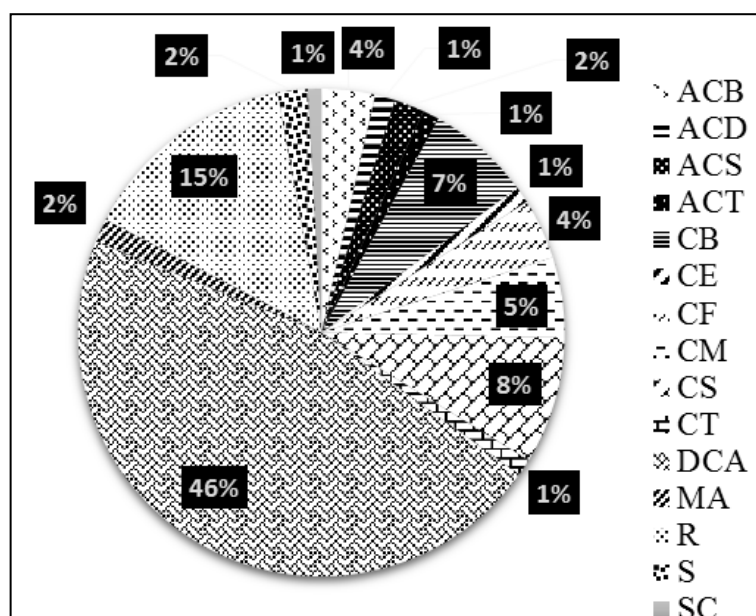
Data collection at all observation stations was carried out in the core zone of the Anambas Islands MTP at a depth of 6-9.7 meters. Based on direct observations at the sampling site, it can be seen that, in general, the coral reefs in the Anambas Archipelago's MTP core zone grow from the reef flat to the edge. The identification of coral growth forms found 10 growth forms, consisting of two groups, namely Acropora and Non-Acropora, and Dead Sceleractinia, Algae, Abiotic and Other Fauna were found at the research station (Table 1).

**Table 1:** Percentage of Coral Reef Cover.

Station	Category					Category Conditions
	Hard Corals	Dead Sceleractinia	Algae	Other Fauna	Abiotic	
ANBC001	10	76	14	0	0	Broken
ANBC002	58	36	0	0	6	Good
ANBC003	20	50	0	8	22	Broken
ANBC004	42	16	0	0	42	Moderate
ANBC005	54	16	0	0	30	Good
ANBC006	22	66	0	0	12	Broken
ANBC007	60	28	0	0	12	Good
ANBC008	26	54	0	0	20	Broken
ANBC009	22	74	0	0	4	Broken
<b>Percent Total (%)</b>	<b>34,89</b>	<b>46,22</b>	<b>1,56</b>	<b>0,89</b>	<b>16,44</b>	<b>Moderate</b>

The percentage of live coral cover found in the core zone of Anambas Island ranged from 10-60%, with an average live coral cover of 34.89%, which was categorized in moderate condition (Kep. MENLH No. 4 2001) [19]. Table 1 shows the highest percentage of live coral cover at stations ANBC 002 with a percentage of 58%, ANBC 005 with a percentage of 54%, and ANBC 007 with a percentage of 60%. Based on the percentage of live coral cover, research stations ANBC 002, ANBC 005, and ANBC 007 can be classified in the excellent

category. This good condition of coral reefs impacts the community in terms of fishing (Zamani 2015) [45]. The lowest percentage of live coral cover was found at the research station ANBC 001, with a percentage of 10% classified as damaged. The damaged category indicates that the coral reef ecosystem is in a state of distress or unfavorable condition. Coral reef ecosystems require more intensive management efforts to maintain the sustainability of coral reef ecosystems (Manembu *et al.* 2012) [25].



**Fig 2:** Percentage of coral reef growth forms in the core zone.

Figure 2 shows the highest percentage of hard coral growth forms in the core zone of the Anambas Islands MTP, namely CS with a coral cover percentage of 8%, while the lowest percentage of hard coral growth forms is CT with a coral cover percentage of 1%.

The growth forms most often found at each station were CB and CM growth forms. The growth forms of CB and CM are forms of growth that are commonly found in the core zone of the Anambas Islands. Massive corals mostly grow on the outer reefs with flowing waters, while branching corals are abundant along the edge of the reef and the top of the slopes,

especially in protected or semi open waters (Johan 2003) [18].

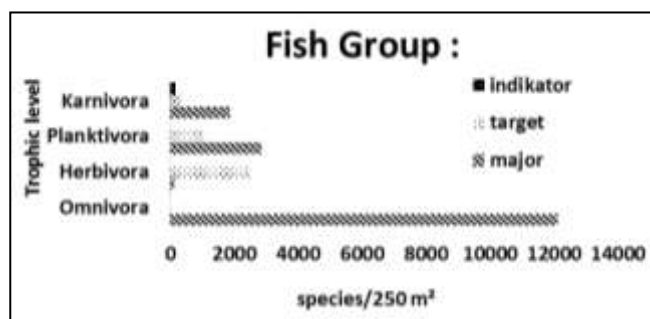
**3.2 Abundance, Trophic Levels of Reef Fish Based on Abundance of Coral Fish Groups**

The observations carried out in the waters of the MTP core zone of the Anambas Islands found 177 species of reef fish belonging to 33 families (Table 2). The composition of reef fish can be grouped into three groups, namely major fish groups, target fish groups, and indicator fish groups (English *et al.* 1997) [10].

**Table 2:** Total number reef fish subdistrict in MTP the Anambas Islands

Family	Research Station								
	ANBC 001	ANBC 002	ANBC 003	ANBC 004	ANBC 005	ANBC 006	ANBC 007	ANBC 008	ANBC 009
Acanthuridae	0	6	0	3	0	0	0	0	1
Apogonidae	14	5	20	27	7	36	0	14	19
Aulostomidae	0	0	0	0	0	0	0	0	1
Balistidae	0	1	0	0	0	0	0	0	0
Caesionidae	0	63	74	37	8	473	63	0	255
Carangidae	0	3	4	0	0	0	0	0	5
Chaetodontidae	6	23	29	20	40	24	6	4	32
Chanidae	0	0	0	0	0	0	0	3	0
Engraulidae	0	0	0	0	0	0	0	0	72
Ephippidae	0	0	0	0	0	0	0	2	1
Gerreidae	0	0	0	0	0	0	0	0	4
Gobiidae	0	0	5	0	0	0	0	0	0
Grammistidae	0	0	0	0	0	0	0	0	2
Haemulidae	0	2	0	0	0	0	0	0	4
Holocentridae	0	0	4	0	0	0	0	0	10
Labridae	38	166	291	259	383	168	142	168	104
Lethrinidae	0	0	10	0	9	0	0	0	0
Lutjanidae	4	18	26	8	6	21	2	3	11
Monacanthidae	8	0	0	0	0	0	0	0	0
Mullidae	0	2	9	0	0	0	0	0	4
Muraenidae	0	0	0	1	0	0	0	3	0
Nemipteridae	0	2	25	17	36	19	0	15	16
Pomacanthidae	15	4	28	10	15	10	16	10	45
Pomacentridae	544	1101	1819	2149	3040	2392	1427	926	1464
Pseudochromidae	2	0	0	0	0	2	0	0	1
Ptereleotrididae	0	0	0	11	0	2	0	5	0
Scaridae	121	74	310	431	253	166	88	170	172
Scorpaenidae	0	0	0	0	0	0	0	0	1
Serranidae	1	4	6	5	9	3	6	2	8
Siganidae	0	10	11	672	10	12	5	12	2
Synodontidae	0	3	0	2	4	0	0	0	0
Tetraodontidae	1	0	0	0	0	0	0	0	1
Zanclidae	0	0	0	0	0	0	0	0	17

The composition of the most diverse fish families observed in the Anambas Islands MTP is presented in Table 2. The most abundant fish family in the Anambas Islands MTP is the Pomacentridae family, followed by the Scaridae. Overall, the most diverse families in the reef community were Pomacentridae and Labridae (Madduppa *et al.* 2013) [24]. Based on the trophic levels, reef fish have four trophic levels, namely omnivores, herbivores, planktivores, and carnivores.



**Fig 3:** Reef fish trophic levels based on the abundance of reef fish groups.

Figure 3 shows the results of observations of the abundance of major fish groups as many as 108 reef fish species from 19 families with an abundance of 16,995 ind/250m<sup>2</sup>. The highest major fish family was dominated by the Labridae, Pomacentridae, Pomacanthidae, and Apogonidae fish family.

Major fish groups are generally found in abundance, both in the number of individuals and types, and territorial. Major fish groups have a trophic level that omnivorous fish groups dominate with an abundance of reef fish species found as much as 12,132 ind/250m<sup>2</sup>. The highest group of omnivorous fish was found from the fish family Pomacentridae. The Pomacentridae family is one of the most common inhabitants of coral reefs and is a key species in coral reef ecosystems (Hixon and Brostoff 1996; Paulangan *et al.* 2019) [17, 33].

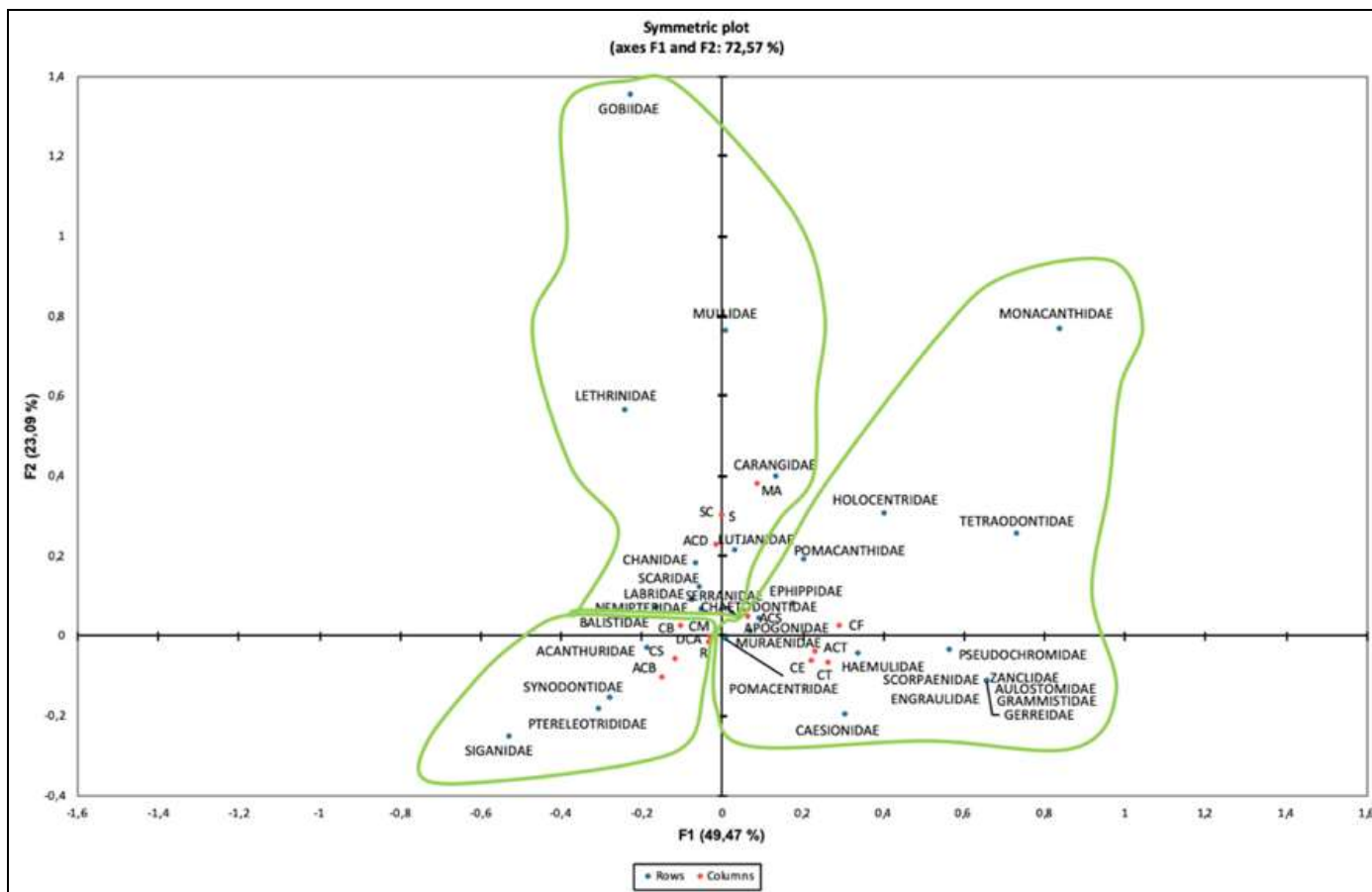
The abundance of target fish groups was 61 reef fish species from 17 families with an abundance of 3,877 ind/250m<sup>2</sup>. The Caesionidae, Lutjanidae, Nemipteridae, Scaridae, Serranidae, and Siganidae fish families dominated the highest target fish family. Under normal conditions, the target fish group can be found in tropical coral waters as much as 30% of the species that can live on coral reefs (Edrus *et al.* 2013) [8]. The target fish group had a trophic level dominated by 2,499 ind/250m<sup>2</sup> herbivorous fish groups, 1,045 ind/250m<sup>2</sup> planktivorous fish groups, and 333 ind/250m<sup>2</sup> carnivorous fish groups. High pressure on reef fishing indicates a decline in target fish catch groups. The target fish species include the fish families Serranidae, Lutjanidae, Lethrinidae, Nemipteridae, Caesionidae, Siganidae, Haemulidae, Scaridae and Acanthuridae (Paulangan *et al.* 2019) [33].

The abundance of indicator fish groups was 11 reef fish species from the Chaetodontidae family, with an abundance of 184 ind/m<sup>2</sup>. The dominant indicator fish species were *Chaetodon baronessa*, *Chaetodon octofasciatus* and

*Chaetodon lunulatus*. The indicator fish group has a trophic level dominated by carnivorous fish groups with an abundance of reef fish species found as much as 184 ind/m<sup>2</sup>. The existence of Chaetodontidae fish species indicates that the percentage of live coral cover is still in relatively good condition because Chaetodontidae fish species are indicators of coral reef health (Panggabean 2012) [32]. The indicator fish group is sporadic, at least one species of the indicator fish group is found in each research station.

### 3.3 Coral Fish Association with Lifeform Coral Reef

Results of correspondence analysis were conducted by looking at the relationship between the two main groups of reef fish families and coral reef growth forms, which are presented on two axes, namely the F1 axis and the F2 axis, with total diversity of 72.57%. The correspondence analysis results found three groupings of reef fish based on their association with coral growth forms.



**Fig 5:** Correspondence analysis based on the association of reef fish families with coral growth forms.

Figure 5 shows the results of the correspondent analysis carried out on three groups of reef fish based on their association with coral growth forms. Group 1 consists of Apogonidae, Aulostomidae, Caesionidae, Engraulidae, Aphippidae, Gerreidae, Grammistidae, Haemulidae, Holocentridae, Monacanthidae, Muraenidae, Pomacanthidae, Pomacentridae, Pseudochromidae, Scorpaenidae, Tetraodontidae and Zanclidae, growth forms closely associated with ACS, CE, CF, and CT. The reef fish distribution is also influenced by the shape of coral reef growth, such as the Caesionidae fish, which prefer massive folios and submassive corals (Harsindhi *et al.* 2020; Faricha *et al.* 2020) [15, 11]. The family group Caesionidae was found in clusters (schooling) in the direction of the water's edge. The association of fish of the Caesionidae family with the growth form of CE is caused by the availability of large space in the water column. The presence of the CE growth form makes it easier for yellowtail fish to get food because many of the biota (plankton) either surviving or settling on the coral can all be seen (Nnggajo *et al.* 2009) [30]. Group 2 consisting of fish families Acanthuridae, Balistidae, Ptereleotrididae, Siganidae, and Synodontidae, which are closely associated with coral reef growth forms ACB, CB, CM, CS, DCA, and R. The fish family Siganidae belongs to

the trophic level of the herbivorous group. Herbivorous fish groups are one of the fish groups that play an important role in maintaining coral reef systems because they affect the growth and diversity of algae and change the structure of reef fish communities (Thacker *et al.* 2000; Gobler *et al.* 2006; Edwards *et al.* 2014; Putra *et al.* 2015; Paulangan *et al.* 2019) [41, 14, 9, 34, 33]. The abundance of herbivorous fish was negatively correlated with the percentage of macroalgae cover but positively correlated with the addition of coral individuals/colonies (Mumby *et al.* 2006; Wibowo *et al.* 2016) [29, 44]. Group 3 consisting of fish families Carangidae, Chaetodontidae, Chanidae, Gobiidae, Labridae, Lethrinidae, Lutjanidae, Mullidae, Nemipteridae, Scaridae, and Serranidae, which are closely associated with coral reef growth forms ACD, MA, S, and SC. The relationship of the Chaetodontidae family group is closely related to the growth form of ACD coral reefs. Species *Chaetodon unimaculatus* prefers to eat coral polyps montiporid leaf shaped (Acroporidae) (Belland and Galzin 1984; Cox 1994; Luthfi *et al.* 2016) [3, 6, 23]. The indicator fish group was dominated by species *Chaetodon octofasciatus*. Fish species *Chaetodon octofasciatus* dominate in the waters and spread over all observation sites (Adrim *et*

al. 2012)<sup>[1]</sup>. The existence of the Chaetodontiade fish family indicates that the percentage of live coral cover is still quite good because this type of fish is an indicator of coral reef health (Panggabean 2012)<sup>[32]</sup>. The presence of indicator fish illustrates that the ecological condition of coral reefs is still capable of being used as a habitat for reef fish.

### 3.4 Classification of Clusters of Similarity and Multidimensional Scaling (MDS) Reef Fish

The cluster analysis results showed a similarity index (*similarity*) of 43% found three groups of entities (habitats), namely groups A, B, and C. This grouping showed differences in the composition of reef fish species between these groups (Setiawan 2016)<sup>[39]</sup>.

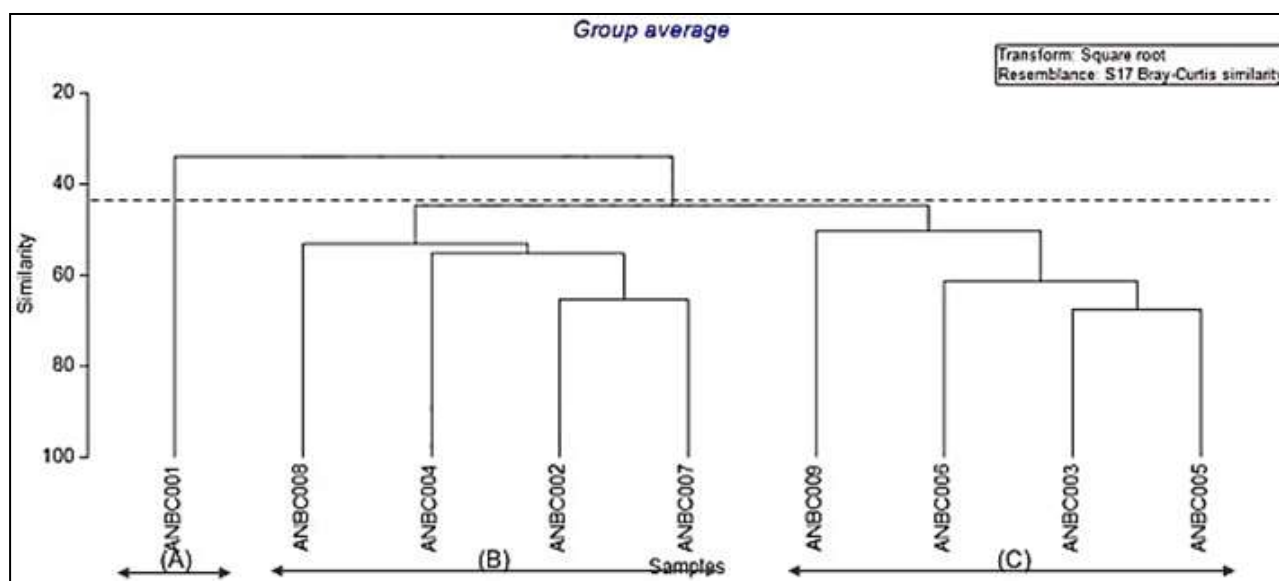


Fig 6: Results of cluster analysis based on the Bray-Curtis similarity index.

Figure 6 shows three groups, namely group A, B, and C. Group A consists of ANBC 001 station, research station ANBC 001 located east of the core zone of the Anambas Islands, a research station located in closed strait waters. Characteristics of semi-enclosed waters where the abundance of fish and coral is limited due to the limited circulation that enters the bay (Setiawan 2016)<sup>[39]</sup>. Group B consists of research stations ANBC 008, ANBC 004, ANBC 002, and ANBC 007 located to the east and west of the core zone of the Anambas Islands. Research stations ANBC 002 and ANBC 004 are located in the east, while research stations ANBC 007 and ANBC 008 are located in the west, having very far distanced between stations but having the exact resemblance to reef fish communities. Locations located quite far apart but pointing towards the outside of the waters have a community resemblance (Adrim et al. 2012)<sup>[1]</sup>. Group C consists of research stations ANBC 009, ANBC 006, ANBC 003, and ANBC 005 located to the east of the core zone of the Anambas Islands, between stations having similarities to reef fish communities. The research stations ANBC 003, ANBC 005, and ANBC 006 are located at a close distance. The proximity of the research sites causes the similarity of reef fish communities.

#### 4. Conclusion

The highest abundance of fish species based on their trophic level in the core zone of the Anambas Islands MTP is an omnivore fish group. Reef fish species are evenly distributed and there is no dominance of one species over another. The condition of the reef fish found in the Anambas Islands TWP is in good condition. The cluster analysis showed that the similarity index (*similarity*) of 43% was found in three groups of entities (habitats). The correspondence analysis results found three groupings of reef fish based on their association with coral growth forms.

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