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Plant Community Structure of a Secondary Forest at Barangay Camias, Porac, Pampanga, The Philippines

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The study described the current plant community structure of a secondary forest in Barangay Camias, Porac, Pampanga. A general floristic list of species was constructed, life forms were determined, most important species were identified, and species diversity in the area was computed. Forty-three (43) undershrub and eighteen (18) tree species were recorded in the area, most of which are members of Fabaceae and Poaceae. A significant difference was observed between the proportion of life forms present and that of Raunkiaer's categories. The most important undershrub species were *Chromolaena odorata*, *Mikania micrantha*, and *Lantana camara*, while the most important tree species were *Leucaena leucocephala*, *Mangifera indica*, and *Albizia saman*. Relatively low species diversity was recorded in the area measured using Simpson's Index of Diversity (0.927 for undershrub species, 0.855 for tree species) and Shannon-Wiener Index (3.00 for undershrub species, 2.28 for tree species). The dominance of Fabaceae and Poaceae species, the significant difference between the expected and observed proportion of life forms, and the prevalence of the most important species being invasive alien species (IAS) are indicative of a very disturbed area. The site is currently in its initial phase of regeneration from an ash and lahar covered area to a secondary forest.

Key Words: plant community structure, secondary forest, Raunkiaer's life forms, Simpson's Index of Diversity, Shannon-Wiener Index, invasive alien species (IAS)

INTRODUCTION

Porac, Pampanga is known to house an array of diverse flora and fauna. A previous survey (Environmental Protection Foundation Agency Inc. 2006) confirmed the existence of lush diversity in the area despite the previous reports indicating that it has experienced large scale degradation due to deforestation activities. The situation in the mountain range of Porac, Pampanga has been reported to worsen (Rantucci 1991) when the 1991 eruption brought in lahar and pyroclastic materials devastated the mountain range forests and destroyed the vegetation in the area. Years after the eruption of Mt. Pinatubo, the mountain range of Porac, Pampanga has slowly recovered from the devastation as new flora and fauna have emerged in the area. Mt. Pinatubo is also the ancestral domain of the Ayta indigenous people. In some cases, the Ayta people have converted some mountain areas into agricultural sites. The Ayta in Barangay Camias, Porac, Pampanga have plans for reforestation and have allocated a 20-hectare site for reforestation. This study aims to characterize the plant community in Brgy. Camias, Porac, Pampanga. It is a contribution to the knowledge of the vegetation of Mt. Pinatubo and its vicinity and natural succession in the midst of human intervention and utilization of the site.

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MATERIALS AND METHODS

Study site and sampling

The study site is a 20-hectare area located in the center of Barangay Camias, Porac, Pampanga. After the eruption of Mt. Pinatubo, the whole area of Barangay Camias was covered in ash and lahar. The Ayta evacuated to refugee areas but returned after about two years. The 20-hectare study site is now a forested area with agricultural patches. It is divided into eleven (11) ancestral parts set by the Ayta people themselves. Purposive sampling design using belt transect method was employed in determining the species composition of the flora in the area, as done in a floristic survey by Austria, Co and Romero (1999).

A belt transect measuring 50m x 2m (= 100m^2) was placed in each of the ten (10) territories recommended by the locals for sampling (cumulative area = 0.1 ha) or 0.5% of the whole study area. (See Table 1). Specific points where the belt transects were laid were randomly chosen. Using GPS device (GARMIN™), exact topographical location was determined in each sampling site. Belt transects were all laid in a north-south direction for uniformity.

Permission to collect plant specimen was secured from the Sangguniang Barangay of Camias.

Collection and identification of species

All vascular plant species enclosed in the 100 m^2 belt transect were recorded. If unidentified, parts of the unknown plant were collected according to the necessity for classification and identification in the laboratory. Only unidentified species were collected.

Specimens of unidentified plants were collected and processed according to standard procedures. Local flora and monographs were consulted, online interactive taxonomic keys, and updated plant systematics books were utilized for proper identification of species. Local botanists and herbaria were also consulted for verification.

Determination of life forms

Sampled species were classified into life-form categories as developed by Raunkiaer (1934): phanerophytes, chamaephytes, hemicryptophytes, cryptophytes, and therophytes.

After classifying the plants, a life form spectrum was generated to describe the plant community. Proportion of the plant species in per cent were plotted against the life-form classes to which they belong. To be able to compare the generated floristic life-form spectrum to Raunkiaer's (1934) normal spectrum, lianas and epiphytes were classified under phanerophytes, where they originally belong (Batalha & Martins 2004). To verify whether the floristic life-form spectrum in the area is significantly different from that expected according to Raunkiaer's normal spectrum, chi-square test was applied (Zar 1999).

Determination of biological structure

Density, Cover, Frequency, and Importance Values

Quantitative parameters such as density, cover, and frequency for each species were simultaneously recorded using the plot quadrat method of abundance estimation. Density was computed by counting individual plants contained within the belt. Frequency was computed by counting the number of plots in each belt in which the species was recorded.

In computing for cover, shrub and subshrub species from the forest understory were distinguished from trees. In measuring cover for the species, modified Braun-Blanquet (BB) scale of dominance was used to estimate its vegetation cover (Hallare 2010).

Table 1. Sampling sites and corresponding geographic details obtained using a GPS device.

SITE NUMBER	LOCAL NAME	MEAN COORDINATES		MEAN ELEVATION (above sea level)
1	Tibungbung	15° 3' 39" N	120° 26' 56" E	514.75 m
2	Barundun	15° 3' 10" N	120° 26' 55" E	390.50 m
3	Sapang Pau	15° 2' 50" N	120° 27' 11" E	352.00 m
4	Talibeng	15° 2' 31" N	120° 26' 52" E	137.00 m
5	Lukid-lukid	15° 2' 45" N	120° 26' 41" E	145.50 m
6	Pamana-na-Pili	15° 3' 2" N	120° 26' 39" E	151.75 m
7	Betac	15° 3' 11" N	120° 26' 39" E	175.00 m
8	Balintaki	15° 2' 25" N	120° 27' 6" E	273.50 m
9	Pansi-pansi	15° 2' 39" N	120° 27' 5" E	349.00 m
10	Batyawan	15° 2' 45" N	120° 27' 5" E	419.00 m

For tree species, basal area was used in estimating its cover, determined by measuring its diameter at breast height (DBH). To be considered a "tree", and to be able to avoid extreme measurement values, a minimum 4 cm diameter or 12.5 cm circumference was set (Mitchell 2007). Brokaw & Thompson (2000) suggested using a 130 cm standard height for DBH.

Species Diversity

Species diversity in each site was computed using Simpson's Index of Diversity (1 - D) and Shannon-Wiener Index (H'). Data were also pooled to determine the species diversity indices in the whole study site.

RESULTS

General floristic composition

Sixty-one (61) species of vascular plants, most of which are angiosperms, were recorded. Of the total number of species, forty-three (43) or 70.5% constitute the undershrub, while eighteen (18) or 29.5% are trees by height. See Tables 2 and 3 for the list of plants and the computed values for each species.

Fabaceae was the dominant plant family in Bgy. Camias. Of the 61 species, twelve (12) were members of Fabaceae (19.7%), six (6) were members of Poaceae (9.8%), and 4 were members of Euphorbiaceae, Moraceae, and Verbenaceae each (6.6% each).

Table 2. List of the undershrub species with their cumulative absolute density (D), cumulative absolute cover (C), cumulative absolute frequency (F), and importance value indices (IVI) after consolidating data from the 10 sampling sites. How the species become part and contribute to the overall density, cover, and frequency of the entire vegetation is given by their relative density (RD), relative cover (RC), and relative frequency (RF) values, expressed in per cent. The sum of the RD, RC, and RF gives the IVI for the particular species. The importance percentage (IP) is simply another representation of importance value index, expressed in per cent. Tree species found in this table occurred in the sampling sites as saplings and therefore were considered part of the undershrub.

SPECIES and TAXON	D	RD	C	RC	F	RF	IVI	IP
Chromolaena odorata	0.156	12.480	0.090	16.917	0.680	16.425	45.822	15.274
Mikania micrantha	0.169	**13.520**	0.075	**14.098**	0.400	**9.662**	**37.280**	12.427
Lantana camara	0.053	**4.240**	0.049	**9.211**	0.360	**8.696**	**22.146**	7.382
Paspalum sp.	0.142	**11.360**	0.028	**5.263**	0.140	**3.382**	**20.005**	6.668
Eleusine sp.	0.124	**9.920**	0.031	**5.827**	0.160	**3.865**	**19.612**	6.537
Leucaena leucocephala	0.055	**4.400**	0.032	**6.015**	0.360	**8.696**	**19.111**	6.370
Clitorea ternatea	0.070	**5.600**	0.031	**5.827**	0.280	**6.763**	**18.190**	6.063
Arachis sp. 1	0.070	**5.600**	0.018	**3.383**	0.100	**2.415**	**11.399**	3.800
Andropogon sp.	0.030	**2.400**	0.017	**3.195**	0.120	**2.899**	**8.494**	2.831
Urena lobata	0.023	**1.840**	0.012	**2.256**	0.160	**3.865**	**7.960**	2.653
Lamiaceae	0.022	**1.760**	0.012	**2.256**	0.140	**3.382**	**7.397**	2.466
Imperata cylindrica	0.025	**2.000**	0.013	**2.444**	0.120	**2.899**	**7.342**	2.447
Arachis sp.	0.019	**1.520**	0.012	**2.256**	0.100	**2.415**	**6.191**	2.064
Mimosa diplotricha	0.050	**4.000**	0.004	**0.752**	0.020	**0.483**	**5.235**	1.745
Sida rhombifolia	0.029	**2.320**	0.006	**1.128**	0.060	**1.449**	**4.897**	1.632
Bambusa vulgaris	0.022	**1.760**	0.011	**2.068**	0.040	**0.966**	**4.794**	1.598
"San Fernando"	0.027	**2.160**	0.004	**0.752**	0.040	**0.966**	**3.878**	1.293
"Malakamote"	0.026	**2.080**	0.004	**0.752**	0.040	**0.966**	**3.798**	1.266
"Kangkong-kangkongan"	0.025	**2.000**	0.004	**0.752**	0.040	**0.966**	**3.718**	1.239
Dioscorea alata	0.005	**0.400**	0.004	**0.752**	0.080	**1.932**	**3.084**	1.028
Myrtaceae	0.007	**0.560**	0.008	**1.504**	0.040	**0.966**	**3.030**	1.010
Mimosa pudica	0.010	**0.800**	0.006	**1.128**	0.040	**0.966**	**2.894**	0.965
Pseudoelephantopus spicatus	0.011	**0.880**	0.004	**0.752**	0.040	**0.966**	**2.598**	0.866
Mucuna pruriens	0.010	**0.800**	0.005	**0.940**	0.020	**0.483**	**2.223**	0.741
"Lanete"	0.003	**0.240**	0.004	**0.752**	0.040	**0.966**	**1.958**	0.653
Gliricidia sepium	0.004	**0.320**	0.006	**1.128**	0.020	**0.483**	**1.931**	0.644

Table 2 continues next page

Ficus septica	0.004	**0.320**	0.003	**0.564**	0.040	**0.966**	**1.850**	0.617
Manihot esculenta	0.006	**0.480**	0.004	**0.752**	0.020	**0.483**	**1.715**	0.572
Cyperus rotundus	0.010	**0.800**	0.002	**0.376**	0.020	**0.483**	**1.659**	0.553
Bauhinia malabarica	0.001	**0.080**	0.005	**0.940**	0.020	**0.483**	**1.503**	0.501
Arachis sp. 2	0.002	**0.160**	0.002	**0.376**	0.040	**0.966**	**1.502**	0.501
Pandanaceae	0.008	**0.640**	0.002	**0.376**	0.020	**0.483**	**1.499**	0.500
“Fern”	0.006	**0.480**	0.002	**0.376**	0.020	**0.483**	**1.339**	0.446
Musa paradisiaca	0.002	**0.160**	0.003	**0.564**	0.020	**0.483**	**1.207**	0.402
Cyperus sp.	0.004	**0.320**	0.002	**0.376**	0.020	**0.483**	**1.179**	0.393
“Kalyamut”	0.004	**0.320**	0.002	**0.376**	0.020	**0.483**	**1.179**	0.393
Passiflora foetida	0.001	**0.080**	0.002	**0.376**	0.020	**0.483**	**0.939**	0.313
Stachytarpeta jamaicensis	0.001	**0.080**	0.002	**0.376**	0.020	**0.483**	**0.939**	0.313
Cyperus sp. 2	0.002	**0.160**	0.001	**0.188**	0.020	**0.483**	**0.831**	0.277
Lamiaceae 2	0.002	**0.160**	0.001	**0.188**	0.020	**0.483**	**0.831**	0.277
Malatadyang	0.002	**0.160**	0.001	**0.188**	0.020	**0.483**	**0.831**	0.277
Amorphophallus paeoniifolius	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Artocarpus blancoi	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Cajanus indicus	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Capsicum annuum	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Euphorbia hirta	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Euphorbiaceae	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Kalbong	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
Vitex parviflora	0.001	**0.080**	0.001	**0.188**	0.020	**0.483**	**0.751**	0.250
TOTAL	1.25	**100**	0.532	**100**	4.14	**100**	**300**	100

Table 3. List of tree species with their cumulative absolute density (D), cumulative absolute cover (C), cumulative absolute frequency (F), and importance value indices (IVI) after consolidating data from the 10 sampling sites. How the species become part and contribute to the overall density, cover, and frequency of the entire canopy is given by their relative density (RD), relative cover (RC), and relative frequency (RF) values, expressed in per cent. The sum of the RD, RC, and RF gives the IVI for the particular species. The importance percentage (IP) is simply another representation of importance value index, expressed in per cent.

SPECIES	D	RD	C	RC	F	RF	IVI	IP
Leucaena leucocephala	0.011	30.556	0.0001246	5.939	0.18	29.032	65.527	21.842
Mangifera indica	0.004	**11.111**	0.0006597	**31.445**	0.0©8	**12.903**	**55.459**	18.486
Albizia saman	0.002	**5.556**	0.0003919	**18.680**	0.04	**6.452**	**30.687**	10.229
Carica papaya	0.005	**13.889**	0.0000542	**2.583**	0.06	**9.677**	**26.150**	8.717
Gmelina arborea	0.002	**5.556**	0.0002903	**13.837**	0.04	**6.452**	**25.844**	8.615
Swietenia mahogani	0.002	**5.556**	0.0001863	**8.880**	0.02	**3.226**	**17.661**	5.887
Ficus variegata	0.001	**2.778**	0.0002088	**9.953**	0.02	**3.226**	**15.956**	5.319
Muntingia calabura	0.002	**5.556**	0.0000288	**1.373**	0.04	**6.452**	**13.380**	4.460
Gliricidia sepium	0.002	**5.556**	0.0000224	**1.068**	0.04	**6.452**	**13.075**	4.358
Terminalia catappa	0.001	**2.778**	0.0000828	**3.947**	0.02	**3.226**	**9.950**	3.317
Tamarindus indica	0.001	**2.778**	0.0000424	**2.021**	0.02	**3.226**	**8.025**	2.675
Sandoricum koetjape	0.001	**2.778**	0.0000042	**0.201**	0.02	**3.226**	**6.204**	2.068
Ficus sp.	0.001	**2.778**	0.0000012	**0.055**	0.02	**3.226**	**6.058**	2.019
Trema orientalis	0.001	**2.778**	0.0000004	**0.019**	0.02	**3.226**	**6.022**	2.007
TOTAL	0.036	**100.000**	0.002098	**100.000**	0.620	**100.000**	**300.000**	100.000

Determination of life forms

Figure 1 shows the proportion of life forms obtained in the study site vis-à-vis normal proportion of life forms in a tropical rainforest as given by Raunkiaer (1934).

Observed proportion of phanerophytes and chamaephytes (species with dormancy buds located *above* ground) were higher than that of Raunkiaer's normal life form spectrum. On the other hand, proportion of therophytes, cryptophytes, and hemicryptophytes, (species with dormancy buds located *below* ground) were lower than that of the projected Raunkiaer's normal life form spectrum.

A significant difference was observed using the χ^2 test ($\chi^2 = 59.22$, $p < 0.05$).

Determination of biological structure

Density, Cover, Frequency, and Importance Values
For the shrubs and undershrub species, *Chromolaena odorata* (IV = 48.8, IP = 15.3%), *Mikania micrantha* (IV = 37.3, IP = 12.40%), and *Lantana camara* (IV = 22.1, IP = 7.4%) are the most important species in the undershrub. For the tree species, *Leucaena leucocephala* (IV = 65.5, IP = 21.8%), *Mangifera indica* (IV = 55.5, IP = 18.5%), and *Albizia saman* (IV = 30.7, IP = 10.2%) are the most important trees in the area.

Species Diversity
Tables 4 and 5 list the Simpson's Indices of Diversity (1-D) and Shannon-Wiener Indices (H') for each sampling site in the undershrub and tree levels, respectively. General species diversity of the area revealed relatively low values ($1\text{-}D_{(undershrub)} = 0.927$, $1\text{-}D_{(trees)} = 0.855$; $H'_{(undershrub)} = 3.000$, $H'_{(trees)} = 2.281$).

Similar trend in diversity level according to Simpson's Index of Diversity for both undershrub and trees were observed for all sites.

DISCUSSION

General Floristic Composition
In many recent studies, species-rich families common across the disturbed plant communities in paleotropical and neotropical regions and in Pacific Oceanic region are

Table 4. Simpson's Index of Diversity (1-D) and Shannon-Wiener Index (H') in the undershrub level for the whole study area. Indices for each sampling site are also provided. Notice opposite ranking of Simpson's and Shannon-Wiener Indices for (5) Lukid-lukid and (8) Balintaki, as well as for (1) Tibungbung, (6) Pamana-na-Pili and (2) Barundun.

SITE	SIMPSON'S	SHANNON-WIENER
Overall	0.927322	3.000134
(9) Pansi-pansi	0.872144	2.254502
(7) Betac	0.843685	2.136854
(5) Lukid-lukid	0.839184	2.067963
(8) Balintaki	0.833268	2.099279
(4) Talibeng	0.831945	2.0587
(3) Sapang Pau	0.808403	1.902657
(1) Tibungbung	0.772064	1.701118
(6) Pamana-na-Pili	0.761938	1.720624
(2) Barundun	0.751052	1.782927
(10) Batyawan	0.747175	1.578156

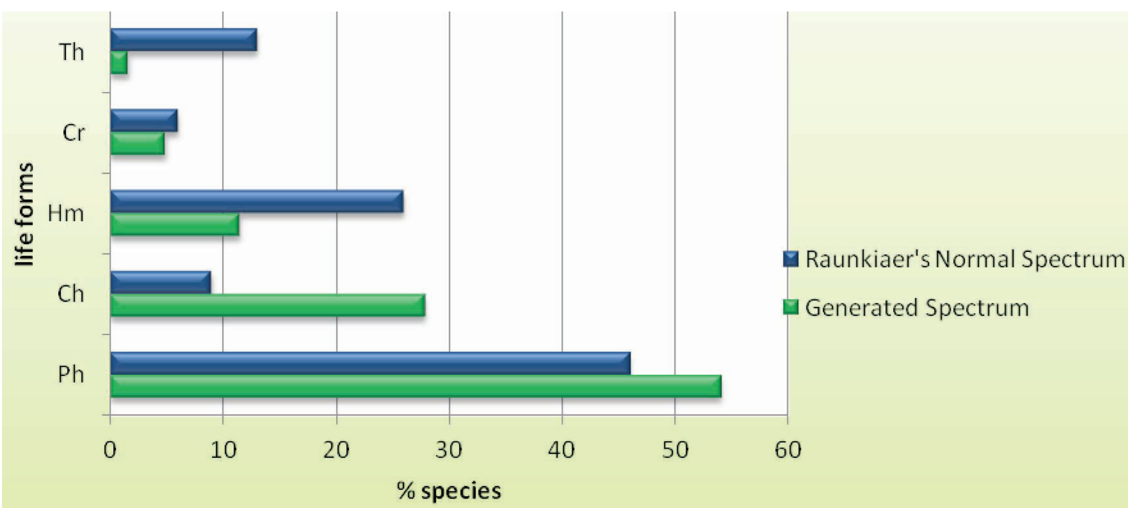

Figure 1. Life-form spectrum obtained from the flora of Brgy. Camias, Porac, Pampanga, vis-a-vis Raunkiaer's normal life-form spectrum for a tropical rainforest. Notice the significant difference in the proportion of therophytes to cryptophytes and that of hemicryptophytes to chamaephytes. A significant difference was observed using the χ^2 test ($\chi^2 = 59.22$, $p < 0.05$, $\alpha = 5\%$, df = 4).

Table 5. Simpson's Index of Diversity (1-D) and Shannon-Wiener Index (H') in the tree level for the whole study area. Indices for each sampling site are also provided. Highest diversity was found in Talibeng and Tibungbung. Notice opposite ranking of Simpson's and Shannon-Wiener Indices for (3) Sapang Pau, (9) Pansi-pansi and (7) Betac.

SITE	SIMPSON'S	SHANNON-WIENER
Overall	0.854938	2.280722
(4) Talibeng	0.75	1.386294
(1) Tibungbung	0.722222	1.329661
(3) Sapang Pau	0.625	1.039721
(9) Pansi-pansi	0.625	1.039721
(7) Betac	0.612245	1.153742
(8) Balintaki	0.5	0.693147
(2) Barundun	0.444444	0.636514
(5) Lukid-lukid	0	0
(6) Pamana-na-Pili	0	0
(10) Batyawan	0	0

the Fabaceae, Poaceae and Euphorbiaceae (Gentry 1995, Gillespie et al 2011). Del Moral and Grishin (1999) in their study of volcanic eruption and ecological impacts affirmed the predominance of wind-pollinated and wind-dispersed species, such as members of Asteraceae and Poaceae in ash-laden areas in continental Asia. Fabaceae species are most common in secondary neotropical forests as analyzed and reported by Gentry (1995). Their most dominant mode of pollination and seed dispersal was observed to be anemophily and zoochory in young secondary neotropical forests (Coelho et al. 2011; Schultz 2011). Again, the dominance of these three families is primarily attributed to anemophily and zoochory being selectively advantageous in pollination and seed dispersal mechanisms. In particular, the mimosoid stamens and fruits of the Fabaceae allow maximum pollination and dispersion (Carlquist 1974, Gillespie et al. 2011). Furthermore, legume fruits serve as food to a variety of reptiles and mammals in the forest and thus make them efficient seed dispersers. Likewise, cyathia from euphorbs also attract many pollinator species such as butterflies and birds found in the wild (Simpsons 2005, Smith & Smith 2006). Species of the family Poaceae remain to be one of the most widely-distributed in open sites also due to anemophily and anemochory. Its broad panicle inflorescence and lightweight grains make wind an efficient agent of distribution (Simpsons 2005).

Family dominance according to species richness is not just affected by the distribution agents in the environment. They also indicate distribution patterns of other species, which affect, in turn, the surrounding physical conditions. For instance, dominance of the Poaceae species indicates that the "open" forest canopy is still under recovery, and is actually way far from completion. The open forest canopy allows light to penetrate to reach the forest floor and for sun-loving ground herbs to proliferate, including grasses (Durst, Sajise & Leslie 2009). In particular, the cumulative relative cover of grasses and sedges is RC, cumulative = 17.169% which is less than half the cumulative relative cover of the 3 most important species (RC, cumulative = 40.226%).

The presence of the members of the family Moraceae, on the other hand, suggests that wasps and pollinator and seed disperser bats are still present in the area even after the devastation of the fauna during the 1991 eruption of Mt. Pinatubo.

Life Forms

Phanerophytes usually exceed in a normal spectrum, especially in humid tropics (i.e. Philippine forests), and in some tropical countries by several times in number (Rana et al. 2002). However, the hilly and mountainous terrain of Brgy. Camias, where chamaephyte species abound, might receive less water during rainfall causing the presence of a higher percentage of chamaephytes, which is characteristic of semi-arid regions (Rana et al. 2002). Chamaephytes or plants with regeneration buds close to the soil surface generally abound in temperate zones (Sudhakar et al. 2011), and its proliferation in a secondary forest reaffirms that the site is still in the primordial stages of vegetational succession. For instance, species of herbaceous and cushion plants, such as members of the Poaceae and Fabaceae families, which are remnants of a grassland vegetation, still abound in the study area. The abundance of their species suggests persisting openness of the canopy that makes water reservoir in the undershrub easily evaporated, even though a high humidity remains. Members of Poaceae and Lamiaceae survive well also in temperate climates (Desai & Ant 2012, Sudhakar et al. 2011).

Meanwhile, the observed lower proportion of hemicryptophytes, cryptophytes, and therophytes is indicative of a disturbed area. Aside from the fact that these groups of life forms usually develop in areas where native vegetation has been disturbed, and that therophytes have high representation in dry-weather areas, natural disturbance and grazing may also be partly responsible for the observation (Tareen and Qadir 1993).

Biological structure of succession

The study area was well proven to be a home for Invasive Alien Species (IASs) at present stage of plant succession. An IAS is a species introduced from outside its normal territorial range of distribution both by intentional or accidental human activity that has been able to self-reproduce in the wild, and has caused obvious damage to local, artificial, or natural ecosystems (Akten & Zuberi

2009). Invasive alien species can aggressively displace indigenous species in their natural habitats. In the area, examples of these are *Lantana camara*, *Chromolaena odorata* and *Leucaena leucocephala*, among others. These species are particularly characterized by a persistent root system and fruits with numerous seeds which easily disperse and germinate even in poor soils (Madulid, Tandang & Agoo 2009).

Tephra (in Greek, meaning ashes), which heavily covered Porac-Gumain and nearby towns during the 1991 Mount Pinatubo eruption (Mercado, Lacsamana and Pineda 1999), provides rooting material and soil residues where root fragments of wind-dispersed species can thrive. In contrast to a coarse and biomass-poor lava flow, tephra is a more effective material to promote secondary succession.

Aside from the presence of IASs, the study area has other species present showing the forest to be in an early secondary succession. *Ficus* spp., *Trema orientalis*, *Leucaena leucocephala* usually dominate Philippine secondary forests (Madulid, Tandang & Agoo 2009). Some of the extant species in the study area have already been included in the IUCN Red List of Threatened Species, which includes *Trema orientalis*, *Artocarpus blancoi*, and *Vitex parviflora*, all of which are currently listed to have a vulnerable status in the country.

The more uniform mature grassland vegetation with few emergents, as seen in the study area, characterizes earlier stage-regeneration of a secondary forest. Mature grasslands and marginal areas of grasslands in the country cover around 2 million hectares (Florece & Coladilla 2009), and tree species around them are important as they become the source of propagules for the pioneering non-grass species in the older grassland areas (Madulid, Tandang & Agoo 2009). Propagule sources are pre-requisite to natural regeneration of the mature grassland into pioneer secondary forest (Guariguata & Ostertag 2001). The growth of herbs and shrubs alongside grasses and sedges in the area in a relatively close association indicates early stage of development to secondary forest (Madulid, Tandang & Agoo 2009).

If the sites were in a more advanced stage of regeneration, numerous and diverse emergents that characterize an old secondary forest in healthy regeneration will be seen (Madulid, Tandang and Agoo 2009). However, species such as *Lithocarpus*, *Palaquium*, *Canarium*, and *Dipterocarpus*, among others, that are indicative of a more advanced state of regeneration of forest ecosystem, are still absent.

While regeneration and consequent dominance of wind-pollinated species is certain on ash-laden vegetation, specific pioneer plant communities may vary. In a study by Tagawa et al (1985) on plant succession at Krakatau Islands in Indonesia, diagnostic species of new plant communities in four islands of the Krakatau group differed according to dispersal capabilities and development of juvenile generations, which in turn is affected by nutrient limitation, substrate instability, and the ability of tree species to establish in many years. Inhibition of further colonialists by initial invaders, including the IASs, increases the variability of habitat conditions, and consequently, of survivors, which become the diagnostic species of the area. Clearly, the slow turnover of seral species in Porac is affected neither by a continuing disturbance (Mount Pinatubo has been inactive for years) or any dramatic climate changes. Rather, the species composition and ensuing interactions seem to be the result of competition between the survivors/diagnostic species and some possible colonialists (Del Moral & Grishin 1999). This affirms that IASs are mainly responsible for the observed persisting low diversity in the area at present.

Using as an index of measurement, the Simpson's Index of Diversity (0.927 for under shrub species, 0.855 for tree species) and Shannon-Wiener Index (3.00 for undershrub species, 2.28 for tree species) show a relatively low species diversity in the study area. This might be a direct result brought by the existence and abundance of IAS in the study area.

CONCLUSION

Barangay Camias, Porac, Pampanga has a secondary forest in its initial stage of secondary succession as determined by the diagnostic species, including *Chromolaena odorata*, *Mikania micrantha*, *Albizia saman* and *Leucaena leucocephala*, all of which were ranked the most important species in the undershrub story and in the canopy category. Many of the species are invasive alien species (IAS) which are characteristic of a disturbed area in the Philippines. They aggressively displace indigenous plants and consequently, decrease species diversity in the plant community. This is proven by a relatively lower number of plant species recorded in the study area and confirmed through a calculation of different indices of species diversity as compared to that reported for a healthy and vigorous old secondary rainforest.

If the dominant IAS in the study area is not controlled in number, the young secondary forest in the study area will have difficulty to proceed to maturity and the original indigenous plant species will not be restored. Control of the said IAS species, alongside new methods of reforestation and expanded research in the area, will be the effective measures to adopt in targeting for the full restoration of forest at Bgy. Camias in the next decade.

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