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Factors affecting Avifanua in the Mangrove forest of Gitagum, Misasis oriental, Philippines

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ABSTRACT Mangrove habitat, microclimate, and human activities may affect avifauna species, especially, its diversity and distribution. This study aimed to assess the avifauna as affected by human activities, microclimate and mangrove factors in Barangay Pangayawan, Gitagum, Misamis Oriental. Point-count and mist-netting methods were used to sample birds, quadrat method for mangroves and microclimate factors were measured. Results showed 20 avifauna species which belong to eight (8) Orders and 17 Families, with a total of 1,056 specimens recorded in the site. In addition, four (4) mangrove species were identified under (3) Orders and (3) Families with a total of 239 specimens. Canonical Correspondence Analysis (CCA) was employed to determine the species-habitat relationship. Findings revealed that five (5) species of birds are closely associated with mangrove factors. It also showed that microclimate factors such as rainfall and relative humidity showed a negative correlation with avifauna diversity. However, human activities were observed in the site, hence, policies and ordinances should be strengthened and strictly implemented.

KEY WORDS Birds; conservation; endemic; mangrove; microclimate.

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INTRODUCTION

Mindanao is regarded as one of the Philippines largest islands, a nation composed with a diversity of flora and fauna species and a sanctuary to 676 bird species, 222 of which are endemic to the country, 325 are restricted to the island of Mindanao, and 90 are worldwide threatened (Amoroso et al., 2018).

One of the habitats of avifauna is the mangroves (Long & Giri, 2011). According to Rajpar & Zakaria (2015), tree size, tree height, cover percentage and its food availability are the foremost factors that influence the composition, richness, distribution and relative abundance of birds.

Birds serve as a significant indicator group for studying the impacts of climate change, especially on tropical ecosystems (Şekercioğlu, 2012). Unfavorable climates lead to an increase of site avoidance, which potentially reduces critical activities of birds, particularly its breeding displays and feeding (Sodhi et al., 2011).

Consequently, an increasing number of human disturbances in mangroves puts avian diversity at risk (Singh & Laura, 2013). Human activities threaten birds, degrading their habitat and directly impair their survival and reproductive success (Ascaño II et al., 2016). The closer human structures are to bird habitats, the fewer diverse bird species there will be.

This study had the following objectives: a.) to identify the composition, richness, abundance, diversity and status of avifauna in the mangrove

forest; b.) to determine the abundance, composition, diversity, range of canopy cover, diameter at breast height, and height; relative frequency, relative density, relative dominance and importance value of mangrove species; c.) to examine the microclimate factors such as air temperature, light intensity, rainfall and relative humidity in the area; and d.) to determine the avifauna species-habitat relationship using the Canonical Correspondence Analysis (CCA).

MATERIAL AND METHODS

Study area

This study was conducted in the coastal area of the mangrove rehabilitation site in Barangay Pangayawan (Fig. 1), the nature preserve in Gitagum, Misamis Oriental (8°35'14.46" N - 124°22'45.44" E). The total area of mangroves in the site is estimated at four (4) hectares along the coastal area. Moreover, Type III is the climate type of the site, which has seasons that are not particularly distinct, generally dry from November to April, and wet the remaining of the year.

Avifauna sampling

Sampling was done using a one (1) kilometer transect line along the coastline; specifically around 6:00 to 7:00 a.m. and 3:00 to 4:00 p.m. when the birds are active since they are diurnal species (Mohagan et al., 2015). Five (5) sampling points with a 250-meter interval were established for the point-count method (Olila & Relox, 2021). This method entailed walking along the transect line and stopping for ten (10) minutes at certain points, then recording all of the birds observed and heard (Kennedy et al., 2000).

For mist-netting, ten (10) mist nets were established during low tide per point within the study site. The mist nets were monitored and checked every 30 minutes to one (1) hour (Olila & Relox, 2021) every day of the week from 6:00 a.m. to 5:00 p.m. The captured bird species were removed from the net and every bird species captured were identified based on its morphometric data. The species were identified using the Guide to the Birds of the Philippines by Kennedy et al. (2000). The bird species were marked with nail polish and released back into the wild.

Mangrove sampling

Five (5) points with a distance of 250 meters along one (1) km transect line were established. In each point, three (3) 10m x 10m plots were established with an interval of 5 meters each. Sampling of mangroves was done along the transect line perpendicular to the shoreline, from where the points for point-count method were also established. The canopy cover, height and Diameter at Breast Height (DBH) of mangrove species were measured inside the plot.

The mangroves species was classified taxonomically based on its fruits, leaves, flowers and other characteristics up to the species level (Olila & Relox, 2021); wherein it is based on the study of Primavera (2009).

Microclimate data collection

Primary data of microclimate was acquired onsite. An anemometer was used to measure air temperature and relative humidity; rain gauge for rainfall; and light intensity meter for light intensity. Measurement of each microclimate factor was conducted daily and hourly in three trials to obtain an average result.

Data analysis of Avifauna Species-Habitat relationship

Pearson correlation was used to analyze the relationship between avifauna and mangrove factors (DBH, Height and estimated canopy) and relationship between avifauna species and microclimate factors (air temperature, relative humidity, light intensity and rainfall) in the area. Moreover, the software Statistical Package for the Social Sciences (SPSS) was used to calculate the Pearson correlation value.

In this study, CCA was used for ordination analysis to assess the relationship between the abundance of avifauna species with the mangrove species' estimated average canopy over, height and diameter at DBH and determine the trends of differences in the species data with the microclimate factors specifically: air temperature, relative humid-

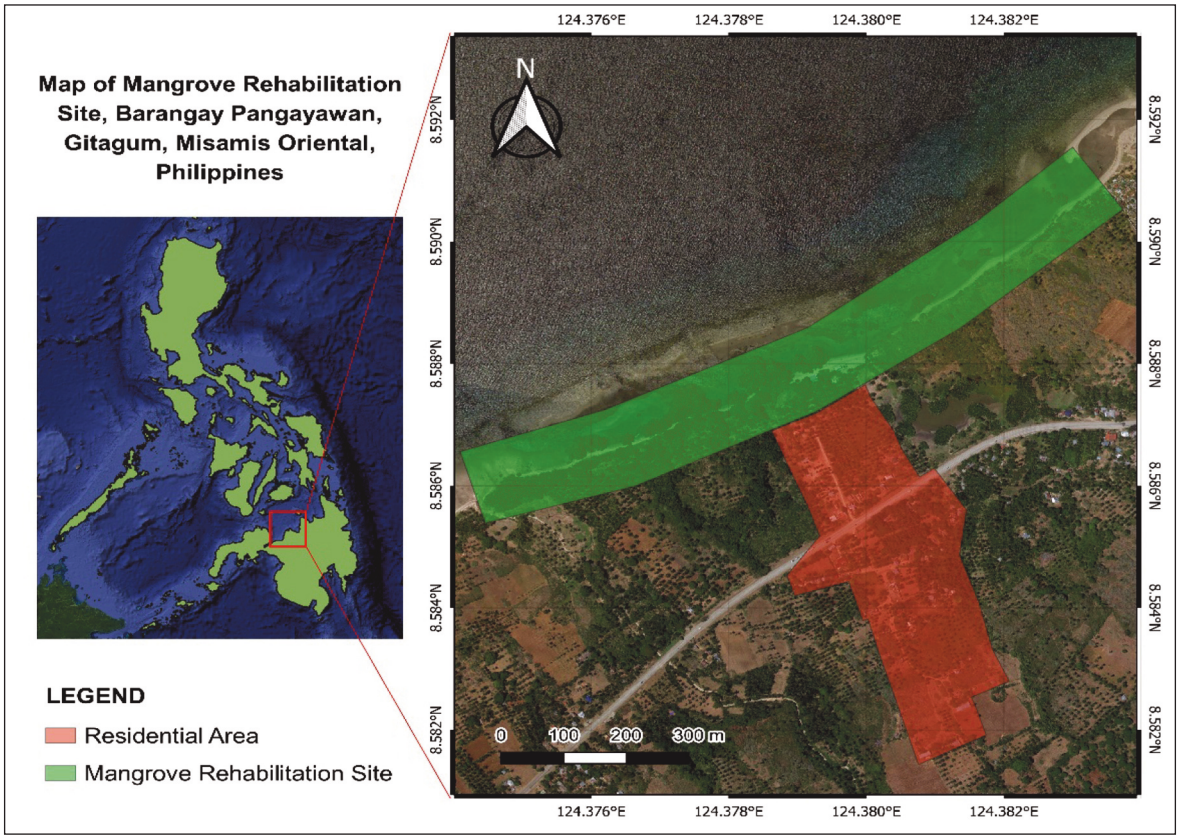

Figure 1. Map of the sampling site in Barangay. Pangayawan, Gitagum, Misamis Oriental.

ity, light intensity, and rainfall. In addition, this study used the Paleontological Statistics (PAST) software version 4.03 to compute and evaluate the findings.

RESULTS AND DISCUSSIONS

Species composition of Avifauna

There were 20 species of birds, belonging to eight (8) orders and 17 families. Most species were seen flying, eating, roosting and scavenging all over the mangrove site. Additionally, most of the listed bird species are associated with mangrove birds commonly found residing in the different regions of the Philippines (Cailing et al., 2018; Anunciado et al., 2021), and belong to the list of birds found in the Philippines (Kennedy et al., 2000).

Bird populations in mangrove habitats can be sustained by these food sources (Anunciado et al., 2021). So, the majorities of the avian species are insectivores and herbivores and commonly settle on the branches of *Sonerratia alba*. Insectivorous birds flock to mangrove forests (Zwarts, 2014), as well as herbivorous birds. The majority of the mangrove bird groups were generalist insectivores that separated insects by size and had moderate to high overlap in what they ate with other species (Mohd-Azlan et al., 2015). Two (2) species, *Todiramphus chloris* (Boddaert, 1783) and *Cinnyris jugularis* (Linnaeus, 1766), were caught using the mist netting method, and the rest were seen and heard using the point count method.

Diversity Index of Avifauna species

The mangrove rehabilitation site has a diverse avifauna with a combination of waterfowl birds, perching birds, chickens, and ducks. In Table 1, the data show that the evenness of the avifauna species is 0.38, which is low. This means that there is a

dominant species which is *Collocalia esculenta* (Linnaeus, 1758) and the population size is not evenly distributed for each species. In the Shannon-Wiener Diversity Index, it resulted in 2.01, which specifies that the mangrove site has a low diversity of avifauna. Mangrove forests with a simple structure may have a similar deterministic effect on the bird community. Habitat structure is a key factor in how species choose their homes and where they live, especially in complex ecosystems. It also contributes to the lower evenness and diversity of species (Mohd-Azlan et al., 2015). Moreover, the population of the bird would continue to decline as a result of developments in land use patterns caused by anthropogenic perturbations and conditions that may have an impact on the diversity of avifauna (Tandan et al., 2015).

Species composition and structure of Mangrove species

four (4) mangrove species were identified in the mangrove rehabilitation site of Gitagum, Misamis Oriental (Table 2), namely *Rhizophora stylosa, Sonneratia alba, Rhizophora apiculata,* and *Lumnitzera racemosa.*

Table 3 shows the mangrove species that were recorded (226 specimens) mostly fall under 2–30

	Diversity Index					
Species	**Evenness _e^H/S**	**Range of Evenness_e^H/S**	**Interpretation**	**Shannon_H'**	**Range of Shannon_H'**	**Interpretation**
Avifauna	0.38	0 = No evenness / 1 = Complete evenness	Low evenness	2.01	1.9 and below = Very low diversity / 3.5 and above = Very high diversity	Low diversity

Table 1. The evenness and diversity index of avifauna species in the mangrove rehabilitation site in Brgy. Pangayawan, Gitagum, Misamis Oriental.

Mangrove species				**Quadrat**				
Order/Family	**Species**	**Common name**	**Local name**	**1**	**2**	**3**	**4**	**5**
Malpighiales/ Rhizophoraceae	*Rhizophora stylosa* Griff.	Bakau Pasir	Bakhaw Bato	X	✓	X	✓	X
Rhizophorales/ Rhizophoraceae	*Rhizophora apiculata* Blume	Tall-stilt Mangrove	Bakhaw Lalaki	✓	X	X	X	X
Myrtales/ Combretaceae	*Lumnitzera racemosa* Willd.	White-flowered black mangrove	Culasi	✓	X	X	X	X
Myrtales/ Sonneratiaceae	*Sonneratia alba* Sm.	Mangrove Apple	Pagatpat	✓	✓	✓	✓	✓

Table 2. Taxonomic classification and composition of mangrove species found at mangrove rehabilitation site, Gitagum, Misamis Oriental, Philippines.

cm height, with one specimen under 91–120 cm height. *Sonneratia alba* was the tallest amongst other species, since it received minimal disturbance while the short height of other species could possibly be attributed to the time they have been planted. Due to its height, most avifauna species seen in the site had perched on tall *S. alba* trees.

With regards to the DBH, 234 specimens were recorded under 2–30 cm and only one (1) specimen of *S. alba* in 91–120 cm. As observed in the site, avifauna species were seen perching on old and large trees. Large sizes of trees host a greater diversity and abundance of insects with tree DBH (Beşkardeş et al., 2018), resulting in higher diversity of birds since it can be their source of food and shelter for its dense cover and defense from predators.

Furthermore, most of the mangrove specimens (243) recorded belong to a 0.3–6 m estimated canopy cover, and only one (1) specimen of *S. alba* had the widest canopy cover. Due to the age and large size of *S. alba*, these species are considered as old and mature, and had wider canopy than other species. A wider canopy may attract more avifauna species to forage or inhabit the tree, which may result in a higher diversity of avifauna.

Evenness and Diversity of Mangrove species

Table 4 presents the evenness and diversity value of mangroves in the study site. The calculated value for species evenness is 0.49, indicating that mangrove species evenness is low. While the mangrove diversity through the Shannon-Wiener diversity index was 0.68, resulting in a very low diversity of mangrove species.

This implies that the low evenness and very low diversity of mangroves can be attributed to the small number of mangrove specimens recorded in the site. Low evenness is due to the presence and

DBH Range	No. of specimens	Height Range	No. of specimens	Canopy Cover Range	No. of specimens
2 − 30 cm	234	1 − 10 m	226	0.3 − 6 m	234
31 − 60 cm	0	11 − 20 m	8	7 − 12 m	3
61 − 90 cm	4	21 − 30 m	4	13 − 18 m	1
91 − 120 cm	1	31 − 40 m	1	19 − 24 m	1

Table 3. Structure of mangrove species found at mangrove rehabilitation site, Gitagum, Misamis Oriental, Philippines.

	Diversity Index					
Species	Evenness _e^H/S	Range of Evenness_e^H/S	Interpretation	Shannon_H'	Range of Shannon_H'	Interpretation
Mangroves	0.49	0 = No evenness 1 = Complete evenness	Low evenness	0.68	1.9 and below = Very low diversity 3.5 and above = Very high diversity	Very low diversity

Table 4. Species evenness and diversity of mangrove species found in mangrove rehabilitation site, Gitagum, Misamis Oriental, Philippines.

high number of specimens of dominant species which are not evenly distributed in the site, including the different population size of all mangrove species. The fewer species of mangroves available in the site indicates that there is less accessibility for birds to forage and take shelter. The findings of this study are similar to the study of Taneo & Areola (2022), indicating that the mangrove community in Barangay Pangayawan, Gitagum has poor diversity of mangrove species because of low species richness and the abundance of most mangrove species.

Species-Habitat Relationship

It is seen in the Fig. 2 that five (5) species of birds namely: *Geopelia striata* (Linnaeus, 1766), *Spilopelia chinensis* (Scopoli, 1786), *C. esculenta*, *Gerygone sulphurea* Wallace, 1864 and *Passer montanus* (Linnaeus, 1758) are closely related with the mangrove factors specifically: DBH, height and estimated canopy cover, and microclimate factors namely: air temperature and light intensity. This implies that these avifauna species are abundant in the area where there is a greater DBH, height and canopy cover of mangrove trees, and high amount of light intensity and warmer temperature since it is their habitat preference.

This means that they are more productive in this area in finding their foods and having their nesting sites. These findings are supported by the study of Rajpar & Zakaria (2011) as they states that the number and diversity of vegetation in a habitat can provide various microhabitats, able to attract a larger number of bird species due to the availability of variety of food resources, suitable breeding sites, and shelter from inclement climate.

Moreover, it can also be seen that in axis one (1) in Fig. 2 there are bird species that have a negative association with the relative humidity and rainfall in the area. This depicts that these species do not prefer areas with high humidity and more occurrence of rainfall since they cannot perform their niches due to the disturbance caused by these microclimates in their environment. This is affirmed by the results in the study of Cabigquez et al. (2021), which stated that air temperature has a significant impact on the diversity of bird species, leading to a positive correlation; a decrease in temperature leads to fewer bird species than a high temperature. Microclimatic variables such as rainfall and relative humidity, on the other hand, showed a negative correlation with bird diversity.

In addition, there are also bird species that are not closely related to the environmental factors presented in the figure. This means that they do not depend on any of the mangrove factors and the microclimate factors do not affect their productivity in an area. They are just flying in the area, either along the shore or above the mangrove trees. As observed by the researchers, most of the birds were seen flying along the shore to catch their food like the *T. chloris*, which was always seen catching fishes in the shore. Furthermore, the area is also surrounded by beach forest and there is a cave, which can be the other habitats of the bird species found to be not closely related to any of the environmental factors.

CONCLUSIONS

Thus, this study revealed the mangrove rehabilitation site in Barangay Pangayawan, Gitagum, Misamis Oriental avifaunal species has low diversity and evenness because of the dominant species. So, this also means that the lack of habitat and food preferences of bird species affects their evenness and diversity in mangrove forest. In such avifauna, species are highly dependent on their environment, and this will affect their distribution, availability of food, and breeding season.

Hence, there is a need for an updated monitoring of the mangrove community should be established in the site, to provide insights, awareness and measures that should be undertaken by government agencies, LGUs and the community to preserve and manage the site. It is necessary to plant more diverse species of mangroves and that follows the appropriate mangrove zonation in the area. This is to increase the diversity of mangrove and avifauna species in the site and also for the protection and management of the coastal area.

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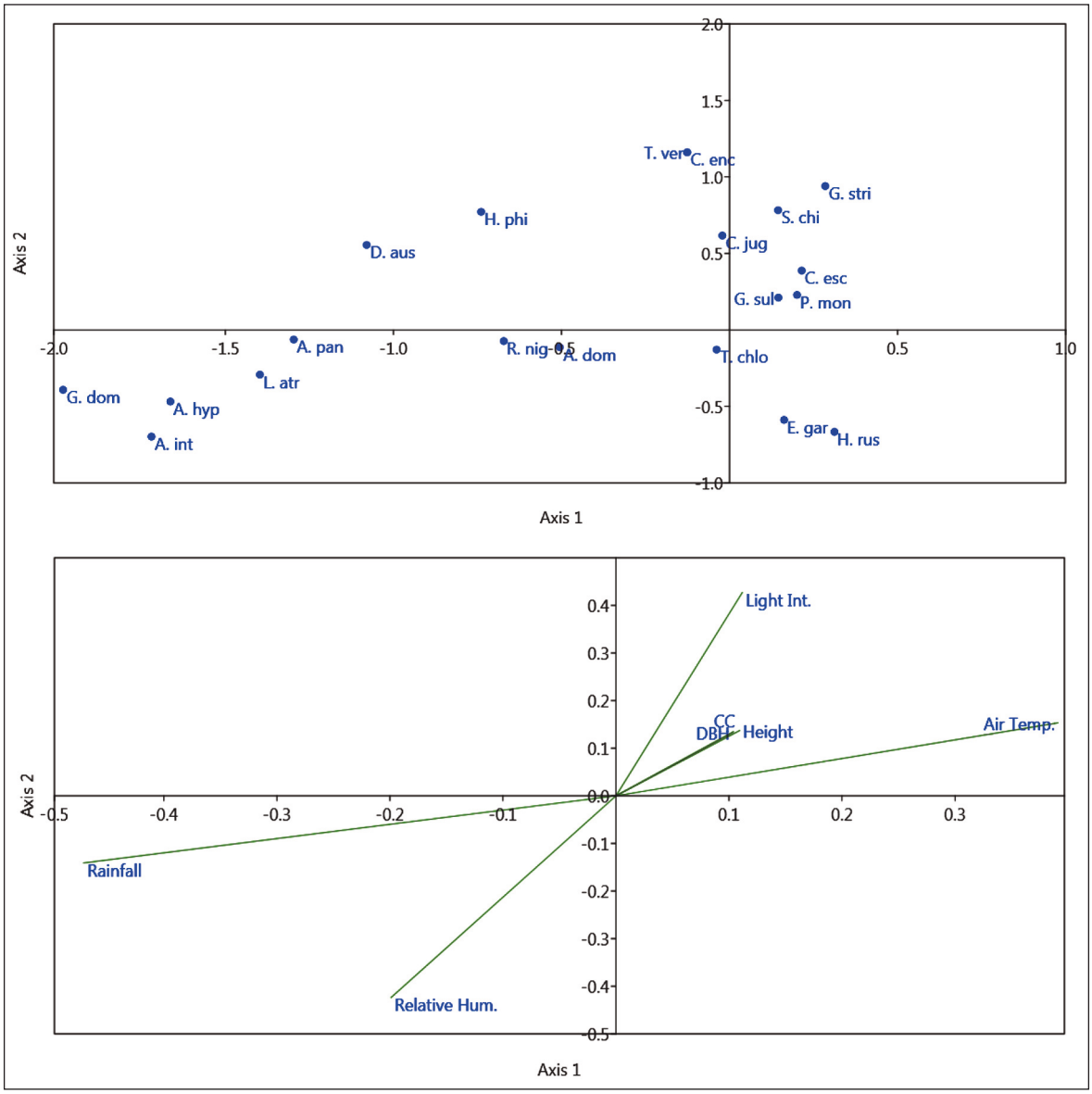

Figure 2. CCA of avifauna against mangrove and microclimate factors in Gitagum, Misamis Oriental.

the study in their area. Gratuitous Permit (GP) was obtained from the DENR-X ensuring safety during the sampling period.

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