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Composition and diversity of floral understory in Mount Matutum Protected Landscape (MMPL), South Cotabato, Philippines

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Abstract. Mount Matutum is a declared protected landscape straddling the municipalities of South Cotabato (Polomolok, Tupi, Tampakan) and in Sarangani (Malungon), Mindanao. Despite its protected status and being one of the biodiversity hotspots in the region, there was only a handful of studies conducted to assess its floral diversity; much of which was dendrological in nature. Under this premise, we assessed the understory vegetation in the mountain across elevation gradient (lowland, montane, and mossy forests) and habitat condition (disturbed and undisturbed areas) by determining the composition, richness, diversity, and conservation status of the floral species. The researchers established eight (8) 5x5 m plots in each elevation gradient. A representative of each species was mounted and deposited in the Research and Development Center, Mindanao State University-General Santos City. One hundred fifty-four (154) understory plant species found in disturbed and undisturbed areas were recorded. Elevation-wise, lowland and montane forests (500-1722 mASL), showed a greater number of floral species compared to the mossy forest. The understory flora was categorized into herbs (27%), shrubs (21%), vines (21%), grasses (10%), aroids (9%), palms (3%), zingibers (3%), orchids (2%), sedges (2%), pandans (1%), and rattans (1%). *Elaeocarpus* sp. (Elaeocarpaceae), *Schismatoglottis rupestris* Zoll & Moritzi ex Zoll. (Araceae), and *Impatiens platypetala* L. (Balsaminaceae) were the most dominant species found in the disturbed area. On the one hand, *Decaspermum fruticosum* Forst. (Myrtaceae), *Cyrtochloa fenixii* (Gamble.) (Poaceae) and *Freycinetia maxima* Merr. (Pandanaceae) dominated the undisturbed area. Using Simpson's diversity index, the montane forest in the undisturbed area showed the highest species diversity with D = 0.96 while the mossy forest in the same area had the lowest with D = 0.83, hence, a low to moderate floral diversity was observed. Assessment of the ecological status revealed 14 native plant species, of which one is endemic to the Philippines, *Dendrocnide luzonensis* (Wedd.) Chew (Urticaceae) locally known as 'lipa'.

Key Words: understory vegetation, floral diversity, elevation gradient, Simpson's diversity index, ecological status.

Introduction. Understory refers to the layer of vegetation beneath the main canopy of a forest which grows at the lowest height level (Smith 2011). The vegetation consists of a mixture of seedlings and saplings of canopy trees together with understory shrubs and herbs. They play a key role in maintaining the structure and function of forest ecosystems (Augusto et al 2003), provide food and shelter to faunal communities (Felton et al 2010), act as a vehicle in nutrient cycling (Hart & Chen 2006), and influence the nutrient fluxes in the ecosystem during throughfalls (Hornung et al 1990). Species composition, richness, and diversity are considered as important factors in providing complex structure and conserving the endemic floras within forests (Halpern & Spies 1995). Floral understory may exhibit different patterns of diversity compared to the tree species since they respond to the different conditions in the forest caused by biotic and

abiotic factors which includes water and nutrient availability, temperature, climate and weather, and differential light levels (Laska 1997; Svenning 2000; Siebert 2002).

In the Philippines, a total of 13,500 floral species were found representing the five percent (5%) of the world's flora (DENR 2015). In the world list of endemic plants, Philippines ranked 8th and noted to have twenty-five (25) endemic plant genera; the Rubiaceae family with 4 genera, Asclepiadaceae (3), Orchidaceae (3), Melastomataceae, Loranthaceae, Zingiberaceae, and Sapindaceae (2 genera each) and Compositae, Euphorbiaceae, Leguminosae, Rutaceae and Urticaceae (one genera each), as well as 2 endemic fern genera. Nineteen (19) of these are monotypic (DENR-UNEP 2005).

The spatial variations in biodiversity generally include species diversity in relation to the size of the area, the relationship between local and regional species diversity and diversity along gradients across space, as well as environmental factors such as altitude, depth, isolation, latitude, moisture and productivity (Gaston 2000). Hence, understory community and biodiversity are focal objectives for sustainable forest management, effective forest biodiversity conservation, and successful forest restoration (Hart & Chen 2006; Nilsson & Wardle 2005). However, the presence of different human activities and forms of farming applications (slash-and-burn activity) greatly affects understory vegetation and its diversity which remains controversial (Schmiedinger et al 2012) as well as the presence of a significant population of invasive species (Vitousek et al 1997; DeWalt 2006). It is a challenge for forest managers to promote forest regeneration while conserving indigenous biodiversity in a large area of clear-cut forestlands.

Despite its rich biodiversity, documented information is limited and fragmented. This study, therefore, makes an attempt to address the question how the floristic composition, diversity, richness and density of understory plant communities differ in the different elevation gradients and determine its conservation/ecological status to enhance the sustainable management in Mount Matutum Protected Landscape (MMPL), South Cotabato, Philippines.

Material and Method

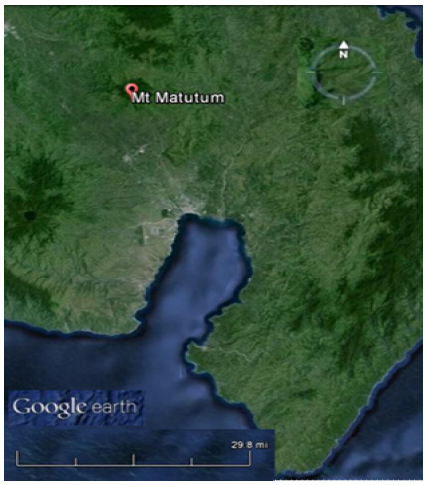
Study site. The Mount Matutum Protected Landscape is located between 6°27'30.99'' to 6°26'9'' Northern Latitude and 124°58'37.5'' to 125°07'63.86'' East Longitude, shown in Figure 1 (PAMB 2005). The area is located in the four (4) barangays of the Municipality of Polomolok (Kinilis, Landan, Maligo, and Palkan); three (3) barangays of the Municipality of Tampakan (Albagan, Tablu, and Lampitak); five (5) barangays of the Municipality of Tupi (Acmonan, Cebuano, Kablon, Linan, and Miasong); two (2) barangays of the Municipality of Malungon (Datalbatong and Datalbila); all in the Province of South Cotabato and Sarangani (DENR–PAWB 2006). This study was conducted from May 2013 to May 2014.

Establishment of the sampling plots. In every sampling area, four (4) plots were established located to the left and right of the transect walk, about 20 meter distance. The understory plants were assessed within the 5 x 5 m plot nested in the 20 x 20 m plot marked with geographical coordinates. Field reconnaissance and secondary data gathering were conducted to determine the disturbed and undisturbed areas in MMPL. The disturbed areas were located at Upper Linan and Sitio Glandang in the Barangay of Kablon, Tupi, South Cotabato. These areas are readily accessible because of its well-established trails likely developed for eco-tourism activities and where agro-ecosystems dominate and a popular destination for mountaineering trekking activities. Meanwhile, undisturbed areas are unexplored and associated with unmanaged sites with no established trails and marked by a lesser degree of human-led disturbance. Undisturbed areas were located in Sitio Kawit, Barangay Maligo, Polomolok, South Cotabato. In each site, three sampling areas were established representative of varying elevation and forest vegetation types namely: lowland (500-999 mASL), montane (1300-1400 mASL) and mossy (1500-1720 mASL). On-site identification of understory species was done and parameter such as number of individuals was determined. Representative species sample within the sampling plots were photographed, collected and marked with plant collection

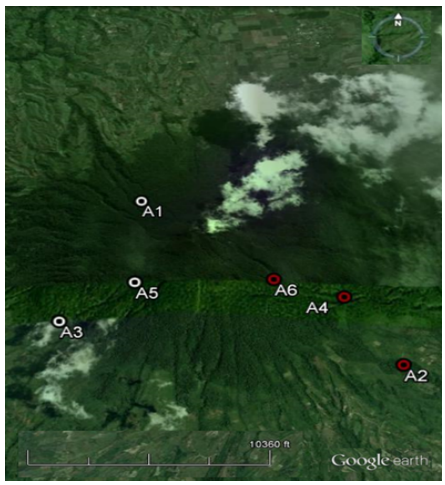
number and then, pressed and mounted as herbarium voucher. These samples were used for identification and confirmation of the unidentified plants.

Philippine map

Mindanao map



Map showing the relative position of Mt. Matutum of Southern Mindanao



The six study sites in Mt. Matutum. Red plots (undisturbed sites), White plots (disturbed sites)

Figure 1. Location Map of Mt. Matutum.

Data gathering and collection of samples. Data collected during the survey included the local name of the plant, number of individual per species and the plots where species occurred. Data gathered was used in computing ecological parameters such as species richness, relative density, relative frequency, relative coverage, species importance value (SIV) and similarity index. Geographical coordinates per sampling plot were taken. Understory species located within the sampling plots were documented, and representative samples were collected for identification and archival purposes.

Data analysis. Results were analyzed based on species composition, richness, and diversity. Species composition is the identity of all the different species that make up community or an area. On the other hand, species richness measures the number of different kinds of species present in a particular area. Species diversity was evaluated through Simpson's diversity index.

Conservation status of understory. Conservation status of identified understory species was assessed using the International Union for Conservation of Nature (IUCN) Red List database version 3.1 (2013), the National List Threatened Plants of the Philippines by Fernando et al (2008) and the DENR Administrative Order (2007).

Results and Discussion

Taxonomic composition. The species composition of understory plants varied in the different ecological land types, as shown in Figure 2. Herbs dominated the composition and categorized under the family Asteraceae and Balmaceae. Species included were *Crassocephalum crepidiodes* S. Moore (Benth), *Elephantopus tomentosus* L., *Pseudelephantopus spicatus* (Juss. ex Aubl.) C.F. Baker, *Chromolaena odorata* (L.) R.M., *Vernonia arborea* Ham., *Bidens pilosa* L., *Acmella grandiflora* (Turcz) R.K. Jansen, *Impatiens platypetala*, *Impatiens balsamina*, and *Impatiens walleriana* Hook.f. Aroids species were mainly fallen under the family Araceae. Poaceae, on the other hand, was the highly composed family of grasses. About three (3) families of vines were identified to have the most number species namely, Convulvulaceae, Apocynaceae, and Vitaceae. Convulvulaceae species observed in the study include the 'Kamkamote' and 'malakamote' species (*Ipomoea* sp.) while Apocynaceae were composed of 'Hoya' (*Hoya multiflora* (Blume) Deam), Lisid (*Chonemorpha elastica* Merr.) and 'Hingiw' (*Ichnocarpus volubilis* (Lour.) Merr.) vines. Moreover, Vitaceae vines included the 'Ayong Kabayo' (*Tetrastigma loherii* Gagnep), 'Sugpon-sugpon' (*Cissus quadrangulis* Linn.) and 'Bariuatuat' (*Tetrastigma harmandii* Planch). Comprising the minority regarding species composition were palms and rattans under Arecaceae/Palmaceae, pandans (Pandanaceae), sedges (Cyperaceae) and Zingibers (Zingiberaceae).

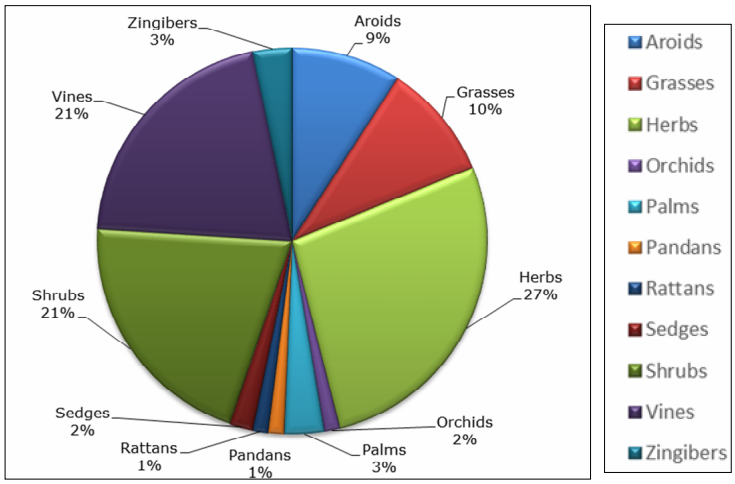


Figure 2. Percentage composition of understory vegetation.

The species composition in Mt. Matutum varies due to external factors such as the different forest types (Hart & Chen 2008) covered in the study, the sampling method used, as well as the overstory and structure and composition (Hart & Chen 2008; Sangar et al 2008). As cited by Humphrey et al (2002) and Bao et al (2009), understory plant composition and biodiversity can also be influenced by the dense canopy tree cover that affects the increasing overstory richness over understory species in younger forest stands. Thus, their ability to compete for available resources in the area declines since light penetration will be restricted to the ground (Baker & Hunter 2002). Moreover, reforestation practices which includes series of activities (Bao et al 2009) and exposing the soil surface reduces the ground vegetation (Yan & Bao 2008).

Species richness. The results across elevation and areas showed that the highest number of understory species were recorded in the undisturbed area of the montane forest and disturbed area of the mossy forest (Figure 3).

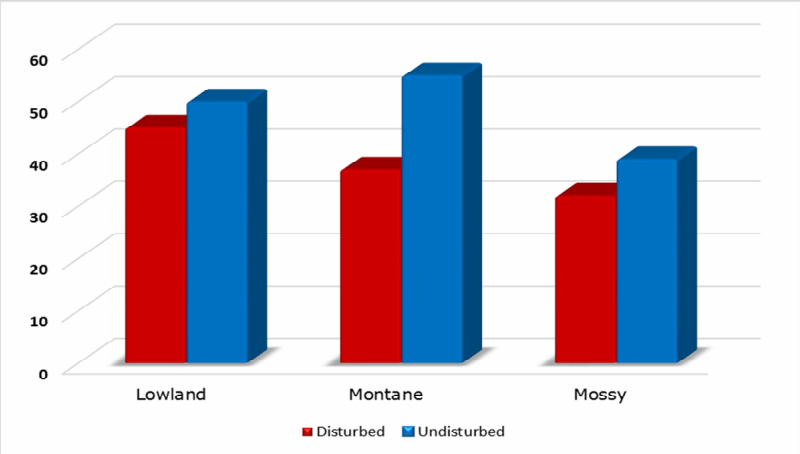


Figure 3. Species richness of understory across elevation gradients.

Zhao et al 2005 presented the same pattern for the montane forest in which plant diversity was high between 900-1500 mASL primarily at 1200 mASL that was referred to as "mid-altitude bulge". They reported the greatest shrub diversity at approximately 1,100 mASL, which is under mid-montane altitudes. In the lowland, species richness in the undisturbed area is higher as compared to the disturbed area. *Decaspermum fruticosum* Forst., *Cyrtochloa fenixii* (Gamble.), and *Freycinetia maxima* Merr. are abundant in the undisturbed area across the elevation gradients. This finding indicates a succession area from a previously disturbed environment as reflected by greater number of understory species and tree saplings along with the presence of invasive exotic species. Species richness in the disturbed area of the montane forest is lower than undisturbed area due to the dominance of large trees, *Dacrycarpus imbricatus* locally known as 'Igem' whose trunk diameter can cover up to more than 100 cm aside from its outreaching buttress roots. In the mossy forest, the disturbed area contains the least understory species while more species in the undisturbed area were recorded. This variation is obviously due to a variety of factors (climate, rainfall, geographic position, altitude) other than disturbances like human interventions. However, altitude strongly influences the plant diversity distribution of forest over human activities (Gao et al 2009). Furthermore, profound variations in the native species composition and in the ecosystem processes (Mack et al 2000) is attributed to the occurrence of invasive species. One of which was *Piper arborescens* (Piperaceae) locally known as 'buyo-buyo' which is widely distributed in the tropics and was found to occupy significant portion of the lowland forest area in MMPL. Another invasive species encountered in the area is the *Ipomoea triloba* locally referred to as 'kamkamote'. This herbaceous, twinning vine is one of the main weeds identified in the Philippines as common in monoculture maize (Pamplona 1988) and intercropped agri-crops and tends to act as pest attractant (Mercado et al 1980) thus, posing a serious concern in the richness of species.

Species dominance Dominance of the species was presented through Species Importance Value (Table 1). These are the species that contribute most to the productivity of Mount Matutum and that have the central role in the maintenance of the MMPL ecosystem. The understory cover in MMPL has recorded different kinds of species dominating across the varying elevations and areas (Table 1). The dominant understory varies in the disturbed and undisturbed areas that further show their unique physical, biological and chemical attributes that may explain such difference.

Table 1

Most dominant understory species in the disturbed and undisturbed areas across elevation gradients (lowland, montane and mossy)

Elevation	*Disturbed*	*Undisturbed*
Lowland	*Elaeocarpus* sp.	*Decaspermum fruticosum* Forst.
Montane	*Schismatoglottis rupestris* Zoll	*Cyrtochloa fenixii* (Gamble.)
Mossy	*Impatiens platypetala* L.	*Freycinetia maxima* Merr.

Species diversity. Computations revealed significant diversity in the lowland and montane forest (Figure 4). However, in the mossy area, a different picture was drawn where the disturbed area appeared to have greater diversity than the undisturbed area. Simpson's index presented the highest understory diversity in the undistubed area of the montane forest (0.96) and the mossy forest (0.83) got the least diversity of the same area. A diversity index takes into account the number of species present, as well as the abundance of each species. Concerning species richness of trees, it can be recalled that the undistubed area appears to be more species-rich than disturbed area across the elevation gradients (lowland, montane, and mossy forests). Hence, Simpson's index have shown that the diversity in the undisturbed area is higher than the disturbed area. Moreover, diversity including the abundance of understory plants are also influenced by biotic factors (Galindo-Gonzales et al 2000; Siebert 2002).

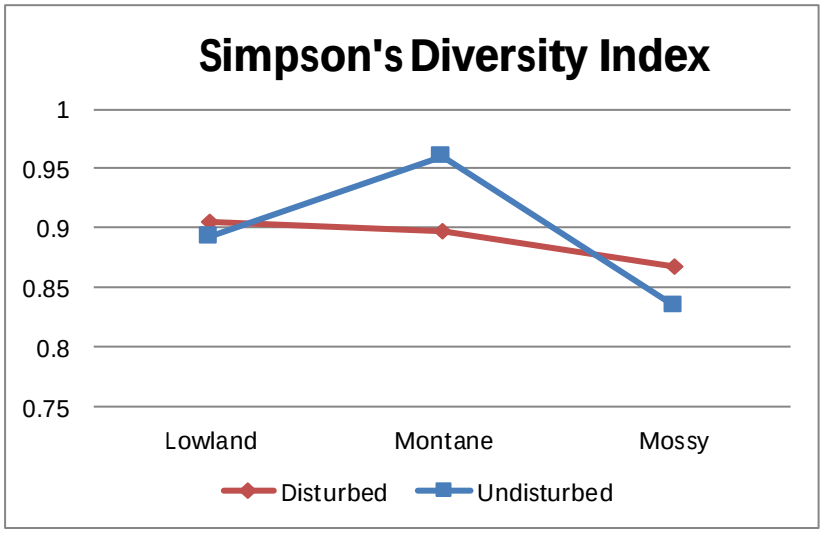


Figure 4. Simpson's diversity index of understory species.

Conservation status. About 154 species of understory belonging to 50 families were recorded. Most of the species were categorized as not yet assessed, 28 species under not in the catalog and 11 species categorized as least concerned. IUCN (International Union for Conservation of Nature) version 2013.2 database on threatened species showed that among the species recorded, *Alocasia sanderiana* W. Bull. (Araceae) is said to be critically endangered. The same status was documented in the list of DAO 2007-01 and Fernando et al (2008). The density of species was as low as one (1) individual to as high as 350 individuals in all the sampling stations. The distributional patterns of understory plants varied in all the areas due to the various vegetational types. Some species noted to have the highest relative density, relative frequency, relative coverage as well as importance value were *Elaeocarpus* sp., *Decaspermum fruticosum* Forst., *Schismatoglottis rupestris* Zoll, *Cyrtochloa fenixii* (Gamble.), *Impatiens platypetala* L., *Freycinetia maxima* Merr.

Conclusions. A moderate to high floral diversity was observed in Mt. Matutum. Lowland and montane forests were noted to exhibit greater number of floral species. Diversity index showed to be high in the montane area with both the disturbed and undisturbed areas dominated by herbs. The presence of invasive species and species associated with succession even in the undisturbed area presents a cause for concern. As such, there is a need to look constantly into the state of biodiversity in forests ecosystems like Mt. Matutum through strict observation of management plans and activities in protected area zones.

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