The Dynamics of Benthic Algae among Herbivorous Coral Reef Fishes

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Submitted: Oct 2, 2013; Accepted: Dec 1, 2013; Published: Dec 20, 2013

Abstract: This study was carried out to determine the extent of herbivores reef fish composition that can control the distribution of algae. A total of three 50 m transect lines placed at three different locations based on domination of algae functional groups. The study was conducted in Barranglompo Island, Makassar, South Sulawesi, Indonesia in March-June, 2012. The abundance and biomass of fish herbivore was observed through underwater visual census. All species were recorded to number and class size and grouped into their functional groups. The benthic algae cover was measured using the quadrant method in transect lines. Their distributions were observed periodically to determine the extent of the effects of grazing reef fish herbivore on benthic algae. The results showed that the epilithic algal matrix tend to correlate negatively with fish herbivore scrapers while the composition of herbivore reef fish can control the existence of algae distribution within the coral reef resilience. However, the turf algae were negatively correlated with the fish herbivore grazers. This study revealed that the composition of herbivore reef fish can control the existence of algae distribution in coral reef resilience.

Key words: Epilithic algal matrix · Turf algae · Scrapers · Grazers

INTRODUCTION

Herbivore fishes have become the main control for algae growth in coral reef ecosystem [1] beside other herbivores such as sea urchins, snails, crabs, etc. [2, 3]. Previous studies have showed the important role of herbivore fishes influencing the competition interaction between corals and microalgae, to reef resilience [4-6]. The role of herbivore fishes enhancing coral recovery depends on their food preference, abundance and relative biomass of benthic cover [7]. For example in Seychelles, the distribution of the corals is an important factor to determine the impact of reef fishes to algae communities, where the bigger impact tend to be applied on high coral coverage and there is a strong competition of limited algae resources. Most herbivore grazing only takes out part of algae tissue which leads to faster algae regeneration in the future [8].

Grazing of herbivores, especially herbivore fishes is one of importantly and widely ecological process that directly affects the macro algae productivity, distribution and their abundance and composition. In such situation, herbivore grazing could facilitate corals to clean up benthic algae. However, when there is less abundance of herbivores, the algae blooms and creates less competition amongst each other. There are two kinds of feedbacks...
from herbivore grazing, namely a negative feedback which lead to phase shift of substrate from coral domination to algae domination and positive feedback which the coral reef ecosystem have the capability to recover themselves from algae competition [9]. Algae grazing by herbivore reef fishes have become a very important ecological process in coral reef management and conservation [5, 6]. Moreover, the herbivores play a big role in benthic community structure on coral reefs [10]. In the area where benthic algae grazing was high, the benthic structure commonly was dominated by crustiest algae overgrown by turf algae [11]. Benthic algae domination on coral reefs associates to their rapid and excessive growth which cannot be controlled by herbivores. The difference structure of algae species, functions and sizes have been grouped according to their forms within hundreds of benthic algae species in the coral reefs [12, 13]. In addition, another study to simplify some algae functional groups discovered in Great Barrier Reef grouped according to their heights, with an assumption that difference group of herbivore fish grazing on different level of height of algae growth was carried out [8].

The effect from algae grazing depends on their functional group (turf, CCA) and algae characteristic (toughness, chemical defense) and other occupied herbivores (crustaceans, mollusks, echinoids, fishes or mega fauna such as manatees). For instance, fleshy algae are more fragile to be grazed than calcified fructose algae, even though the fleshy algae contains lots of chemical compound which deter fish to consume. However, this does not apply to invertebrates such snails [8]. Some studies have been carried out on relationship between reef fish and benthic algae, especially macro algae, by cage or natural design. Nevertheless, the intensity of grazing according to their functional groups versus functional group of benthic algae has not been more explored yet, particularly in Indonesia waters. Hence, this study was held to reveal how the composition of herbivore reef fish can control the existence of algae coverage in coral reef resilience.

MATERIALS AND METHODS

Location and Description of Study Area: The study was conducted in Barranglompo Island, Makassar from March to June 2012. A-50 m line transect with three replicates was deployed in three different sites according to algae domination. Site A dominated by epilithic algal matrix (EAM), site B dominated by turf algae (TA) and site C was covered by comparable EAM and TA (MIX). EAM and TA are the most functional groups of benthic algae seen in most coral reefs. Abundance and biomass of herbivore fishes was observed by underwater visual census (UVC) on each transect. All species of herbivore fishes were observed, the number was counted, size was estimated into size categories and then grouped functionally. The abundance of each functional group was revealed as individual per 250 m². Biomass was counted according to fish weight by formula: W=a x L², where the a and b are constant for each species [14].

Benthic coverage was observed by quadrant method, installed along the line transects used for herbivore fishes observation, at least five quadrant transect of 10x10cm² on each site [15-17]. Algae benthic coverage observed along transects was set into their functional group, which fill the whole quadrant for at least more than 85% coverage – assumed as the severe phase shift measurement [18]. To obtain percentage of algae coverage accurately, a-100 sub quadrant of 1x1 cm² was virtually set. The observation of benthic algae coverage was done periodically to understand in what extent the effect of grazing herbivore fishes to benthic algae. Algae were identified to genus of each functional group, referring to [19]. ANOVA was used to test the difference of abundance and biomass of herbivore fishes to dominated algae. ANOSIM, SIMPER and MDS tests with PRIMER 6 done to reveal similarity the functional herbivore fishes on each alga.

RESULTS AND DISCUSSION

Dynamics of Group of Algae: The dynamic of both benthic algae groups’ coverage on site A and C tend to differ, whilst in site B tend similar in Figure 1. Correlation analysis showed no correlation between the change of coverage neither to EAM nor TA on site A and C, however there was a positive Pearson correlation on site B (r = 0.961, P<0.01). This indicated that site B showed similar proportion dynamic of EAM and TA, hence the proportion of their predator (functional groups of herbivore fish) seems alike.

The average of abundance and biomass of each functional group of herbivore fishes were illustrated in Figure 2. MDS ordination of abundance and biomass of herbivore fish functional groups demonstrated the clear pattern clump. This revealed from pair wise comparison
test (one way layout ANOSIM) amongst all groups which significantly different (R=0.604-1.000, p<0.05).

SIMPER procedure showed the average of dissimilarity between site A and B was 13.15% for abundance and 10.80% for biomass. The most contribute of functional group of dissimilarity was scrapers for abundance and browsers for biomass. In site A and C, the average dissimilarity was 5.45% for abundance and 12.27% for biomass; the contributing group was scrapers, both for abundance and biomass. In site B and C, the average dissimilarity was 5.97% for abundance and 15.36% for biomass. The most contributing group was the excavators for abundance and browsers for biomass.

**Dynamic of Algae and Herbivore Fish:** The relationship between the dynamics of algal cover with and with algal cover with biomass of fish herbivore for each functional group can be seen in Figure 3. At site A, the results of Pearson correlation analysis showed a negative correlation between the EAM with browsers biomass and biomass excavators to the same value (r=0.900, P<0.05).

Site B there is a negative correlation between the abundance of scrapers with EAM (r = 0.817, P <0.05) and TA (r = 0.907, P <0.05), as well as the negative correlation of the abundance of grazers with TA (r = 0.865, P<0.05).
Fig. 2: Average abundance (ind/250 m²) and biomass (kg/ha) of each of the functional groups of reef fish herbivore at each study site. Description: a and b are the results of Tukey Multiple Comparison Test.

Fig. 3: Dynamics of benthic algal cover versus abundance (ind/250 m²) and biomass (kg/ha) for each functional groups of reef fish herbivore at each study site.

At site C, the EAM is negatively correlated with the abundance of grazers ($r = 0.873$, $P < 0.05$) and biomass browsers ($r = 0.823$, $P < 0.05$). EAM functional groups (epilithic algal matrix) are a component of the reef and into the main substrate wiped out by most of reef fishes [20]. Generally, the group size is <10 mm, consist of various types of benthic algae, beside other elements of detritus within 10-70%. The types of algae that were observed include calcareous algae and Neogoniolithon. The Pearson analysis showed that all functional groups of fish herbivore were correlated with EAM in different locations and only grazers and scrapers are correlated with TA (turf algae).

Almost all functional groups of herbivore fish in this study tend to like the EAM, while the browsers and grazers like both the EAM and TA. This preference is also found in fish herbivore in the Caribbean [21] and the Indo-Pacific [22]. Analysis of the stomach contents of some species also supports the existence of some kind of EAM and TA. Amongst the grazers such as Siganus guttatus, the scrapers Scarus rivulatus and excavators Chlorurus microrhinos consume EAM [23], but also pick calcareous macroalgae up when present in abundance. Groups of grazers such as Siganidae obviously pick up Sargassum sp (Phaeophyta) and avoid macro calcareous algae [24].

Previous studies had reported that the gut content of the grazers (Zebrasoma xanthurum) consists of brown
algae (44.4%) as the main meal, followed by red algae (26.4%), blue-green algae (18.2%), green algae (4.7%) and diatoms (2.4%). Other species such as Ctenochaetus striatus contain sand and coral rubbles (58.6%) substrates, diatoms (8.6%), red algae (7.6%), brown algae (6.7%) and blue-green algae (5.6%) [25].

CONCLUSION

The dynamics of EAM group tend to correlate negatively with the scrapers while the TA group was negatively correlated with the grazers. It can be implied that benthic algae is so important to the growth and development of herbivores fish in the coral reef. More research should be done to study the dynamics of algae on different herbivores fish elsewhere in Indonesia.

REFERENCES

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