Feeding Habit and Predation Selectivity of Reef Fish *Chaetodon octofasciatus* in Panjang Island, Jepara

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Abstract

Chaetodon octofasciatus is a species of fish in the Chaetodontidae family, commonly known as an indicator fish in the reef ecosystem as the frequency of its appearance in the wild can interfere with the state of the coral reef ecosystem in the waters. Panjang Island is located in Jepara, Central Java, Indonesia, in which one method of coral reef ecosystem rehabilitation in a a form of Artificial Patch Reef (APR) has been implemented. This study aims to investigate the levels of *C. octofasciatus* predation on corals in the APR and Natural reef of Panjang Island. We used the LIT (Line Intercept Transect) to measure the density of coral reefs at both locations. The abundance of *C. octofasciatus* was calculated using the Belt Transect method, while selectivity and bite ratio was observed and counted every 5 minutes. The results shows that *C. octofasciatus* from natural reefs have the highest predation rate (185 bites/5 min) and mostly eat the coral with lifeform massive while the ones from APR shows 144 bites/5 min and mostly eat the coral with lifeform *Acropora* branching. This selectivity could be due to the availability of corals in both areas. While massive corals were highly available in the natural reefs, branchich corals esp. Acropora is mostly planted in the APR. A more diverse coral lifeform in the natural reef also showed the type of corals that are less selected by *C. octofasciatus* such as submassive corals and Acropora tabulate, as well as corals with the foliose life form.

Keywords: *Chaetodontidae,* predation selectivity, Artificial reef

INTRODUCTION

Coral reefs as one of the ecosystems in coastal area, has been playing important roles by providing various ecosystem services, ecologically and economically. In Indonesia and many tropical countries around the world, coral reefs became a major source of income for local communities from fisheries, as well as tourism. Hard corals are a key structural component of coral reef ecosystems, playing a crucial role in reef formation and biodiversity. The percentage of hard coral cover is commonly used as an indicator of reef health, as it reflects the vitality and resilience of the reef ecosystem. Monitoring coral cover allows for the assessment of changes over time due to natural or anthropogenic factors.

Panjang Island, located in Jepara Regency, is a popular destination among local tourists due to its coastal beauty and religious tourism destination (Sugianto *et al*., 2019). However, the coral reef ecosystems in Panjang Island are under threat due to increased coastal area utilization and sediment runoff from rivers in the mainland Java, as indicated by Indarjo (2004) and Munasik *et al*. (2018). This has resulted in a shift in the basic substrate of the area to rubbles and sandy mud, a condition previously noted by Luthfi (2003). The degradation of coral reefs has prompted conservation efforts initiations, including coral reef rehabilitation through the implementation of Artificial Patch Reefs (APR) Munasik (2020), which are designed to provide new habitats for marine life, especially corals and reef fishes, as well as to promote biodiversity.

In coral reef ecosystems, certain fish species, particularly those from the Chaetodontidae family, serve as critical bioindicators due to their reliance on coral for food (Kulbicki and Bozec, 2005).

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According to Nurijana (2016), research conducted on Thousand Islands, Jakarta, stated that Chaetodontidae fish are indicator fish in the coral reef ecosystem due to their presence as an obligate coral feeder, indicating that coral reefs are relatively still in good condition, especially for the species which specifically consume hard coral, such as *C. octofasciatus*, *C. trifasciatus*, *C. trifascialis*, and *C. ornatissimus*. When *C. octofasciatus* is found in dominant numbers, it indicates that the coral reef has undergone changes (Maddupa *et al*., 2014).

Despite a limited diversity of Chaetodontidae in Panjang Island, the establishment of APRs has shown promising results. Munasik (2020) found that the fish abundance in APRs is comparable to that of natural reefs, suggesting that APRs provide a conducive environment for coral fish survival. This is particularly important for species like *C. octofasciatus*, which are coral-dependent and thrive in ecosystems where corals as food supply are abundant. The aim of this research is to determine the relationship between differences in the level of coral predation with the density of coral reefs found in the natural reef and APRs of Panjang Island Jepara and to determine the bite ratio of the number of coral colonies found in the two locations.

MATERIAL AND METHODS

This research was carried out by taking fish data including fish abundance, fish bite ratio and fish samples in two locations, namely the first station is the location of artificial coral waters called Artificial Patch Reef (APR) and in Natural reef of Panjang Island Jepara, Central Java (Figure 1).

The material in this research is fish found in Artificial Patch Reef and Natural Reef which were taken at a depth of 4 meters at a distance of 250 meters from the coastline. In addition, the material studied is coral lifeforms that grow on the Artificial Patch Reef. Observing data on the percentage of coral cover on the Artificial Patch Reef (APR) uses growth monitoring data by calculating the area of the APR base and measuring the length and width of each colony to determine the density of coral found on it. 12 APR while the Natural Reef uses the LIT (Line Intercept Transect) method on Panjang Island. The percentage of coral colony cover is determined using the following formula (English *et al*., 1994)

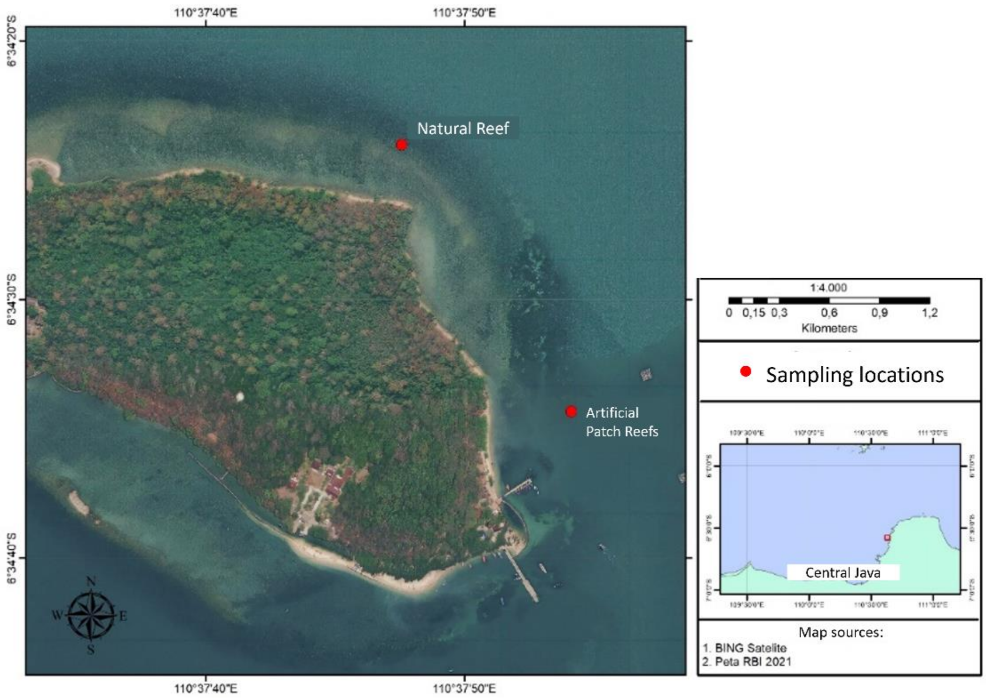

Figure 1. Map of research location

Table 1. Category of coral reef cover (Gomez *et al*., 1994)

No.	Category	Value (%)
1	Poor	0 - 24,9
2	Medium	25 - 49,9
3	Fair	50 - 74,9
4	Very good	75 - 100

$$n_i = \frac{li}{L} \times 100\%$$

Note: ni = Percentage of coral colony cover (%), li = Length of coral colony per length of line transect, L = Total length of transect

According to the Indonesian Minister of the Environment (2001), coral reef conditions are categorized based on the percentage of hard coral cover (Table 1). Gomez *et al*. (1994) also used a widely recognized classification system for assessing coral reef health, which is cited worldwide to compare reef conditions. Additionally, studies by Wilkinson (2004), Burke *et al*. (2011) and Hughes *et al*. (2017) emphasize the importance of coral cover as a key metric in evaluating the overall status of coral reefs and their ability to provide ecological services.

The method used in investigating the abundance of *C. octofasciatus* fish associated with Artificial Patch Reef (APR) and Natural reef on Panjang Island Jepara is to use the belt transect method, namely stretching a 50 m long line transect above the natural reefs or APR, with an imaginary line 1 m to the left and to the right (WCS, 2005). Reef fish data collection was carried out using the visual census method. Data collection was carried out 10 minutes after the transect was carried out so that the coral fish that live in the area were not disturbed when the transect was installed. We determine the type of *Chaetodon* fish by morphological observation refering to the reef fish identification book by Gerry *et al.* (2000).

Data collection on fish feeding behaviour followed the focus animal method (Lehner, 1998). This method has 2 aspects in observing fish eating behaviour, the first is by counting the number of bites the fish take and the second is by recording what types of coral are consumed. These observations were taken by diving and then following one individual fish for 5 minutes by recording these 2 aspects for 6 individuals in one transect.

Predation levels were calculated by randomly observing selected butterflyfish in the study area. The level of predation of butterflyfish is calculated based on fish bites per unit time. The formula for the level of predation by Gregson *et al*. (2008) is as follows:

$$FR : \frac{n}{a}$$

Note: FR = level of predation (feeding rates), n = number of bites, a = time (5 minutes)

To calculate predation selectivity, the Ivlev Selection Index (E) is used by comparing food utilization with its availability. This index has been used successfully to determine prey selectivity over a wide range of marine and freshwater fishes as well as invertebrates (Smith 2004; Alwany *et al*. 2003). The following is Ivlev's preferred index formula (Smith 2004):

$$E = \frac{(r_i - p_i)}{(r_i + p_i)}$$

Note: E= Ivlev selection index, ri = proportion of food type i consumed, pi = proportion of food type available in the environment.

Predation selectivity can be divided into three following categories: Category I (E> 0.5): indicates the type of coral that is the main choice for *C. octofasciatus* fish, namely coral with the lifeform *Acropora* branching and Coral massive. Category II (0 ≤ E ≤ 0.5): indicates the type of coral that is less liked by the fish *C. octofasciatus*, namely coral with the lifeform coral submassive and *Acropora* tabulate. Category III (E < 0): indicates the type of coral that is avoided by the *C. octofasciatus* fish, namely coral with a foliose lifeform.

RESULTS AND DISCUSSION

The condition of Panjang Island's coral reefs in this study was analyzed based on the percentage of bottom substrate cover, especially hard coral cover. The percentage of cover of the bottom substrate in the waters of Panjang Island at the time the research took place (November 2022), showed that the Natural Reef at a depth of 4 meters had a coral percentage of 32% with various life forms such as coral massive, submassive, *Acropora* branching *Acropora* tabulate, as well as soft corals (Figure 2). On the contrary, results from the APRs showed less hard coral variable lifeform (Figure 3) and dominated with *Acropora* branching. *Acropora* branching colonies were predominantly found due to the chosen hard coral species that were selected during the transplantation of APRs. According to Munasik (2020), coral fragments from the surrounding area of panjang island waters are *Acropora aspera* and *Acropora copiosa*. Branching corals were by far the most common lifeform that were used for transplantation (Ferse *et al*., 2021). This is due to the general fast-growing abilities of branching corals compared to the slower massive corals. Although, massive corals tend to have a higher survival rate of transplantation (Clark and Edward, 1995). Additionally, *Acropora* branching corals are common coral varieties that were usually used for coral transplantation such as *Acropora formosa* and *Acropora aspera* (Bowden-Kerby, 2001).

While the results from the APRs showed less life forms of hard corals such as Acropora branching, coral massive and coral submasiive (Figure. 3). More *Acropora* branching colonies were found because the transplantation carried out on 12 APR used more fragments of *Acropora* coral, so 897 colonies could be found during data collection from 12 APR structures. Massive coral lifeforms were found in 12 colonies in APR, then there were corals with foliose and sub-massive branching forms, each found in 1 colony and 4 colonies. In addition, our visual census showed as many as 25 and 39 individuals *C. octofasciatus* present on the Natural Reef and APRs, respectively.

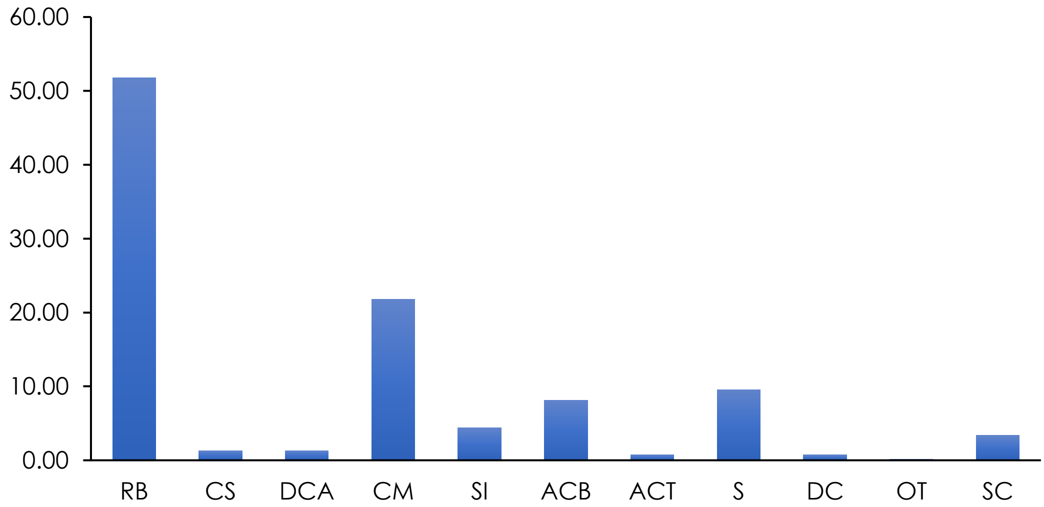

Figure 2. Percentage of substrate cover in the natural reef of Panjang Island. RB: rubble; CS: coral submassive; DCA: dead coral algae; CM: coral massive; ACB: *Acropora* branching; ACT: *Acropora* tabulate; S: sand; DC: dead coral; OT: other; SC: soft coral.

By looking at the number and coral resources available at this location, it can be seen that predation by C. *octofasciatus* fish at both stations shows the difference in results. The highest value for the amount of predation is in the Natural Reef with a total of 185 bites from 3 fish per 5 minutes and 144 bites in the APR every 5 minutes (Figure 3).

Figure 3 shows that there is the highest selection of predation from several coral lifeforms. The ratio of bites obtained for the APR station was highest for the *Acropora* branching lifeform, 42 bites on one of the fish and the lowest for coral massive was 1 bite, while the ratio of bites obtained at the Natural Reef station with the coral massive lifeform was 30 bites and the lowest was for the foliose lifeform (3 bites). The highest results obtained in monitoring the bite ratio of 3 fish at the APR station were *Acropora* branching lifeforms with 42,; 21; and 34 bites per 5 minutes respectively, while the lowest were coral massive with 2; 2; and 1 bites per 5 minutes respectively, on 3 fishes, because the percent cover level of *Acropora* branching at this station reached 59%. Meanwhile, the highest results obtained at the Natural Reef station showed that the ratio of bites on coral massive lifeform was 30; 23; and 26 bites per 5 minutes respectively, and the lowest was on coral with the foliose lifeform with 7; 3; and 5 bites per 5 minutes, respectively.

There were 5 types of *scleractinian* coral lifeforms recorded at the research location. For all research locations, there were 5 types of *scleractinian* coral lifeforms which became food for *Chaetodon octofasciatus* fish during the research period. The *C. octofasciatus* fish likes some types of coral and wants to avoid other types of coral. Of the coral lifeforms that were food recorded during the research, there are types of lifeforms that provide special characteristics to predation by *C. octofasciatus*. These preferences on predation were shown by different levels of selection index (E) (Table 2).

In this research, predation predation selectivity seemed to be affected by the availability of coral types in each location. Natural reefs and APR has different types of corals, in which natural reefs has a more diverse lifeform, while APR has mostly *Acropora*. The percentage of live coral found at APR was 59% and was dominated by branching Acropora with 897 colonies recorded, this was because the transplant program carried out at APR on Panjang Island was mostly aimed at corals with branching forms such as *Acropora Aspera, Acropora Formosa*, *Acropora muricata* (Munasik *et al*., 2018). Acropora corals are also known to be fast growing, therefore the density and hardness of the skeleton is relatively low compare to those of coral massive and submassive. Although Chaetodontidae fish has special feature on its mouth, which is a protruding sharp upper tooth that help during coral predation (Figure 4), the easy-to-eat Acropora could also be one of the reasons why Chaetodontidae fish seem to show preference on this coral for predation.

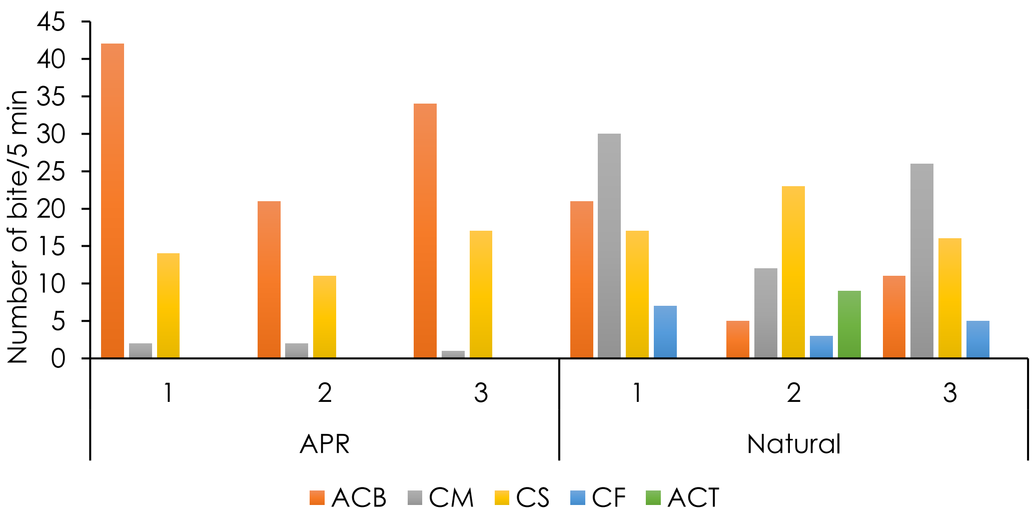

Figure 3. Comparison level of predation (bites/5min) to corals by *C. octofasciatus* at APR and Natural reef stations. ACB: *Acropora* branching; CM: coral massive; CS: coral submassive; CF: coral foliose; ACT: *Acropora* tabulate

Table 2. Selection Index (E) of *Chaetodon octofasciatus* in APR and Natural Reef

No	Corals code	APR			Natural		
		1	2	3	1	2	3
1	ACB	0,75045	0,86692	0,79307	0,31926	0,78117	0,57445
2	CM	0,125093	0,125093	-0,2173	0,56828	-0,80162	0,61476
3	CS	0,842245	0,92801	0,89089	0,441341	0,554624	0,416609
4	CF	-	-	-	0,287242	-0,1274	0,126638
5	ACT	-	-	-	0,589322	0,397953	-

Figure 4. The shape of the mouth of the fish *Chaetodon octofasciatus* when normal (left) and when it shows its teeth to help in predation (right)

The percentage of coral cover found in the Natural Reef is 32% and is dominated by massive type corals. The condition of the coral reefs in the Natural Reef is in the medium category for coral cover because it is in the range of 25 - 49.9%. This condition is influenced by the turbidity of the sea water due to the build-up of sedimentation. The effect of sedimentation itself will hinder the penetration of sunlight into the water column and make it difficult for coral reefs to carry out photosynthesis (Putra *et al*., 2020). This is due to the large number of river flows that flow into Jepara waters (Maslukah *et al*., 2018) which bring land run offs and nutrients from coastal anthropogenic activity, thereby causing environmental pressure on the coral reef ecosystem on Panjang Island. This is common in densely populated Indonesian waters, indicated by high turbidity / suspended particulate matter (SPM) reaching 21.83 ± 8.40 mg/l with a resuspension of 26.19 ± 24.42 mg/cm^2 /day (Holmes *et al*. 2000), with the consequence that dissolved organic matter is also high. The high turbidity of the waters will force coral species to respond by adapting to survive in these waters (Morgan *et al*., 2016). So that hard coral communities that are able to withstand the pressure of the aquatic environment are vulnerable, moderate and resistant. The next consequence of environmental disturbance is the increasing prevalence of coral disease. The prevalence of coral disease in Panjang Island has reached 73% (Sabdono *et al*., 2014). The research on rate of predation of Chaetodontidae fish on coral has been widely carried out, for example on Virginia Island and in Hawaii. This research concludes that the rate of fish predation is correlated with the calorific value of coral.

Predation on coral by Chaetodontidae fish, because coral provides protein contained in polyps and carbohydrates contained in symbiotic algae in the tissue (Reese, 1977). According to Alwany *et al.* (2003), coral mucus is a source of energy and nutrients. The mucus from *Acropora* and

Porites have a richer carbon content compared to other types of corals (Hadaidi *et al*., 2019). This may have influenced the result of this study, because corals of types other than *Acropora* and coral massive and submassive are more avoided by C. *octofasciatus* fish. This answers what was found when conducting observations at APR, where 39 *C. octofasciatus* were found, and only 25 *C. octofasciatus* were found at Natural Reef. More *C. octofasciatus* are found in the APR, possibly because the distribution and dominance of *Acropora* branching in this location is also high, so that food that provides nutrition is abundant and more *C. octofasciatus* are found.

Predation on coral is also influenced by natural phenomena such as El Nino. Research from Glynn *et al.* (1985) stated that due to the El-Nino event in 1982 - 1983 in Panama, the population size and 58 predations of corallivorous biota decreased. This is because many coral colonies turned white and eventually died due to high temperatures (30 and 31°C). Therefore, coral-predating Chaetodontidae are an ideal indicator because they prey on coral directly. This research shows the level of preference for certain coral species so that they will be very sensitive if changes occur in a coral reef system. In addition, because they are very territorial (Madduppa *et al*., 2014) it will be very easy to monitor them periodically. The size of a butterflyfish's territory is determined by the amount of coral food available. If there is little coral food available in a coral reef area, the fish will expand their territory (Crosby & Reese 1996). These changes in social behaviour provide sensitive early indications that instability and changes are occurring in the ecosystem.

CONCLUSION

The level of predation that occurred at the two research locations was different. In the APR area, there were 144 bites/5 min with a predominance of *Acropora* branching bites of 42 bites/5 min, while in the Natural Reef there were a total of 185 bites per 5 minutes with a dominance of massive coral with an average of 30 bites per 5 minutes. This research highlights a clear preference of *C. octofasciatus* predation and feeding behaviour on certain types of coral lifeforms. While artificial reefs are designed to be planted with corals that are fast-growing, it is also worth to consider that a more diverse planting might be beneficial to mimic natural reef, as well as to reduce predation pressure on specific corals. This finding might become a useful guide for a better reef restoration effort in the future.

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