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DIVERSITY OF LICHENS IN SAN ANTONIO EAST, HOLY MOUNTAIN MIRACLE, BUKIDNON

Christan Joshua A. Cuerquis [1], Shamaine Lyka M. Sentorias [2], Erich Aces Tuson [3], Rhoechris V. Acenas[4], Pauleen Valerie Mae E. Abadies[5], Almae Jill L. Udal [6],Chyna Mae C. Tabalba [7]

[1]*Senior High Students, Loyola School of Don Carlos, Inc., Don Carlos, Bukidnon*
[2] *Faculty, Loyola School of Don Carlos, Inc., Don Carlos, Bukidnon*

ABSTRACT

Lichens are unique symbiotic organisms formed through the association of fungi, algae, and cyanobacteria in some cases. This study aims to identify the current diversity of lichens, describe the status of each species and examine the diversity of lichens species in different elevations. Acknowledging that lichens respond to environmental factors such as humidity and, temperature. This study examined the diversity of lichens at three elevations on Holy Mountain Miracles using field surveys, molecular techniques, and the Shannon-Weiner index. A 20x20-meter plot method was employed to collect data and identify species diversity and status. Researchers identified 41 species across the three sites, with most lichens being crustose, followed by foliose forms. Pertusariaceae was the most abundant family, while Lecanoraceae, Parmeliaceae, Physciaceae, and Graphidaceae were the least represented. The conservation status of these species ranged from Data Deficient (DD) to Apparently Secured (G4). As of diversity, results showed that Holy Mountain Miracles in San Antonio East, hosts a diverse lichen community with the diversity index of 3.466 using the Shanon-Weiner statistical tool, reflecting its ecological richness and variety across elevations. This study contributes to the documentation of local biodiversity, which is often overlooked in less urbanized regions. By identifying and cataloging lichen species, this research not only enriches scientific understanding but also provides a baseline for the localities, Local Government Unit (LGU), students, future researchers and the Department of Environment and Natural Resources (DENR).

Keyword: Lichen diversity, conservation status, diversity each elevation site

1. INTRODUCTION

Lichens are nonvascular plants, small with slow growth and thrive in cool environment in higher forest elevation with about 20,000 species worldwide. These organisms are well adapted to areas where other plants may struggle, such as on rocky surfaces or tree bark. (Azuelo

& Puno, 2018). Despite their simple structure, lichens are a crucial part of our ecosystem. Lichens are significant components of air purity because they remove dust particles from the environment and absorb hazardous pollutants such as sulfur, carbon monoxide, and nitrogen dioxide, releasing cleaner and healthier air into the environment.

Lichens have been a significant supporter of human ecology, and thus become the keystones in various ecosystems. They can be in different forms under three primary groups; the Crustose which looks like crusts; the Foliose which looks like leaves; and the Fruticose which looks like sticks with branches. The diversity of adaptations and ecological roles can be seen within the different categories and among their numerous subgroups. Lichens appear to have evolved from crust-like forms to leaf-like structures before developing into more complex, shrub-like plants.

However, very few scientific efforts have been directed towards the assessment of lichen diversities in the Philippine countryside, more so areas that receive high levels of protection such as Holy Mountain Miracle in San Antonio East, Bukidnon. This problem affects understanding the current state of lichen communities in the area, as well as how they adapt to local environmental factors like air quality, climate, and human activity.

The researchers conducted their research to provide valuable data to students, future researchers, the local government, DENR, and the community. This research will document species that may be rare or unrecognized in their

abundance in the province of Bukidnon. In more effectively fulfilling the ecological value of lichens in Holy Mountain Miracle and researching the biodiversity of lichens, the researcher will hence be in a position to support the conservation of this portion of land adequately.

This study intends to address the following three objectives. First, it aims to identify the current diversity of lichen species in San Antonio, Holy Mountain, Bukidnon to present the species present in this area. Second, the study will determine the quantity of each of the lichen species to establish how often a certain species is found on the selected trees. Finally, the study will also look at the distribution of the lichen species about elevation and whether or not altitude influences the number of different species and distribution.

2. MATERIALS AND METHODS

2.1. Research Design

This paper used a descriptive-quantitative approach to investigate different outcomes. It employs description to determine and comprehend the species of lichen richness and analyze its possible observable impact on the ecosystem Related to the richness of different Lichen species in San Antonio East, Holy Mountain Miracle, Bukidnon. Observations with quadrat sampling and data collection through a 20 x 20 plot size for the investigation of lichens at the site. Data will be gathered and interpreted using statistical measures and other types of numerical formats.

2.2. Locale of the Study

The researchers conducted their study within the premises of Holy Mountain of Miracles in San Antonio East, Bukidnon. This mountain is in the Municipality of Don Carlos in the Province of Bukidnon in Mindanao, Philippines. The Holy Mountain of Miracles possesses high-altitude areas and a cool moist climate that are positive conditions for lichen growth. Agricultural lands, forests, and probably patches of undisturbed forest, can be seen surrounding this area that can contribute to lichen diversity.

2.3. Research Materials

To collect lichens, the researchers needed a few simple materials. As the very first thing, the researchers needed a collection bag or a plastic container. The researchers made sure it was clean and dry to avoid growth of mold. A little scalpel or a sharp knife and gloves to remove them carefully from their habitat. A notebook and a pencil to record the place of collection and lichen description. A field vest that helped store tools to make sure everything is organized and easy to find. A magnifying glass to help the researchers see the species clearly. Lastly, the researchers used a measuring tape, straw, and a phone upon collecting data.

2.4. Methods of collection

Upon collecting lichens species, the researchers first assess the field site and plotted a 20x20 quadrant sampling. The researchers then used scalpels to detach the lichens from the trees. They used three elevation sites to evaluate the diversity of lichen species.

2.5. Species identification, classification and confirmation

The species collected in this study were identified using taxonomical keys, and then classified into three main groups. Each species was meticulously described and was confirmed with the help of Dr. Andrea Azuelo, an expert in the field of lichens identification.

2.6. Statistical Analysis

When gathering and organizing data and information, the researchers made use of Shannon-Wiener's diversity index as a Statistical Analysis Tool, the data which is obtained in this research were subject to Shannon-Wiener diversity index. The Shannon-Wiener diversity index provides a precise statistical measure of lichen diversity, enabling analyses across different areas in the locale.

3. RESULTS & DISCUSSIONS

This study was conducted to evaluate the diversity of lichens in different elevation sites in Holy Mountain of Miracles, San Antonio East, Don Carlos, Bukidnon. This Chapter highlights the following A) overall diversity of lichens, B) diversity of lichen species in each elevation sites; and C) conservation status of lichens species.

3.1. Diversity of Lichens.

The table below illustrates the diversity of each individual lichen species. This data serves as a

basis for analyzing the overall species richness and diversity, highlighting both the dominant and less common species within the ecosystem.

GROUP	FAMILY	SPECIES	SITE 1	SITE 2	SITE 3
		Pertusaria	3	2	1
		Pertusaria angabagensis	1		
		Pertusaria leioplacella	1		
		Pertusaria subvaginata/ Var. Orientalis	1		
CRUSTOSE	PERTUSARIACEAE	*Pertusaria inconspicuous*	1		
		Pertusaria leioplaca/ var. Pycnocarpa	1		
		Pertusaria Subobductans	1		
		Pertusaria thwaitesii	1		
CRUSTOSE		*Pertusaria commutata/var. Hypothamnolica*	1		
		Pertusaria	3		
	PHYSCIACEAE	*Pyxine*	1		
	PAMELIACEAE	*Pamelinopsis minarum*	1		
		Parmotrema tinctorum	1		
		Parmotrema gardneri	1		
CRUSTOSE	PHYSCIACEAE	*Physcia*	1		
	PERTUSARIACEAE	*Pertusaria*	3	1	1
	LECANORACEAE	*Lecanora*		5	
		Pertusaria xanthodes		1	
		Pertusaria striolata		1	
	PERTUSARIACEAE	*Pertusaria ewersii*		1	

		Pertusartia velata		1	
	LECANORACEAE	*Lecanora bolcena*		1	
	PERTUSARIACEAE	*Pertusaria buloloensis*	1	1	
CRUSTOSE		*Lecanora prosecha*		1	
	LECANORACEAE	*Lecanora*		5	
	PERTUSARIACEAE	*Pertusaria*		3	
		Lecanora		5	
	LECANORACEAE	*Lecanora*		5	
	PERTUSARIACEAE	*Pertusaria*		3	
	LECANORACEAE	*Lecanora*		5	
	PERTUSARIACEAE	*Pertusaria ophthalmiza*		1	
CRUSTOSE	PERTUSARIACEAE	*Pertusaria subrosacea*			1
		Pertusaria subobductans	1		1
	GRAPHIDACEAE	*Graphis caesilla*			1
FOLIOSE	PARMELIACEAE	*Parmelinopsis*			1
CRUSTOSE	PHYSCIACEAE	*Pyxine*	1		2
	PERTUSARIACEAE	*Pertusaria*		1	1
	GRAPHIDACEAE	*Graphis*			1

	PHYSCIACEAE	*Pyxine*	1		2
	PERTUSARIACEAE	*Pertusaria subobducens*			1
UNIIDENTIFIED	UNIDENTIFIED	*UNIDENTIFIED*	1		
TOTAL	**5**	**31**	**18**	**15**	**9**

Table 1. List of Lichens collected in Holy Mountain Miracle

The table 1 examines lichen diversity at three elevation sites where it finds that Site 1 the base has the highest richness with 18 species, primarily crustose lichens from families like Pertusariaceae and Lecanoraceae. Site 2 the slope shows a decline to 15 species, while Site 3 the peak has only 9, dominated by specialized species due to harsher conditions. This pattern points to the fact to their vulnerability to temperature and substrate habitats, crucial information that would help in the conservation of biodiversity in the lowland communities.

The implication of these findings is that lichen diversity is significantly affected by elevation, with lower elevations supporting greater diversity due to milder conditions and more available substrates. Furthermore, two of the foliose species found demonstrated some ability to change their growth patterns, suggesting that there are possible ways in which lichens can withstand threats posed by climate change.

Lichens adapt to environmental challenges like reduced temperatures and limited substrate availability (Armstrong, 2017). Reduced temperatures and limited substrate availability are primary concerns for these organisms (Stanton et al., 2023). This suggests that lower elevation areas, influenced by these gradients, may serve as potential hotspots for biodiversity conservation within lichen communities (Hurtado et al., 2020).

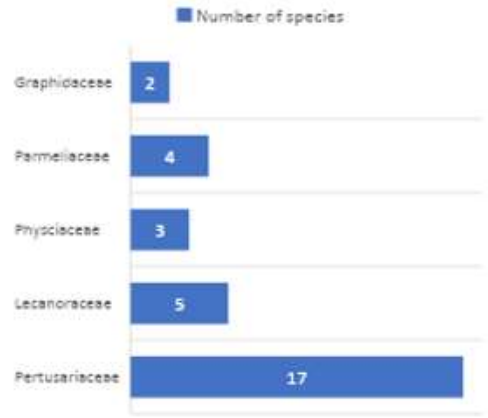

Figure 1. *Total numbers of individuals in the Lichens Family in the study sites.*

The Pertusariaceae family is the most abundant family in Holy Mountain Miracles, with 17 species collected and is dominant in the region's lichen diversity. This distribution underscores the ecological significance of Pertusariaceae while illustrating the varying levels of representation among lichen families in the region. The family Graphidaceae is the least collected in each elevation site, indicating a less varied species in Holy Mountain Miracle.

The Implication of the following differences may show different adaptations within the families for specific environmental conditions, such as tolerance to moisture, temperature, air quality or the lichens base or foundation. The dominance of Pertusariaceae may reflect its competitive advantages in nutrient uptake or resilience in ecological disturbances.

According to Boggess et al. (2024) sun-loving crustose species can become more abundant as trees are being destroyed and foliose species

which need wet shady environments may decrease. Thus, resulting in fewer species collected at the elevated site and at the peak. The study showed that lichen cover was relatively lower in some quadrat plots at higher elevations compared to lower elevations. (Azuelo, 2014). Therefore, it is anticipated that additional shrub expansion will result in significant changes to lichen communities, which could have detrimental effects on ecosystem functioning and the global climate (Chagnon & Boudreau, 2019).

4. CONSERVATION STATUS OF LICHEN SPECIES

Provided below is a table that summarizes the identified lichen species and their conservation status. The researches may gain a better understanding of the conservation requirements in this area by evaluating the species richness, diversity, and environmental roles.

GROUP	FAMILY	SPECIES	CONSERVATION STATUS
		Pertusaria	DD
		Pertusaria angabagensis	DD
		Pertusaria leioplacella	DD
		Pertusaria subvaginata/ Var. Orientalis	DD
		Pertusaria inconspicuous	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria leioplaca/ var. Pycnocarpa*	DD
		Pertusaria Subobductans	DD
		Pertusaria thwaitesii	DD
		Pertusaria commutata/var. Hypothamnolica	DD
		Pertusaria	DD
FOLIOSE	PHYSCIACEAE	*Pyxine*	DD
		Physcia tenuis	DD
FOLIOSE	PAMELIACEAE	*Pamelinopsis minarum*	DD
		Parmotrema tinctorum	DD
		Parmotrema gardneri	DD
FOLIOSE	PHYSCIACEAE	*Physcia*	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria*	DD
CRUSTOSE	LECANORACEAE	*Lecanora*	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria xanthodes*	S4
		Pertusaria striolata	DD
		Pertusaria ewersii	DD
		Pertusartia velata	S4
CRUSTOSE	LECANORACEAE	*Lecanora bolcena*	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria buloloensis*	DD
CRUSTOSE	LECANORACEAE	*Lecanora prosecha*	DD
		Lecanora	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria*	DD
CRUSTOSE	LECANORACEAE	*Lecanora*	DD
		Lecanora	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria*	DD
CRUSTOSE	LECANORACEAE	*Lecanora*	DD
CRUSTOSE	PERTUSARIACEAE	*Pertusaria ophthalmiza*	S4
		Pertusaria subrosacea	DD

Table 2. Conservation status of each lichen species

Categories	Conservation Status/Level	Qualitative Interpretation
1	Data Deficient (DD)	Inadequate Information
2	Least Concern (LC)	Does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened
3	Near Threatened (NT)	Does not qualify for Critically Endangered, Endagered, or Vulnerable but close to qualifying for a threatened category
4	Vulnerable (VU)	Meets any Criteria of A to E for Vulnerable - High Rick of Extinction
5	Endangered (EN)	Meets any criteria of A to E of Endangered - Very High Rick of Extinction
6	Critically Endangered (CR)	Meets any criteria of A to E for Critically Endangered - Extremely High Risk of Extinction
7	Extinct in the Wild (EW)	Known to survive in cultivation, captivity or as naturalized population

8	Extinct (EX)	There is no reasonable doubt that the last individual died
9	Not Evaluated (NE)	Has not yet been evaluated against the criteria.

(Source: NatureServe, 2025)

Categories	Conservation Status/Level	Qualitative Interpretation
1	Critically Imperiled (G1)	Extremely high risk of extinction due to very few populations or occurrences, very steep declines, or other severe threats.
2	Imperiled (G2)	High risk of extinction due to a restricted range, few populations, or threats.
3	Vulnerable (G3)	At moderate risk of extinction due to a fairly restricted range or specific threats.
4	Apparently Secure (G4)	Uncommon but not rare; some concerns due to local declines or other threats.
5	Secure (G5)	Widespread and abundant, with no significant extinction risk.
6	Presumed Extinct (GX)	Species is believed to be extinct; not located despite repeated searches.
7	Possibly Extinct (GH)	Species is possibly extinct but confirmation is required.
8	Unranked (GU)	Lack of information prevents assigning a conservation status.
9	Not Applicable (GNA)	Conservation status not applicable due to ineligibility for conservation ranking (e.g., non-native species).

This table indicates the conservation status of different lichen species, which fall into either the Data Deficient (DD) or Apparently Secure (G4) categories. A species classified as DD according to the IUCN Red (2025) list lacks sufficient information to assess its risk of extinction. This classification does not necessarily mean that the species is not at risk; it only means that more data are required to determine its conservation status. G4 means, in NatureServe Explorer (2025), that a species or ecological community is ranked as being secure, although there may be some potential threats in the future.

The table implies that these findings is important inorder for us to understand and identify the conservation status of lichens. Lichen species are not well studied enough, and most fall into the category of DD. This implies there is not enough information known about these species to determine whether or not they face risk of extinction. The few species that are categorized as Apparently Secure (G4) have probably been studied more, so scientists are aware that they are stable at present, even though they could face problems in the future. This shows how important it is to do more research to understand and protect lichens better.

5. DIVERSITY OF LICHENS ACROSS ELEVATION SITES.

The following tables below illustrates the diversity of lichens species across three elevation sites. This visual representation highlights the relative diversity of lichens population, indicating which species support the higher distribution, dominance and richness.

Site	Shannon_H (Diversity Index)	Species Richness (Taxa_S)	Dominant species	Dominance (D)	Coordinates	Altitude [m]	Temperature [°C]
Site 1	2.962	22	Pertusaria and Lecanora (Crustose lichens)	0.06	125.0490°E, 7.6649 °N	415.44 (m)	30
Site 2	2.662	18	Pyxine (Foliose lichens)	0.08148	125.0507°E, 7.6652 °N	415.68 (m)	27.5
Site 3	2.352	11	Lecanora and Graphis (Crustose lichens)	0.1006	125.0512°E, 7.6659 °N	437.52 (m)	34

Table 3. Lichen Diversity Across Elevation Sites

The Shannon diversity index was used in measuring lichen diversity at elevation sites, which showed that Site 1 exhibited the highest diversity with H = 2.962 and had 22 species, which points to good environmental conditions. Site 2 had moderate diversity (H = 2.662) and 18 species, with a shift towards foliose lichens, suggesting some ecological stress, while Site 3 had the lowest diversity (H = 2.352) and only 11 species, reflecting challenges for lichens at high altitudes. The diversity values of 2.962, 2.662, and 2.352 shows variations in diversity throughout every site, yet the overall total across all sites was 3.466 showcasing a relatively high level of diversity within the location. Overall, higher elevations are linked to lower species richness and diversity, as indicated by the dominance index.

The results on lichen diversity at different elevation sites highlight the need for focused conservation efforts, especially in areas with fewer species and higher dominance. The drop-in lichen diversity, particularly at higher elevations, suggests that factors like climate change may be harming these communities. To protect overall biodiversity and ecosystem health, it is important to maintain and improve the environmental conditions in areas with higher lichen diversity.

The Shannon diversity index, indicating that a higher index value typically reflects greater diversity. (Konopiński, 2020). The dominance index of lichens being lower at higher elevations indicates reduced species richness and diversity. (Chitra et al., 2024). It emphasizes shifts in lichen species composition primarily due to climate warming. (Anna et al., 2021).

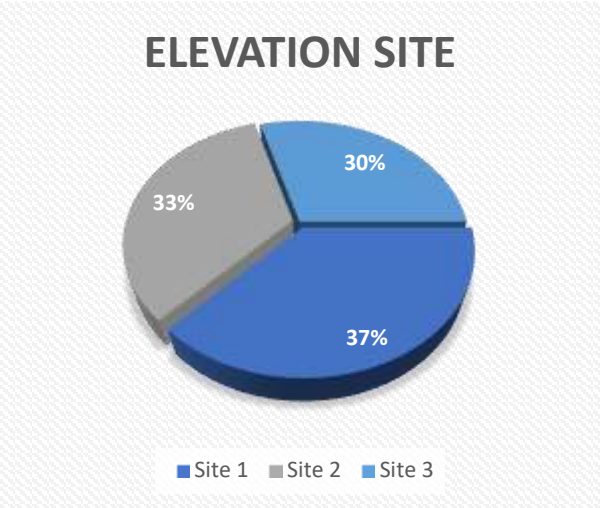

Figure 2. Total numbers of individuals in each elevation site

Researchers collected 42 lichen samples from three elevation sites, with one unidentified sample. Site 1 had 18 samples, Site 2 had 15, and Site 3 had 9. Using the Shannon-Wiener diversity index, they calculated lichen diversity at each site. Site 1 was the most diverse, with a score of 2.962 (37%), followed by Site 2 with 2.662 (30%), and Site 3 with 2.352 (33%). Site 1 contained crustose lichens from the genus Pertusaria and foliose lichens from the Pameliaceae and Physciaceae genera, making it the most diverse of the three sites.

This indicate that the results are remarkable for understanding how different elevations affect the diversity of lichen species. Site 1 dominates the other sites because of the weather condition and elevation of the site. On contrast of the other sites which indicates that the decrease of lichens varies on the elevation as site 2 has moderate amount of lichens and site 3 has low amount of lichens compared to site 1 because of its latitude.

Lichen species richness appeared lowest at high latitudes, but functional diversity rose with latitude (Chagnon et al., 2021). Thus suggests that ecological factors at higher elevations may limit lichen growth, resulting in a lower dominance index in those areas. (Vinayaka, 2016)

6. CONCLUSION

The study of lichen diversity in San Antonio East, Holy Mountain Miracles provides valuable insights that focus on identifying the current diversity of lichen species, describing the status of each species, and examining how lichen diversity changes with elevation. Through descriptive-quantitative approach and Shannon-Weiner diversity index researchers aim to analyze lichen distribution. Furthermore, the findings highlight lichens importance as contributors to ecosystem productivity. The study identified crustose lichens as the most diverse group. A total of 41 species, including one unidentified specie, summing up to a total of 42 species collected and identified. Forty-two species were collected across three sites: 18 from Site 1, 15 from Site 2, and 9 from Site 3. The Shannon-Wiener diversity index revealed that Site 1 had the highest diversity, while Site 3 had the lowest. Additionally, the dominance index increased at higher elevations. Thus, sites at higher elevation receives lesser diversity. Pertusariaceae was the most abundant family, with 17 species, followed by Lecanoraceae with 5 species. Parmeliaceae had 4 species, while Physciaceae and Graphidaceae contributed 3 and 2 species, respectively. This shows Pertusariaceae's dominance in the area. Lastly this research improves understanding of lichen communities and highlights the need to preserve biodiversity. It also supports efforts to improve environmental policies and protect ecosystems in the region.

7. RECOMMENDATION

The findings of lichen survey in Holy Mountain Miracle, Bukidnon offer several potential recommendations for enhancing research and lichen conservation. It proposes continuous supervision of lichen changes with regard for

seasonal fluctuations and other environmental conditions, in addition to the expansion of sampling techniques not only with regard to elevation sites but also concerning micro-habitats that would provide a more inclusive episcopic of lichen species. Local government units cannot be underestimated in the formulation of the policies which are needed to protect identified biodiversity hotspots and the conformity of disparity measurements of lichen catalogues with the environmental assessments will guarantee that they form part of the policy making system. Further research should also be directed to the Data Deficient lichens to obtain valuable information on their presence.

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