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Biodiversity of Mushrooms at Dansolihon, Cagayan de Oro City, Philippines

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ABSTRACT

The study was conducted mainly to assess the biodiversity of the mushroom species at three different sampling sites (altitudes 100, 200, 400 masl) at Dansolihon, Cagayan de Oro City, Philippines. Specifically, this study was designed to assess the species richness, and distribution of mushroom species. The researchers utilized random sampling in the collection of samples. Once mushrooms were located, they were then photographed from their respective natural habitats. Furthermore, physical factors such as temperature, relative humidity, altitude and light exposure were recorded during the sampling. After the collection, specimens were preserved in containers with 10% formalin solution. The preparation for the storage of the samples collected was performed at Liceo de Cagayan University. Different taxonomic keys from books and literatures were used as aids in the identification. The samples were then sent to Central Mindanao University, Musuan Bukidnon for the confirmation of the identified samples and identification of the unidentified ones. Species diversity, species richness, and relative abundance were then computed through the use of various biodiversity indices. A total of forty-seven species were collected. Thirty-nine of these were identified and eight were not. The sampling site at 200 masl has the

highest number of genera collected. There were forty-five collections belonging to twenty-nine species. The most abundant species was the Mycena sp.2, with a relative abundance of 8.62%. The highest value of species diversity was recorded at 200 masl (3.088). Moreover, this altitude had the highest value of species richness as well (4.323). The highest value of species dominance was recorded at 400 masl (0.1126). Furthermore, a high value of species diversity indicates that the environmental pollution and disturbance in Uguiaban, Dansolihon, Cagayan de Oro City are at manageable level and not extremely alarming.

Keywords: Biodiversity, Mushroom, Species richness, Distribution

INTRODUCTION

Fungi are one of the most diverse groups of life forms that include molds, yeasts, and above all, mushrooms (Vaupotic et al., 2008). Most fungi are not easily seen mainly due to their size. Humans may merely observe them when fruiting, just like the mushrooms. Fungi classification is constantly suffering from inconsistencies (Abou-Zeid and Altalhi, 2006). There are around 100,000 fungi species that have been officially described by numerous taxonomists (Kirk et al., 2008), but their total biodiversity is not entirely understood yet (Mueller et al., 2006). The kingdom of fungi has been guessed to have around 1.5 million species (Hawksworth, 2006). A recent study by Blackwell (2011) estimated that there might be more than 5 million species of fungi.

Mushroom is a general term utilized largely for the fruiting body of the macro fungi (Ascomycota and Basidiomycota), and only has a short reproductive phase in their life cycle (Das, 2010). They inhabit diverse richness in the natural world particularly in forest ecosystems (Pushpa and Purushothama, 2012). They have numerous impacts in ecology, biology, and economy (Das, 2010). In the Philippines, they frequently occur during the wet season. While in countries with four seasons, they take place during spring as soon as the snow melts. As cited by Pushpa and Purushothama (2012) mushrooms are indeed the 'fruits' of the fungal mycelium located underground.

Fungi have had long connections with humans. Since the past, humans have been consuming wild mushrooms. They contain a rich dietary value with a large amount of minerals, vitamins, proteins, fibers, and trace elements, and may have little or no cholesterol and calories (Das, 2010). For many centuries, many of

the aforementioned fruiting body has been utilized in folk medicine. A few can produce effective nutriceuticals (Das, 2010). Apart from their importance as a source of food and as mycorrhizal partners of various trees. Das (2010) mentioned that, some can be bioactive compound sources, thus proving medicinal relevance. In addition, mushrooms are utilized as indicators of the forest conditions (Stamets, 2000). Their absence or presence is a useful indicator to determine the maturity or damage of an ecosystem, or whether it is weak or healthy. Information with regards to their diversity in various flora types is vital for planning and dealing with ecosystem biodiversity (Engola et al., 2007). Awareness of biodiversity at the species and community level is extremely significant in keeping an eye on the effects and effectiveness of artificial and natural disturbances. Additionally, mushrooms can likely be bioindicators of ecological pollution by means of assessing trace elements of heavy metals (Kalac and Svoboda, 1999). High-accumulating ability in over a few species supported their test as bioindicators. However, Kalac and Svoboda (1999) concluded that no mushroom species can be considered as an exact indicator of ecological pollution by means of heavy metals nonetheless fruiting bodies can be helpful for distinguishing and differentiating polluted and unpolluted areas.

On the other hand, mushrooms do not incessantly do well to the humans. Serious forest tree damage is attributable to numerous wood-rotten mushrooms, therefore causing significant economic loss to the industry of timber each year (Das, 2010). The majority of wild mushrooms are safe to eat, but a few are toxic and deadly. One may die due to unwise consumption.

Unfortunately, because of pollution, urban development, extraction of natural resources (mining, logging, etc.), habitat loss or modification, and climate change, the normal population of mushrooms have been generally altered, and this inclination is assumed to keep on doing so at some point, possibly, at an increasing pace (O'Hanlon and Harrington, 2011).

Mushrooms have been extensively studied in the western countries. In contrast, the said organism is less explored here in the Philippines (Dwivedi et al., 2012). This is probably the very reason only little information has been reported about their diversity and taxonomic status. The area of the study (Dansolihon Slope, Cagayan de Oro City, Philippines) may be inhabited by various genera and species of both edible and toxic mushrooms. To date, no taxonomic study on mushrooms has been conducted at Dansolihon Slope, Cagayan de Oro City. It is for this primary reason that this research on the taxonomy, species richness, and distribution of mushrooms was conducted in the said area.

As BS Biology students, the researchers were interested in conducting the

said study because, like all the other species of organisms, mushrooms should be understood as well. The study on mushrooms helped the researchers apply their knowledge in taxonomy and ecology as major subjects in the course.

OBJECTIVES OF THE STUDY

The study was conducted mainly to assess the diversity of the mushroom species found in Dansolihon Slope, Cagayan de Oro City, Philippines. Specifically, this study aimed to: (1) determine the physical factors of the sampling sites; collect, preserve, and identify the mushrooms found in the sampling sites; (2)(2) determine the species composition and the relative abundance of mushrooms at various sampling sites; (3) determine the pattern of species richness and species diversity at various sampling sites; and (4) determine the conservation status of the species collected.

MATERIALS AND METHODS

Research Protocol

The letter for request for permission to conduct research was noted by the College of Arts and Sciences Dean, Dr. Fe S. Tolibas on June 4, 2013. The researchers were able to request permission to conduct the study from the barangay captain of Dansolihon, Cagayan de Oro City, Mr. Gilbert D. Nacabalan on June 4, 2013. Three waivers of liability were signed on June 6, 2013 by the parents and guardians of the researchers in order to conduct the study. Moreover, the identification of the mushroom species was aided by Dr. Guia G. Saludares conducted at the Plant Disease Clinic, Plant Pathology Department of Central Mindanao University. The samples were sent to be identified on September 2013 and were obtained back on January 2014.

Research Design

The researchers utilized the descriptive design of research. This study was designed to assess the diversity, species richness, and distribution of mushroom species found in Dansolihon Slope, Cagayan de Oro City, Philippines. Random sampling was employed in the collection of mushrooms from three different sampling sites.

Research Setting

The collection of mushroom species was done at three different sampling elevations in Dansolihon Slope, Cagayan de Oro City, Philippines: 100 masl (Site 1), 200 masl (Site 2) and 400 masl (Site 3). Random sampling was applied during the collection. The collection of the said fungi was done during the months of June and July, and done twice a month. Sampling Site 3 at 400 masl was slightly undulating and slightly sloping. This site was an open area. Logs were present. Soil was dry due to the high exposure to sunlight. Only few grasses were observed. The site was also inhabited by few young, growing banana trees. Burnt trees and grasses were initially observed during the first sampling but later on, the area was slowly being inhabited by few growing trees. The site was evidently disturbed due to agricultural burning, a type of burning that farmers do after crop harvest to decrease unwanted and unessential plant materials. The preparation for the storage of the samples collected was performed at Liceo de Cagayan University. The specimens were compared with the identified collection in the Department of Plant Pathology, College of Agriculture, Central Mindanao University, Musuan Bukidnon. Different taxonomic keys from books and literatures were used as aids in the identification. The samples were then sent to the Department of Plant Pathology, College of Agriculture, Central Mindanao University, Musuan Bukidnon for the confirmation of the identified samples and identification of the unidentified ones.

Materials for Mushroom Collections

Techniques utilized in this study were parallel to those formerly published surveys of mushroom diversity (Smith and Weber, 1980). The equipment for proficient mushroom gathering was relatively inexpensive and simple. A digital camera was essential for taking of pictures where the fungi were located. The researchers needed a big basket which was an excellent container for transporting the collections. A hunting knife with a tough blade or a trowel was utilized for cutting and prying the mushrooms from logs or trees, or for digging them out of the soil. The collections were solely wrapped in waxed papers, which would allow some air circulation on them, and would as well avoid them from 'stewing' like they do in plastic bags on a warm day. Plastic bags are an awful idea. Mushrooms have a tendency to sweat, particularly in hot weather (Kuo, 2006). A pocket magnifier or hand lens was utilized for making keen observations on tiny fruiting bodies or examining details on bigger ones. A pen or pencil and a notebook were

utilized as well for taking notes. Noting down directly on waxed paper bags and writing information on them were the most convenient way, particularly when it comes to arranging them (Kuo, 2006).

Collection of Mushrooms

Once the mushrooms were found, pictures of them were taken in their individual natural habitats. They were then collected in a way that no significant facts were lost. The bases of the stalks were dug up and were not cut off at ground level otherwise significant characters would have been left behind. The mushrooms that appeared to be alike were gathered in one package. As more specimens were added, the bigger and heavier ones were positioned at the base of the container and the more fragile, lighter ones on top. For every collection, it was written down how the mushrooms grew, i.e., scattered or clustered, duff, manured soil, muchy soil, and so forth (Smith and Weber, 1980). Moreover, if specimens were growing on wood, it was noted down if the wood was living or dead. If the tree was living, the region of the tree where the specimen grew was noted as well (Kuo, 2006).

Mushroom Storage

After the collection, specimens which were soft and easily deteriorate were preserved in containers with 10% formalin solution. Hard specimens were placed in separate plastic bags and then were air-dried and preserved in separate boxes for identification (Bautista, 2006).

Identification of Mushrooms

Each species collected was described based on their morphological characteristics. Morphological bases are the type of basidiocarp, shape, color, and structure of the basidium formed. The specimens were compared with the identified collection in the Department of Plant Pathology, College of Agriculture, Central Mindanao University, Musuan, Bukidnon with the aid of a mushroom expert, Dr. Guia G. Saludares. Additionally, various keys from literatures and books were utilized as aids in the identification (Bautista, 2006). Spore prints would have been taken when needed (Bunyard, 2003). In order to do this, the stipe of the mushroom would be removed, and the cap would be positioned in a gill-side down manner on a piece of paper, covered with a bell jar so as to get rid of air currents. The bell jar and cap should be removed 24 hours later. In order to make a spore print permanent, a little clear shellac or varnish should be applied

on them. Black paper for light-colored or white spores, and white paper for dark-colored spores should be employed (Stern et al., 2003). The spore print color should be compared with descriptions from keys and field guides (Kuo, 2006).

Determining the Physical Factors of the Sampling Sites

Various physical factors of a sample site include the altitude, relative humidity, ambient temperature, and light exposure. The altimeter was used in measuring the vertical direction or the altitude of the area. Ambient temperature was determined with the help of a thermometer. In calculating the relative humidity, two different values of temperature were recorded, wet bulb and dry bulb. The value of wet bulb was deducted from the dry bulb value. The value of the difference had an equivalent value of the percentage from a relative humidity chart (Hessong, 2012). Like all the other species, there are numerous factors that could change or alter its diversity. The factors that could greatly alter the diversity of mushroom are the physical factors. The physical factors consist of the altitude, relative humidity, ambient temperature, and light exposure. According to Sibounnavong et al. (2008), mushrooms can be located in an extremely humid place. Consequently, if an area is very humid, then it is extremely likely to study the diversity of mushroom species. Temperature, on the other hand, is another significant physical factor that can have an effect on its diversity. Mushrooms can endure both in hot and cold ecosystems; on the other hand more mushrooms favor warm weather with a great amount of moisture. The speed or diversity of fungal development can be influenced by atmospheric pressure circumstances. High atmospheric pressure may set off fungal growth or not.

Determining the Biodiversity Indices

Species Richness. Species richness determines the number of species located in a sample. The more number of species are likely to be found in a bigger sample. Species richness measures the actual number of species. This certain measure of species richness is known as D, the Menhinick's index.

Species Diversity. Species diversity is different from species richness since it considers both the evenness or dominance of species and the number of species present with regards to one another. To determine the species diversity, Shannon index, H, was calculated. The Shannon index has been an accepted diversity index in the biological or ecological literature, where it is known as Shannon-Wiener

index, Shannon's diversity index, Shannon entropy, and Shannon-Wiener index as well.

Species Composition and Relative Abundance

Mushroom collection was performed in order to distinguish the species composition in every elevation. The collection initiated at the lowest altitude by means of hiking the trail. Species richness and relative species abundance explain the main elements of biodiversity (Hubell, 2001). Species abundance is the number of individuals for each species, and relative abundance tackles about the evenness of distribution of the individuals among species within a community.

RESULTS AND DISCUSSION

Physical Factors of the Sampling Sites

Table 1. Values of physical factors measured at various sampling sites

Physical Factors	Altitudinal Sampling Sites		
	100 masl S1	200 masl S2	400 masl S3
Temp. (°C)			
a. Ambient	33	32	34
b. Wet	27	26	28
Relative Humidity	63%	63%	64%
Light Exposure	High, moderate	Moderate	High

As shown in Table 1, the highest ambient temperature was 34°C observed at elevation 400 masl. This condition may be pointed to the fact that this certain elevation is an open area with only few scattered trees. Furthermore, the area is directly exposed to sunlight. Elevation 100 masl has an ambient temperature of 33°C. This site has two parts; a shady area and an open area. A part of elevation 100 masl which was shady, had moderate light exposure while the open area had a high light exposure. The shady area was inhabited by few medium sized trees, ferns and grasses. The open area had little occupancy of plants. Meanwhile, elevation at 200 masl had a temperature of 32°C, the lowest among the three sampling sites. This may be due to the inhabitance of trees, ferns, shrubs and mosses at this site. The highest value of relative humidity was recorded at 64%

and was observed at elevation 400 masl. The openness of the area and its direct exposure to sunlight may have contributed to the increased value of relative humidity. As temperature rises, relative humidity, as well, rises, causing a sultry weather. Conversely, a relative humidity of 63% was recorded at elevation 200 masl. This area is covered with small to medium sized trees. The presence of various shrubs, ferns and mosses were observed as well. Hence, the area did not get enough sunlight exposure. A relative humidity of 63% was also recorded at elevation 100 masl. Again, Sampling Site 1 has two parts: an open area and a shady area. The shady area contributed much to lower the temperature of the site. The open area provided much to higher the temperature of the said site. Light exposure was very high at elevation 400 masl. Unsurprisingly, this area was exposed to direct sunlight with only few trees. Elevation 100 masl had high to moderate light exposure because a part of the site is an open area while the other part is shady. However, elevation 200 masl receives moderate to low exposure to sunlight. This condition is due to the shades contributed by bent tall trees, various shrubs, ferns and mosses. Thus, direct sunlight could not traverse, owing to the interference of tall trees, various shrubs, ferns and mosses.

Species Composition and Relative Abundance

Overall, there were twenty-five genera identified, while the total number of species identified to the genus level was thirty. Nine species were identified down to the species level, and there were eight unidentified species.

Table 2. Species Composition and Relative Abundance of Mushrooms found in Dansolihon Slope, Cagayan de Oro City

	Mushroom	100 masl	200 masl	400 masl	Collection #	Total Individuals	Ra (%)
1	*Bjerkandera* sp.1	1			6	1	1.08
2	*Calocera viscosa* Pers.			1	58	1	1.08
3	*Coprinellus disseminatus* (Pers.) Lange	4	3		18, 27, 30, 31, 56, 59, 78	7	7.53
4	*Coprinus* sp.1	1			28	1	1.08
5	*Coprinus* sp.2	1			29	1	1.08
6	*Coprinus* sp.3		1		37	1	1.08
7	*Coprinus* sp.4		1		33	1	1.08
8	*Collybia* sp.1	2	1		17, 81, 82	3	3.23
9	*Crepidotus variabilis* (Pers.) Kumm.		2		36, 39	2	2.15
10	*Crepidotus* sp.1	1			3	1	1.08
11	*Dacrymyces chrysospermus* (Bull.) Tul.		1		74	1	1.08
12	*Entoloma* sp.1		1		13	1	1.08

13	*Geastrum triplex* Jungh.		1		47	1	1.08
14	*Marasmiellus* sp.1			1	23	1	1.08
15	*Marasmius siccus* (Schwein.) Fr.		1		69	1	1.08
16	*Marasmius* sp.1			1	21	1	1.08
17	*Micromphale* sp.1		1		64	1	1.08
18	*Mycena* sp.1	1			4	1	1.08
19	*Mycena* sp.2	4	3	1	7, 57, 72, 91, 50, 46, 67, 85	8	8.62
20	*Mycena* sp.3		3		14, 32, 38	3	3.23
21	*Mycena* sp.4		2		15, 43	2	2.15
22	*Mycena* sp.5	1	1	2	53, 54, 68, 88	4	4.30
23	*Mycena* sp.6	1			79	1	1.08
24	*Omphalina* sp.1			2	60, 61	2	2.15
25	*Oudemansiella* sp.1			1	71	1	1.08
26	*Panellus* sp.1		1		45	1	1.08
27	*Peziza* sp.1	1	2		49, 65, 83	3	3.23
28	*Pholiota squarossa* (Oeder.) Kumm.		2	5	22, 51, 52, 55, 70, 84, 89	7	7.53
29	*Pholiota* sp.1		1		16	1	1.08
30	*Pleurotus ostreatus* Kumm.			2	76, 77	2	2.15
31	*Pleurotus* sp.1	3	3		11, 12, 34, 80, 86, 87	6	6.45
32	*Polyporus* sp.1		1		40	1	1.08
33	*Psathyrella* sp.1	1	1	1	2, 41, 90	3	3.23
34	*Psathyrella* sp.2		1		44	1	1.08
35	*Psathyrella* sp.3			1	92	1	1.08
36	*Pyncnoporus coccineus* (Fr.) Bond. Sing.			1	75	1	1.08
37	*Trametes* sp.1		4		25, 62, 73, 93	4	4.30
38	*Trametes* sp.2		1		48	1	1.08
39	*Tricholoma* sp.1		1		19	1	1.08
40	Unidentified Species 1	1			1	1	1.08
41	Unidentified Species 2	1				1	1.08
42	Unidentified Species 3	1			8	1	1.08
43	Unidentified Species 4	1	1	1	9, 24, 35	3	3.23
44	Unidentified Species 5	1			10	1	1.08
45	Unidentified Species 6		1		20	1	1.08
46	Unidentified Species 7		2	1	42, 66, 65	3	3.23
47	Unidentified Species 8		1		63	1	1.08
	Total # of collection/ elevation	**27**	**45**	**21**		**93**	
	Total # of species present	**18**	**29**	**14**		**61**	

Mushroom species collected at increasing elevation is shown in Table 2. In this study, forty-seven species were collected. Thirty of these were identified down to the genus level, while nine down to the species level and eight were not. The identified species include the following: *Bjerkandera* sp.1, *Calocera- viscosa* Pers., *Coprinellus disseminatus* (Pers.) *Lange, Coprinus* sp.1, *Coprinus* sp.2, *Coprinus* sp.3, *Coprinus* sp.4, *Collybia* sp.1, *Crepidotus variabilis* (Pers.) Kumm., *Crepidotus* sp.1, *Dacrymyces chrysospermus* (Bull.) Tul., *Entoloma* sp.1, *Geastrum triplex* Jungh., *Marasmiellus* sp.1, *Marasmius siccus* (Schwein.) Fr., *Marasmius* sp.1, *Micromphale* sp.1, *Mycena* sp.1, *Mycena* sp.2, *Mycena* sp.3, *Mycena* sp.4, *Mycena* sp.5, *Mycena* sp.6, *Omphalina* sp.1, *Oudemansiella* sp.1, *Panellus* sp.1, *Peziza* sp.1, *Pholiota squarossa* (Oeder.) Kumm., *Pholiota* sp.1, *Pleurotus ostreatus* Kumm., *Pleurotus* sp.1, *Polyporus* sp.1, *Psathyrella* sp.1, *Psathyrella* sp.2, *Psathyrella* sp.3, *Pyncnoporus coccineus* (Fr.) Bond. Sing., *Trametes* sp.1, *Trametes* sp.1 and *Tricholoma* sp.1.

The sampling site at 200 masl has the highest number of genera collected. There were forty-five collections belonging to twenty-nine species. In addition, the sampling site at elevation 100 masl had a total of twenty-seven collections belonging to sixteen species. Lastly, the elevation 400 masl had the least number of genera collected. It only had a total number of twenty-one collections belonging to fourteen species. It was observed that there is a difference in the number of species collected at various elevations. This might be basically attributed to the nature and the physical factors of the sampling sites. Elevation 200 masl, which had the highest number of samples collected, had a temperature of 32°C, the lowest among the three sampling sites. This might be one of the reasons why mushrooms prefer to grow at this particular elevation, considering that the site was inhabited with trees, ferns, shrubs and mosses (Sibounnavong et al., 2008). In addition, the relative humidity of this particular site was also favorable to the growth of mushrooms since they love to thrive on moist and cool areas. The moderate light exposure might have also helped in the prosperity if the mushrooms because the area had diffused light. Too much light exposure dries up the mushrooms (Sibounnavong et al., 2008). It should be noted that this area was covered with small to medium-sized trees.

The elevation at 100 masl had the second highest number of species (eighteen species) collected most likely due to its equal value of relative humidity which was 63 % at elevation 200 masl. But the two differed only with their light exposure. The elevation at 100 masl had a high to moderate exposure to sunlight while elevation 200 masl only had a moderate exposure. Furthermore, Sibounnavong et al., (2008) stated that the best place and time to gather mushrooms, particularly fleshy fungi is during the raining season in an extremely humid area with diffused sunlight. The least number of species collected occurred at an elevation of 400 masl. This condition could be attributed to the nature and physical factors of the area. This site was an open area. Logs were present. Soil was dry due to the high exposure to sunlight. It must be noted that the area was evidently disturbed due to agricultural burning. Therefore, the said area was not a preferable place for mushrooms to survive.

At elevation 100 masl, eighteen species were collected: *Bjerkandera* sp.1, *Crepidotus* sp.1, *Coprinus* sp.1, *Coprinus* sp.2, *Mycena* sp.1, *Mycena* sp.5, *Mycena* sp.6, *Peziza* sp.1, and *Psathyrella* sp.1 had only one collection each. *Collybia* sp. had two collections while *Pleurotus* sp. had three. Lastly, *Mycena* sp.2 and *Coprinellus* disseminates had the greatest number of collection which was four.

Moreover, there were five unidentified species collected. At an elevation of 200 masl, twenty-nine species were collected. One collection represented *Collybia* sp.1, *Coprinus* sp.3, *Coprinus* sp.4, *Dacrymyces chrysospermus* (Bull.) Tul., *Entoloma* sp.1, *Geastrum triplex* Jungh., *Marasmius siccus* (Schwein.) Fr., *Micromphale* sp.1, *Mycena* sp.5, *Mycena* sp.6, *Panellus* sp.1, *Pholiota* sp.1, *Polyporus* sp.1, *Psathyrella* sp.1, *Psathyrella* sp.2, *Trametes* sp.1, *Trametes* sp.2 and *Tricholoma* sp.1. In the meantime, *Crepidotus variabilis* (Pers.) Kumm., *Mycena* sp.4, *Peziza* sp.1 and *Pholiota squarrosa (Oeder.)* Kumm. had two collections each. Meanwhile, *Coprinellus disseminatus* (Pers.) Lange, *Mycena* sp.2, *Mycena* sp.3 and *Pleurotus* sp.1 had three collections each. Lastly, *Pyncnoporus coccineus* (Fr.) Bond. Sing. had the greatest collection which was four. On the other hand there were four unidentified species collected.

Lastly, at an elevation of 400 masl, fourteen species were collected. One collection represented *Calocera viscosa* Pers., *Marasmiellus* sp.1, *Marasmius* sp.1, *Mycena* sp.2, *Mycena* sp.5, *Oudemansiella* sp.1, *Psathyrella* sp.1, *Psathyrella* sp.3 and *Pyncnoporus coccineus* (Fr.) Bond. Sing. Meanwhile, *Omphalina* sp.1 and *Pleurotus ostreatus* Kumm. each had two. Lastly, *Pholiota squarrosa* (Oeder.) Kumm. had the greatest number of samples collected which was five. In addition, there were two unidentified species collected. *Bjerkandera* sp.1, *Calocera viscosa* Pers., *Coprinus* sp.1, *Coprinus* sp.2, *Coprinus* sp.3, *Coprinus* sp.4, *Crepidotus* sp.1, *Dacrymyces chysospermus* (Bull.) Tul., *Entoloma* sp.1, *Geastrum triplex* Jungh., *Marasmiellus* sp.1, *Marasmius siccus* (Schwein.) Fr., *Marasmius* sp.1, *Micromphale* sp.1, *Mycena* sp.1, *Mycena* sp.6, *Oudemansiella* sp.1, *Panellus* sp.1, *Pholiota* sp.1, *Polyporus* sp.1, *Psathyrella* sp.2, *Psathyrella* sp.3, *Pyncnoporus coccineus* (Fr.) Bond. Sing., *Tricholoma* sp.1, *Trametes* sp.2 and six unidentified species all have a relative abundance of 1.08% with one collection each. With a relative abundance of 2.15%, *Mycena* sp.4, *Omphalina* sp.1, *Crepidotus variabilis* (Pers.) Kumm. and *Pleurotus ostreatus* Kumm. only have a total of two collections each. *Collybia* sp.1, *Mycena* sp.3, *Peziza* sp.1, *Psathyrella* sp.1 and two unidentified species all have a relative abundance of 3.23%. *Mycena* sp.5 and *Trametes* sp.1 both have a relative abundance of 4.30%. *Pleurotus* sp.1 has relative abundance of 6.45%. *Coprinellus disseminatus* (Pers.) *Lange* and *Pholiota squarossa (Oeder.)* Kumm. both have a relative abundance of 7.53%. Lastly, *Mycena* sp.2, has the greatest amount of relative abundance of 8.62%. It had a total number of eight collections obtain. Four of which were obtained from 100 masl, three from 200 masl and one from 400 masl.

Elevational Distribution and Species Habitat

Mushroom		Elevation (masl)	Habitat						
			Duff	Li-ving tree	Log	Stick	Moist soil	Rock	Dead leaves
1.	*Bjerkandera* sp.1	100		1					
2.	*Calocera viscosa* Pers.	400				1			
3.	*Coprinellus disseminatus* (Pers.) Lange	100-200	2		3	1	1		
4.	*Coprinus* sp.1	100			1				
5.	*Coprinus* sp.2	100			1				
6.	*Coprinus* sp.3	200					1		
7.	*Coprinus* sp.4	200					1		
8	*Collybia* sp.1	100-200	2				1		
9	*Crepidotus variabilis* (Pers.) Kumm.	200		1			1		
10	*Crepidotus* sp.	100		1					
11	*Dacrymyces chysospermus* (Bull.) Tul.	200			1				
12	*Entoloma* sp.1	200					1		
13	*Geastrum triplex* Jungh.	200				1			
14	*Marasmiellus* sp.1	400							1
15	*Marasmius siccus* (Schwein.) Fr.	200	1						
16	*Marasmius* sp.1	400			1				
17	*Micromphale* sp.1	200		1					
18	*Mycena* sp.1	100	1						
19	*Mycena* sp.2	100-400	4				4		
20	*Mycena* sp.3	200		1	1	1			
21	*Mycena* sp.4	200	1			1			
22	*Mycena* sp.5	100-400	1			1			2
23	*Mycena* sp.6	100	1						
24	*Omphalina* sp.1	400			1		1		
25	*Oudemansiella* sp.1	400	1						
26	*Panellus* sp.1	200					1		
27	*Peziza* sp.1	100-200					3		
28	*Pholiota squarossa* (Oeder.) Kumm.	200-400	3		1		3		
29	*Pholiota* sp.1	200					1		
30	*Pleurotus ostreatus* Kumm.	400			2				

31	*Pleurotus* sp.1	100-200	1		2		2	1	
32	*Polyporus* sp.1	200					1		
33	*Psathyrella* sp.1	100-400	2				1		
34	*Psathyrella* sp.2	200	1						
35	*Psathyrella* sp.3	400					1		
36	*Pyncnoporus coccineus* (Fr.) Bond. Sing.	400			1				
37	*Trametes* sp.1	200			4				
38	*Trametes* sp.2	200				1			
39	*Tricholoma* sp.1	200	1						
40	Unidentified Species 1	100	1						
41	Unidentified Species 2	100				1			
42	Unidentified Species 3	100			1				
43	Unidentified Species 4	100-400				2	1		
44	Unidentified Species 5	100					1		
45	Unidentified Species 6	200		1					
46	Unidentified Species 7	200-400	3						
47	Unidentified Species 8	200	1						
	Total # of species present		**17**	**6**	**13**	**9**	**20**	**1**	**2**

Table 3 shows the elevational distribution of mushrooms and their respective habitats. The data reveal that four species of mushrooms were found in all elevations, 100 masl to 400 masl. These species were *Mycena* sp.1, *Mycena* sp.2, *Psathyrella* sp.1, and one unidentified species. This implies that the species prefer the same factors most favorable for growth and the same habitat from where they acquire their nutrients. In the case of *Bjerkandera* sp.1, it was spotted at an elevation of 100 masl. It was collected only once on a living tree. According to Kuo (2006), *Bjerkandera* sp.1, is saprobic (it derives sustenance from decaying or non-living matter) on the woods and sometimes conifers, causing a white rot. *Calocera viscosa* Pers. was collected only at an elevation of 400 masl. A collection was made from a stick. It is usually found clustered on rotting wood (Ellis and Ellis, 1990). *Collybia* sp.1 was collected at an elevation 100-200 masl. Three collections were obtained. One collection was obtained from moist soil and the remaining two were gathered from duff. Furthermore, it was reported that the genus grows on decomposing remains of other mushrooms (Kirk et al., 2008).

Coprinellus disseminatus (Pers.) Lange was observed at elevations 100 to 200 masl. It had a total of seven collections. Two collections were obtained from duff,

three from log, one from stick and one from moist soil. *Coprinellus disseminatus* (Pers.) Lange is saprobic and occurs on and beside stumps and other forms of rotting wood (Kirk et. al., 2008).

Coprinus sp.1 only had one collection obtained from a log at an elevation of 100 masl. *Coprinus* sp.2 had one collection as well, collected from a log at an elevation of 100 masl. In the case of *Coprinus* sp.3, it was collected at an elevation of 200 masl with one collection obtained from moist soil. *Coprinus* sp.4 was obtained at elevation 200 masl as well, and was obtained from moist soil. According to Kuo (2008), they are saprobes, supporting in the decomposition of forest litter, wood, grassy debris, dung, and so on.

Crepidotus variabilis (Pers.) Kumm. had two collections obtained from a tree and moist soil. This species was collected at an elevation of 200 masl. They are saprobic, on twigs in deciduous and mixed woodland and at the bases of hedgerows (Kirk et. al., 2008). *Crepidotus* sp.1 was spotted at an elevation of 100 masl. One collection was obtained from a living tree. According to (Aurora, 1986), the mushrooms grow in groups or overlapping tiers on hardwood such as: tree trunks, fallen branches and sawdust. It rarely grows on coniferous trees (Pacioni and Gray, 1989).

Dacrymyces chysospermus (Bull.) Tul. only had one collection from a log at an elevation of 200 masl. Usually gregarious or in large merging groups, this genus is usually collected on dead broadleaf or conifer wood, this includes rails and fence posts, also branches and fallen trunks. *Dacrymyces chysospermus* (Bull.) Tul. displays preference for timber that has been well rotted fairly (Kirk, et. al., 2008).

In the case of *Entoloma* sp.1, it only had one collection obtained from moist soil at an elevation of 200 masl. *Entoloma* sp.1 can be found often on clay and soil, however, they may grow in fields, parks and areas that are grassy nearby (Zeitlmayr, 1976).

Geastrum triplex Jungh. was only collected once from a stick in a duff environment at an elevation of 200 masl. According to Healy et al. (2008), its fruit body is often observed around rotted trees, and it is usually buried in duff.

In the case of *Marasmiellus* sp., Kuo (2013) adds that these mushrooms can

be found on decomposing debris of plants, for instance, grasses, rushes, sedges, ferns, flowers, vines etc. He further adds that they can be found on decomposing tree litter. *Marasmiellus* sp. was collected once from dead leaves at 400 masl.

A collection was obtained from *Marasmius siccus* (Schwein.) Fr. from duff at an elevation of 200 masl. *Marasmius* sp.1 had one collection obtained from log at 400 masl. This genus usually survives on decomposing plant debris or tree litter or debris of hardwoods (Kuo, 2013). A collection of one *Micromphale* sp.1 was obtained from a living tree at an elevation of 200 masl. They can also be found on fallen needles of firs, spruces, sometimes pines (Kuo, 2013).

Mycena genus had six different species collected. *Mycena* sp.1 had one collection obtained from duff at an elevation of 100 masl. In the case of *Mycena* sp.2, it had eight collections, four of which were acquired from duff and the other four were obtained from moist soil. It was spotted in all elevations, 100 to 400 masl. *Mycena* sp.3 was spotted at an elevation of 200 masl. It had three collections. One collected from a tree, one from log and one from stick. *Mycena* sp.4 had two collections obtained from duff and stick. Both collections were obtained at an elevation of 200 masl. *Mycena* sp.5 was spotted in all elevations, 100 to 400 masl. It had a total of four collections, one obtained from duff, one from stick and two from dead leaves. Lastly, *Mycena* sp.6 only had one collection obtained from duff at an elevation of 100 masl. Mycena species usually appear on leaf litter with moderate temperature (Kirk et. al., 2008). Furthermore, Kuo (2010) stated that many of these species produce in clusters on decaying logs and stumps, while others take place from debris on the forest floor or from the bark of living or recently dead trees.

Omphalina sp.1, as well, was present at elevation 400 masl. However, it only had two collections obtained. One collection was acquired from a log and one from moist soil. This species usually thrives gregariously in open habitats, just like in the slope in Uguiaban, Dansolihon, sometimes; they grow on bare soils (Lamoure, 1982).

Oudemansiella sp.1 was present only at elevation 400 masl. It only had one collection obtained from duff. It loves to thrive in breezy days, in autumn, and it usually appears on dead trunk and fallen branches and sometimes grows on dead branches high up in living trees (Kirk et. al., 2008). Hence, *Oudemansiella* sp.1

loves growing in an environment with a little high on the temperature.

Panellus sp.1 was obtained at an elevation of 200 masl and only had one collection acquired from moist soil. It was possible that *Panellus* sp.1 was found at this elevation since moderate temperature usually favors this type of mushroom (Fuhrer, 1985).

Three collections were obtained from *Peziza* sp.1. Appearing at an elevation of 100 to 200 masl, each collection was obtained from moist soil. *Peziza* sp.1 prefers moderate temperature and usually grows on the ground, dung or rotting wood (Kirk et. al, 2008).

Pholiota squarrosa (Oeder.) Kumm. was spotted at elevations 200 to 400 masl. It had a total of seven collections. Three of which were obtained from duff, one from a log and three were collected from moist soil. According to Kuo (2007), they are saprobic and possibly parasitic; they grow in clusters on the wood of hardwoods or conifers; often found at the bases of living or dead trees. In the case of *Pholiota* sp.1, it had only one collection obtained from moist soil at an elevation of 200 masl. Kirk et. al. (2008) stated that this type of mushroom can be observed on a wet weather and furthermore, *Pholiota* sp1. can be observed in clusters at the base of stumps or standing living or dead broad-leaf trees.

Pleurotus ostreatus Kumm. was spotted at an elevation of 400 masl. It had two collections both obtained from log. It is commonly known as the oyster mushroom. It is a saprotroph that acts as a primary decomposer of wood, especially deciduous trees, and beech trees in particular (Phillips, 2006). Furthermore, while this fruiting body is frequently seen growing on dying hardwood trees, it merely comes out to be acting parasitically. When the tree dies of other causes, *P. ostreatus* produces on the fast increasing mass of dying and dead wood. They, in fact, benefit the forest through decomposing the dead wood, gaining vital minerals and elements to the ecosystem in a way functional to other organisms and plants (Stamets, 200). In the case of *Pleurotus* sp.1, it had a total of six collections. One was obtained from duff, two from log, two from moist soil, and one from rock. It was spotted at all elevations, 100 to 400 masl. According to Chang and Miles (2004), Pleurotus species are found in temperate and tropical areas around the world. Furthermore, species of Pleurotus are often saprobic and are usually found on dead or dying trees (Kirk et. al., 2008). *Pleurotus* sp1. is one

of the most widely eaten mushrooms, and they may be commonly called tree, abalone or oyster mushrooms (Chang and Miles, 2004).

Polyporus sp.1 was spotted at an elevation of 200 masl only, having one collection obtained from a moist soil. According to Kuo (2004), they are also saprobic on decaying hardwood stick and also on small logs, growing scattered or alone. They usually grow during late summer wherein the temperature is moderate (Mattheck and Weber, 2003) (Kirk et. al., 2008).

Psathyrella sp.1 was spotted in all elevations, 100 to 400 masl. It had three collections, two obtained from and one from moist soil. *Psathyrella* sp.2 only had one collection obtained from duff at an elevation of 200 masl. Lastly, *Psathyrella* sp.3 had one collection as well obtained from moist soil. It was spotted at an elevation of 400 masl. Psathyrella species can be sometimes spotted near the shoreline however it is most often encountered in more stable and established sand dunes and dune slacks inland as stated in the study of Rotheroe (1993).

In the case of *Pycnoporus coccineus* (Fr.) Bond. Sing., it only had one collection obtained from a log at an elevation of 400 masl. Most of these fruiting bodies are found on fallen hardwood logs, but can be found on coniferous trees as well, and they live in diverse habitats, but are usually situated near a source of water in a quite high temperature (Egert et. al., 1996).

In the case of *Trametes* sp.1, it was spotted at elevation 200 masl only and had four collections obtained from log. *Trametes* sp.2 only had one collection obtained from stick at an elevation of 200 masl. According to Kuo (2005), they are usually found on dead wood of deciduous trees most especially on fallen trunks, plus, they season all year round.

Tricholoma sp.1 was spotted at an elevation of 200 masl and only had one collection obtained from duff. In Kuo's study (2004), it can be found nearly year-round in warm climates, the mushrooms have a tendency to like cooler conditions, that they are most abundant in northern forests.

Eight species were unidentified during the study. First unidentified species was collected at 100 masl. It only had one collection obtained from duff. The second unidentified species was spotted at an elevation 100 masl as well. It had one collection obtained from stick. The third unidentified species had one collection

obtained from log at an elevation of 100 masl. Three collections represented the fourth unidentified species, two obtained from stick and one from moist soil. It was spotted at all elevations, 100 to 400 masl. The fifth unidentified species had one collection obtained from moist soil at an elevation of 100 masl. The sixth unidentified species had one collection as well. It was obtained from a living tree at an elevation of 200 masl. Three collections represented the seventh unidentified species. All three were obtained from duff at elevations 200 to 400 masl. Lastly, the eight unidentified species was spotted at an elevation of 200 masl. It only had one collection obtained from duff.

As to the number of species present per elevation, the habitat moist soil, has the greatest number of species collected, which was twenty. Second, seventeen species were collected from duff. Thirteen species were obtained from logs, nine from sticks, six from living trees, two from dead leaves and lastly, one species was obtained from a rock, two from dead leaves and lastly, one species was obtained from a rock.

Elevation	Sp. Richness (R)	Sp. Diversity (S)	Sp. Dominance (D)
100	3.464	2.791	0.0844
200	4.323	3.088	0.0389
400	3.055	2.514	0.1126

The patterns of species richness, diversity and dominance are shown in Table 4. Species richness began with a value of 3.464 at an elevation of 100 masl. The value increased to 4.323 at elevation 200 masl since this particular elevation had loads of various tress and mosses. Furthermore, this area had the least value of temperature recorded and this likely had affected the growth of mushrooms. Mushrooms love growing in places with moderate temperature with high humidity. However, when it comes to the third elevation, 400 masl, the species richness value went down. This is likely attributed to the fact that the area was very disturbed. Plus, the area was very exposed to direct sunlight which is not suitable for mushroom growth. Additionally, the site was very disturbed since agricultural burning occurred here in the past months affecting the reproduction of the said fungi at an elevation of 100 masl, species diversity began with the value of 2.791. The value rose to 3.088 at elevation 200 masl. However, it decreased at elevation 400 masl to 2.514. Elevation 200 masl had the greatest

number of species richness and species diversity. This elevation had the least value of temperature that mushrooms love. Furthermore, this site had the presence of various trees, shrubs, mosses and ferns which are favorable to the growth and reproduction of mushrooms. The third site, 400 masl, had the least value of both species richness and diversity. Again, this site was disturbed. Only few trees were observed in the site. With regards to species dominance, the third site, 400 masl, had the greatest value of 0.1126. Meanwhile, elevation 200 masl had the lowest species dominance with a value of 0.0389. Lastly, a species dominance value of 0.0844 was recorded at elevation 100 masl.

Conservation Status

The Conservation Status of Mushrooms found in Dansolihon Slope, Cagayan de Oro City based on The IUCN Red List of Threatened Species is shown in Appendix A.

Calocera viscosa Pers., *Coprinellus disseminatus* (Pers.) Lange, *Crepidotus variabilis* (Pers.) Kumm., *Dacrymyces chrysospermus* (Bull.) Tul., *Geastrum triplex* Jungh., *Marasmius siccus* (Schwein.) Fr., *Pholiota squarossa* (Oeder.) Kumm., *Pleurotus ostreatus* Kumm., and *Pyncnoporus coccineus* (Fr.) Bond. Sing, all have a conservation status of LC, which means Least Concern, having lowest risk, and are widespread as well as having abundant taxa.

Bjerkandera sp.1, *Coprinus* sp.1, *Coprinus* sp.2, *Coprinus* sp.3, *Coprinus* sp.4, *Collybiasp*.1, *Crepidotus* sp.1, *Entoloma* sp.1, *Marasmiellus* sp.1, *Marasmius* sp.1, *Micromphale* sp.1, *Mycena* sp.1, *Mycena* sp.2, *Mycena* sp.3, *Mycena* sp.4, *Mycena* sp.5, *Mycena* sp.6, *Omphalina* sp.1, *Oudemansiella* sp.1, *Panellus* sp.1, *Peziza* sp.1, *Pholiota* sp.1, *Pleurotus* sp.1, *Polyporus* sp.1, *Psathyrella* sp.1, *Psathyrella* sp.2, *Psathyrella* sp.3, *Trametes* sp.1, *Trametes* sp.2, *Tricholoma* sp.1, as well as eight unidentified species have not been labeled according to The IUCN Red List of Threatened Species due to insufficient data and, therefore, have been ranked as DD, meaning Data Deficient. They do not have enough data to make an assessment.

CONCLUSIONS

As evident from the results of the study, the mushroom species were not evenly distributed all throughout the various elevations. Loads of species were found only on a particular elevation while few are observed in all elevations. In

general, the area is moderately diverse since the values of diversity index are fairly above 1, the value, 1, being the lowest and 5 being the highest (Gerami, 2013).

RECOMMENDATIONS

1. The number of months for the mushroom collection must be increased to determine better the pattern of species diversity.

2. Other areas of Dansolihon, Cagayan de Oro City, Philippines must also be studied to know the presence of endemic species.

3. The collected mushroom samples should be further examined and classified to know if they are fit for human consumption.

4. A seminar on the importance of mushrooms must be conducted so that people will become aware of their ecological roles and possible economic value.

5. The unknown species must be identified.

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Plate 1. Sampling Site 1 (100 masl)

Plate 2. Sampling Site 2 (200 masl)

Plate 3. Sampling Site 2 (200 masl)

Plate 4. Sampling Site 3 (400 masl)

Mushroom Species

Plate 5. *Bjerkandera* sp.1

Plate 6. *Calocera viscosa Pers.*

Plate 7. *Coprinellus disseminates*

Plate 8. *Coprinus* sp.1

Plate 9. *Coprinus* sp.2

Plate 10. *Coprinus* sp.3

Plate 11. *Coprinus* sp.4

Plate 12. *Collybia* sp.1

Plate 13. *Crepidotus variabilis*

Plate 14. *Crepidotus* sp.1

Plate 15. *Dacrymyces chrysospermus*

Plate 16. *Entoloma* sp.1

Plate 17. *Geastrum triplex*

Plate 18. *Marasmiellus* sp.1

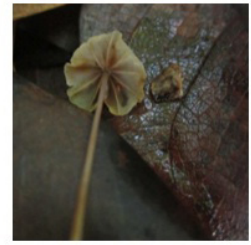

Plate 19. *Marasmius siccus*

Plate 20. *Marasmius* sp.1

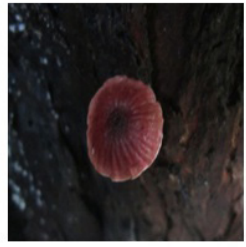

Plate 21. *Micromphale* sp.1

Plate 22. *Mycena* sp.1

Plate 23. *Mycena* sp.2

Plate 24. *Mycena* sp.3

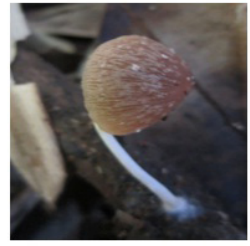

Plate 25. *Mycena* sp.4

Plate 26. *Mycena* sp.5

Plate 27. *Mycena* sp.6

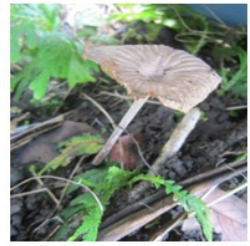

Plate 28. *Omphalina* sp.1

Plate 29. *Oudemansiella* sp.1

Plate 30. *Panellus* sp.1

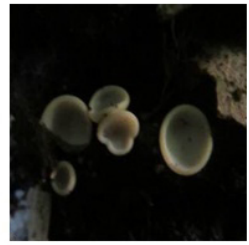

Plate 31. *Peziza* sp.1

Plate 32. *Pholiota squarossa*

Plate 33. *Pholiota* sp.1

Plate 34. *Pleurotus ostreatus*

Plate 35. *Pleurotus* sp.1

Plate 36. *Polyporus* sp.1

Plate 37. *Psathyrella* sp.1

Plate 38. *Psathyrella* sp.2

Plate 39. *Psathyrella* sp.3

Plate 40. *Pyncnoporus coccineus*

Plate 41. *Trametes* sp.1

Plate 42. *Trametes* sp.2

Plate 43. *Tricholoma* sp.1

Plate 44. Unidentified Species 1

Plate 45. Unidentified Species 2

Plate 46. Unidentified Species 3

Plate 47. Unidentified Species 4

Plate 48. Unidentified Species 5

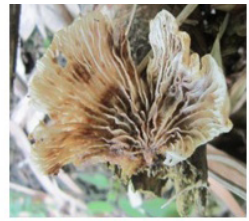

Plate 49. Unidentified Species 6

Plate 50. Unidentified Species 7

Plate 51. Unidentified Species 8