FLORAL DIVERSITY OF THE REMNANT MOSSY FOREST PATCHES IN ATOK, BENGUET, NORTHERN PHILIPPINES

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Abstract: Mossy forests are important support ecosystems to human society by serving as water source, erosion control and habitat for several endemic species. Originally protected by their rugged terrain and remoteness, now these are also being heavily exploited. In Cordillera Central Range, Philippines, massive areas of mossy forest have been and keep being converted to vegetable farms indiscriminately. Also, this forest is one of the understudied forest type in the country. This makes the inventory of mossy forest crucial as baseline information for conservation efforts and to document the remaining diversity before they are lost forever. To contribute to this data gap, the study has documented the floral diversity in the remaining forest patches of Paoay, Atok, Benguet. A total of 123 species under 95 genera and 63 families were inventoried. The diversity indices showed high species richness, semi-balanced to almost balanced evenness, and high diversity. Moreover, several endemic/ native species and some conservation important species were inventoried. An important update from this present inventory is the presence of some exotic species that were absent in the previous inventory. This shows that amidst the small area of the remaining patches, they are important habitats for several plant species and, thus, need continuous protection. These findings are important contribution to properly account the plant diversity in mossy forests and to serve as a monitoring data for the remaining forest patches.

Keywords: baseline for conservation, Benguet, forest patches, mossy forest

Introduction:

The tropical montane cloud forests or mossy forests cover about 0.3% of the Earth's surface but is of global importance due to their exceptionally high levels of endemic species. Mossy forests are also ecologically important in water provision and erosion reduction (Currie 1999). In the Philippines, the majority of its remaining forests are the noncommercial native types like the mossy forests. Among its three largest islands, Luzon has the most extensive mossy forest that are mostly located in the Central

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Cordillera Range (CCR). Leyte Mountains and Panay Mountains in the Visayas and Mount Apo in Mindanao also have large areas of mossy forest (Penafiel 1995).

In previous decades, mossy forests had scarcely came under assaults compared to the downslope montane and lowland forests. Its inhospitable environments for human occupation, remoteness and difficult terrain have given them de facto protection. But with the loss of other forests, mossy forests are now under threat globally from human exploitation (Hamilton et al. 1995). The same could be said for the remnant mossy forest in the Philippines, Penafiel noted in 1995 that these remain unexploited because of steep slopes and the presence of crooked and stunted trees that lack commercial value. However, with the boom of semi-temperate vegetable production, massive swath of mossy forest in CCR had been converted to permanent vegetable farms (Lleva 2003; Lapniten 2020). Aside from forest conversion, another major hurdle in the effective conservation of mossy forests in the country is the lack of baseline information on its biodiversity. Recent forest surveys have yielded discoveries of new species like *Nepenthes candalaga* (Lagunday et al. 2022), *Tristaniopsis flexuosa* (Fernando and Wilson 2021), *Dendrochilum ignisiflorum* (Tamayo et al. 2020) and most likely several more in the future but floristic inventories on mossy forest are very limited.

The latest survey on the mossy forests of the CCR estimates an area of 204,700 ha, about 11.18% of the total land area. These forests are usually located at the highest elevations of the scattered Cordillera range (Banwa 2012). However, with the improvement of road access and the introduction of backhoe/loader, the conversion of mossy forest into vegetable gardens have been much easier and faster. Thus, the numbers above have shrunk considerably in the past 5 years. Compounded with this issue is the lack of floristic inventories on mossy forest of the CCR. In 1910, Merril and Meritt enumerated 528 plant species belonging to 357 genera in the mossy forest of Mt Pulag, of which 357 species and 251 genera were endemic. The most recent floristic survey was conducted in 2012 by Banwa in Monamun Norte, Mountain Province where 37 tree species representing 20 genera and 17 families were listed. This shows the dearth of available information on mossy forests of the CCR amidst its rampant conversion to vegetable farms.

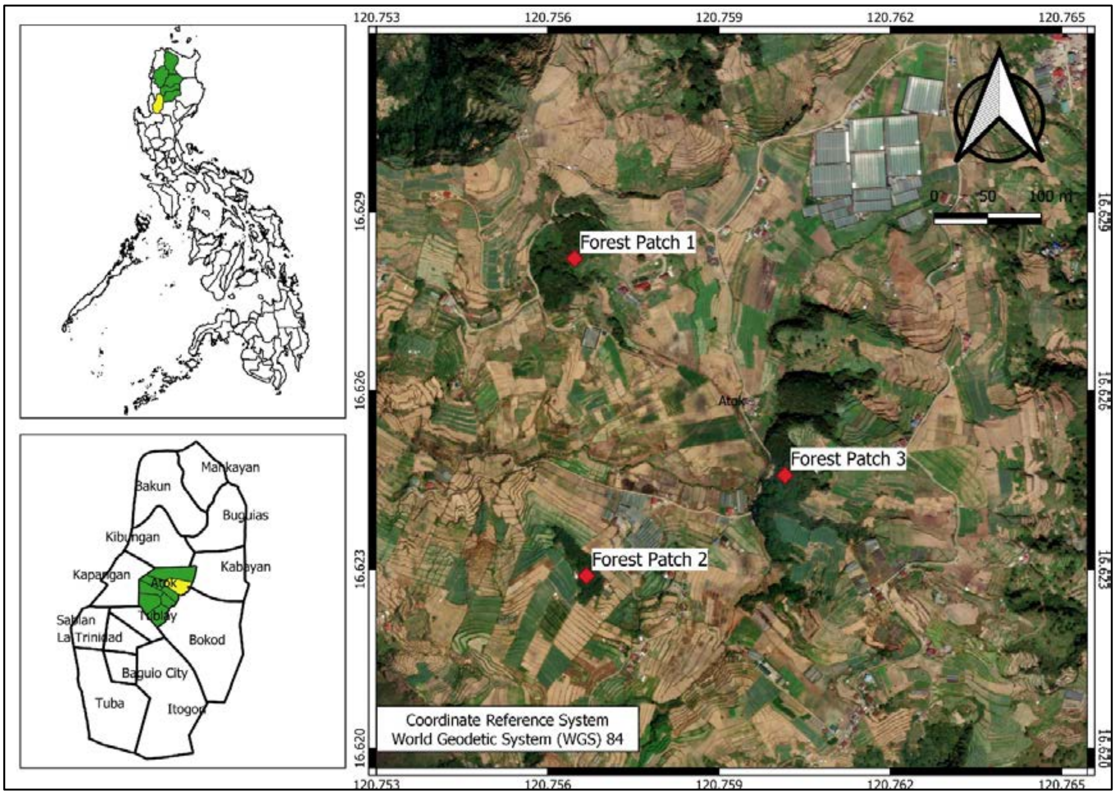
Barangay Paoay in Atok, Benguet is a classic example of mossy forest conversion to vegetable farms. The area is originally a mossy forest with scattered grasslands but now only three mossy forest patches have remained. These forests patches have been inventoried by Austria et al. in 1999, albeit unpublished. With 20 years difference, it would be interesting to note its current floral diversity for comparison and monitoring purposes which this study did. Moreover, the floral inventory from this study will contribute as baseline information to the glaring lack of data on the biodiversity of mossy forests. Such data are basic premise for protection, preservation, and management of the biological resources and to prevent the soaring loss of biodiversity (Lumbres et al. 2014). Locally, the study is an important data for the development of the land-use plan of the municipality.

Materials and methods:

The Study Site

Benguet is one of six provinces within the CCR and has the highest number of mountain peaks with elevation higher than 2000 masl such as Mt. Pulag, Mt. Tabayoc, Mt. Ugo, Mt. Santo Tomas, Mt. Timbak, among others. The province has a total of 8,634 hectares of mixed forest (Forest Management Bureau (FMB) 2003) but is gravely threatened with forest conversion to vegetable farms. One of its municipality that experienced massive conversion of forest into vegetable farms is Atok. In 2001, DENR reported that Atok had only 639 hectares of remaining forest or 11.6% of its total area; 83.6% was converted into vegetable farms while 4.8% was converted into settlement areas (Bao-idang et al. 2016). In one of its village, Barangay Paoay, the area was originally a mossy forest with scattered grassland but now only three patches of mossy forests remain. These serve as the sampling sites of the study (Fig. 1).

Figure no. 1 The study site – the three remaining mossy forest patches in Paoay, Atok, Benguet



The study site falls under Climate Type I under the Coronas Classification System, with rainy days from May to October followed by the dry spells from November to April. Table 1 presents the meteorological data of the study site.

Floral Diversity Assessment

The floral diversity assessment followed the method by Guron et al. (2019). One 20 m x 50 m nested plot was established in each forest patch. Trees within these plots were identified and counted. Also, the diameter at breast height and basal area of the trees was measured. Within the 20m x 50m plot, five 5 m x 5 m quadrats were also established for shrubs and ten 1m x 1m quadrats for herbs or grasses. All shrubs, ferns and herbs found within the quadrats were identified and counted. Density, frequency, dominance and their relative values were the major parameters measured using standard formulae (Hernandez et al. 2021). Additionally, the plants inventoried were photo documented for profiling purposes.

Biodiversity Indices

Species diversity were calculated using Shannon-Wiener index (H'), Simpson's index (D) and Margalef's index (R) thru standard formulae. To describe the distribution of abundance across the species and to compare the diversity of the three patches, Species Evenness (E) and Jaccard index of similarity were used. The biodiversity indices calculated were interpreted using Table 2 (Fernando 1998; Hill 1973; Magguran 1988; Jorgensen et al. 2005; Ulfah et al. 2019).

Table no. 1 Climatological Data in the Baguio-Benguet area that includes the study site

Month	Temp (°C)			Rainy days	Rainfall (cm)	Humidity (%)	Wind Speed (mph)	Cloud %
	Max	Min	Ave					
Jan	21.11	13.33	16.67	1.7	1.78	6.0	6.0	47.0
Feb	21.67	13.89	17.22	1.7	1.52	8.0	5.5	44.0
Mar	22.78	15.00	18.33	3.2	1.52	12.0	4.8	48.0
Apr	23.33	16.11	19.44	6.3	3.56	23.0	4.3	66.0
May	22.78	16.67	19.44	15.8	18.29	34.0	5.2	89.0
June	22.78	16.67	18.89	19.3	26.16	31.0	5.2	93.0
July	21.67	16.11	18.33	22.2	37.34	29.0	6.1	92.0
Aug	21.11	16.11	18.33	23.5	53.59	20.5	6.8	94.0
Sept	21.67	16.11	18.33	21.0	48.26	21.0	6.2	91.0
Oct	22.22	16.11	18.33	13.6	30.23	24.0	5.1	81.0
Nov	22.22	15.00	18.33	6.5	14.22	18.0	6.2	68.0
Dec	21.67	13.89	17.22	3.5	4.83	13.0	6.6	54.0

(Data Source: Baguio Pagasa Weather station from 1980 to 2016)

Table no. 2 Diversity Index and Species Evenness Values and their interpretation

Values	Interpretation
Shannon- Wiener (H')	
>3.5000	Very high
3.0000-3.4999	High
2.5000-2.9999	Moderate
2.0000-2.5999	Low
<1.9999	Very Low
Evenness Pielou index (E)	
0.96-1.0	Balanced
0.76-0.95	Almost Balanced
0.51-0.75	Semi-balanced
0.26-0.50	Less balanced
0.00-0.25	Unbalanced
Simpson's index (D)	
0.00	Absence of diversity
0.01-0.40	Low diversity
0.41-0.60	Moderate diversity
0.60-0.80	Moderately high diversity
0.81-0.99	High diversity
1.00	Absolute (perfect) diversity
Margalef's index (R)	
>4	High species richness
2.5-4	Medium species richness
<2.5	Low species richness

Human Activities and Conservation Management Practices

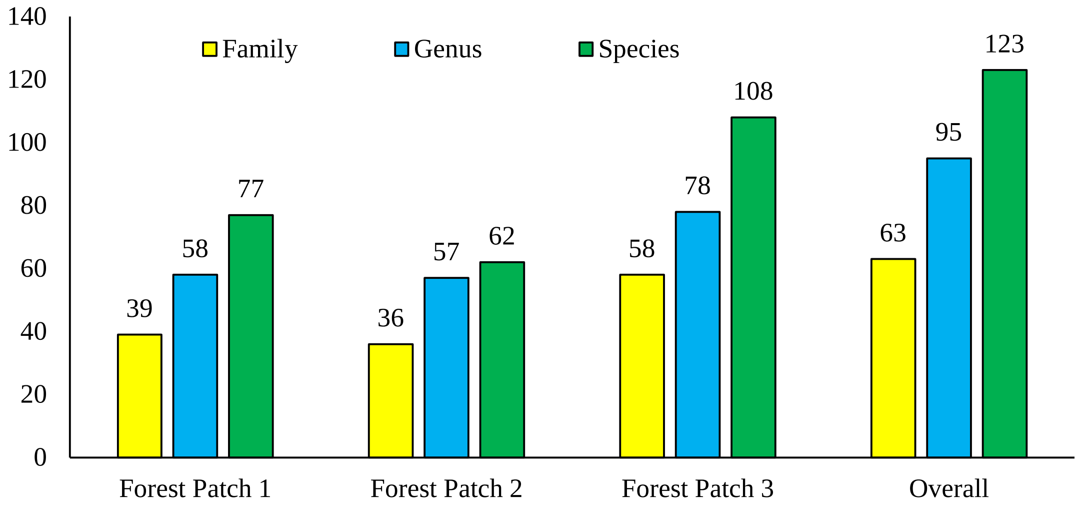
Field observation and interview were used to identify the human activities that contributed to the floral diversity loss in the study site. For the interview, purposive sampling was used to select the five key informants who are knowledgeable in the management of the forest patches. Prior to the interview, the researchers sought permission from the owners, the barangay captain, and the municipal mayor. During the interview, the researchers introduced themselves to the respondents. The objectives of the activity were explained then a consent was secured from the respondents.

Results and discussion:

Floral Diversity of the Remaining Forest Patches in Paoay, Atok, Benguet

A total of 123 plant species under 95 genera and 63 families (Fig. 2) were recorded in the three mossy forest patches in Paoay, Atok, Benguet. In Forest Patch 1, 77 species under 58 genera and 39 families recorded while 62 species under 57 genera, and 36 families in Forest Patch 2 and 108 species under 78 genera and 58 families were recorded in Forest Patch 3. In terms of vertical distribution, 39 species are recorded in the canopy, 49 in the understorey, and 63 in the forest floor.

Figure no. 2 Species, genera and family richness in the remaining forest patches in Paoay, Atok, Benguet

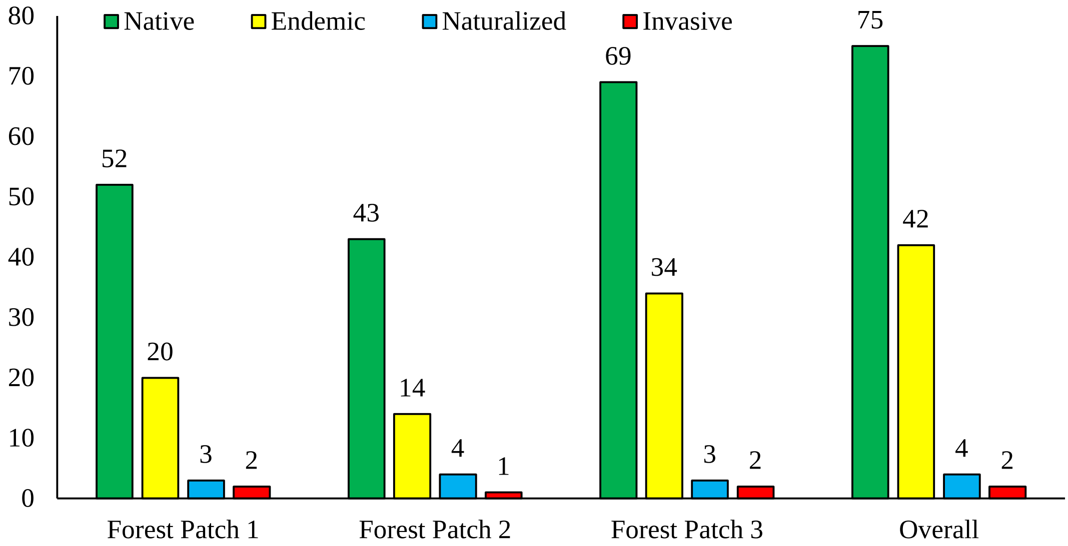


The species richness in this inventory is comparable with the previous inventory in the same site by Austria et al. (1999) that documented 117 species belonging to 57 families. The difference could be attributed to the presence of exotic species in the present inventory and the absence of some species noted in the previous inventory. However, the bulk of species richness was maintained. This is an encouraging sign that amidst the relatively small area of the remaining mossy forest patches, several endemic and native species are still present; and therefore, need continuous protection.

Compared with the inventory of Merrill and Meritt (1910) in Mt. Pulag with 528 species under 357 genera, our result is much lower. This shows the devastating effect of forest conversion into vegetable farms on floral diversity. Much of the original floral composition of the study area was wipe out with the conversion of the area into its current lucrative vegetable farms.

In terms of ecological distribution, 75 native species, 42 endemic, 4 naturalized, and 2 invasive species were recorded in the three forest patches (Fig. 3). Forest Patch 1 has 52 native, 20 endemic, 3 naturalized, and 2 invasive species; Forest Patch 2 has 43 native, 14 endemic, 4 naturalized, and 1 invasive species were identified; and, Forest Patch 3 has 69 native, 34 endemic, 3 naturalized, and 2 invasive species. Forest Patch 2 has the smallest area among the three forest patches and also has lowest species richness and lowest number of native/endemic species. The dominance of the exotic species *Ageratina riparia* was also most observed in Forest Patch 2. This species, a native of South America (Turner 1997), is now widespread in several areas of CCR (Guron et al. 2019; Batani et al. in press).

Figure no. 3 Distribution status of the floral species in the remaining forest patches in Paoay, Atok, Benguet



The most represented family in the study area is Rosaceae with seven (7) species, followed by family Myrtaceae, Poaceae and Polygonaceae with six (6) species each (Fig. 4, Annexes). Majority of the other families were represented by a single species. On the other hand, family Asteraceae has the higher number of individuals due to the frequent occurrence of *Ageratina riparia* and *Ageratina adenophora*. Family Fagaceae is represented by a single species, *Lithocarpus luzoniensis*, but has the second highest number of individuals and most among trees.

Dominant Floral Species in the Mossy Forest Patches of Paoay, Atok

Forest Floor. The forest floor species composition and dominance in the three mossy forest patches are presented in Table 3 (Annexes). A total of 63 species including herbs, grasses, small fern, and tree seedlings were documented in the forest floor. It can be readily gleaned from the table the dominance of the exotic *Ageratina riparia* across the three stations. This species, also known as mist flower, is a shrubby, perennial herb that grows to about 1m in height and produces large number of small white flowers (Frohlich et al. 2000). It is an aggressive, fast-growing and moderately shade-tolerant plant with seeds that disperse by the wind and water. In the study site, it is most dominant under canopy openings particularly at forest edges and least under dense canopy. Other dominant species are natives like *Ardisia elliptica*, *Impatiens platypetala*, *Sarcandra glabra* and *Strobilanthes mearnsii*; common weeds like *Commelina diffusa*, *Ottochloa nodosa* and *Persicaria chinensis*; and, native ferns like *Asplenium normale* and *Athyrium nitidulum*.

Forest Patch 1 has 32 species, Patch 2 has 31 and highest in Patch 3 with 42. The greater species richness of Forest Patch 3 could be attributed to the lesser dominance of *A. riparia* as compared to Patch 1 and 2. Its lesser dominance allowed other native species to occur particularly under dense canopy and thereby contributing to the greater species richness of Patch 3.

Understorey. The understorey species composition and dominance of the mossy forest patches are presented in Table 4 (Annexes). A total of 49 species of shrubs including saplings and large ferns were inventoried. Forest Patch 1 has 24 species, 21 in Patch 2 and greatest in Patch 3 with 35. It can be readily gleaned from the table that no particular shrub dominates across the three forest patches, rather they differ between patches. Majority of the dominant shrubs are native/endemic except for exotic *Brugmansia arborea* that is most dominant in Forest Patch 2. *Ardisia pyramidalis* and *Turpinia sphaerocarpa* are the most dominant in Forest Patch 1 while *Helicia robusta* and *Schefflera microphylla* in Forest Patch 3.

Canopy. The canopy composition and dominance in the mossy forest patches are presented in Table 5 (Annexes). A total of 39 species were documented with 21 in Forest Patch 1, least in Patch 2 with 10 and highest in Patch 3 with 31. *Lithocarpus luzoniensis* is dominant across all stations especially in Forest Patch 2 while *Acer laurinum* is most dominant in Patch 1 and *Pinus kesiya* in Patch 3. *Lithocarpus luzoniensis* was also documented to be most dominant in the area by the Austria et al. in 1999. This species was reported by Pelser et al. (2011 onwards) to be endemic but rather common in CCR highlands. It provides food to variety of birds leading to its prolific dispersal in the area. However, it was included as one of the Other Threatened Species under DAO 2019-09 due to the massive conversion of its habitat – the mossy forest – into vegetable farms.

On the other, *Acer laurinum* is an impressive tree with leaves and fruits that stand out from a distance. This species is an anomaly among maples and is of biogeographic importance because it has a geographic range from southern China, Vietnam, and Thailand to the Philippines and Java (Harris et al. 2017). It is also widely distributed in Borneo, Cambodia, China, India, Java, Laos, Lesser Sunda Isls., Malay Peninsula, Myanmar, Philippines, Sulawesi, Sumatra, Thailand, Tibet, and Vietnam. In the Philippines, it is mostly found in Abra, Bataan, Benguet (that include the study site) and Cagayan.

The dominance of *Pinus kesiya* in Forest Patch 3 is interesting because pine is usually not dominant in mossy forest. Its dominance is due to its much bigger diameter compared to the other trees resulting to its higher basal area and much higher importance value. However, the number of its individual is actually comparable to the other mossy forest trees.

Across the three forest patches, three exotic species were noted namely *Alnus japonica*, *Callitropsis nootkatensis* and *Eucalyptus camaldulensis* while the rest are endemic or native species. These exotic species were not included in the earlier inventory of Austria et al. in 1999. This is one of the major difference in this current inventory with the earlier one – the presence of some exotic species. *Alnus japonica* was widely introduced in CCR as a N-fixing tree as source of organic fertilizer/compost but now becoming invasive in other areas. On the other hand, *Callitropsis nootkatensis* and *Eucalyptus camaldulensis* were introduced as ornamental trees in the locality but few have escaped cultivation like in this inventory.

Several 'commonly-referred-to-as' shrub species were included in the tree inventory like *Clethra canescens*, *Eurya buxifolia*, *Ilex* spp., and *Vaccinium barandanum* with some even being dominant. Several individuals of these species have greater than 5 cm dbh, hence their inclusion as trees. Generally, these species are technically shrubs in lower elevation but they become tree individuals in upper elevation as in the study site. This replacement phenomenon was also observed by Kowal (1966) in Mt. Data and by Buot and Okitsu (1998) in. Mt. Pulag.

In terms of species richness, herb species is highest at 63, followed by shrubs at 49 and least by tree species at 39. This finding supports the claim of Langenberger (2004) that understory vegetation should be adequately sampled in forest inventories as these often outnumber the canopy tree species.

Biodiversity Indices in the Remaining Forest Patches of Paoay, Atok, Benguet

The Shannon-Wiener, Simpson, Species Evenness and Margalef Index values in the study site are presented in Table 6. All the three forest patches have very high Shannon-Wiener index and Simpson diversity, high species richness as well as semi-balanced to almost balanced species evenness. Forest Patch 3 has the highest species richness and diversity based on Shannon-Wiener and Simpson indices. In terms of evenness index (E), Forest Patch 1 has an almost balanced distribution of individuals of different species while forest patches 2 and 3 have semi-balanced evenness. This implies that almost all the species are relatively equal number of individuals except for few species like *Ageratina riparia* that comprises 15.53% of the total number of individuals.

Table no. 6 Biodiversity indices in the three forest patches in Paoay, Atok, Benguet

	Number of Species	Shannon-Wiener (H')	Evenness (E)	Simpson (D)	Margalef (R)
Forest Patch 1	64	3.684 (VH)	0.848 (A)	0.956 (HD)	13.43 (H)
Forest Patch 2	57	3.664 (VH)	0.642 (S)	0.965 (HD)	10.682 (H)
Forest Patch 3	91	4.044 (VH)	0.661 (S)	0.973 (HD)	17.495 (H)

Note: For H': VL = Very Low, L = Low, M = Moderate, H = High, VH = Very High; For E: B = Balanced, A = Almost balanced, S = Semi-balanced, L = Less balanced, U = Unbalanced; For D: A = Absence of diversity, LD = A low degree of diversity, MD = A moderate degree ofdiversity, MHD = A moderate high degree of diversity, HD = A high degree of diversity, AD = Absolute diversity; For R: H = High species richness, M = Medium species richness, L = Low species richness

Interestingly, the high diversity of the forest patches is comparable with Shannon-Weiner indices in full ecosystem inventory like in Alno Communal Forest by Lumbres et al. (2014) with 3.21 and in riparian forest along Intek River with 3.92 (Balangen et al. 2021). This shows the importance of forest patches in recovering fragmented ecosystems. Harvey et al. (2000) noted the importance of forest patches for conserving both local and regional biodiversity because they provide an important food source and habitat for a variety of species, plants and animals (particularly birds), and may serve as stepping stones that facilitate animal movement across the agricultural landscape. Small patches can contribute to landscape connectivity, because even a small patch that was dispersed can serve as a stepping stone to increase connectivity among patches which is to enhance the dispersal of species.

The similarity among the three patches based on Jaccard index is presented in Table 7. Forest Patches 1 and 2 are most similar with 51.22% while Patches 2 and 3 are most dissimilar 26.27%. It is interesting to note that amidst the proximity of the patches with one another, they still differ significantly in terms of species composition. Nonetheless, this contributes to the higher overall species richness.

Table no. 7 Jaccard index of similarity among the three forest patches and with the previous study

Comparison	Jaccard Index
Forest Patch 1 vs Forest Patch 2	51.22%
Forest Patch 2 vs Forest Patch 3	26.27%
Forest Patch 3 vs Forest Patch 1	38.94%
Present study and Previous study (Austria et al. 1999)	16.06%

Comparing this present inventory with the previous inventory of Austria et al. (1999), the index of similarity is low at 16.06%. The difference could be attributed to the difference in the location of plots inventoried, thus differing in species composition. Another factor is the introduction of exotic species noted in the present inventory that were absent in the previous. Also, the dominant species differ. In Austria et al.'s inventory, *Lithocarpus luzoniensis* (11.97%), *Symplocos lancifolia* (9.67%), *Cyathea fuliginosa* (7.37%), and *Clethra canescens* var. *luzonica* (7.13%) were the dominant trees. Similarly, *Lithocarpus luzoniensis* and *Clethra canescens* are still dominant in the present inventory.

In the previous inventory, *Carex turita*, *Ophiopogan japonicum*, *Ainsliaea reflexa* and *Ageratina adenophora* are the understory species with the highest importance value. *Carex turita* and *Ainsliaea reflexa* (*A. latifolia* in the present inventory) were also noted in the present inventory, however, they were not dominant. The other species, *O. japonicum*, is absent in the current inventory. In addition, *Ageratina riparia* which has the highest importance value in all the three patches is not present in the previous inventory.

Aside from the endemic species, the three mossy forest patches also harbour 10 conservation important species (Tab. 8) with one (1) endangered, 7 vulnerable and 2 other threatened species.

Table no. 8 List of Conservation Important Species in the Mossy Forest Patches of Paoay, Atok

Species	Conservation Status*	Ni	Forest Patch where it occurs
Ardisia elliptica Thunb.	Vulnerable	19	1,2,3
Bulbophyllum curranii Ames	Vulnerable	2	1
Cibotium cumingii Kunze	Endangered	9	1, 3
Cyathea fuliginosa (Christ) Copel.	Vulnerable	1	3
Diploblechnum fraseri (A.Cunn.) De Vol	Vulnerable	8	1,3
Lithocarpus luzoniensis (Merr.) Rehder	Other Threatened Species	54	1,2,3
Machilus philippinensis Merr.	Other Threatened Species	21	1,2,3
Microsorum sarawakense (Baker) Holttum	Vulnerable	33	3
Rhododendron subsessile Rendle	Vulnerable	2	3
Schefflera microphylla Merr.	Vulnerable	14	1,3

*conservation status is based on DAO 2019-09

The endangered species is *Cibotium cumingii* with 9 individuals that occur in Forest Patch 1 and 3. This species occurs in Borneo and in the Philippines but its population has decreased rapidly because of over exploitation and there has been no artificial cultivation until now (Praptosuwiryo et al. 2011). The main reason why a species becomes endangered is overexploitation causing habitat loss and change. Knowing that the forest patches are home for *Cibotium cumingii*, it is then essential to continue that the forest patches are home for *Cibotium cumingii*, it is then essential to continue protecting the area to ensure the continued survival of the remaining individuals. Moreover, the presence of the vulnerable species and other threatened species in the forest patches requires active intervention to remove or mitigate the unfavorable circumstances that place them under threat to maintain healthy ecosystems and prevent the further extinction of species (Safeopedia 2022).

The Forest Services, Problems, and Conservation Strategies in the Remaining Forest Patches of Paoay, Atok

Results of the interviews showed that the local community is aware that the forest patches provide a variety of environmental services to the community such as serving as watershed (Fig. 5), erosion control, and source of firewood. In addition, the forest patches also provide habitats for several plant species.

Figure no. 5 Forest services of Forest Patch 3 – as watershed (Photo credit to C.P. Kiligto, S.S.D. Cajigan, J.O. Agtarap)

However, there are activities that contribute to the further degradation of the remaining forest patches. These include introduction of non-native species (such as the Japanese tomato, and *Pinus kesiya*), agricultural expansion (Fig. 6), road construction, and poaching. In Forest Patch 3, road construction is currently occurring and destroying the forest as some parts of the forest is now used. Forest Patch 2 is also prone to disturbances due to the construction of houses near it. During the boom of 'plantitas and plantitos' with increased demand for ornamental plants, poaching of plants has occurred in the forest. In the recollection of one key informants, one car was spotted carrying a full load of plants including orchids and the Benguet lily from Forest Patch 3. Moreover, the owner of the Forest Patch 1 and 3 observed that some residents enter the forest to get plants. Due to these, the Benguet lilies that previously grew in the forest do not exist now.

In addition, introduction of new plant species was made in all the three patches. In Forest Patch 1, Japanese tomato was introduced by the barangay officials before, but it did proliferate. According to the owner, cypress tree is currently introduced in the Forest Patch 2 as a way to protect the forest. For Patch 3, *Pinus kesiya* and *Eucalyptus* sp. were introduced in 1990 during the tree planting of the barangay officials.

Figure no. 6 One of the threats to the remaining forest patches, the continuous encroachment of vegetable farms (Photo credit to C.P. Kiligto, S.S.D. Cajigan, J.O. Agtarap)

The main conservation strategies of the key informants, who are the owners and caretakers of the forest patches, are to educate the residents and ban them from entering the forest. Seminars have also been given to remind those residents not to poach and cut trees in the forest. In Forest Patch 1, fences were established to protect the forest as it serves as their watershed and so that the residents will not enter the forest (Fig. 7).

Conclusion:

A total of 123 species under 95 genera and 63 families were recorded in the three mossy forest patches of Paoay, Atok, Benguet. In Forest Patch 1, 77 species under 58 genera and 39 families recorded while 62 species under 57 genera, and 36 families in Forest Patch 2 and 108 species under 78 genera and 58 families in Forest Patch 3. The diversity indices showed high species richness, semi-balanced to almost balanced evenness, and high diversity. Moreover, several endemic/ native species and some conservation important species were inventoried. This shows that amidst the small area of the remaining patches, they are important habitat for several plant species and, thus, need continuous protection. The findings suggest then that despite having a high diversity, human disturbances still contribute to the diversity loss in the area. Also, the existing management strategies are not enough to protect the forest. Thus, if these disturbances continue then there is a possibility that the diversity of the forest patches may further decrease.

Figure no. 7 One of conservation strategies in protecting the forest patches – fencing in Forest Patch 1 (Photo credit to CP Kiligto, SSD. Cajigan, JO Agtarap)

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Rezumat:

DIVERSITATEA FLORALĂ A RESTURILOR DE PĂDURE CU MUȘCHI DIN ATOK, BENGUET, FILIPINELE DE NORD

Pădurile cu mușchi reprezintă un ecosistem important de sprijin pentru societatea umană, fiind o sursă de apă, în controlul eroziunii dar și habitat pentru mai multe specii endemice. Inițial protejați de terenul accidentat și de depărtarea lor, acum sunt, la fel de bine, puternic exploatați. În zona Cordilierilor Centrali, Filipine, suprafețe masive de pădure cu mușchi au fost și sunt transformate fără discernământ în ferme de legume. Totodată, acestea sunt unele dintre cele mai puțin studiate tipuri de pădure din țară. Acest lucru face ca inventarul pădurii cu mușchi să fie esențial ca și informație de referință pentru eforturile de conservare și pentru a documenta diversitatea rămasă înainte ca aceasta să se piardă pentru totdeauna. Pentru a contribui la acest decalaj de date, studiul a documentat diversitatea florală din peticele forestiere rămase din Paoay, Atok, Benguet. Au fost inventariate un total de 123 de specii din 95 de genuri și 63 de familii. Indicii de diversitate au arătat o bogăție mare de specii,

uniformitate semi-echilibrată până la aproape echilibrată și o diversitate ridicată. Mai mult, au fost inventariate mai multe specii endemice/native și unele specii importante pentru conservare. O actualizare importantă din acest inventar actual este prezența unor specii exotice care au fost absente în inventarele anterioare. Acest lucru arată că, mijlocul suprafeței mici a peticelor rămase reprezintă un habitat important pentru mai multe specii de plante și, prin urmare, acestea au nevoie de protecție continuă. Aceste constatări reprezintă o contribuție importantă pentru a contabiliza în mod corespunzător diversitatea plantelor din pădurile cu mușchi și pentru a servi drept date de monitorizare pentru peticele de pădure rămase.

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Annexes:

Figure no. 4 Family representation of the floral species in the remaining forest patches in Paoay, Atok, Benguet

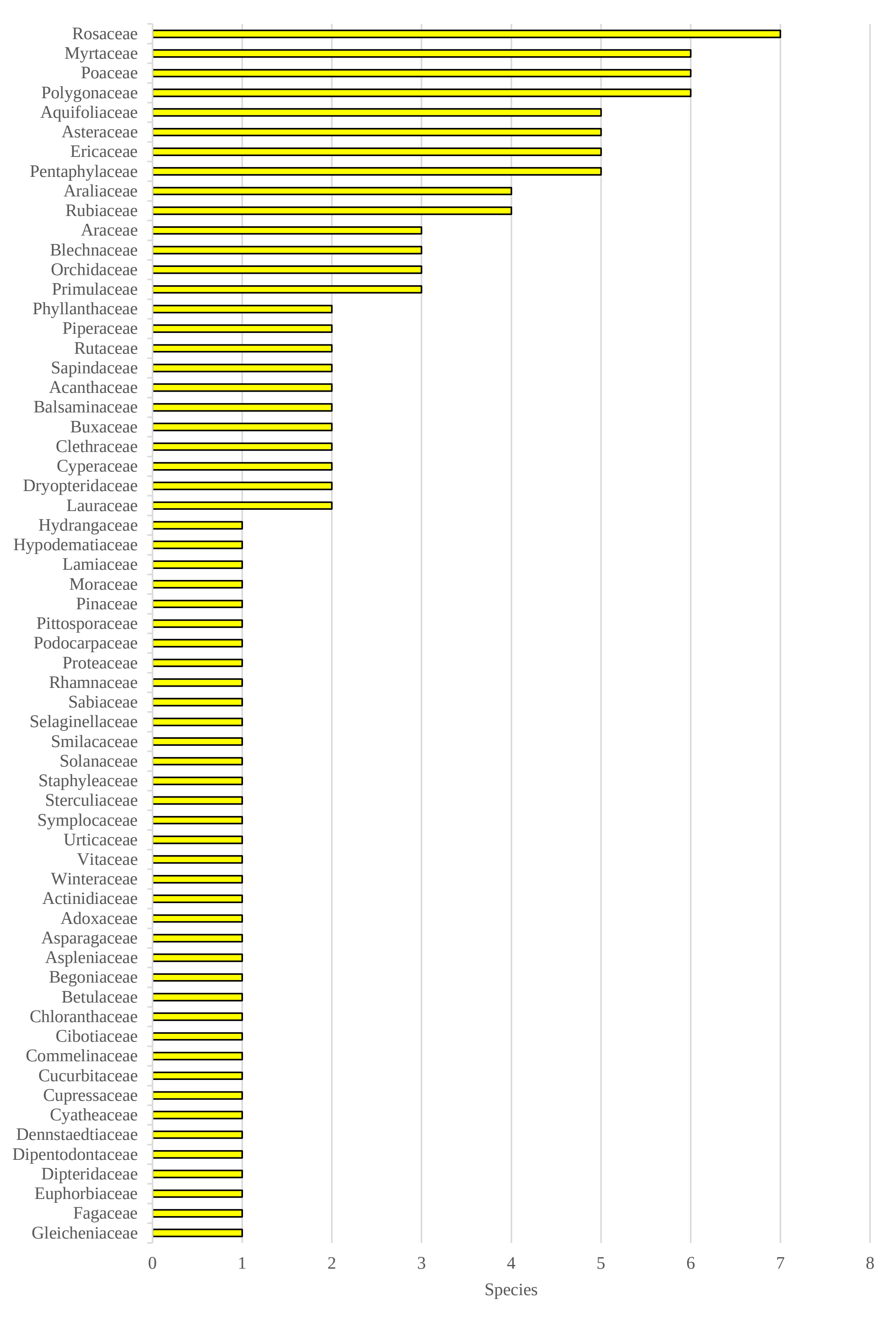

Table no. 3 Herb Species Composition and Dominance in the Forest Patches of Paoay, Atok

Herb Species	Importance Value (IV)		
	Forest Patch 1	Forest Patch 2	Forest Patch 3
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	-	**5.61**	2.99
Ageratina riparia (Regel) R.M.King & H.Rob.	**20.43**	**15.83**	**12.35**
Ainsliaea latifolia (D.Don) Sch.-Bip.	3.31	-	3.34
Ardisia elliptica Thunb.	**6.18**	4.65	0.86
Arisaema polyphyllum (Blanco) Merr.	-	-	0.86
Asplenium normale D.Don	-	-	**4.71**
Athyrium anisopterum Christ	1.06	2.04	-
Athyrium nitidulum (Kunze) Milde	4.53	-	**9.97**
Avena fatua L.	-	1.87	-
Begonia merrittii Merr.	1.06	-	-
Blechnopsis orientalis (L.) C.Presl	-	-	0.86
Bulbophyllum curranii Ames	1.36	-	1.37
Calanthe lacerata Ames	1.36	-	1.37
Cardiospermum halicacabum L.	1.06	-	-
Carex alopecuroides D.Don	3.31	3.18	1.37
Carex turrita C.B.Clarke	-	1.59	3.09
Coleus scutellarioides (L.) Benth.	-	-	1.11
Commelina diffusa Zoll. ex C.B.Clarke	-	**5.90**	-
Dendrochilum graminifolium (Ames) Pfitzer	1.06	1.02	1.98
Dicranopteris linearis (Burm.f.) Underw.	-	-	0.86
Diploblechnum fraseri (A.Cunn.) De Vol	2.11	2.61	3.95
Dipteris conjugata Reinw.	-	-	1.11
Disporopsis luzoniensis (Merr.) J.M.H.Shaw	-	-	1.11
Elaphoglossum blumeanum (Fée) J.Sm	-	-	1.11
Elatostema filicaule C.B.Rob.	-	1.59	1.72
Eleutherococcus trifoliatus (L.) S.Y.Hu	1.06	-	-
Embelia whitfordii Merr.	-	1.02	1.11
Gaultheria borneensis Stapf	-	-	1.11
Gaultheria cumingiana S. Vidal	-	-	0.86
Gynura vidaliana Elmer	1.36	-	-
Hedyotis benguetensis (Elmer) Elmer	2.25	2.04	2.59
Hymenasplenium ofeliae (Salgado) Barcelona & Pelser	1.36	2.32	1.11
Hypodematium crenatum (Forssk.) Kuhn	1.06	-	1.98
Impatiens platypetala Lindl.	-	1.30	**5.97**
Impatiens walleriana Hook.f.	2.71	4.31	-
Lepisorus validinervis (Kunze) Li Wang	1.06	2.61	2.23
Microsorum sarawakense (Baker) Holttum	-	-	1.37
Neolitsea microphylla Merr.	1.06	-	-
Oplismenus hirtellus (L.) P.Beauv.	-	1.59	-
Ottochloa nodosa (Kunth) Dandy	**9.32**	-	1.87
Pennisetum clandestenum Hochst. ex Chiov.	-	1.02	-
Peperomia copelandii Quisumb	-	1.59	-
Persicaria capitata (Buch.- Ham. ex D.Don) H.Gross	-	1.59	1.11
Persicaria chinensis (L.) H.Gross	2.11	**6.80**	-
Piper curtifolium C.DC.	-	-	0.86
Pteridium revolutum (Blume) Nakai	1.06	-	-
Rhamnus philippinensis C.B.Rob.	1.36	-	-
Rubia cordifolia L.	1.06	1.02	2.23
Rubus benguetensis Elmer	1.06	-	-
Rubus copelandii Merr.	-	-	0.86
Rubus ellipticus Sm.	1.36	-	-

Rubus fraxinifolius Poir.	-	1.02	-
Rubus luzoniensis Merr.	-	2.04	1.72
Rubus pectinellus Maxim.	-	4.19	3.85
Sarcandra glabra (Thunb.) Nakai	**7.08**	**7.37**	**4.96**
Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi	1.66	-	-
Selaginella involvens (Sw.) Spring	-	-	1.37
Selliguea taeniata (Sw.) Parris	1.06	-	1.11
Smilax china L.	3.47	2.04	1.72
Sonchus oleraceus L.	-	1.02	-
Strobilanthes mearnsii Merr.	**10.69**	**5.61**	2.99
Zantedeschia aethiopica (L.) Spreng.	-	3.63	-
Zehneria mucronata (Blume) Miq.	-	-	0.86

Note: the most dominant species are in bold font

Table no. 4 Shrub Species Composition and Dominance in the Forest Patches of Paoay, Atok

Shrub Species	Importance Value (IV)		
	Forest Patch 1	Forest Patch 2	Forest Patch 3
Acer lauricum Hassk.	2.158	-	1.579
Adinandra luzonica Merr.	2.158	-	1.579
Adinandra macgregorii Merr.	-	2.252	-
Aralia bipinnata Blanco	2.964	4.504	-
Ardisia elliptica Thunb.	-	4.596	-
Ardisia pyramidalis (Cav.) Pers.	**14.015**	2.252	-
Brugmansia arborea (L.) Sweet	-	**13.787**	-
Cibotium cumingii Kunze	**5.122**	3.033	**6.588**
Clethra canescens Reinw. ex Blume	2.964	**5.285**	2.196
Cleyera japonica Thunb.	-	**5.285**	1.579
Dacrycarpus imbricatus (Blume) de Laub.	-	-	1.579
Decaspermum parviflorum (Lam.) Scott	2.158	-	-
Dinochloa elmeri Gamble	2.158	-	-
Embelia whitfordii Merr.	-	-	2.813
Eurya buxifolia Merr.	2.158	**7.629**	**7.550**
Eurya coriacea Merr.	**5.122**	-	-
Glochidion merrillii C.B.Rob.	2.158	-	1.579
Glochidion rubrum Blume	2.158	**7.629**	-
Hedyotis philippensis (Willd. ex Spreng.) Merr. ex C.B.Rob.	-	-	1.579
Helicia robusta (Roxb.) R.Br. ex Blume	2.158	**6.756**	**9.746**
Hydrangea chinensis Maxim.	-	2.252	1.579
Ilex asprella (Hook. & Arn.) Champ. ex Benth.	4.316	-	1.579
Ilex buergeri Miq.	-	-	1.579
Ilex crenata Thunb.	2.964	4.504	2.196
Ilex malaccensis Loes.	-	-	1.579
Machilus philippinensis Merr.	-	5.285	3.158
Melicope sessilifoliola (Merr.) T.G.Hartley	4.316	-	-
Melicope triphylla (Lam.) Merr.	4.577	-	1.579
Miscanthus floridulus (Labill.) Warb. ex Schum. & Lauterb.	-	3.814	2.196
Neolitsea microphylla Merr.	**6.735**	2.252	2.196
Perrottetia alpestris (Blume) Loes.	-	**5.285**	1.579
Pittosporum resiniferum Hemsl.	-	2.252	-
Rhamnus philippinensis C.B.Rob.	-	-	1.579
Rhaphiolepis philippinensis (S.Vidal) Kalkman	**5.122**	-	1.579
Rhododendron subsessile Rendle	-	-	2.196
Rubus benguetensis Elmer	-	-	1.579
Rubus copelandii Merr.	-	2.252	-
Schefflera microphylla Merr.	2.964	-	**9.675**
Smilax china L.	-	-	4.392
Syzygium alvarezii (C.B.Rob.) Merr.	-	4.596	1.579
Syzygium congestum (Merr.) Merr.	-	-	1.579
Syzygium santosii (Merr.) Merr.	2.158	-	1.579
Tasmannia piperita (Hook.f.) Miers	-	-	3.775
Tetrastigma brunneum Merr.	-	-	1.579
Turpinia sphaerocarpa Hassk.	**14.276**	4.504	-
Vaccinium barandanum S.Vidal	-	-	3.775

Vaccinium cumingianum var. *igorotorum* H.F.Copel.	-	-	2.196
Viburnum odoratissimum Ker Gawl.	2.158	-	**5.354**
Woodwardia unigemmata (Makino) Nakai	2.964	-	-

Note: the most dominant species are in bold font

Table no. 5 Tree Species Composition and Dominance in the Forest Patches of Paoay, Atok.

Tree Species	Importance Value (IV)		
	Forest Patch 1	Forest Patch 2	Forest Patch 3
Acer laurinum Hassk.	**51.14**	0.82	-
Adinandra luzonica Merr.	-	-	0.60
Alnus japonica (Thunb.) Steud.	**4.49**	-	0.30
Callitropsis nootkatensis (D.Don) Oerst	-	-	0.29
Cibotium cumingii Kunze	**5.78**	-	0.59
Clethra canescens Reinw. ex Blume	-	-	**13.77**
Clethra tomentella Rolfe	2.33	-	0.89
Cleyera japonica Thunb.	-	-	0.29
Cyathea fuliginosa (Christ) Copel.	-	-	0.29
Dacrycarpus imbricatus (Blume) de Laub.	-	0.90	0.58
Decaspermum blancoi S. Vidal	-	-	0.29
Eucalyptus camaldulensis Dehnh.	-	-	0.30
Eurya buxifolia Merr.	**5.71**	-	**6.19**
Ficus ampelas Burm.f.	-	-	0.63
Glochidion merillii C.B.Rob.	0.65	-	0.29
Helicia robusta (Roxb.) R.Br. Ex Blume	0.65	-	3.57
Ilex asprella (Hook. & Arn.) Champ. ex Benth.	2.01	0.86	1.79
Ilex crenata Thunb.	0.64	-	0.58
Ilex malaccensis Loes.	-	-	0.58
Lithocarpus luzoniensis (Merr.) Rehder	**8.18**	**41.03**	**11.49**
Machilus philippensis Merr.	0.64	**27.89**	-
Melicope sessilifoliola (Merr.) T.G.Hartley	0.69	2.99	-
Meliosma pinnata (Roxb.) Maxim.	2.83	**15.19**	0.91
Neolitsea microphylla Merr.	**6.45**	**6.65**	2.40
Omalanthus fastuosus (Linden) Fern.-Vill	-	-	3.10
Pinus kesiya Royle ex Gordon	-	-	**47.22**
Pittosporum resiniferum Hemsl.	1.44	1.90	-
Sarcococca philippinensis Stapf ex Sealy	-	-	0.29
Sarcococca saligna (D.Don) Müll. Arg.	0.65	-	-
Saurauia sparsiflora Elmer	1.40	-	-
Schefflera ovoidea Merr.	-	-	0.29
Sterculia rubiginosa Vent.	0.69	-	-
Symplocos odoratissima (Blume) Choisy ex Zoll.	0.65	-	0.31
Syzygium congestum (Merr.) Merr.	-	-	0.29
Syzygium santosii (Merr.) Merr.	-	-	0.64
Tarennoidea wallichii (Hook.f.) Tirveng. & Sastre	0.64	-	-
Tasmannia piperita (Hook.f.) Miers	-	-	0.59
Turpinia sphaerocarpa Hassk.	2.35	1.76	0.29
Vaccinium barandanum S.Vidal	-	-	0.37

Note: the most dominant species are in bold font