Biodiversity of macroalgae in Pari Island

E S Srimariana1*, M Kawaroe1, D F Lestari1, WA Setyaningsih1, A H Nugraha2

1Department of Marine Science and Technology, Faculty of Fisheries and Marine Sciences, IPB University, West Java, Indonesia
2Department of Marine Science, Faculty of Marine Sciences and Fisheries, Maritime Raja Ali Haji University, Tanjungpinang, Riau Island, Indonesia

*e-mail: endangsunarwatis@apps.ipb.ac.id

Abstract. Macroalgae is one of the marine biological resources that have the potential to be utilized further by humans. This research aims to study macroalgae diversity in Pari Island. The study was conducted at two stations using the line transect method at the reef flat area. The results of this study indicate that there are 3 class macroalgae found in Pari Island. 17 species of macroalgae found in the south of Pari Island and 10 species found at the North of Pari Island. Macroalgae species with high abundance are Padina minor and Halimeda opuntia. The highest macroalgae diversity was found at south Pari Island with a diversity value index 2.02.

1. Introduction
Macroalgae is an organism that plays a role as a source of productivity in the marine ecosystem. Macroalgae have an important role in ecological and human life [1][2]. Several types of macroalgae which found in waters have economic value and significant advantages for human such as, Gracilaria, Sargassum, and others that can be used as a source of medicines, food and industrial basic materials [2].

The aquatic environment conditions strongly affect the distribution of macroalgae types in nature [3]. Some factors that affect the diversity of macroalgae in waters are light penetration, substrate waters, the concentration of nutrients in the waters, and the condition of coral cover [4]. Also, the season affects the distribution of macroalgae in nature.

Pari Island is a small island located in the Seribu Island region. Currently, there has been a decrease in the aquatic environmental quality, due to high human activities in the area such as tourism and development area [5]. It certainly would give an impact on biodiversity conditions, including macroalgae. The study that related to the distribution of macroalgae types in Pari Island is very important, it can be used as a database related to macroalgae-species information found in Pari Island.

2. Methods
This study was conducted in April 2018, in the reef flat area located in Pari Island, Seribu Islands. There are two stations in this research (Fig. 1), the first station is located on southern of Pari Island and the second station on northern of Pari Island.
Macroalgae data collection method was carried out at each station by using the belt transect method by taking the length of the transect line along the reef plat perpendicular to sea and the transect width of 2 meters. Subsequently, the transaction was identified and recorded against the types of macroalgae. Univariate analysis approach was to describe some ecological indicators through a diversity index. Diversity index was based on Shannon and Wiener index with the following formula:

$$H' = - \sum \left( \frac{n_i}{N} \right) \ln \left( \frac{n_i}{N} \right)$$  \hspace{1cm} (1)

where: \(n_i\) = number of individual in each species; \(N\) = total number of individual

Macroalgae dominant was calculated with the formula:

$$C = \sum \left( \frac{n_i}{N} \right)$$  \hspace{1cm} (2)

where: \(C\) = dominance index; \(n_i\) = number of individual species; \(N\) = total number of individuals

3. Results and discussion

3.1 Macroalgae diversity

According to observations at two stations in Pari Island. Total found eighteen species macroalgae from three-class, seventeen species found in southern of Pari Island and ten species found in northern of Pari Island (Table 1).

| Parameter       | Southern | Northern |
|-----------------|----------|----------|
| Total Species   | 17       | 10       |
| Total individu  | 327      | 92       |
| Density (ind/m²)| 2.86     | 1.90     |
The highest total individuals and densities are found at the southern station. The reef plat area at the north station has a substrate that mixed with mud at several observation points, thus impacting on the low intensity of light entering the water column. The southern station generally has substrate rubble and sand, it has an impact on the high intensity of light entering the water column and affects the high diversity of macroalgae [6]. Environmental and climatic factors affect the abundance of macroalgae [7]. There are 13 species of macroalgae found in Pari Island [8]. Pari Island located in the middle zone of Seribu Islands which generally have a high diversity of macroalgae than the northern and southern zone of Seribu Islands, it is influenced by environmental factors of the waters [4].

| No. | Species                   | Class    | Southern | Northern | Proportion |
|-----|---------------------------|----------|----------|----------|------------|
| 1   | *Boergesenia forbesii*    | Chlorophyta | +        | -        |            |
| 2   | *Caulerpa racemosa*       | Chlorophyta | +        | -        |            |
| 3   | *Caulerpa serrulata*      | Chlorophyta | +        | -        |            |
| 4   | *Caulerpa sertularioides* | Chlorophyta | ++       | +        |            |
| 5   | *Caulerpa* sp.            | Chlorophyta | +        | +        |            |
| 6   | *Chaetomorpha* sp.        | Chlorophyta | +        | +++      | 67%        |
| 7   | *Cladophora leativen*     | Chlorophyta | +        | -        |            |
| 8   | *Cladhopora simpsonii*    | Chlorophyta | -        | ++       |            |
| 9   | *Halimeda macroloba*      | Chlorophyta | +++      | +++      |            |
| 10  | *Halimeda opuntia*        | Chlorophyta | +++      | +++      |            |
| 11  | *Pseudocladophora conchophoria* | Chlorophyta | ++       | +        |            |
| 12  | *Ulva* sp.                | Chlorophyta | +        | -        |            |
| 13  | *Acanthopora spicifera*   | Rhodophyta | +        | -        |            |
| 14  | *Gracilaria salicornia*   | Rhodophyta | +++      | ++       |            |
| 15  | *Hypnea asiatica*         | Rhodophyta | +        | -        |            |
| 16  | *Laurencia* sp.           | Rhodophyta | +++      | ++       |            |
| 17  | *Palisada capituliformis* | Rhodophyta | +        | -        |            |
| 18  | *Padina minor*            | Phaeophyta | +++      | +++      | 6%         |

Based on the information in Table 2, it can be seen that macroalgae are dominated by the Chlorophyta class. The high abundance of Chlorophyta is due to a great level of Chlorophyta adaptation to changing environmental conditions [9].
The high value of Shannon-Wiener's index (H') was recorded in southern (2.02), followed by northern (1.84). It means that the diversity index of macroalgae at Pulau Pari is categorized as a moderate stable community. The Simpson (dominance) index varies between 0.16 and 0.19. The highest value was in the north (0.19) followed by south (0.16). The index ranges from 0-1, meaning low dominance since the value was less than 0.5. Diversity is dependent on key ecological.

3.2 Macroalgae abundance

Retrieval of macroalgae abundance data examines to determine the type of macroalgae which found along with the level of abundance at each observation station in Pari Island. The abundance of macroalgae types in Pari Island is presented on the graph in Figure 3.

Based on the information in Figure 3, several macroalgae species that have high abundance at both stations are *Padina minor*, *Halimeda*, and *Gracilaria salicornia*. *Padina* and *Halimeda* are commonly found in benthic habitats in small islands around Pari Island [4]. It shows that the two macroalgae are...
dominant around Pari Island. Also, *Padina* and *Halimeda* macroalgae belong to the cosmopolitan macroalgae group which is commonly found in Seribu Island waters [4]. The high abundance of *Halimeda* macroalgae is also caused by high resilience in different environments [10]. The underwater substrate condition also plays a role in determining the abundance of macroalgae, generally in the sand substrate found many macroalgae species of *Halimeda* and *Gracilaria* [11].

4. Conclusion
There are 18 types of macroalgae found in Pari Island waters. Macroalgae are generally dominated by Chlorophyta class. The types of macroalgae that have the highest abundance are *Padina minor*, *Halimeda opuntia*, and *Gracilaria salicornia*. Based on the diversity index, the diversity of macroalgae in Pari Island is in a moderate condition.

References
[1] Melville F 2005 *Mangrove Algae in the Assessment of Estuarine Pollution* [Dissertation] University of Technology, Sydney
[2] Radulovich R, Umanzor S, Cabrera R and Mata R 2015 Tropical seaweeds for human food, their cultivation and it's the effect on biodiversity enrichment *Aquaculture* **436** 40-46
[3] Bruno J F, Precht W F, Vroom P S, Aronson R B 2014 Coral reef baselines: how much macroalgae are natural? *Mar Pollut Bull.* **80** 24-29
[4] Draisma S G A, Van Reine W F P, Herandarude wi S M C and Hoeksema B W 2018 Macroalgal diversity along inshore-offshore environmental gradient in Jakarta Bay –Thousand Island reef complex, Indonesia *Estuarine, Coastal and Shelf Science* **200** 258-269
[5] Nugraha A H, Bengen D G and Kawaroe M 2017 Physiological response of *Thallasia hemprichii* on anthropogenic pressure in Pari Island, Seribu Islands, DKI Jakarta *Ilmu Kelautan* **22**(1) 40-48
[6] Hurrey L P, Pitcher C R, Lovelock C E and Schmidt S 2013 Macroalgal species richness and assemblage composition of the Great Barrier Reef seabed. *Mar Ecol Prog Ser.* **492** 69-83
[7] Dawes C J 1981 *Marine Botani* (New York: John Wiley & Sons)
[8] Paonganan Y 2008 Analysis of macroalgae invasion on the living coral colony related to the nutrient concentration sedimentation on Bokor Island, Pari Island, Payung Island DKI Jakarta [Dissertation]:IPB University
[9] Irwandi, Salwiyah and Nurgayah W A 2017 Structure community of macroalgae in the different substrates at Tanjung Tiram Village, District North Moramo, South Konawe, Southeast Sulawesi *Journal of Management Aquatic Living Resources* **2**(3) 215-224
[10] Kadi and Atmajaya W S 1988 *Seaweed, Species, Reproduction, Production, Culture and Post Harvest* (Indonesia Science Institute Jakarta)
[11] Lirman D 2001 *Competition between Macroalgae and Corals: Effects of Herbivore Exclusion and Increased Algal Biomass on Coral Survivorship and Growth* (Springer, New York) 392-399