Feeding preference of herbivorous fish: Family Scaridae

S A El Rahimi1*, E Hendra2, A Isdianto3, O M Luthfi3

1 Department of Marine Science, Faculty of Marine and Fisheries, Universitas Syiah Kuala, Banda Aceh, Indonesia
2 Department of Marine Science, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia

Corresponding author: sayid.afdhal@unsyiah.ac.id

Abstract. Parrotfish is one of dominant species in Indo-Pacific areas which have 9 genera and 83 species. In ecological perspective, the feeding behaviours of these fish very important, due to control population of algae in coral reef ecosystem. They used their jaw to excavate and scrape alga which living on coral substrata, so sometime resulted on erosion in substrates and coral. The aim of this research to record the diet preference of Scariids fish in NCF Putri Menjangan conservation area, Bali on January to February 2020. Group of Scariids fish was recorded by underwater camera for one minute then the bites scared were calculated manually and photographed. The result of study showed that 10 species from two genera (Chlorurus and Scarus) was dominantly herbivorous fish in this area. The highest number of fish bites at station 1 was obtained from S. qouyi species with a total of 41.27 bpm, while stations 2 and 3 were obtained from S. rivulatus species with a number of 40.96 bpm and 41.59 bpm, respectively. The majority of parrotfish species found chose to forage on dead coral with algae substrates because the water conditions were not optimal for the growth of coral, so many corals died and their skeletons were overgrown by algae.

1. Introduction

Parrotfish (Scaridae) become a large part of the herbivorous fish group that lives in coral reef ecosystems (83 species from 9 genera) with ecological, reproductive, and behavioral differences in each genera [1]. The majority of these are in the Indo Pacific region [2]. The most common thing that occurs in Parrotfish is a sex reversal or can be referred to as protogynous hermaphrodite [3]. This fish also goes through three different phases of life, where each phase has a specific color (adolescent phase, early phase and terminal phase). Parrotfish are diurnal animals, where some of these fish activities are only carried out during the day [4]. Most parrotfish species forage by biting algae that grow on the surface of dead coral [5]. Along with this process, the substrate (reef) where the algae live is also often eaten by Parrotfish. However, the diet of Parrotfish is different for each species [6].

Each parrotfish species has a different diet [7, 8] observed several parrotfish species in the Maldives islands and stated that the Chlorurus strongylocephalus eats 0.26 ± 0.08 g of substrate per individual bite of fish with a size of more than 45 cm. The species Scarus rubroviolaceus only ate 0.002 ± 9.13 × 10^-4 g per bite, but no significant difference was found in small or large individuals. The C. strongylocephalus species had a bioerosion rate of 462 ± 128 kg/individual per year from the largest individual, while the S. rubroviolaceus species had a bioerosion rate of ~3.6 ± 1.4 kg/individual per year. The sediment produced by these fish will accumulate around the reef and will eventually make the
surviving corals buried. This phenomenon can also cause shoaling of waters in coral reef ecosystems and affect the development of new zones [9].

Research on bites from parrotfish has been carried out by [8] on an atoll in the Maldives Islands by examining the species Chlorurus sordidus, C. strongylocephalus, Scarus frenatus, S. niger, S. Psittacus, and S. rubroviolaceus to determine the bioerosion rate of these fish. Another research on parrotfish bites was also carried out by [4] in Africa by observing the Scarus niger species to categorize fish bites based on their size. Research conducted by [10] also investigated the substrate preferences eaten by S. rivulatus species in the Great Barrier Reef region, Australia as well.

The Nature Conservation Forum Putri Menjangan (NCF Putri Menjangan) located on the island of Bali, Indonesia, has waters inhabited by Parrotfish in its coral reef ecosystem. The purpose of this study was to determine the distribution, number of bites and eating preferences of parrotfish in Putri Menjangan Bali. Information about parrotfish eating preferences can be used to support conservation programs carried out by NCF Putri Menjangan.

2. Material and Methods

2.1. Research location

The research was carried out from January to February 2020 at the NCF Putri Menjangan Bali. Observation points are considered to represent the overall condition of the waters for the observation station. After determining the point of observation then determining the coordinates using GPS. The research station is determined in reef flat and slope areas with a depth of between 5 to 10 meters. The points of this research station can be seen in Figure 1 and their coordinates can be seen in Table 1.

![Research location indicating red round tips in NCF Putri Menjangan, Bali](image)

Figure 1. The research location indicates of red round tips in NCF Putri Menjangan, Bali

| No | Stasiun | Latitude | Longitude |
|----|---------|----------|-----------|
| 1  | 1       | 8° 7' 14.45" | 114° 34' 33.80" |
| 2  | 2       | 8° 7' 21.07" | 114° 34' 21.03" |
| 3  | 3       | 8° 7' 28.57" | 114° 34' 9.57" |
2.2. Data collection of fish
The method used in this study was using Underwater Visual Census (UVC) on a 100 meter long transect. Transects are rectangular in which the length and width are clearly defined [11]. The equipment used is diving equipment (SCUBA), underwater stationery, GPS, and ropes. The transect was made parallel to the shoreline, with an imaginary distance of 2.5 meters from the transect line. Data collection was carried out at 20 stations. Transect lines are placed at a depth of between 3 and 7 meters. Fish of the Scaridae family were found, observed, counted and recorded in the slate. To complete the data, observations were also made through taking photos and videos underwater and identified referring to [12].

2.3. Grazing ID
Group of parrotfish were followed and recorded for one minute or until the fish were disturbed by the observer [13]. The calculation of the total number of fish bites on the substrate by each species per unit of time was carried out on the observed video, which was then converted into bites per minute (bpm). The length of feeding time was determined from the time of the first bite by each species to the point at which there were no follow-up bites. Parrotfish bite marks on the substrate were observed to measure the volume of substrate eaten by the fish [8]. Illustration of fish bite data collection can be seen in Figure 2.

2.4. Fish bites
The number of bites per individual parrotfish per minute is obtained by observing the video recording and counting the number of times the fish bites the substrate, then converted to bites per minute (bpm) [8]. From the results obtained, a comparison between fish species is then carried out and presented in a graph. This method can be used as a formula as follows:

\[
\text{Fish bites/minute} = (\text{Number of Fish Bite/Time}) \times 60
\]

(1)

3. Result and Discussion

3.1. Types of Parrotfish
Ten species of Parrotfish were found with a total of 57 fish individuals. The most species found was Scarus niger with a total number of fish were 17 individuals in all stations. The fewest species found from all research stations were Chlorurus oedema and Scarus altipinnis with 1 individual in each species. There are also several species of Parrotfish that were only found at station 2, such as Chlorurus troschelii, Chlorurus oedema and Scarus altipinnis.

Station 1 has 5 species that was dominated by Swarth Parrotfish (Scarus niger) occupying the highest number of individuals (12 species). While Quoy's Parrotfish (Scarus quoyi), Yellowbarred Parrotfish (Scarus dimidiatus), and Shabby Parrotfish (Chlorurus sordidus) were found view (3 fishes each). Station 2 has more variety of Parrotfish species (10 species), with the highest number of fish (3
individuals) obtained from the Swarthy Parrotfish (*Scarus niger*) species others only be found 1 individual such as Yellowfin Parrotfish (*Scarus flavipectoralis*), Yellowbarred Parrotfish (*Scarus dimidiatus*), Black Parrotfish (*Chlorurus oedema*), Minifin Parrotfish (*Scarus altipinnis*) and Shabby Parrotfish (*Chlorurus sordidus*). Station 3 is only inhabited by six species of Parrotfish, with the highest number of fish belonging to the Yellowbarred Parrotfish (*Scarus dimidiatus*) and Shabby Parrotfish (*Chlorurus sordidus*) with the number of individuals reaching three individuals per species (Table 2).

**Table 2. Number of fish per station.**

| Species           | Common Name               | Number of Fish | Total |
|-------------------|---------------------------|----------------|-------|
| *S. niger*        | Swarthy Parrotfish        | 12 3 2         | 17    |
| *C. bleekeri*     | Bleker's Parrotfish       | 7 2 1          | 10    |
| *S. quoyi*        | Quoy's Parrotfish         | 3 2 0          | 5     |
| *S. flavipectoralis* | Yellowfin Parrotfish   | 0 1 2          | 3     |
| *S. dimidiatus*   | Yellowbarred Parrotfish   | 3 1 3          | 7     |
| *C. troscheli*    | Greenhead Parrotfish      | 0 2 0          | 2     |
| *C. oedema*       | Black Parrotfish          | 0 1 0          | 1     |
| *S. rivulatus*    | Surf Parrotfish           | 0 2 2          | 4     |
| *S. altipinnis*   | Minifin Parrotfish        | 0 1 0          | 1     |
| *C. sordidus*     | Shabby Parrotfish         | 3 1 3          | 7     |
| **Total**         |                           | **28 16 13**   | **57**|

About 100 parrotfish species currently recognized in the world, the majority (73 species) had been found in Indo-Pacific waters [14]. 10 of these species were found in the NCF Putri Menjangan which were divided into 2 genera (*Chlorurus* and *Scarus*) with a total of 57 individuals (Table 2). These fish have various sizes, ranging from 10-35 cm. The maximum size of these species ranges from 30-40 cm [12]. The size of the male parrotfish is larger than the female [15]. All fish found were at a depth of 1 - 10 meters, where parrotfish were abundant at that depth [16].

Parrotfish have an important role in the survival and balance of coral reefs ecosystem [9]. These fish eat algae and other plants that grow on dead coral [17]. But it was recorded one of parrotfish (*Bolbometopon muricatum*) that feeding on live coral, more than 50% of these species fed on coral [18]. There are several different types of algae live in the ocean substrate such as turf algae, fleshy algae and crustose coralline. The abundance of algal populations in substrate of seawater will have a negative impact on the ecosystem of coral reef. Algae can block the sunlight that is important for corals and became main competitor of coral growth [4]. Research from [19] also confirmed that parrotfish contribute to the control of algae growth, so that these fish are considered to be the main agents in the maintenance of coral cover in the tropics.

The dominance of *S. niger* in this location could be due to the abundance of the algae as the main where growth on dead and live coral. *Scarus niger* has also been seen feeding on algae growing on sediments at the bottom of the water [4]. Scarids also called as scrapers because it has weak jaws and are rarely seen scraping coral. So that these fish usually looking for food on the bottom of the waters with a sandy substrate [18].

Comparing others research from Indonesia some of species from NCF Putri Menjangan was similar from Kendari, Southeast Sulawesi such as *S. flavipectoralis*, *C. bleekeri*, *S. niger*, *S. quoyi* and *S. rivulatus* [20]. The research by [21] in the Seribu Islands, Jakarta has been found nine species of
parrotfish with 4 species similar to the waters of the NCF Putri Menjangan (C. bleekeri, S. quoyi, C. sordidus and S. dimidiatus). Bunaken National Park has 9 species of Parrotfish with 3 species also found in the waters of the NCF Putri Menjangan (S. quoyi, S. niger and C. bleekeri) [22]. This difference in fish distribution between regions can be caused by the availability of parrotfish food in the area. In addition, physical factors such as waves, habitat structure, sedimentation and fishing activity can also affect the distribution of these fish [19].

3.2. Number of Parrotfish Bite

Based on observations of the number of bites of the Scaridae family in the NCF Putri Menjangan differed at each station. There are lima species of Parrotfish at station 1 with the highest number of fish bites obtained from the S. quoyi fish species. Station 2 is inhabited by the parrotfish with the highest number of bites obtained from S. rivulatus. Station 3 is only inhabited by six species of Parrotfish with the highest number of bites obtained from the same species as station 2, S. rivulatus (Figure 3).

![Figure 3. Number of fish bites per station](image)

The average bite of all parrotfish species in the waters of NCF Putri Menjangan was 24.21 bpm. Species Surf Parrotfish (S. rivulatus) occupies the highest number of bites among other species, which is 41,275 bpm. Species C. troschelii and C. oedema had the lowest number of bites with results that were not much different, namely 9.04 bpm and 9.00 bpm, respectively. The bite marks of the Parrotfish can be seen in Figure 3. Each species of parrotfish has a different jaw structure and diet. Based on these dietary differences, Parrotfish are divided into 3 classifications: browsers, scrapers and excavators [19]. Browsers are a group of fish that are often seen eating macroalgae [23]. Fish that fall into the category of scrapers are seen eating turf algae and biting the substrate where the algae grow. The excavators group consists of Parrotfish that are the perpetrators of bioerosion, eating dead coral and providing clean substrate for coral recruitment. Fish that fall into this category are more than 35 cm in size [18].

The results of observations in the waters of the NCF Putri Menjangan showed that stations 1 and 2 were dominated by S. niger, while station 3 was dominated by S. dimidiatus and C. sordidus. Dominated S. niger in station 1 might be caused by dominated sand substrate with algae in this location. This species is often seen foraging on sandy substrates due to the weak jaws of the Scarus group [24]. Scarids fish are rarely seen eating live coral [19]. Station 2 was dominated by S. niger. Research conducted by [4] showed that these fish not only forage on sandy substrates, but also appear to eat algae that grow on the surface of dead coral. Coral lifeforms that are often seen as feeding grounds for S. niger are massive and branching. Station 3 was dominated by species of S. dimidiatus and C. sordidus with the number of each
species being three individuals. Both species are often seen feeding on algae that live on dead coral surfaces [4], [25].

The majority of Parrotfish (9 species) found in the waters of NCF Putri Menjangan choose to forage on DCA substrates because this substrate contains a lot of algae which is the main food source for herbivorous fish, including parrotfish [26]. Studies on the diet of reef fish in Okinawa, Japan [27] have also shown that several species of parrotfish (C. sordidus, S. niger and S. rivulatus) prefer to eat algae on hard substrates such as rock or dead coral with algae (DCA). Parrotfish such as S. niger and S. rivulatus also tend to prefer fast-growing and nutrient-rich algae [4], [10], [13].

The size of fish body can also affect the eating preferences of this parrotfish. The diet of juvenile parrotfish is dominated by crustaceans and foraminifera. After this carnivorous phase has passed, these small fish will only eat the ends of the algae and do not leave marks or erode the substrate under the algae. Following the growth of fish, developing jaws and muscles around their mouths allow them to bite deeper into algae, erode substrate and dig up substrate in some species. So that parrotfish with larger sizes have a high contribution to the decrease in algal populations and bioerosion compared to smaller individuals [19].

4. Conclusion
In conclusion there were 10 species of reef fish in the Scaridae family with a total of 57 individuals, while the dominant species was C. sordidus (13 individuals). The highest number of bites at station 1 was obtained from S. gouyi species (41.27 bpm), at station 2 and station 3 it was obtained from the same species that was S. rivulatus (40.96 bpm and 41.59 bpm). Most parrotfish choose to forage on abundant dead coral and dead coral with algae substrates in NCF Putri Menjangan.

5. Acknowledgment
We are very grateful to the member of Coral Reef Study Club Acropora for technical assistance and many thanks to anonymous reviewers for the critical review to improve quality of this article.

References

[1] Streelman J T, Alfaro M, Westneat M W, Bellwood D R and Karl S A 2002, Evolution, 56, 961–971.
[2] Bay L K, Choat J H, Herwerden L V and Robertson D R 2004, Marine Biology, 144, 757–767.
[3] Hodge J R, Santiniand F, Wainwright P C 2020, The American Naturalist, 196, 57–73.
[4] Charlotte Johansson 2006
[5] Grutter A S, Bejarano S, Cheney K L, Goldizen A W, Sinclair-Taylorand T, Waldie P A 2020, Marine Ecology Progress Series, 643, 99–114.
[6] J H Bruggemann J H, Van A M, Kessel J, Rooijand M V, Breeman A M 1996, Marine Ecology Progress Series, 134, 59–71.
[7] Radkham A R and Eagleri S 2020, Springer, 2020.
[8] Yarlett R T, PerryRod C T, Wilson W and Philpot K E 2018, Marine Ecology Progress Series, 590, 155–169.
[9] Glynn P W and Manzello D P 2015, in Coral reefs in the Anthropocene, Springer, 2015, 67–97.
[10] Gordon S E, Christopher, Goatleyand H R, Bellwood D R 2016, Coral Reefs, 35, 285–291.
[11] Oktiyas Muzaky Luthfi Abdur Rosyid Andik Isdiandto Alfan Jauhari and Daduk Setyohadi 2018, in AIP Conference Proceedings, 2018, 2019, 50007.
[12] Allen G R, White W T, Erdmann M V 2013 Journal of the ocean science foundation, 6, 33-51
[13] Bonaldo R M and Bellwood D R 2008, Marine Ecology Progress Series, 360, 237–244.
[14] Parenti P and Randall J E 2011, Smithiana, 29.
[15] Ali T E S, Osman A M, Abdel-Aziz S H and Bawazeer F A 2011, Journal of Applied Ichthyology, 27, 840–846.
Bellwood D R, Hughes T P, Folkeand C, Nyström M 2004, Nature, 429, 827.

Asriyana A, Asrin L, Halili Hand Irawati N, Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology, 16, 8–14.

Mantyka C S and Bellwood D R 2007, Marine Ecology Progress Series, 352, 177–185.

Bonaldo R M, Hoeyand A S, Bellwood D R 2014, Oceanography and Marine Biology: An Annual Review, 52, 81–132.

Edrus I N, and Hadi T A 2020, Jurnal Penelitian Perikanan Indonesia, 26, 59–73.

Prabowo B, Fahlevy K, Putra N F D, Rizqydiandi M, Rahman B M K, Habibie A, Subhan B, Madduppa H 2019, in IOP Conference Series: Earth and Environmental Science, 2019, 278, 12059.

Rachmad B, Suharti R, Irayana D A, and Zulkifli D 2019, Jurnal Kelautan dan Perikanan Terapan (JKPT), 1, 69–76.

Ronaldo B Francini-FilhoRodrigo L MouraCamilo M Ferreiraand Ericka O C Coni 2008, Neotropical Ichthyology, 6, 191–200.

Kerry J Tand Bellwood D R 2012, Coral Reefs, 31, 415–424.

Chen L 2002, ZOOLOGICAL STUDIES-TAIPEI-, 41, 47–58.

Adrim M 2008 Jurnal oseana, 33, 41–50.

Nanami A 2016, Peer J, 4, e2425.