The condition of reef fish (family Chaetodontidae) in Krueng Raya and Ujong Pancu waters, Aceh Besar District

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Abstract. This study aims to determine the condition of reef fish of the Chaetodontidae family in Krueng Raya and Ujong Pancu waters, Aceh Besar District. The study was conducted in October 2019, where six observation locations were representing the two regions. Fish observations were carried out using the Underwater Visual Census (UVC) method. The results of the study found four genera of Chaetodontidae fish consisting of 21 species. Benteng Inong Balee Station is the location with the highest number of individuals and species of Chaetodontidae fish, 38 individuals belonging to 11 species. On the other hand, Lhok Mee Station is the location with the least number of individuals and species of Chaetodontidae fish found, only 13 individuals belonging to 6 species. The highest abundance of Chaetodontidae fish was found at Ahmad Rhang Mayang Station (521.11 ind/ha). Meanwhile, the least abundance of Chaetodontidae fish was found at Lhok Mee Station, (115.38 ind/ha). The number of species, Krueng Raya waters have a higher number of Chaetodontidae fish species than Ujong Pancu waters. On the other hand, the abundance value Ujong Pancu waters have a higher average abundance value of Chaetodontidae fish than Krueng Raya waters. Overall, based on the biological index, the community structure of reef fish of the Chaetodontidae is still stable. Compared to previous study, the present study shows that, within a period of 6 years, the condition of Chaetodontidae fish in Aceh Besar waters has increased in the number of species, abundance, and diversity of fish.

1. Introduction
Aceh Besar is one of the districts in Aceh Province, Indonesia, which has coral reef resources [1]. The condition of Aceh's coral reef ecosystem varies from region to region. In recent years, there has been an
increase in coral mortality in Aceh Besar waters caused by natural and human factors [2][3]. Overall, the condition of the coral reef ecosystem in Aceh is classified as damaged to good [4][5].

Damage to the coral reef ecosystem is certainly very influential on the organisms that live in it, one of which is reef fish. Reef fish utilize coral reef ecosystems as a place for spawning ground, nursery ground, and feeding ground [6,7]. One group of organisms that inhabit coral reef ecosystems is the fish of the Chaetodontidae family [8][9]. This group of fish has a wide distribution and is always found living in association with coral reefs. Based on data, the Chaetodontidae family consists of 114 species belonging to 10 countries worldwide [10], ninety percent of the species distributed in the Indo-Pacific [11].

According to [12], fish of the Chaetodontidae family can be used as indicators of coral reef conditions because they are actual coral inhabitants. So, if there is damage to the coral reef ecosystem, these fish can be used as a reference to control the condition of coral reefs. [13] stated that the presence of obligate coral feeder Chaetodontidae fish can be used to reference that coral reefs are still in good condition.

Research on Chaetodontidae fish has been widely carried out in several areas in Indonesia [14-18], but it is still very limited for the Aceh area. The only specific research on this topic has only been studied in 2013 [19]. Therefore, it is crucial to conduct this research to obtain the latest information regarding the condition of Chaetodontidae fish, especially in Aceh Besar waters, to support the management of the marine conservation area.

2. Material and Methods

2.1. Site and Time

This research was conducted in October 2019. There are six observation locations in Aceh Besar District, namely Lhok Mee, Ahmad Rhang Manyang, Benteng Inong Balee, Tuan Island, Lhok Mata Ie and Lhok Keutapang. Geographical observation locations are presented in Figure 1.
2.2. Fish Data Collection
Observation of Chaetodontidae fish using Underwater Visual Census (UVC) technique with belt transect method. A 100 m line transect is stretched parallel to the shoreline at a depth of 3-8 m. Each transect is 20 m long with four repetitions and has an interval of 5 m. The observation area is 2.5 m to the left and right and 5 m above. The data recorded consisted of the number of individuals from each Chaetodontidae fish species [20]. Identification of Chaetodontidae fish refers to [21,22].

2.3. Data Analysis

2.3.1. Fish Abundance
The number of individual fish per unit area of observation is said to be the abundance of fish. According to [22], abundance can be calculated using the formula:

\[ K = \frac{\text{Number of individuals}}{\text{Transect area}} \]

Remark: \( K \) = Abundance of fish

2.3.2. Frequency of Occurrence
The frequency of occurrence (FO) of reef fish at each station was calculated using the equation [24]. The category of occurrence frequency values is 0-25% in very rare category, 26-50% rarely, 51-75% often, >75% very often.

\[ \text{FO} = \frac{\text{Number of locations occupied by a species}}{\text{Total number of locations}} \times 100\% \]

2.3.3. Diversity Index
The diversity index (H') used is the Shannon-Weiner index. The criteria for the diversity index are H'\( \leq 1 \) for the low diversity category; 1< H'\( \leq 3 \) moderate diversity; and H'\( \geq 3 \) high diversity. The diversity index is calculated by the following equation [24]:

\[ H' = -\sum Pi \ln Pi \]

Remarks: H' = Shannon – Weiner diversity index, Pi = ni/N, ni = Number of individuals of a species, N = Total individuals of all species

2.3.4. Uniformity Index
The uniformity index (E) describes the number of individuals between species in a fish community. The more evenly spread of individuals between species, the balance of the ecosystem will increase. The value of the uniformity index ranged from 0-1 where 0.0\(< E \leq 0.5 \) for the depressed community category, 0.5< E \( \leq 0.75 \) for the unstable community, and 0.75 < E \( \leq 1 \) for the stable community. The uniformity index is calculated by the following equation [23]:

\[ E = \frac{H'}{H_{\text{max}}} \]

Remarks: E = Uniformity index, H' = Diversity index, and H max = Maximum diversity index.

2.3.5. Dominance Index
The dominance index (C) indicates the abundance of fish is dominated by several species or not. The value of the dominance index ranged from 0-1 where 0.0 \(< D \leq 0.5 \) low dominance category, 0.5 < D \( \leq 0.75 \) moderate dominance and 0.75 < D \( \leq 1 \) high dominance. The dominance index is calculated using the following equation [23]:

...
D' = $\sum Pi^2$

Remarks: D = Dominance index, pi = Proportion of the number of individuals in a biota.

3. Result and Discussion

3.1. Composition and Frequency of Presence of Chaetodontidae
The study results found 21 species of Chaetodontidae family that belong to 4 genera. Most Chaetodontidae species were found at the Banteng Inong Balee location, with 11 species, and the least found at the Lhok Mata Ie location with five species. However, when viewed from the number of individuals found, Benteng Inong Balee had the highest number of individuals, namely 38 ind. At the same time, the Lhok Mee was the location with the least number of fish individuals of the Chaetodontidae family, which was only 13 ind. The number of individuals and species found in each location is presented in Table 1. When compared with research [1] which was conducted in 2013, the number of abundances obtained in 2019 increased dramatically. The highest abundance found in Tuan Island was 0.093 ind/m², and the highest abundance value was obtained in Lhok Keutapang waters of 0.083 ind/m².

Table 1. Species composition of Chaetodontidae fish in Aceh Besar waters.

| Genera      | Species            | Lhok Mee | Ahmad Rhang Manyang | Benteng Inong Balee | Tuan Island | Lhok Mata Ie | Lhok Keutapang |
|-------------|--------------------|----------|---------------------|---------------------|-------------|-------------|---------------|
| Chaetodon   | Chaetodon auriga   | 1        | 0                   | 0                   | 0           | 0           | 0             |
|             | Chaetodon citrinellus | 1       | 0                   | 0                   | 0           | 2           |               |
|             | Chaetodon collare  | 0        | 5                   | 4                   | 0           | 3           | 5             |
|             | Chaetodon decussatus | 0      | 0                   | 2                   | 0           | 0           |               |
|             | Chaetodon falcula  | 0        | 0                   | 0                   | 1           | 0           | 2             |
|             | Chaetodon gattatissimus | 3     | 0                   | 1                   | 0           | 0           |               |
|             | Chaetodon lunulatus | 0       | 0                   | 4                   | 4           | 0           | 2             |
|             | Chaetodon meyeri   | 0        | 0                   | 5                   | 2           | 0           | 0             |
|             | Chaetodon rafflesii | 0       | 1                   | 0                   | 0           | 0           | 0             |
|             | Chaetodon trifascialis | 0   | 1                   | 0                   | 0           | 2           | 3             |
|             | Chaetodon trifasciatus | 3    | 3                   | 4                   | 0           | 7           | 4             |
|             | Chaetodon ulietensi | 1       | 0                   | 0                   | 0           | 0           | 0             |
|             | Chaetodon vagabundus | 4       | 5                   | 7                   | 2           | 4           | 4             |
|             | Chaetodon xanthurus | 0       | 0                   | 0                   | 3           | 3           | 0             |
|             | Chetodon lunulatus  | 0       | 0                   | 0                   | 1           | 0           | 0             |
| Forcipiger  | Forcipiger flavissimus | 0    | 1                   | 3                   | 0           | 0           | 0             |
| Hemitaurichthys | Hemitaurichthys zoster | 0 | 0                   | 1                   | 0           | 0           | 0             |
| Heniochus   | Heniochus acuminatus | 0       | 2                   | 0                   | 0           | 0           | 3             |
|             | Heniochus monoceros | 0       | 0                   | 3                   | 0           | 0           | 0             |
|             | Heniochus pleurotaenia | 0   | 0                   | 0                   | 1           | 0           | 0             |
|             | Heniochus varius   | 0        | 0                   | 4                   | 0           | 0           | 0             |
| Total       |                    | 13       | 18                  | 38                  | 14          | 19          | 25            |
The high number of individual Chaetodontidae fish found in the waters can reference that coral reef in the area are in good condition, followed by the percentage of live coral cover [25]. The many species of Chaetodontidae fish make coral reefs as a shelter and as a source of food. Changes in the natural conditions of coral reefs can also affect the number of individuals and the composition of fish species living in the area [26,19]. In addition, several external factors, such as the occurrence of sedimentation in water bodies, the mooring of fishing boats that can cause damage that threatens the existence of Chaetodontidae fish so that it can cause low species found at the study site [26].

The species of fish of the Chaetodontidae family included in the category of very often found is *Chaetodon vagabundus*, where this species is found in both water areas. In addition, Chaetodon trifasciatus species is also included in the category of species that is very often found. However, in the Ujong Pancu waters, this species is included in the category of frequently found (Table 2). This is presumably due to natural factors and good coral cover conditions. [27] stated that substrate conditions and the availability of food sources significantly affect differences in fish biomass. In addition, several other factors such as complexity and type of habitat, depth, distance to the beach, season, and level of fish exploitation are carried out in that location. Furthermore, the eastern waters have a sandy and slightly rocky substrate due to the physical conditions, while the western waters have a rocky and slightly sandy substrate.

### Table 2. Frequency of occurrence of Chaetodontidae fish in Aceh Besar waters.

| Species               | Krueng Raya Area | Ujong Pancu Area |
|-----------------------|------------------|------------------|
|                       | FO (%) | Category | FO (%) | Category |
| *Chaetodon auriga*    | 33,33  | Rarely   | -      | -        |
| *Chaetodon citrinellus* | 33,33  | Rarely   | 33,33  | Rarely   |
| *Chaetodon collare*   | 66,67  | Often    | 66,67  | Often    |
| *Chaetodon decussatus* | 33,33  | Rarely   | -      | -        |
| *Chaetodon falcula*   | -      |          | 66,67  | Often    |
| *Chaetodon guttatissimus* | 66,67  | Often    | -      | -        |
| *Chaetodon lunulatus* | 33,33  | Rarely   | 66,67  | Often    |
| *Chaetodon meyeri*    | 33,33  | Rarely   | 33,33  | Rarely   |
| *Chaetodon rafflesii* | 33,33  | Rarely   | -      | -        |
| *Chaetodon trifascialis* | 33,33  | Rarely   | 66,67  | Often    |
| *Chaetodon trifasciatus* | 100    | Very Often | 66,67  | Often    |
| *Chaetodon ulietensi* | 33,33  | Rarely   | -      | -        |
| *Chaetodon vagabundus* | 100    | Very Often | 100    | Very Often |
| *Chaetodon xanthurus* | -     |          | 66,67  | Often    |
| *Chetodon lunulatus*  | -     |          | 33,33  | Rarely   |
| *Forcipiger flavissimus* | 66,67  | Often    | -      | -        |
| *Hemitauricthys zoster* | 33,33  | Rarely   | 33,33  | Rarely   |
| *Heniochus acuminatus* | 33,33  | Rarely   | 33,33  | Rarely   |
| *Heniochus monoceros* | 33,33  | Rarely   | -      | -        |
| *Heniochus pleurotaenia* | -     |          | 33,33  | Rarely   |
| *Heniochus varius*    | 33,33  | Rarely   | -      | -        |

In addition, in 2016, the high sand substrate made it difficult to recruit attached corals as well as natural factors such as the availability of nutrients or fish and other marine animals that make corals as prey from human activities [3]. [5] stated that the coral cover found in Masjid Raya waters, Aceh Besar District, Lhok Mee water was classified as damaged coral cover, and in the lowest coral cover condition
a year to year, the percentage of coral cover is <25%. The condition of coral reefs in 2017 experienced a very drastic decline of 50% from the previous year [7].

3.2. Abundance of Chaetodontidae

Although when viewed in terms of the number of species and individuals, the most commonly found is at the Benteng Inong Balee location. However, when viewed in terms of abundance, Ahmad Rhang Manyang has the highest abundance value. Overall, the highest abundance of Chaetodontidae fish was found at the Ahmad Rhang Manyang location, with a value of 521.11 ind/ha. The lowest was at the Lhok Mee location, with a value of 155.38 ind/ha. However, the abundance of Chaetodontidae fish at the Ahmad Rhang Manyang and Lhok Keutapang locations has a value that is not much different, which is only 2.71 ind/ha (Figure 2). Chaetodontidae fish depend on healthy coral reefs in the Lhok Mata Ie and Lhok Keutapang areas because the condition of the corals is still good. Following the research of [6], there are reef fish of the Pomacanthidae family that are most commonly found in the area.

![Figure 2. The abundance of Chaetodontidae family in Aceh Besar waters.](image)

| Location          | Diversity Index (H') | Category | Uniformity Index (E) | Category | Dominance Index (C) | Category |
|-------------------|----------------------|----------|----------------------|----------|---------------------|----------|
| Lhok Mee          | 1.63                 | Moderate | 0.54                 | Moderate | 0.22                | Low      |
| Ahmad Rhang Manyang | 1.74                | Moderate | 0.57                 | Moderate | 0.2                 | Low      |
| Benteng Inong Balee | 2.27               | Moderate | 0.75                 | High     | 0.11                | Low      |
| Tuan Island       | 1.81                 | Moderate | 0.59                 | Moderate | 0.18                | Low      |
| Lhok Mata Ie      | 1.52                 | Moderate | 0.5                  | Moderate | 0.24                | Low      |
| Lhok Keutapang    | 2.02                 | Moderate | 0.66                 | High     | 0.14                | Low      |

Table 3. Diversity index, uniformity index, and dominance index in Krueng Raya and Ujong Pancu waters, Aceh Besar.

The fish diversity index of the Chaetodontidae family in Aceh Besar waters ranges from 1.52 to 2.27, which indicates the category of moderate diversity. Like the research results conducted by [28] in Raya...
Island, Rusa Island, and Rondo Island, reef fish have a diversity index value ranging from 2.33-2.95 with a medium diversity category. The uniformity index of fish of the Chaetodontidae family in the waters of Aceh Besar ranged from 0.5 to 0.75, indicating a medium to high uniformity category. According to [7], the uniformity index of reef fish in Mesjid Raya District ranges from 0.48-0.52, and Peukan Bada District ranges with a value of 0.37-0.50 belonging to the depressed community category. The fish dominance index of the Chaetodontidae family in the Aceh Besar waters ranges from 0.11 to 0.24, which indicates a low dominance category. According to [9], the low dominance index obtained was 0.08–0.122. According to [7], the total species found in Aceh Besar waters during 2014-2018 were 115 species belonging to 39 families. The average results of reef fish ecological index values in Mesjid Raya and Peukan Bada Subdistricts in 2014-2018 did not significantly differ. The average percentage of live coral cover is still in the good category with a cover percentage of 66%. Due to the high percentage of coral cover, the abundance of reef fish in Lhok Mata Ie waters is also high (Table 3).

Conclusion
There are four genera of Chaetodontidae fish consisting of 21 species found. Chaetodon vagabundus is a species of the Chaetodontidae family that is very often found in the waters of Aceh Besar. The highest abundance of Chaetodontidae fish was found at the Ahmad Rhang Mayang location. Meanwhile, the least abundance of Chaetodontidae fish was found in the Lhok Mee location. The calculation of the diversity index value belongs to the medium diversity category. The uniformity index value is included in the low to a high category. While the dominance index value is low. The present study provides the latest data to support the management of marine protected area in Aceh Besar District.

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