The diversity of mangrove forests in Kumbewaha, Buton Island, Indonesia

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Abstract. This study aims to determine the diversity of mangroves in Kumbewaha, Buton, Indonesia. The method used in this study is line transect, data retrieval with roaming. The number of mangrove species found was 20 species and 17 mangrove tribes including, Acrostichum aureum (L.), Aegiceras corniculatum (L.) Blanco, Allophylus cobbe (L.) Raeusch, Avicennia marina (Forssk.) Vierh., Bruguiera gymnorrhiza (L.) Lam, Ceriops tagal (Perr.) C.B.Rob, Colubrina asiatica (L.) Brongn, Cordia sebestena (L.), Crinum asiaticum (L.), Cyclosorus heterocarpus (Blume) Ching, Desmodium umbellatum (L.) DC, Dendrolobium umbellatum (L.) Benth, Inocarpus fagifer (Parkinson) Fosberg, Nephrolepis falcata (Cav.) C. Christens, Pongamia pinnata (L.) Pierre, Rhizophora mucronata Lam, Scaevola taccada (Gaertn.) Roxb, Sonneratia ovata Backer, Thespesia populnea (L.) Sol. ex Correa, And Xylocarpus moluccensis M. Roem. Rhizophora mucronata Lam, is the type that has the highest diversity value (H’) of 0.863 while the lowest diversity value (H’) is the Sonneratia ovata Backer mangrove, with a value of 0.087.

1. Introduction
Mangroves are one of the plants that can live in coastal areas found along the coast or river estuary which are affected by tides. Mangrove forests have physical, chemical and biological roles that greatly support the needs of human life and as a buffer for the balance of ecosystems in coastal areas [1,2]. Physically, the mangrove forest serves as a coastal protector from the influence of ocean waves [3]. Mangrove forests as a complex ecosystem have many benefits and have functions especially for the environment [4]. The existence of mangrove forests for life, the benefits can be felt directly (direct use-value) such as utilization for firewood, fishing, crabs and ecotourism, and indirect use such as coastal abrasion, sediment retention, wave dampers and anchoring seawater intrusion [3,5].

Mangrove forests have a very high level of diversity. Diversity is a community that has different characteristics with other communities. The characteristics of the community in an environment are biodiversity, the more diverse the biotic component (biodiversity), the higher the diversity. The less diversity, it is said that biodiversity is low and, conversely, the more diversity, the higher the diversity [2,6,7]. Diversity includes all living things, one of which is the diversity of flora or the world of plants, as is the case with mangroves.
The high level of mangrove diversity makes mangrove forest a very valuable asset not only seen from its ecological function, but also from its economic function [3,8]. Mangroves are spread in several countries in the world with an area of around 19.9 million hectares, of which Indonesia is one of the countries that has extensive mangrove forests in the world. In addition, Indonesia has a very high level of mangrove diversity.

Many mangrove ecosystems grow in coastal areas [3]. The coastal area is a meeting area between land and sea [3,9]. The coastal area covers parts of the land, both dry and submerged in water and still influenced by the characteristics of the sea such as tides, sea breeze and seepage of salt water [9]. For coastal areas in the coast, it covers parts of the ocean which are still affected by natural processes that occur such as sedimentation and freshwater flow, as well as those caused by human activities [3,10].

One of the coastal areas that have many mangrove forest ecosystems is kumbewaha. The Kumbewaha region is part of the Southeast Sulawesi Province. This area is very rich in the potential of coastal, marine and fishery resources which include biological, non-biological and environmental services that serve as the basic capital of development. The potential of mangrove ecosystems found in Kumbewaha is very large for increasing marine and fisheries resources. The area of mangrove ecosystem around Kumbewaha is the settlement of people with fishermen's livelihoods and their catches in the form of fish, crabs and molluscs that live in the mangrove ecosystem.

2. Methods

2.1. Data collection techniques

Plot area measurements are used to characterize true mangroves [2]. The quadratic method is used for structural analysis of true mangrove flora. At each location, four transects are placed perpendicular to the water line at 50 m intervals. On each transect, five squares (5×5 m) were placed at 50 m intervals, taking into account the diversity of mangroves (figure 1). Each species in the square is identified, calculated, and analyzed.

![Figure 1. Schematic diagram of transect and quadratic locations at the study site [2]](image-url)
2.2. Research locations

![Map of research locations](image)

**Figure 2.** Maps research location

2.3. Data analysis

Data were analyzed by a variety index, diversity of Shanon (H') [11].

With the formula equation as follows:

\[
H' = -\sum \frac{n_i}{N} \log \frac{n_i}{N}
\]  

(1)

Where:

- $H'$ = Diversity Index
- $n_i$ = Amount of a type i
- $N$ = Total number of all types
The level of diversity based on the Shannon-Weaver diversity index is as follows:

a. The value of $H' > 3$ indicates that species diversity is abundantly high.
b. The values of $1 \leq H' \leq 3$ indicate that species diversity is moderate.
c. The value of $H' < 1$ indicates that species diversity is small or low.

3. Results and discussion

Based on the results of the study found 20 species and 17 tribes of mangroves including, *Acrostichum aureum* (L.), *Aegiceras corniculatum* (L.) Blanco, *Allophylus cobbe* (L.) Raeusch, *Avicennia marina* (Forssk.) Vierh, *Bruguiera gymnorrhiza* (L.) Lam, *Ceriops tagal* (Perr.) C.B.Rob, *Colubrina asiatica* (L.) Brongn, *Cordia sebestena* (L.), *Crinum asiaticum* (L.), *Cyclosorus heterocarpus* (Blume) Ching, *Desmodium umbellatum* (L.) DC, *Dendrolobium umbellatum* (L.) Benth, *Inocarpus fagifer* (Parkinson) Fosberg, *Nephelepis falcata* (Cav.) C. Christens, *Pongamia pinnata* (L.) Pierre, *Rhizophora mucronata* Lam, *Scaevola taccada* (Gaertn.) Roxb, *Sonneratia ovata* Backer, *Thespesia populnea* (L.) Sol. ex Correa, and *Xylocarpus moluccensis* M.Roem [1].

It is known that *Rhizophora mucronata* Lam, the highest diversity value ($H'$), was 0.86 while the lowest diversity value ($H'$) of *Sonneratia ovata* Backer mangrove was 0.087. If seen from the average diversity value overall, it can be stated that the diversity value of mangroves in Kumbewaha is relatively low. This situation is a factor that greatly affects the ecological and economic value of society [12,13]. This low diversity greatly affects the food chain and food webs found in the mangrove ecosystem [14,15].

| Mangrove sp                             | Index Diversity ($H'$) |
|----------------------------------------|------------------------|
| *Acrostichum aureum* (L.) (n-74)       | 0.319                  |
| *Aegiceras corniculatum* (L.) Blanco (n-62) | 0.352                  |
| *Allophylus cobbe* (L.) Raeusch (n-22) | 0.302                  |
| *Avicennia marina* (Forssk.) Vierh (n-8) | 0.172                  |
| *Bruguiera gymnorrhiza* (L.) Lam (n-87) | 0.266                  |
| *Ceriops tagal* (Perr.) C.B.Rob (n-24) | 0.313                  |
| *Colubrina asiatica* (L.) Brongn (n-12) | 0.221                  |
| *Cordia sebestena* (L.) (n-5)          | 0.126                  |
| *Crinum asiaticum* (L.) (n-7)          | 0.158                  |
| *Cyclosorus heterocarpus* (Blume) Ching (n-63) | 0.350                  |
| *Desmodium umbellatum* (L.) DC. (n-35) | 0.354                  |
| *Dendrolobium umbellatum* (L.) Benth (n-40) | 0.363                  |
| *Inocarpus fagifer* (Parkinson) Fosberg (n-7) | 0.158                  |
| *Nephelepis falcata* (Cav.) C. Christens (n-39) | 0.362                  |
| *Pongamia pinnata* (L.) Pierre (n-21) | 0.296                  |
| *Rhizophora mucronata* Lam (n-113)     | 0.863                  |
| *Scaevola taccada* (Gaertn.) Roxb (n-24) | 0.318                  |
| *Sonneratia ovata* Backer (n-3)        | 0.087                  |
| *Thespesia populnea* (L.) Sol. ex Correa (n-16) | 0.259                  |
| *Xylocarpus moluccensis* M.Roem. (n-57) | 0.361                  |

n = Number of individuals, $H'$= Diversity index
4. Conclusion
Conclusions from the results and discussion that there were 20 species and 17 mangrove tribes were found, with different levels of diversity of each species of mangrove plants. This is based on several factors including the conversion of mangrove forests to fishponds, the use of mangrove trees as firewood and building materials, the disposal of garbage around the mangrove area, consequently decreasing diversity will reduce the number of other types of biota that occupy the mangrove as their habitat and to forage [15,9].

References
[1] Giesen W 2006 M Angrove Guidebook
[2] Sreelekshmi S, Preethy C M, Varghese R, Joseph P, Asha C V, Bijoy Nandan S and Radhakrishnan C K 2018 Diversity, stand structure, and zonation pattern of mangroves in southwest coast of India J. Asia-Pacific Biodivers. 11 573–82
[3] Friess D A 2016 Mangrove forests Curr. Biol. 26 R746–8
[4] Salampessy M L, Febyano I G, Martin E, Siahaya M E and Papilaya R 2015 Cultural Capital of the Communities in the Mangrove Conservation in the Coastal areas of Ambon Dalam Bay, Moluccas, Indonesia Procedia Environ. Sci. 23 222–9
[5] Bosire J O, Dahdouh-Guebas F, Walton M, Crona B I, Lewis R R, Field C, Kairo J G and Koedam N 2008 Functionality of restored mangroves: A review Aquat. Bot. 89 251–9
[6] Sinfuego K S and Buot I E 2014 Mangrove zonation and utilization by the local people in Ajuy and Pedada Bays, Panay Island, Philippines J. Mar. Isl. Cult. 3 1–8
[7] Patarkalashvili T 2017 Forest biodiversity of Georgia and endangered plant species Ann. Agrar. Sci. 15 349–51
[8] Duncan C, Primavera J H, Pettorelli N, Thompson J R, Loma R J A and Koldewey H J 2016 Rehabilitating mangrove ecosystem services: A case study on the relative benefits of abandoned pond reversion from Panay Island, Philippines Mar. Pollut. Bull. 109 772–82
[9] Mbense S, Rajkaran A, Bolosha U and Adams J 2016 Rapid colonization of degraded mangrove habitat by succulent salt marsh *South African J. Bot.* **107** 129–36

[10] Gao Y, Zhou J, Wang L, Guo J, Feng J, Wu H and Lin G 2019 Distribution patterns and controlling factors for the soil organic carbon in four mangrove forests of China *Glob. Ecol. Conserv.* **17** e00575

[11] Shannon and Weaver 1963 *The mathematical theory of communication* (Urbana University Illinois Press)

[12] Dangan-Galon F, Dolorosa R G, Sespeñe J S and Mendoza N I 2016 Diversity and structural complexity of mangrove forest along Puerto Princesa Bay, Palawan Island, Philippines *J. Mar. Isl. Cult.* **5** 118–25

[13] Englong A, Punwong P, Selby K, Marchant R, Traiperm P and Pumijumnong N 2019 Mangrove dynamics and environmental changes on Koh Chang, Thailand during the last millennium *Quat. Int.* **500** 128–38

[14] Roy M, Ray S and Ghosh P B 2012 Modelling of Impact of Detritus on Detritivorous Food Chain of Sundarban Mangrove Ecosystem, India *Procedia Environ. Sci.* **13** 377–90

[15] Martin C, Almahasheer H and Duarte C M 2019 Mangrove forests as traps for marine litter *Environ. Pollut.* **247** 499–508