DIVERSITY OF GASTROPOD AND BIVALVE MOLLUSCS IN THE KAISU MANGROVE FOREST OF SARMI REGENCY, PAPUA PROVINCE, INDONESIA

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Abstract

Molluscs play important roles in the mangrove ecosystem. However, scientific information related to gastropod and Bivalvia in Kaisu mangrove is not known for certain. Thus, this study aims at identifying the diversity of molluscs (gastropod and Bivalvia) in Kaisu mangrove forest. This study used descriptive method with observation techniques. The observation station was determined using purposive sampling which is considering the zonation of mangrove vegetation. The taken data were analyzed qualitatively and quantitatively based on each parameter and therefore presented in tables and figures (charts, graphs and photographs). The resuls of the study show that in the Kaisu mangrove forest of Bongga District, Sarmi Regency, 10 species of molluscs were identified with 1804 individuals consisting of 8 species of gastropoda (*Telescopium telescopium, Steno melani, Nerita articulate, Ellobium aurisjudae, Cheritidea obtuse, Indothais gradate, Spherassiminea mimata, Littoraria melanostoma*) and 2 species of bivalvia (*Geloina expansa, Anumalocardi squamasa*). The dominance index of the mollusca species of this mangrove forest was 0.74, indicated the dominance of *Telescopium telescopium* with species diversity index of 0.27 (low category) and a species evenness index of 0.32 (low category).

Keywords: *molluscs, bivalvia, mangrove forest, ecosystem*

Introduction

Mangrove plays a very important role for the live of wildlife including birds, mammals, reptiles, fishes and other organisms such as molluscs (Angrianto, et al., 2018). Mangroves are among the world's most productive ecosystems (Berger, et al., 2008). It is one of the biologically diverse ecosystems in the world, rich in organic matter and nutrients and support very large biomass of flora and fauna (Prabhakar, 2012). High rates of tree and plant growth, coupled with anaerobic, water-logged soils that slow decomposition, result in large long-term C storage within the mangroves (Murdiyarso, et al., 2015). In the economic point of view, they have a very high economic and ecological value because of the large range of ecosystem goods and services they offer (Clüsener-Godt & Cárdenas Tomažič, 2016). Mangroves are highly beneficial, because they yield many valuable products, while also performing, free-of-cost, many important functions that support the often-dense coastal populations (Balasuriya, 2018).

Molluscs are the second species-rich phylum in the world after the arthropods (Prié, 2019). They are soft-bodied, unsegmented animals, with a body organized into a muscular foot, a head, a visceral mass containing most of the organ systems, and a fleshy mantle that secretes the calcareous shell (Pyron & Brown,

2015). According to Brusca & Brusca (1990), Mollusca consists of seven classes namely Polyplacophora (chiton), gastropod (snail), bivalve (clam), Scaphopoda (hornshell), Cephalopoda (squid or chiton), aplacophora and monoplacopora. Bivalvia group is a group that plays a vital role in the ecosystem of mangrove forest as well as in common people who are living in the coastal region. Molluscs are a valuable source of high-quality proteins, and rich in minerals and vitamins (Corbeil & Berthe, 2009).

Along with crustaceans, Molluscs play important roles in the mangrove ecosystem, processing mangrove-derived and algal detritus through their feeding and bioturbation activities (Kristensen, Bouillon, Dittmar, & Marchand, 2008). According to (Pramudji, 2001), Mollusca inhabiting mangrove forests in Indonesia are generally dominated by gastropod, which are around 61 species. Gastropod in mangrove ecosystems has important values, both ecologically and economically. Gastropod (limpets, snails, whelks, slugs) is by far the most diverse group of mollusc with about 100,000 species (0.5 mm to 100 cm long) that inhabit all marine, freshwater and terrestrial habitats (Haszprunar & Wanninger, 2012). In terms of ecological aspect, gastropod is considered as type of fauna that have a role in food chain. Gastropod are detritus-eaters that have function in tearing and minimizing newly fallen litter, and accelerating the process of litter decomposition which is done by microorganisms (Pramudji, 2001; Rusnaningsih, 2012). Gastropod in mangrove ecosystem also have economic value, which are used by coastal community as food, for instance, *Terebralia palustris*, *Telescopium telescopium*, and *Cerithidea obtusa* (Rusnaningsih, 2012).

The total area of mangrove forests in Papua Island included Papua and West Papua is estimated to reach 1.3 million ha (Angrianto, et al., 2018). The mangrove areas in Papua covers the North and South coasts of Papua Island, Saireri Bay, Mamberamo River, Homblot Bay, Wasoki Bay, Ansus, the Eastern part of between Biak and Yapen Islands. In the Southern Part of West Papua, in addition, mangroves flourish along the Waigeo coast, the northern part of Barai peninsula around Bintuni Bay (Angrianto, et al., 2018), of which mangroves in Bintuni is the most significant ecosystem in storing large number of carbon (Taberima, Nugroho, & Murdiyarso, 2014).

Sarmi Regency is an area that has several locations of mangrove forests distribution, including along the East coast. The distribution of mangroves in the area is not only potentially related to ecological function, but also related to the socio-economic conditions of the community. Ecologically, mangrove forest has an important role as a buffer zone which protects coast from Pacific Ocean waves. Mangroves play an important role in buffering coastlines against storm surges and tsunamis through wave attenuation (Kathiresan & Rajendran, 2005). For socio-economic matters, mangroves provide benefits for coastal communities' livelihoods. The socio-economic value of the mangrove is likely to be more than double of the direct forest product value through the ecosystem linkage with the aquatic production and the effect on fishery (Christensen, Tarp, & Hjortsø, 2008). A number of potentials inhabiting fauna such as fish, shrimp, crabs become important part of the mangrove ecosystem. Similarly, Mollusca groups (gastropod and Bivalvia) are known to play an important role in mangrove ecosystem and

people's lives. Yet, scientific information related to gastropod and Bivalvia in Kaisu mangrove is not known for certain. Therefore, the aim of the research is to examine the diversity of molluscs (gastropod and Bivalvia) in Kaisu mangrove forest.

Method

This research was conducted in the Kaisu mangrove forest, the District of Bonggo in Sarmi Regency, Papua Province of Indonesia. The study was done for two months from October to November 2019. The equipment used consisted of GPS (Global Positioning System), levers, plastics, collection bottles, tweezers, digital camera, Vernier caliper, surgical boards, gauges, raffia and stationery. The materials used were label paper and alcohol 70% and formalin.

The study used descriptive method with observation techniques. The observation station was determined using purposive sampling which is considering the zonation of mangrove vegetation. The Kaisu mangrove forest has characteristics and species relatively similar with a forest width of approximately 150-350 m. Considering the condition, 2 observation sites (sampling stations) were determined in one transect 320 m long with site I position (75 m from land-sea point) dominated by *Rhizophora* sp, *Avicennia* sp, *Bruguera gymnorhiza*), and site II (position 250 m from point 0 or 175 m from site I which was presented by species like *Rhizophora* sp, *Bruguera gymnorhiza* and *Sonneratia* sp). Each site had one observation plot with size of 20 m x 20 m.

The main variables observed were morphological characters of mollusca (gastropoda and bivalvia) in form of color, body size (length, width, diameter expressed in cm) in order to determine the species and number of individuals. Besides, general condition of study site was documented.

Collecting samples of mollusca (gastropoda and bivalvia) were done at low tide and in sunny day. The samples on substrate and attached to mangrove roots (inside the plot) were taken entirely. The collected samples thus were preserved using alcohol 70% and put into specimen box. Furthermore, the samples were identified using the journal (Jutting, 1956), (Poutiers, 1998), (Houbrick, 1991), (Karyanto & Hadisusanto, 2004).

The taken data were analyzed qualitatively and quantitatively based on each parameter and therefore presented in tables and figures (charts, graphs and photographs). To determine the abundance of species in the area, the equation was used as follows:

$$A = \frac{xi}{ni}$$

Note: A = Abundance (number of individual / $20m^2$); xi = number of individuals; ni = Number of squares

The concentration of individual species of mollusca was determined using index of domination (C) ((Simpson, 1949) in (Odum, 1993)) as followed:

$$C = \left(\frac{ni}{N}\right)^2$$

Note: C = index of dominance; ni = number of individuals of a species; n = number of individuals of all species

Domination is a community characteristic that shows the abundance of species in a region ((Odum, 1971) in (Cappenberg & Panggabean, 2005)). The criteria of domination index according to (Odum, 1993) are: 0 <C <0.5 = There are no dominant species; 0.5> C> 1 = There are dominant species.

To determine the diversity of mollusca as an indicator of habitat, species index diversity (H) according to Shanon and Wiener (1949) in (Magurran, 1988) was used with the equation:

$$H = -\sum \left[\frac{ni}{N}\right] \ln \left[\frac{ni}{N}\right]$$

Note: H = diversity index (Shanon-weinner index); ni = Number of individuals of a species, N = Number of individuals of all species.

The evenness of species of mollusca at the study site was analyzed using the index of evenness (e), according to (Pielou, 1966) in (Odum, 1993), (Pielou, 1966) in (Bratawinata, 1988) as follows:

$$e = \frac{H'}{LogS} = \frac{H'}{Hmax}$$

$$Hmax = 2\ln s$$

Note: e = species evenness index; H = species diversity index; S = Number of species

Evenness index according to (Krebs, 1985) in (Sinery, 2015) ranged from 0-1, where: 0.6-1 = high species evenness; 0.4 <e <0.6 = moderate species evenness; 0–04 = low species evenness.

Results

Species Composition

Based on identification of the morphological characteristics, 10 species of Mollusca were identified in the Kaisu mangrove area, which were consisting of 7 families and 8 species of gastropoda, 2 families and 2 species of bivalves (Table 1 and Table 2).

Table 1. Composition of Mollusca in the Kaisu Mangrove Forest

No	Family	Species	Individual	Percent (%)
Gastropoda				
1	Potamididae	*Telescopium telescopium,* Linnaeus, 1758	1550	85,92
2	Thiaridae	*Steno melania,* Fischer, 1885	100	5,54
3	Neritidae	*Nerita articulat,* Linnaeus, 1758	55	3,05
4	Ellobiidae	*Ellobium aurisjudae,* Roding, 1798	51	2,83
5	Potamididae	*Cheritidea obtusa,* Lamarck, 1822	23	1,27

6	Muricidae	*Indothais gradata,* Jonas, 1849	7	0,39
7	Assimineidae	*Sphaerassiminea miniata*	4	0,22
8	Littorinidae	*Littoraria melanostoma, Gray, 1839*	2	0,11
Bivalvia				
9	Corbiculoidea	*Geloina expansa,* Mousson, 1849	10	0,55
10	Veneridae	*Anumalocardi squamasa,* Linnaeus, 1758	2	0,11
		Amount	1804	100

Table 2. Composition of Molluscas by Site

No	Species	Individual	
		Site I	Site II
1	*Telescopium telescopium,* Linnaeus, 1758	1500	50
2	*Steno melania,* Fischer, 1885	100	
3	*Nerita articulata,* Linnaeus, 1758	30	25
4	*Ellobium aurisjudae,* Roding, 1798	51	
5	*Cheritidea obtusa,* Lamarck, 1822		23
6	*Indothais gradata,* Jonas, 1849		7
7	*Sphaerassiminea miniata*	4	
8	*Littoraria melanostoma,* Gray, 1839		2
9	*Geloina expansa,* Mousson, 1849	10	
10	*Anumalocardi squamasa,* Linnaeus, 1758	2	
	Amount	1697	107

Note : Site I: mud substrate (land / mid zone),
Site II: mud substrate with sand (mid zone and sea)

Domination, Diversity and Evenness Index of Mollusca

In this research, the level of species domination, variation of species and evenness of species, as indicators of community stabilization in the Kaisu mangrove forest, were analyzed using the dominance, diversity and evenness index. The dominance, diversity and evenness index of Mollusca species in Kaisu mangrove area were presented in the following Figure 1.

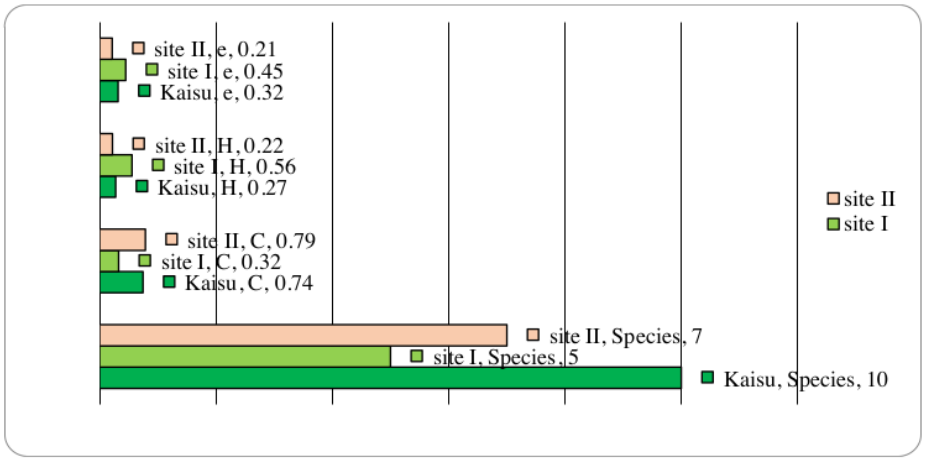

Fig 1. Domination index (C), diversity index (H) and evenness index (e) of mollusca in the Kaisu mangrove forest

Discussion

The data presented in the Table 1 revealed that composition of the mollusca in Kaisu mangrove forest was less compared to the study by (Nurrudin, Hamidah, & Kartika, 2015) in the vicinity of TPI Parit 7, Tungkal I Village, Tanjung Jabung Barat, which found 15 species. Similarly, (Ayunda, 2011) identified 33 species of gastropods in the mangrove ecosystem in the Gugus Pari Island, 19 species of gastropods in the Cilacap mangrove ecosystem (Karyanto & Hadisusanto, 2004), 16 species of gastropods in the mangrove forests of Teluk Awur Jepara (Silaen, Hendrarto, & Supardjo, 2013), 29 species of gastropods in the mangrove forest area of Segara Anakan Cilacap (Pribadi, Hartati, & Suryono, 2009), 14 species of Gastropods and 5 species of Bivalves in Aceh Besar (Irma & Sofyatuddin, 2012), and 14 families of mollusks comprised of 11 gastropod families (21 species) and bivalve families (3 types) in North Sulawesi (Baderan, Hamidun, Utina, Rahim, & Dali, 2019). Many species of gastropods found in that study were due to the wider research location and longer sampling time. While in this research, the location of the research was not large and the sampling time was limited.

Telescopium telescopium was the species with the highest number of individuals found at the study sites. Furthermore, *Littoraria melanostoma* and *Anumalocardi squamasa* were species with a smaller number of individuals. It could be seen as well that distribution of the species at the two sites or observation plots tended to be different. Site I was part of land side or deepest zoning in the mangroves formation which was characterized by slightly hard substrate. Site II was middle zonation near to the outer and contained muddy substrate. The location was dominated by anchor root plants (*Rhizopora* sp.). The result revealed that 10 species of Mollusca were identified in the observation sites and only 2 species could be found at the two observation sites, which are *Telescopium telescopium* and *Nerita articulate*, as shown in the following table.

1) Telescopium telescopium, Linnaeus, 1758

Telescopium telescopium belonged to gastropod group and was found with the highest number of individuals in the sites study. It is one of the organisms lives in mangrove (Kurniawati, Bengen, & Maddupa, 2014). This species was commonly known as a mangrove-dwelling gastropod with habitat criteria which have open land, fine muddy, sufficiently large puddles, and have high availability of organic matter (Budiman, 1991). According to (Poutiers, 1998), the species could be found on mangrove floors where condition was very brackish. This type of gastropod had a pointed apex, with a length of about 11-13 cm, blackish-brown shell and the surface of the shell had a tight suture and spiral cords. According to Jutting (1956) *T. telescopium* was purplish brown or dark brown. The aperture of *T. telescopium* was oblique in shape, relatively small, and narrow (Poutiers, 1998; Houbrick, 1991). This species adapted to both inundated and non-inundated mud substrate and were found in the two observation plots.

2) Steno melania, Fischer, 1885

Steno melania was one species of the gastropod and it was found in the largest number of individuals after *Telescopium telescopium*. This species inhabited mangrove forests in both waterlogged and dry mud substrate. This species was distributed limited in the location and could only be found in site II.

3) Nerita articulata, Linnaeus, 1758

Nerita articulata was one of the gastropod species. The species was dwellers in the mangrove area and found in high number after *Telescopium telescopium* and *Steno melania*. This species was found on mud substrates and fairly distributed on the location. This species had black spiral cords with a combination of yellowish-brown color. The size of the shell was relatively small. The species was fairly distributed so it could be found in the observation sites.

4) Ellobium aurisjudae, Roding, 1798

Ellobium aurisjudae was one of the most abundant gastropoda found in the study site after *Telescopium telescopium, Steno melania* and *Nerita articulata*. This species inhabited mangrove forest and was found on the mud substrate. Based on field observation, the species was only found at site I.

5) Cheritidea obtusa, Lamarck, 1822

This species of gastropoda was found on muddy substrates and only at the site II. According to (Poutiers, 1998), *Cerithidea obtusa* was commonly found in roots and stems of mangroves as well as mud substrates. They are widely found in mangrove ecosystem across the Asia-Pacific (Cahyani, 2015). *C. obtusa* had a blunt apex, a shell length of about 3.5-4.1 cm, and a yellowish-brown shell color. According to (Jutting, 1956), *C.obtusa* shells were brown or purplish brown with a slightly lighter part of the suture and the base of the whorl widens with a slightly brown or yellowish color with a dark brown zone. Outer and inner lips were glossy

white (Poutiers, 1998). The aperture in *C. obtusa* was wide and circular in shape (Jutting, 1956; Karyanto & Hadisusanto, 2004).

6) Indothais gradata, Jonas, 1849

Indhothais gradata was a species of gastropod found only at the site II. They inhabit both hard and soft substrata (Proum, Santos, Lim, & Marshall, 2016). As other species of molluscs, this species was found on muddy substrated and considered as inhabitant of mangrove vegetation.

7) Spherassiminea mimata

Spherassiminea mimata was a species of gastropod documented only at the site I. This species was found on a muddy substrated with a very small number of individuals. This species was the inhabitant of mangrove vegetation.

8) *Littoraria melanostoma*, Gray, 1839

Littoraria melanostoma was a species of gastropoda only recorded at the site II. Smilar to *S. Mimata,* the species was found on muddy substrated with very small number of individuals. This species was also the inhabitant of mangrove vegetation. the gastropod *Littoraria melanostoma* relied mainly on mangrove leaves and brown algae as food sources, with significant differences among the three mangrove forests, and showed significant seasonal variation in its diet (Chen, Yan, Xiong, Zhang, & Lin, 2017).

9) Geloina expansa, Mousson, 1849

Geloina expansa belonged to bivalvia group. Based on field observation, this species was only documented at the site I. The clams, known locally as Omapoko or Siini and Kawe or Kae, are used as protein source by local people (Dwiono, 2003). The species was found on muddy habitat as well as other species. This species was the inhabitant of mangrove vegetation. Shells of this type of shell can reach sizes of more than 120 mm, are oval in shape, the length of the shell is much larger than the height of the shell, the outer part is yellow in young shells and brownish yellow in adult shells. Umbo is somewhat convex; the dorsal side is flat. The anterior side is rounded. The inside of the skin is white, resembling chalk or porcelain. Hinge teeth are well developed but not as strong as *G. erosa*. Central and posterior cardinal teeth in the right shell and middle and anterior cardinal teeth in the left branching shell (Van Benthem Jutting, 1953).

10) Anumalocardi squamasa, Linnaeus, 1758

Anumalocardi squamasa belonged to bivalvia group and it was found only at the observation site I. This species was found on muddy habitat with a very small number of individuals. This species was also the inhabitant of mangrove vegetation. They are widespread species (Roopnarine, Signorelli, & Laumer, 2008) which reside in the 2-4 cm depth stratum (Lee, 1996).

The Fig.1 presents the dominance index of the mollusca species in the Kaisu mangrove was 0.74 (close to 1). This indicated the dominance of certain species, especially *Telescopium telescopium*. It similarly occurred in site II, however in site

I there was no apparent dominance of certain species. The criteria for dominance index according to (Odum, 1993) were 0 <C <0.5 = there was no dominant species; 0.5> C> 1 = There were dominant species. According to (Odum, 1971) in (Sinery, Farida, & Manusawai, 2016), the dominance of certain species explained that the species were more focus on an area as well as had greater influence in the community. According to (Odum, 1993), when the value of dominance index reached 1, then only one species was dominant in a community. Conversely, when the value of dominance index was 0, it indicated that there was no dominant species in a community.

The result shows that diversity index of mollusca in the Kaisu mangrove forest was 0.27. Observation also indicated species diversity of site II was higher than site I, however diversity both of sites was considered in the low category. According to Shanon and Wiener (1949) in (Odum, 1993), species diversity was considered high if the species diversity index was more than three (H≥3), medium if species diversity index was between one to three (1 <H <3) and low if species diversity index was less than one (H <1). Based on these criteria, the diversity of species of Mollusca in the Kaisu mangrove forest area was considered low.

(Odum, 1993) asserted that a community would have high species diversity if the community was composed of many species with the similar abundance or almost the same. Conversely, if the community was composed of several species and if only a very few species were dominant, then the species diversity was low. In addition, Vutman and Wiratun (1984) in (Sinery, Boer, & Farida, 2012) stated that the level of species diversity could describe the stability of ecosystem, when the diversity of species in an area is higher, the ecosystem tends to be more stable and it would develop interaction of species which could involve transfers energy, competition and more complex division of space.

Analysis of species evenness level shows that value of evenness index of mollusca species in Kaisu mangrove forest was 0.32, in which site I was 0.45 and site II was 0.21. (Krebs, 1978) in (Odum, 1993) stated that the evenness value was considered high when e ≥ 0.6, moderate when e = 0.4 <e ≤0.6 and low when e = 0 <e ≤ 0.4. Based on the criteria, the evenness index of mollusca in the Kaisu mangrove forest was low, including at site I and site II. The value of species evenness index, according to (Krebs, 1989) in (Sugianto, 1994), ranged from 0 to 1. According to (Santosa, 1995) in (Sinery, 2015), the evenness index of species indicated the size or proportion of individuals of each species in a community. If each species had similar number of individuals, then the community had maximum value of evenness index. Evenness refers to the relative abundance of species. It is high if all species have similar distribution (i.e., similar population density) (Baker & Savage, 2008).

The result revealed that 2 species of mollusca were found distributed in all sites. They were *Telescopium telescopium* and *Nerita articulata*. This indicated that the evenness of mollusca in the Kaisu mangrove area was low due to 10 species of molluscs identified, yet only 2 species (20%) were scattered at the two observation sites. Therefore, it can be said that *Telescopium telescopium* and *Nerita articulata* were more adaptable than other species in the Kaisu mangrove area. This condition

was influenced by habitat components such as the distribution of vegetations and substrates. Generally, the evenness of mollusca in the study site was mostly influenced by the presence of mangrove vegetations namely *Rhizophora* as well as other species such as *Sonneratia* sp, *Avicennia* sp and *Bruguera gymnorhiza* which were considered as source of organic material and habitat for molluscas. Moreover, condition of mud substrate which dominated the Kaisu mangrove forest area became a factor that affected the presence of mollusca in this forest. (Nurrudin, Hamidah, & Kartika, 2015) found out that characteristics of habitat and environmental conditions such as temperature, pH, salinity and types of substrate were factors that greatly influence the presence of mollusca besides the condition of the mud substrate. They are among the dominant group in structuring the mangrove ecosystem and also constitute a component of fouling communities (Vilardy and Polania, 2004 in (Mohanjaru, 2015). Bivalve and gastropod are considered as the main molluscs of mangrove forests and comprise an important trophic component of detritus-based food webs. Gastropods have high distribution in the mangrove forests probably due to their mobile characteristic, while bivalves are often confined to a narrow seaward zone, due to feeding, larval settlement restrictions and sediment texture such as low pH and high organic matter (Kabir, et al., 2014).

Conclusion

Based on the result of the analysis, this study concludes that the total number and species of gastropod and bivalvia identified in the Kaisu mangrove forest area of Bongga District, Sarmi Regency were 10 species with 1804 individuals consisting of 8 species of gastropda (*Telescopium telescopium, Steno melani, Nerita articulate, Ellobium aurisjudae, Cheritidea obtuse, Indothais gradate, Spherassiminea mimata, Littoraria melanostoma*) and 2 species bivalvia (*Geloina expansa, Anumalocardi squamasa*). The dominance index of the identified mollusca in the Kaisu area was 0.74, indicated by dominance of *Telescopium telescopium* with the species diversity index of 0.27 (low category) and species evenness index of 0.32 (low category).

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