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Tree and Macrofungal diversity of the two different habitat types in Mt. Makiling forest reserve

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Abstract

The study covered the assessment of tree and macrofungal diversity of two different types of forest habitat in Mt. Makiling in the Philippines. Minimum disturbances such as trails, signs of previous human activities and minor erosion patterns where used to distinguish the disturbed site from the undisturbed. Minimum diameter set for trees included in the assessment was 5 cm. For fungal diversity, only the macrofungi were assessed. Soil fungus is generally microscopic while leaf litter and wood fungus are macroscopic. This study has found out that fungal diversity is positively correlated with tree diversity. The more diverse and less disturbed the forest ecosystem is, the greater also is its fungal diversity. This study will serve as baseline information to better improve the management practices in Mt. Makiling to preserve its remaining biodiversity.

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Introduction

Biodiversity is the assortment of species, their genotypic attributes and the environment in which they inhabit is defined as biodiversity (Lloyd, 2012). Biodiversity expresses the wide association of different species in a common habitat. For example, when a specific plant organism coexists with a number of other different plant species, their totality can already be considered biodiversity. Biodiversity has so much importance on the forest and its impact is large enough to affect the forest itself because the species themselves consist the forest. The air we breathe mainly comes from the variety of plant and tree species in the forests, the food we eat comes also from the plants we see around us and 30% of medicines which are important to human health are extracted from plants and animals (Lloyd, 2012). Biodiversity is life and it has to be sustained for the next generation to benefit from it (Santiago & Buot, 2015).

Nowadays, the trend of biodiversity research encompasses not only flora and fauna but also fungi. Scientists become more interested in studying fungi in the context of biodiversity and taxonomy due to the emerging technologies and discoveries unveiling the importance of the group. Fungi are essential to such crucial activities as decomposition, nutrient cycling, and nutrient transport and are indispensable for achieving sustainable development (Palm & Chapela 1998). Some species of fungi also form symbiotic associations with trees making it valuable for growth and adaptive survival of certain species. Few species are utilized for biotechnology, industrial fermentation, biofertilizer, and other species are used as food. However, fungal diversity is now threatened by natural and anthropogenic disturbances more than ever (Hacksworth 1974).

With human population continually growing, anthropogenic pressures create more disturbances especially in sensitive areas such as forest where diversity is greatest. These disturbances affect biodiversity in many ways, but more commonly through habitat alteration. Habitat alteration can be an initial ladder to a potential loss of habitat. It should be well understood that every species occupy a unique space in a habitat and possesses varying levels of tolerance to disturbance. Recent studies showed that, habitat alteration or disturbance is one of the main causes of biodiversity loss.

Trees and fungi are inseparable in forest ecosystems (Deacon 2006). Being the dominant flora, trees are the most important host and at the same time substrate of fungi. The crucial part is on how to relate the diversity of the two, given a specific environmental condition. Many studies detailed that biodiversity can be also functional. In this case, the greater number of interlinked organisms, the higher is biodiversity.

Therefore this study aim to answer these questions by investigating the difference between an intact and a disturbed site to determine and compare macrofungal diversity of the two different habitat types of Mt. Makiling Forest Reserve; generate information on the taxonomy of collected macrofungal species and establish fungal collection herbarium. This study only on macrofungi since most taxonomic work in the Philippines has focused on general descriptions of Basidiomycota were many macrofungi belongs (Musngi, 2005).

Materials and methods

Time and Place of Study

This research was conducted in two different habitat types in Mt. Makiling forest reserve (Fig. 1).

The area is geographically located at 14.14439, 121.23230 degrees (latitude, longitude), and around 4 kilometers from Mt. Makiling Forest Reserve Entrance Station. Since macrofungi need moisture to develop (Sibounnavong, 2008), the fieldwork was conducted during the rainy season.

The altered or disturbed habitat was represented PLFA 3 while the adjacent forest with relatively no signs of natural or anthropogenic disturbances represent the undisturbed habitat. PFLA 3 is highly dominated by broad-leaved mahogany which was planted a few decades ago as part of the program that aimed to reforest the area. In the understory, palm species such as Kaong *(Arenga pinnata)* and Rattan (*Calamus* spp.) are present. Signs such as trails, fresh research plots, tree markings and eroded sediments have been considered as causes of disturbance of the site. In contrast, the adjacent site reveals no signs of anthropogenic activities.

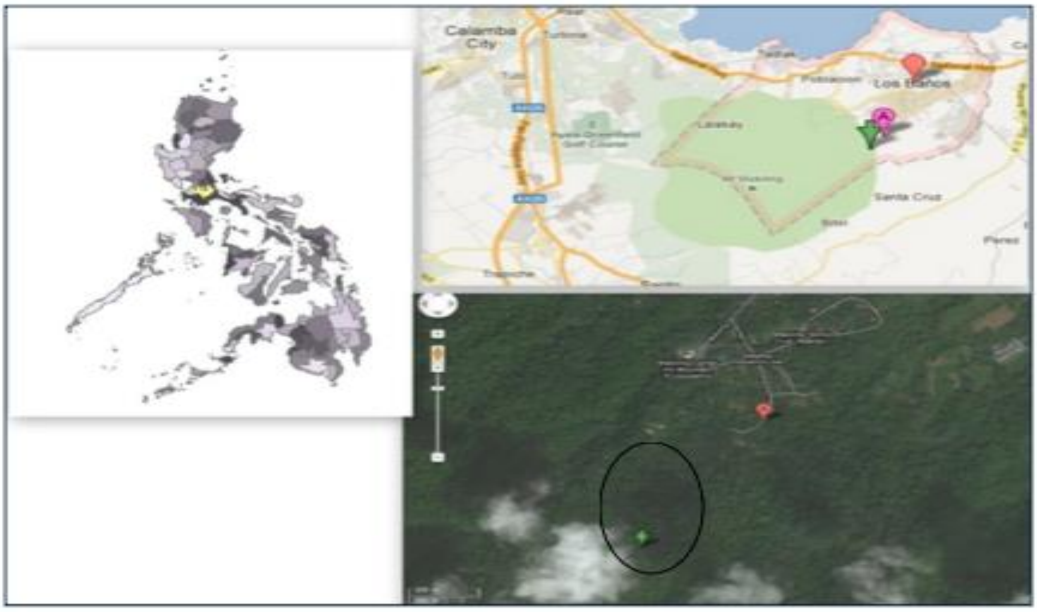

Fig. 1. Location map of the site.

Establishment of sampling plots

In order to factor-in aspect, location of the four cardinal direction of each site was determined using a handheld GPS receiver. A ground point was marked to serve as center of the axes. Within each cardinal direction, one 10x10m plot was established and the x,y,z data of its corners were recorded.

Table 1. Geographic locations and elevation of the sampling plots.

Habitat type	*Plots*	*GPS coordinates*		*Elevation (masl)*
		Y	*X*	
Undisturbed	NE	14.13251	121.23225	313
	NW	14.14384	121.23201	313
	SW	14.14362	121.23205	302
	SE	14.14354	121.23236	306
	NE	14.14442	121.23225	267
Disturbed	NW	14.14442	121.23201	273
	SW	14.14450	121.23205	276
	SE	14.14439	121.23236	275

Sampling of Trees

In the established plots all trees with a Diameter at Breast Height (DBH) of ≥ 15cm were identified and measured. The DBH of each species was measured using a diameter tape and recorded in the field notes. The sampling was done in a counterclockwise direction from Northeast; the sequence is shown in the diagram below (Fig. 2).

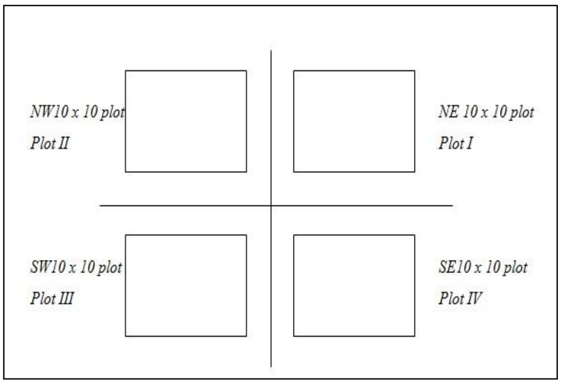

Fig. 2. Sampling flow in each plot.

Sampling of Macrofungi

A modified method was used to simplify sampling inside the 10 by 10 meter plots. A short transect was established in each plot measuring 2 meters in width. The sampling was performed from west to east. This means that in every plot, an alternate west to east pace of sampling direction was done (Fig. 3).

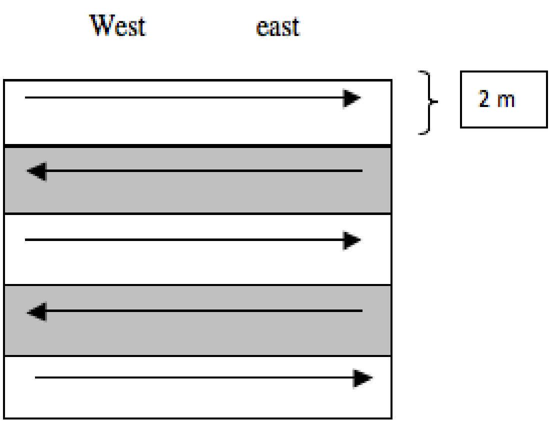

Fig. 3. Sampling flow in each plot.

Data regarding the substrate (e.g., soil, leaf litter and wood) were recorded. All macrofungi that were located was photo-documented while still attached to the substrate for future reference. All collected fungi were stored in a plastic bag labeled with the appropriate plot number.

The collection where then brought to CFNR-FBS laboratory for description, identification, and drying. Appropriate books and manuals were used to support the identification of the collections. Dry biomass of the collected macrofungi was determined using a digital weight balance.

Data Analysis

Tree and Macrofungi diversity was analyzed using relevant quantitative measures. Tree Diversity was computed using the Shannon's Diversity Index. The ecological parameters used include species diversity, evenness and abundance. Descriptive statistics was also employed in this study.

Results and discussion

Tree diversity

In the Permanent Field Laboratory Area 3 (PLFA 3), there were only two species of trees recorded. These are mahogany *(Swietenia macrophylla)* and yemane *(Gmelina arboria).* 79% and 21% of the total number individuals belong to mahogany and yemane respectively (Fig. 4).

This information indicates that a very large proportion of the total species composition of the site belongs to mahogany. Since mahogany is the main plantation tree species thriving in the area, its dominance in highly evident. Its dominance may indicate that the species is highly competitive and may not favor the establishment of other species.

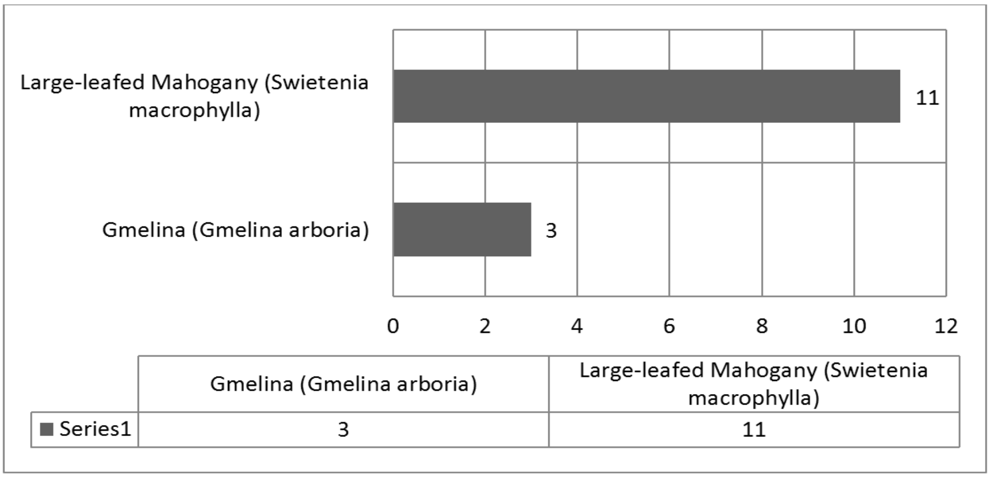

Fig. 4. Number of individuals per tree species in the disturbed plot.

There are reports stating that mahogany exhibits allelopathy but the case remains less understood and more research is needed on the subject. These findings may suggest that while mahogany is a good industrial tree plantation species, it may not be the right species to be planted in areas intended for biodiversity conservation.

Fig. 5 below shows the species composition and the number of individuals per species in the undisturbed site. In terms of number, the three most dominant tree species were mahogany *(Swietenia macrophylla),* dita (*Alstonia scholaris)* and prickly narra *(Pterocarpus indicus var. echinatus).*

Because of close proximity, it was believed that the species composition in the undisturbed site maybe affected by the nearby-disturbed sites with exotic tree species thriving especially mahogany. This may suggest that mahogany is starting to invade and the site might require immediate intervention. Mahogany is a known exotic species with wide environmental range. Its presence in the undisturbed site maybe attributed to migration via propagules. It was found out that mahogany in the intact site have smaller DBH in comparison with those in the disturbed site. This may suggest that other species are competing at a high level with the invasive mahogany.

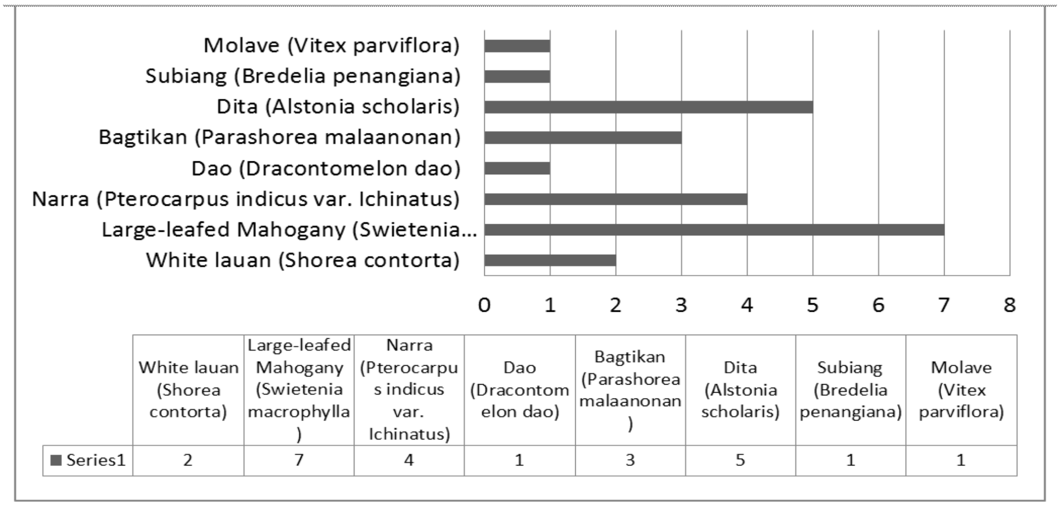

Fig. 5. Percentage number of individuals of each species in the undisturbed site.

In terms of diversity, the results show that there is a difference between the two sites (Fig. 6). The diversity index of the undisturbed site (1.85) is more than twice higher than that of the disturbed site (0.52). However, categorically the diversity indexes of the former and latter are classified as low and very low respectively.

Fig. 6 details the implicative numbers of measured ecological parameters. Species diversity as discussed previously is categorized as low and very low for intact and disturb habitat type respectively. In terms of species richness, the intact forest attained a relatively higher index. The intact site obtained an evenness index value of 0.89 which is comparably higher than 0.75 of the disturbed site.

The evenness index of the undisturbed habitat is much higher than that of the disturbed habitat. The undisturbed habitat not only has a greater number of species present, but the individuals in the community are distributed more evenly.

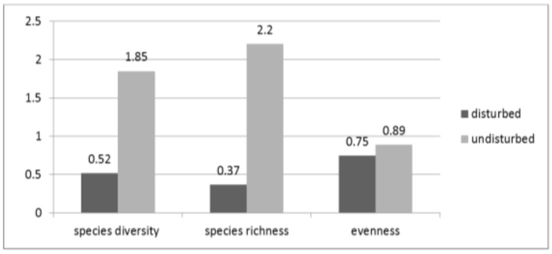

Fig. 6. Species Diversity, Richness and Evenness Index on the two sites.

Macrofungal Diversity

Three fungal substrates in site 1 were recorded to have fungal signs; wood, forest litter and soil. These substrates are observed to be the most common especially under forested environment. These substrates are the ultimate source of fungal nutrition. Although virtually hidden from human vision, fungal mycelia grow extensively within these different kinds of substrate. This idea proves that fungi as a group have a broad-range of habitat or substrate. In both sites, several macrofungi were observed to grow on dead wood but there is higher species richness in the undisturbed site.

This result could be associated with the higher tree diversity in the site, which implies that a broader range of woody substrates is available for wood-inhabiting macrofungi.

This is consistent with Kutszegi *et al*. (2015) when they stated that wood-inhabiting fungal species composition is driven primarily by the species composition of living trees.

The disturbed site had two types of substrate, forest litter and soil. These findings may indicate that an undisturbed and disturbed site could offer a generally similar set of substrate to support macrofungal growth. However it is important to emphasize that the undisturbed site offers a more diverse source of substrate especially the woody debris. Thus, The sustainable management of these sites will require retaining dead wood of all sizes, species and decay stages to maintain wood-inhabiting fungal diversity (Gates *et al*., 2011).

There were 11 fungal genera recorded in the undisturbed forest habitat. *Xylaria spp.* has the highest number of individuals equal to 13 fruiting structures. In the undisturbed site, *Cantharellus* spp. appeared to have the highest number of individuals present. *Cantharellus* spp. frequently occurred in various plots for both forest habitat types.

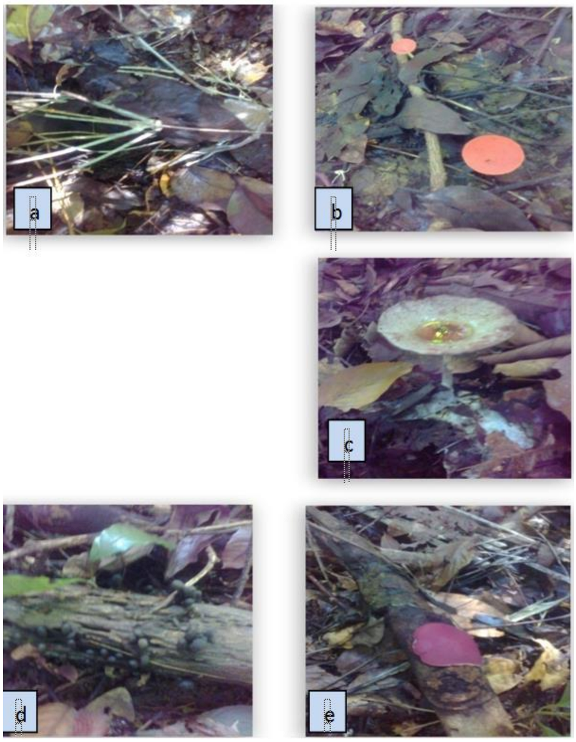

Fig. 7. Representative Fungal substrates a-b (forest litter), (c) soil, *(d-e) wood from both sites.*

There is a significant variation between the ecological parameters computed for each type of forest habitat (Fig. 8). The undisturbed and disturbed forest habitat obtained moderate and very low diversity respectively.

These values reflect that the undisturbed area does not only have a greater number of species present but a more equitably distributed number of individuals per species.

However, the two habitats did not differ significantly in terms of evenness. Both fall under very high category for evenness because both have values close to 1. It has been reported that 0.75-1.0 evenness index is classified as very high.

This means that the number of individuals per macrofungal species is highly homologous. Numerically, the disturbed site has four (4) species fewer than the undisturbed site.

The slight evenness difference can be attributed to the variation of proportion of individual distribution for each species. In the disturbed site, 28% of the number of individuals belongs to one species compared to only 22 % in the undisturbed site.

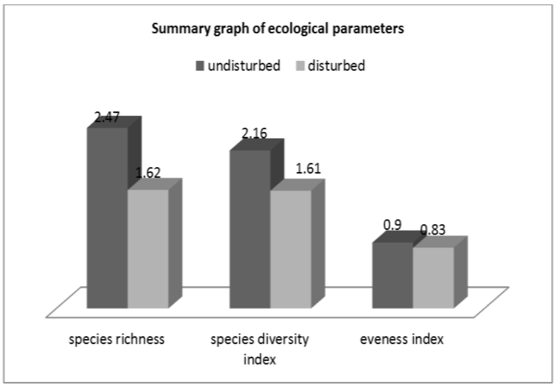

Fig. 8. Summary table showing Ecological parameters (diversity, density, evenness) from two selected sites in Mt. Makiling Forest Reserve*.*

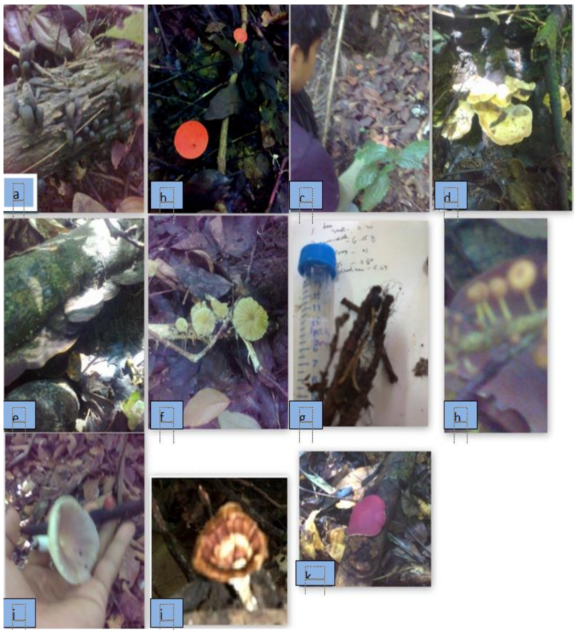

Fig. 9. Images of macrofungi in the undisturbed forest habitat (*a. Xylaria* spp., *b. Cookeina* spp., *c. Marasmius* spp., *d. Ganoderma* spp., *e. Polyporus* spp., *f. cantharellus* spp. *g. Rhizopus* spp., *h. Coprinus* spp., *i. Agaricus* spp., *i. Polystrictus* spp.)

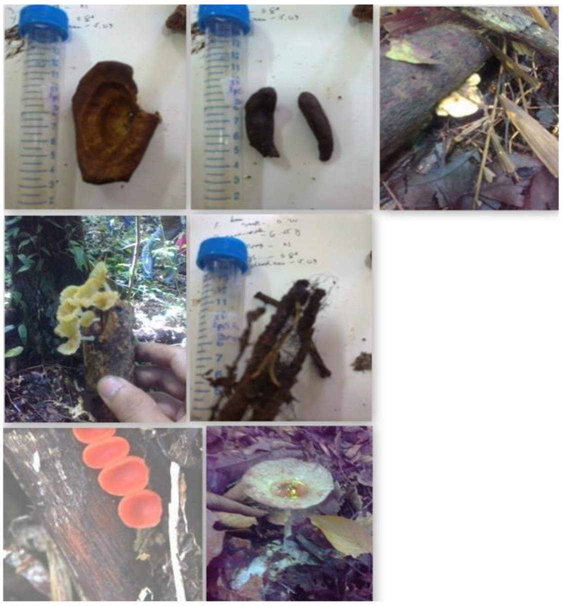

Fig. 10. Images of Macrofungi in Disturbed Forest Habitat (from the top: *Polystrictus* spp., *Xylaria* spp., *Ganoderma* spp., *Cantharellus* spp., *Rhizopus* spp., *Cookeina* spp., *Agaricus* spp.)

Conclusions

The undisturbed site contains more species of flora and macrofungi. Macrofungal diversity was higher in the undisturbed site compared to the disturbed. This result may lead us to the conclusion that fungal diversity could be higher in sites with also higher diversity of trees. In undisturbed and more diverse areas, the environmental conditions are highly favorable for the fungus and various substrates are available. Overall, the undisturbed site contain four more species that the compared site.

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