INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 15, No. 5, p. 113-124, 2019
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Floral diversity of the lowland ultrabasic forest in the Northern Sierra Madre Natural Park, Isabela, Luzon, Philippines

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Article published on November 30, 2019

Key words: Philippine endemics, Ultrabasic forest, Species richness, Threatened species

Abstract

This study provides information on the floral diversity, endemism and conservation status of the lowland ultrabasic forest in the Northern Sierra Madre Natural Park (NSMNP), Palanan, Isabela, Northeast Luzon, Philippines, which is vital to the management of the protected area. A total of 266 plant species in 140 genera and 71 families were recorded consisting of 12 herbs, 18 lianas, 66 shrubs, 169 trees and an endemic-epiphytic woody parasite. The most diverse among the genera with the highest number of taxa were *Syzygium* (32 spp.), *Palaquium* (12 spp.), *Garcinia* (9 spp.), *Glochidion* (9 spp.), and *Trigonostemon* (5 spp.). *S*pecies richness was highest for family Myrtaceae (35 spp.) followed by Rubiaceae (23 spp.), Phyllanthaceae (17 spp.), Sapotaceae (16 spp.), and Euphorbiaceae (14 spp.). Forty-two (42) of the total families were represented by a single genus. Species endemism was high with 40% (107 spp.) Philippine endemics: four (4) were found endemic only to Isabela Province - one of which was recorded endemic only to Sierra Madre Natural Park while 23 were endemic only to Luzon Island. Thirty-nine (39) species are globally threatened: six (6) being critically endangered, four (4) endangered, 22 vulnerable and seven (7) near threatened.

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Introduction

The Sierra Madre Mountain Range dominates the eastern pacific side of Northern Luzon, Philippines. The Northern Sierra Madre Natural Park (NSMNP) which lies within the Sierra Madre Biogeographic Zone is one of the country's ten priority protected areas and the largest remaining tract of tropical rainforest with a total of 359,486 hectares. It consists of seven forest vegetation types, the ultrabasic forest as one of the most diverse forest ecosystems and the highest in terms of endemism. The reason for such outstanding high biodiversity is that the country is fundamentally archipelagic in nature, each island with diverse (but specific) geological origins and histories. Each of the geo-historically distinct sets of islands is home to a unique set of species of flora and fauna. Declining temperatures and increasing rainfall in one particular mountainous area gives rise to major types of rainforests. Layers of humus are thin and scattered in the lowland forest, but build into a blanket at higher elevations.

The ultrabasic forest occurs in soil rich in heavy metals like silica, nickel, chromium, cobalt, iron and magnesium. It is generally characterized by sclerophyllous stunted vegetation. Unlike the other ultrabasic forests in the Philippines, NSMNP has a unique flora including its own Isabela endemic, Sierra Madre mangkono (*Xanthostemon fruticosus* Peter G. Wilson & Co) which is dominant in some parts of the ultrabasic forest. Other species include small trees, low-spreading to erect shrubs and several herbaceous plants (Co, 2006). An updated species list was provided based on field surveys from 1991 onwards and analysis of herbarium records. The study aimed to assess the diversity of flora of NSMNP as basis for its conservation. Specifically it aimed to: a) describe the plant community composition of the lowland ultrabasic forest; b) determine the plant richness of taxa by family, genera and species; c) determine plant endemism; and d) assess the conservation status of the species.

Materials and methods

Study Area

The study area is located within the Northern Sierra Madre Natural Park, southern part of Palanan, Isabela Province, Luzon, Philippines (16º 56' N and 122 º26" E). It is characterized by flat to sloping near riverbanks, gently sloping to rolling on the southern portion and undulating on the eastern portion. About 5,390 ha are within the slope range of 3%-8%. Slope range of 8%-18% cover about 726 ha while at slope range 0%-3% cover 490 ha. Clay soil type is the most prevalent. Other soil types identified in the area include loam, sandy, clay loam, sandy loam, and sandy clay. Rainfall is more or less evenly distributed throughout the year with mean annual rainfall of 3,218 mm and annual totals ranging from 1,347 to 6,841 mm and all months exceeding 100 mm of rain. Mean annual temperature during summer was recorded at 29ºC and 18ºC during rainy season. About 20 typhoons frequently come from the northeast border with wind gusts up to 200 kph, which have significant effects on the forest through direct crown damage. Major portion of the area (about 5,000 ha) is situated at 0-100 meters above sea level (masl) while the 1,606-hectare ultrabasic forest is situated at range of 100-300masl (Fig. 1).

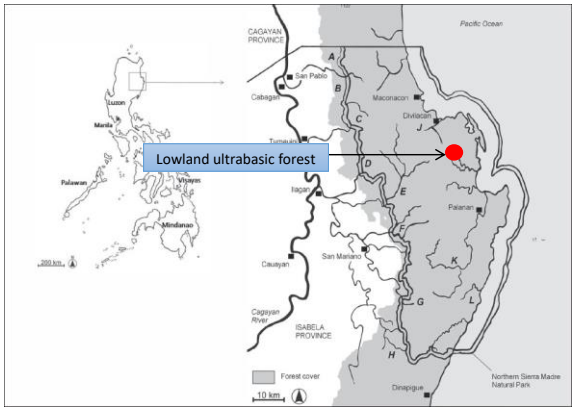

Fig. 1. Location map of the study area in NSMNP, Palanan, Isabela.

Floristic Inventory

Floristic inventory was conducted by repeated transect walks in the study area. Ten transect plots of 10 x 100 m equivalent to 0.1 ha per plot were established. All plots were surveyed giving a total sample area of one ha. All woody plants (lianas, trees and shrubs) with girth at breast height (GBH) above 2.5 cm for trees and over one cm GBH for lianas within the plots were counted, numbered, pre-identified, photo-documented

and taken for sample. Herbaceous plants were also pre-identified and collected. Plant samples were transported to the Isabela State University Herbarium (ISUH) for processing.

Collection, Processing and Identification of Specimens

Ten fertile samples and a minimum of three sterile samples per species were collected and processed using the wet method. All samples were dried at the Isabela State University at Cabagan Campus and deposited at the ISUH. Specimens were identified and verified using various floral keys and comparison with herbarium specimens. Plants were classified by families using the Angiosperm Phylogenetic Group (APG) III classification scheme (Bremer *et al.* 2009).

Data Analysis

Qualitative floristic measures of data were used to determine the species composition and level of plant richness at species, genera and family levels. Importance value index for woody species was calculated by determining the relative frequency, relative density and relative basal area.

The global conservation status of the species was assessed based largely on the available data from the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (2017). Locally threatened species were based from the National List of Threatened Philippine Plants issued by the Department of Environment and Natural Resources (DENR-DAO 2017-11).

Results and discussion

Floristic composition

The lowland ultrabasic forest of the NSMNP is probably one of the most diverse among forest types in the country. This forest type is interesting because of its exceptionally rich flora, its remarkable levels of species and generic endemism. The vegetation is sparse and plants are stunted. Trees and shrubs tend to have thick, leathery leaves and sometimes reach to only one or two meters tall. The soils are rich in toxic minerals such as nickel, iron and magnesium but very poor in potassium, calcium and phosphorus which are essential elements for many plants. But despite this harsh soil environment the flora is very rich with endemic plants.

Seventy - one (71) families consisting of 140 genera were recorded in the lowland ultrabasic forest. The species composition is an assemblage of 12 herbaceous terrestrial and epiphytic plants, 18 lianas/woody climbers, 66 shrubs, 169 trees and an endemic-epiphytic woody parasite. It is very interesting to note this remarkable total number of 266 identified taxa despite the extreme concentrations on heavy metal toxic to many plants and how the plants were able to tolerate such soil conditions (Table 1). Taxonomic studies on similar soil formations in the Philippines reveal the same species richness and diversity.

Table 1. Species composition of lowland ultrabasic forest in the Northern Sierra Madre Natural Park. Legend: t=tree, s=shrub, l=liana, th=terrestrial herb, eh=epiphytic herb, ewp=epiphytic woody parasite.

Species Name	Family Name	Common Name & Habit
Adenanthera intermedia Merr.	Fabaceae	Tanglin (t)
Adenanthera kostermansii I.C.Nielsen	Fabaceae	Rawal (t)
Agathis philippensis Warb.	Araucariaeae	Almaciga (t)
Agelaea borneensis (Hook.f.) Merr.	Connaraceae	Tayabak (l)
Agrostistachys borneensis Becc.	Euphorbiaceae	Haginis-agos (s)
Alchornea rugosa (Lour.) Müll.Arg.	Euphorbiaceae	Aguioi (s)
Alpinia brevilabris C.Presl	Zingiberaceae	Shell ginger (th)
Alstonia spectabilis R.Br.	Apocynaceae	Kahoi-dilau (t)
Alyxia monticola C.B.Rob.	Apocynaceae	Harupagot (l)
Alyxia sibuyanensis Elmer	Apocynaceae	Alyxia
Ampelocissus ochracea (Teijsm. & Binn.) Merr.	Vitaceae	Ampelocissus (l)
Amyema acuta (Tiegh.) Danser	Loranthaceae	Amyena (ewp)
Anisoptera thurifera (Blanco) Blume	Dipterocarpaceae	Palosapis (t)
Antidesma macgregorii C.B.Rob.	Phyllanthaceae	Bignai-gubat (t)
Antidesma montanum Blume	Phyllanthaceae	Bignai-kintab (s)

Species Name	Family Name	Common Name & Habit
Antirhea caudata (M.E.Jansen) Chaw	Rubiaceae	Dimupang-buntotan (s)
Antirhea ramosii Chaw	Rubiaceae	Ramos dimupa (s)
Antirhea tayabensis Chaw	Rubiaceae	Tayabas dimupa (s)
Aporosa symplocifolia Merr.	Phyllanthaceae	Malabignai (t)
Aquilaria cumingiana (Decne.) Ridl.	Thymelaeaceae	Butlo (s)
Arcangelisia flava (L.) Merr.	Menispermaceae	Abutra (l)
Archidendron clypearia (Jack) I.C.Nielsen	Fabaceae	Tiagkot (t)
Archidendron scutiferum (Blanco) I.C.Nielsen	Fabaceae	Anagap (t)
Ardisia alverezii Merr.	Primulaceae	Alverez tagpo (s)
Ardisia darlingii Merr.	Primulaceae	Barasingag (s)
Ardisia tomentosa C.Presl	Primulaceae	Mulang (s)
Artocarpus altilis (Parkinson) Fosberg	Moraceae	Rimas/Antipolo (t)
Artocarpus rubrovenius Warb.	Moraceae	Kalulot (t)
Atuna racemosa subsp. *racemosa* Raf.	Chrysobalanaceae	Tabon-tabon (t)
Barringtonia macrostachya (Jack) Kurz	Lecythidaceae	Karakuat (t)
Beilschmiedia glomerata Merr.	Lauraceae	Tirukan (t)
Beilschmiedia lucidula (Miq.) Kosterm.	Lauraceae	Bagaoring (t)
Brackenridgea fascicularis (Blanco) Fern.-Vill.	Ochnaceae	Bitas (t)
Breynia cernua (Poir.) Mull.-Arg	Phyllanthaceae	Kalamyasan (s)
Breynia vitis-idaea (Burm.f.) C.E.C.Fisch.	Phyllanthaceae	Matang-hipon (s)
Buchanania arborescens (Blume) Blume	Anacardiaceae	Balinghasai (t)
Buchanania insignis Blume	Anacardiaceae	Balihud (t)
Buxus rolfei S.Vidal	Buxaceae	Malagaapi (s)
Calophyllum blancoi Planch. & Triana	Calophyllaceae	Bitanghol (t)
Calophyllum soulattri Burm.f.	Calophyllaceae	Pamintaogon (t)
Calophyllum whitfordii Merr.	Calophyllaceae	Pamitaogen (t)
Camellia lanceolata (Blume) Seem.	Theaceae	Haikan (s)
Cananga odorata (Lam.) Hook.f. & Thomson	Annonaceae	Ilang-ilang (t)
Canarium euryphyllum var. *europhyllum* Perkins	Burseraceae	Mayakiat (t)
Canarium gracile Engl.	Burseraceae	Pagsahingin-langgam (t)
Canarium hirsutum Willd.	Burseraceae	Milipili (t)
Canarium luzonicum (Blume) A.Gray	Burseraceae	Piling-liitan (t)
Canthium monstrosum (A.Rich.) Merr.	Rubiaceae	Tadiang-anuang (t)
Canthium trichophorum Quisumb. & Merr.	Rubiaceae	Ambabasal (t)
Carallia brachiata (Lour.) Merr.	Rhizophoraceae	Bakauan-gubat (t)
Casearia fuliginosa (Blanco) Blanco	Salicaceae	Talitan (t)
Cephalomanes obscurum (Blume) K.Iwats.	Hymenophyllaceae	Cephalomanes (h)
Champereia manillana (Blume) Merr.	Opiliaceae	Garimo (t)
Cleistanthus everettii C.B.Rob.	Phyllanthaceae	Everett anupag (t)
Cleistanthus pedicellatus Hook.f.	Phyllanthaceae	Anupag (s)
Croton leiophyllus Müll.Arg.	Euphorbiaceae	Tagoang-uak (s)
Croton luzoniensis Müll.Arg.	Euphorbiaceae	Pagaibayong (s)
Croton quisumbingianus Croizat	Euphorbiaceae	Quisumbing tuba (s)
Cyrtandra disparifolia Quisumb.	Gesneriaceae	Cyrtandra (s)
Cyrtandra oblongata Merr.	Gesneriaceae	Cyrtandra (s)
Dacryodes incurvata (Engl.) H.J.Lam.	Burseraceae	Kamingi (t)
Dacryodes rostrata (Blume) H.J.Lam.	Burseraceae	Lunai (t)
Daemonorops mollis (Blanco) Merr.	Arecaceae	Alimuran (l)
Daemonorops ochrolepis Becc.	Arecaceae	Ditan (l)
Daphniphyllum glaucescens Blume	Daphniphyllaceae	Inutatan (t)
Dasymaschalon clusiflorum (Merr.) Merr.	Annonaceae	Malaatis (s)
Decaspermum fruticosum J.R.Forst. & G.Forst.	Myrtaceae	Patalsik (s)
Dimocarpus longan subsp. *malesianus* Leenh.	Sapindaceae	Alupag (t)
Dimorphocalyx ixoroides (C.B.Rob.) Airy Shaw	Euphorbiaceae	Agindulong (s)
Dinochloa dielsiana Pilg.	Poaceae	Bamboo (l)
Diospyros buxifolia (Blume) Hiern	Ebenaceae	Gumunan (t)
Diospyros cauliflora Blume	Ebenaceae	Tamil (t)
Diospyros discolor Willd.	Ebenaceae	Kamagong (t)
Diospyros nitida Merr.	Ebenaceae	Katilma (t)

Species Name	Family Name	Common Name & Habit
Diplospora fasciculiflora (Elmer) Elmer	Rubiaceae	Kaping-bundok (s)
Discocalyx cybianthoides (A.DC.) Mez	Primulaceae	Paginga (t)
Dracaena multiflora Warb.ex Sarasin	Asparagaceae	Dracaena (h)
Elaeocarpus argenteus Merr.	Elaeocarpaceae	Bakani (t)
Elaeocarpus cumingii Turcz.	Elaeocarpaceae	Hunggo (t)
Elaeocarpus ilocanus Merr.	Elaeocarpaceae	Panulauen (t)
Elaeocarpus monocera Cav.	Elaeocarpaceae	Tabian (t)
Ellipanthus tomentosus Kurz	Connaraceae	Luzon alomangoi (t)
Endocomia macrocoma subsp. *macrocoma* (Miq.) W.J.de Wilde	Myristicaceae	Kumpang (t)
Falcatifolium gruezoi de Laub.	Podocarpaceae	Binaton (t)
Ficus fistulosa Reinw. ex Blume	Moraceae	Kamahiuan (t)
Ficus punctata Thunb.	Moraceae	Is-is maya (l)
Ficus rivularis Merr.	Moraceae	Baleteng-bato (s)
Ficus ruficaulis Merr.	Moraceae	Tabgun (t)
Flagellaria indica L.	Flagellariaceae	Whip vine (l)
Garcinia brevirostris Scheff.	Clusiaceae	Basan (t)
Garcinia celebica L.	Clusiaceae	Bunog (t)
Garcinia dulcis (Roxb.) Kurz	Clusiaceae	Taklang-anak (t)
Garcinia lateriflora Blume	Clusiaceae	Kandis (t)
Garcinia luzoniensis Merr.	Clusiaceae	Malabinukau (t)
Garcinia macgregorii Merr.	Clusiaceae	Tagkon (t)
Garcinia oligophlebia Merr.	Clusiaceae	Dilis (t)
Garcinia rubra Merr.	Clusiaceae	Kamandiis (t)
Garcinia venulosa (Blanco) Choisy	Clusiaceae	Gatasan (t)
Gardenia elata var. *longipedicellata* K.M.Wong	Rubiaceae	Balanigan (s)
Gardenia merrillii Elmer	Rubiaceae	Bagaoi (s)
Geniostoma rupestre J.R.Forst. & G.Forst.	Loganiaceae	Gagadang (s)
Gironniera subaequalis Planch.	Cannabaceae	Ngahil (t)
Glochidion lutescens Blume	Phyllanthaceae	Salanisin (t)
Glochidion luzonense Elmer	Phyllanthaceae	Apaped (s)
Glochidion philippicum (Cav.) C.B.Rob.	Phyllanthaceae	Iba-ibaan (t)
Glochidion pubicapsa Airy Shaw	Phyllanthaceae	Kainag (s)
Glochidion rubrum Blume	Phyllanthaceae	Bagnang-pula (s)
Glochidion subfalcatum var. *nitidum* (Merr.) Chakrab. & M.Gangop.	Phyllanthaceae	Bagnang-gubat (t)
Glochidion triandrum (Blanco) C.B.Rob.	Phyllanthaceae	Bagna (t)
Glochidion urophylloides Elmer	Phyllanthaceae	Halakan (t)
Glochidion williamsii C.B.Rob.	Phyllanthaceae	Tumuhan (t)
Gnetum gnemon L.	Gnetaceae	Bago (t)
Gnetum latifolium Blume	Gnetaceae	Lamparahan (l)
Gomphandra coi Schori	Stemonuraceae	Co marumai (t)
Gomphia serrata (Gaertn.) Kanis	Ochnaceae	Salaktok (t)
Goniothalamus elmeri Merr.	Annonaceae	Bigus (t)
Gonocaryum calleryanum (Baill.) Becc.	Cardiopteridaceae	Taingang-babui (t)
Gonystylus macrophyllus (Miq.) Airy Shaw	Thymelaeaceae	Lanutan-bagyo (t)
Greeniopsis discolor Merr.	Rubiaceae	Pangalimanan (s)
Greeniopsis multiflora (Elmer) Merr.	Rubiaceae	Paluai (s)
Greeniopsis pubescens Merr.	Rubiaceae	Paluai-mabolo (s)
Guioa bicolor Merr.	Sapindaceae	Kaningning (t)
Guioa koelreuteria (Blanco) Merr.	Sapindaceae	Alahan (t)
Guioa pleuropteris (Blume) Radlk.	Sapindaceae	Bunsikag (t)
Gymnacranthera farquhariana var. *paniculata* (A.DC.) R.T.A.Schouten	Myristicaceae	Anuping (t)
Gymnostoma rumphianum (Miq.) L.A.S.Johnson	Casuarinaceae	Ahoho del Monte (t)
Gynochthodes philippinensis (Elmer) Merr.	Rubiaceae	*Gynochthodes* (l)
Helicia robusta (Roxb.) R.Br. ex Blume	Proteaceae	Salimai-lakihan (t)
Heterospathe brevicaulis Fernando	Arecaceae	Bilisan (t)
Heterospathe cagayanensis Becc.	Arecaceae	Cagayan bilisan (t)
Homalium panayanum Fern.-Vill.	Salicaceae	Ampupuyot (s)
Homonoia riparia Lour.	Euphorbiaceae	Mangapos (s)
Horsfieldia ardisiifolia (A.DC.) Warb.	Myristicaceae	Tapol (t)
Horsfieldia costulata (Miq.) Warb.	Myristicaceae	Dugo-dugoan (t)
Horsfieldia polyspherula (Hook.f. ex King) J.Sinclair	Myristicaceae	Dara-dara (t)

Species Name	Family Name	Common Name & Habit
Hoya imbricata Decne.	Apocynaceae	Hoya (eh)
Intsia bijuga (Colebr.) Kuntze	Fabaceae	Ipil (t)
Intsia palembanica Miq.	Fabaceae	Palawan ipil (t)
Ixora crassifolia Merr.	Rubiaceae	Mangopong (s)
Kibatalia blancoi (Rolfe ex Stapf) Merr.	Apocynaceae	Pasnit (t)
Knema glomerata Merr.	Myristicaceae	Tambalau (t)
Knema kunstleri (King) Warb.	Myristicaceae	Tambalau-kapalan (t)
Knema ridsdaleana W.J.de Wilde	Myristicaceae	Ridsdale tambalau (t)
Knema stellata Merr.	Myristicaceae	Durugo (t)
Lagerstroemia paniculata (Turcz.) S.Vidal	Lythraceae	Talulong (t)
Licania splendens (Korth.) Prance	Chrysobalanaceae	Buku-buku (t)
Lithocarpus robinsonii Rehder	Fagaceae	Babaisakan (t)
Lithocarpus sulitii Soepadmo	Fagaceae	Pangnan (t)
Lophopetalum beccarianum Pierre	Celastraceae	Aras (t)
Lygodium merrillii Copel.	Lygodiaceae	fern (th)
Maasia glauca (Hassk.) Mols, Kessler & Rogstad	Annonaceae	Dogan (s)
Madhuca betis (Blanco) J.F.Macbr.	Sapotaceae	Betis (t)
Magnolia liliifera (L.) Baill.	Magnoliaceae	Patangis (t)
Myristica colinridsdalei W.J.de Wilde	Myristicaceae	Ridsdale duguan (t)
Oldenlandia prostrata (Blume) Kuntze	Rubiaceae	Oldenlandia (th)
Palaquium bataanense Merr.	Sapotaceae	Bataan tagatoi (t)
Palaquium elliptilimbum Merr.	Sapotaceae	Alakaak-tilos (t)
Palaquium elongatum Merr.	Sapotaceae	Alakaak-haba (t)
Palaquium gigantifolium Merr.	Sapotaceae	Alakaak (t)
Palaquium globosum H.J.Lam	Sapotaceae	Arabon (t)
Palaquium lanceolatum Blanco	Sapotaceae	Palak-palak (t)
Palaquium luzoniense (Fern.-Vill.) S.Vidal	Sapotaceae	Nato (t)
Palaquium merrillii Dubard	Sapotaceae	Dulitan (t)
Palaquium philippense (Perr.) C.B.Rob.	Sapotaceae	Malak-malak (t)
Palaquium pseudocuneatum H.J.Lam	Sapotaceae	Isabela nato (t)
Palaquium sorsogonense Elmer ex H.J.Lam.	Sapotaceae	Sorsogon nato (t)
Palaquium tenuipetiolatum Merr.	Sapotaceae	Maniknik (t)
Paracroton pendulus (Hassk.) Miq.	Euphorbiaceae	Panantolen (t)
Paraderris luzoniensis Adema	Fabaceae	Paraderis (l)
Pavetta indica L.	Rubiaceae	Gusokan (s)
Phryium fasciculatum (C.Presl) Horan.	Marantaceae	Phryium (h)
Phyllanthus tenuipes C.B.Rob.	Phyllanthaceae	Phyllanthus (s)
Pinanga isabelensis Becc.	Arecaceae	Takon (t)
Pinanga maculata Porte ex Lem.	Arecaceae	Mottled- leaf pinanga (t)
Piper lessertianum (Miq.) C.DC.	Piperaceae	Malapaminta (l)
Planchonella firma (Miq.) Dubard	Sapotaceae	Bagomaho (t)
Planchonella obovata (R.Br.) Pierre	Sapotaceae	Mangkas (t)
Podocarpus neriifolius D.Don	Podocarpaceae	Mala-adelfa (t)
Podocarpus polystachyus R.Br. ex Endl.	Podocarpaceae	Dilang-butiki (t)
Podocarpus rumphii Blume	Podocarpaceae	Malakauayan (t)
Podochilus plumosus Ames	Orchidaceae	Podochilus (eh)
Pothoidium lobbianum Schott	Araceae	Pothoidium (eh)
Pothos inequilaterus (C.Presl) Engl.	Araceae	Pothos (eh)
Pothos scandens L.	Araceae	Pothos (eh)
Pouteria macrantha (Merr.) Baehni	Sapotaceae	White nato (t)
Prismatomeris brachypus Ridl.	Rubiaceae	Malahagpo (s)
Prismatomeris tetrandra (Roxb.) K.Schum.	Rubiaceae	Hagpo (s)
Prunus grisea (Blume) Kalkman	Rosaceae	Lago (t)
Psychotria nitens (Merr.) Merr.	Rubiaceae	Psychotria (s)
Psychotria pilosella Elmer	Rubiaceae	Pasnoban (s)
Pycnarrhena tumefacta Miers.	Menispermaceae	Pycnarrhena (l)
Quassia indica (Gaertn.) Noot.	Simaroubaceae	Manungal (s)
Radermachera coriacea Merr.	Bignoniaceae	Labayanana (t)
Radermachera gigantea (Blume) Miq.	Bignoniaceae	Sayo (t)
Radermachera pinnata (Blanco) Seem.	Bignoniaceae	Banai-banai (t)
Rhaphiolepis philippinensis (S.Vidal) Kalkman	Rosaceae	Marabarani (t)
Rinorea bengalensis (Wall.) Gagnep.	Violaceae	Tuak (s)
Rourea minor (Gaertn.) Alston	Connaraceae	Kamagsa (l)

Species Name	Family Name	Common Name & Habit
Salacia chinensis L.	Celastraceae	Matang-ulang (l)
Semecarpus macrophyllus Merr.	Anacardiaceae	Ligas-laki (t)
Severinia disticha (Blanco) Swingle	Rutaceae	Malarayap (s)
Shorea polysperma (Blanco) Merr.	Dipterocarpaceae	Tangile (t)
Strychnos minor Dennst.	Loganiaceae	Mulawin-baging (l)
Suregada glomerulata (Blume) Baill.	Euphorbiaceae	Malaua (t)
Swintonia acuta Engl.	Anacardiaceae	Kaluis (t)
Syzygium antisepticum (Blume) Merr. & L.M.Perry	Myrtaceae	Marlig (t)
Syzygium arcuatinervium (Merr.) Craven & Biffin	Myrtaceae	Birakbak (t)
Syzygium bataanense (Merr.) Merr.	Myrtaceae	Bataan malaruhat (t)
Syzygium bernardoi (Merr.) Merr.	Myrtaceae	Maramaatam (t)
Syzygium bordenii (Merr.) Merr.	Myrtaceae	Malaruhat-puti (t)
Syzygium brachyurum Merr.	Myrtaceae	Tonau-pugot (s)
Syzygium calubcob (C.B.Rob.) Merr.	Myrtaceae	Kalubkob (s)
Syzygium ciliatosetosum (Merr.) Merr.	Myrtaceae	Lakangan (t)
Syzygium crassipes (C.B.Rob.) Merr.	Myrtaceae	Barukbak (s)
Syzygium curranii (C.B.Rob.) Merr.	Myrtaceae	Curran lipote (t)
Syzygium densinervium (Merr.) Merr.	Myrtaceae	Salakadan (s)
Syzygium everettii (C.B.Rob.) Merr.	Myrtaceae	Malahagnit (s)
Syzygium fastigiatum (Blume) Merr. & L.M.Perry	Myrtaceae	Hahanum (s)
Syzygium grande (Wight) Walp.	Myrtaceae	Midbit-laparan (t)
Syzygium intumescens (C.B.Rob.) Merr.	Myrtaceae	Hagoho (t)
Syzygium isabelense (Quisumb.) Merr.	Myrtaceae	Gubal (t)
Syzygium longissimum (Merr.) Merr.	Myrtaceae	Tual (t)
Syzygium longistylum (Merr.) Merr.	Myrtaceae	Lobagan (t)
Syzygium luzonense (Merr.) Merr.	Myrtaceae	Duktulan (t)
Syzygium mainitense (Elmer) Merr.	Myrtaceae	Malabikuas (t)
Syzygium mananquil (Blanco) Merr.	Myrtaceae	Manangkil (t)
Syzygium nervosum A.Cunn. ex DC.	Myrtaceae	Malaruhat (t)
Syzygium nitidum Benth.	Myrtaceae	Makaasim (t)
Syzygium pallidum Merr.	Myrtaceae	Kauag (t)
Syzygium phanerophlebium (C.B.Rob.) Merr.	Myrtaceae	Malayambu (t)
Syzygium philippinense (C.B.Rob.) Merr.	Myrtaceae	Bagohian (t)
Syzygium polycephaloides (C.B.Rob.) Merr.	Myrtaceae	Lipote (t)
Syzygium ramosii (C.B.Rob.) Merr.	Myrtaceae	Magtalulong (t)
Syzygium robertii (Merr.) Merr.	Myrtaceae	Kiyugkug (t)
Syzygium subrotundifolium (C.B.Rob.) Merr.	Myrtaceae	Kalogkog-dagat (s)
Syzygium tripinnatum (Blanco) Merr.	Myrtaceae	Hagis (s)
Syzygium xanthophyllum (C.B.Rob.) Merr.	Myrtaceae	Malatampui-haba (s)
Tabernaemontana pandacaqui Lam.	Apocynaceae	Pandakaki (s)
Taenitis blechnoides (Willd.) Sw.	Pteridaceae	Taenitis (th)
Tapeinidium acuminatum K.U.Kramer	Lindsaeaceae	Tapeinidium (th)
Teijsmanniodendron ahernianum (Merr.) Bakh.	Lamiaceae	Sasalit/Dangula (t)
Terminalia citrina Roxb. ex Fleming	Combretaceae	Bingas (t)
Terminalia darlingii Merr.	Combretaceae	Malaputat (t)
Terminalia edulis Blanco	Combretaceae	Kalumpit (t)
Terminalia foetidissima Griff.	Combretaceae	Talisai-gubat (t)
Ternstroemia gitingensis Elmer	Pentaphylacaceae	Apin (t)
Ternstroemia philippinensis Merr.	Pentaphylacaceae	Arana (t)
Timonius arboreus Elmer	Rubiaceae	Hambabayud (s)
Timonius oligophlebius Merr.	Rubiaceae	Upong-ilanan (s)
Timonius quinqueflorus Merr.	Rubiaceae	Malabalod (s)
Tinospora glabra (Burm.f.) Merr.	Menispermaceae	Baging (l)
Trigonachras acuta (Hiern) Radlk.	Sapindaceae	Darunga (t)
Trigonostemon aurantiacus (Kurz ex Teijsm. & Binn.) Boerl.	Euphorbiaceae	Trigonostemon (t)
Trigonostemon filiformis Quisumb.	Euphorbiaceae	Katap-himaymay (s)
Trigonostemon hirsutus C.B.Rob.	Euphorbiaceae	Malakokonon (s)
Trigonostemon longipedunculatus (Elmer) Elmer	Euphorbiaceae	Kulis (s)
Trigonostemon longipes (Merr.) Merr.	Euphorbiaceae	Katap (t)

Species Name	Family Name	Common Name & Habit
Tristaniopsis oblongifolia (Merr.) Peter G.Wilson & Waterh.	Myrtaceae	Tigang-haba (t)
Vatica mangachapoi Blanco	Dipterocarpaceae	Narig (t)
Vavaea amicorum Benth.	Meliaceae	Nangka-nangka (t)
Villaria fasciculiflora Quisumb. & Merr.	Rubiaceae	Otto (t)
Xanthophyllum bracteatum Chodat	Polygalaceae	Durog (s)
Xanthophyllum discolor Chodat	Polygalaceae	Kabot (t)
Xanthostemon fruticosus Peter G.Wilson & Co	Myrtaceae	Sierra Madre mangkono (s)
Xylopia dehiscens (Blanco) Merr.	Annonaceae	Sudkad (t)
Xylopia densifolia Elmer	Annonaceae	Tangisang-bagyo (t)

Diversity

Among the 71 families encountered, almost all were represented by angiosperms with only three (3) gymnosperms such as Araucariaceae, Gnetaceae and Podocarpaceae. The angiosperm families having the most number of genera is Rubiaceae (13) followed by Euphorbiaceae (8) and Phyllanthaceae (6). Floristic study in tropical dry forests in the Pacific and other tropical dry forests sites of the world (Gillespie *et al*., 2000; Gillespie *et al*., 2011; Genry, 1995) reveals similar floristic composition with Rubiaceae, Euphorbiaceae and Myrtaceae as the most speciose angiosperm families. The most diverse among the genera with the highest number of taxa was *Syzygium* of the family Myrtaceae with 32 species. Other speciose genera were *Palaquium* (12 spp.), *Garcinia* (9 spp.), *Glochidion* (9 spp.), and *Trigonostemon* (5 spp.).

In terms of species richness, the highest number of taxa was represented by family Myrtaceae with 35 species followed by Rubiaceae (23 spp.), Phyllanthaceae (17 spp.), Sapotaceae (16 spp.), and Euphorbiaceae (14 spp.). Forty-two (42) of the families (59%) were represented by a single genus.

One hundred and twenty-five (125) species or 52 percent of the total number of taxa recorded in this forest type were specialists, 24 of which are threatened species. There was no available data elsewhere in the region to compare ultrabasic forest diversity and this could provide valuable basic information on the different life forms and species of this forest type.

Endemism and Conservation Status

Endemism in the lowland ultrabasic forest was high in NSMNP. Of its total species composition, 107 taxa (40%) were endemic to the Philippines, four (4) of which were found endemic only to Isabela Province while 23 were endemic only to Luzon Island (Table 2). Isabela endemics include *Canthium trichophorum* Quisumb. & Merr. (Rubiaceae), *Cyrtandra disparifolia* Quisumb. (Gesneriaceae), *Pinanga isabelensis* Becc. (Arecaceae) and *Xanthostemon fruticosus* Peter G.Wilson & Co (Myrtaceae). *Xanthostemon fruticosus*, the Sierra Madre Mangkono was recorded only from the Sierra Madre Mountain Range. Most of the endemic species were represented by families Myrtaceae (21), Rubiaceae (15), Sapotaceae (10), Myristicaceae (7), Euphorbiaceae (7), Arecaceae (6), Phyllanthaceae (5) and Annonaceae (4).

Table 2. Endemic taxa in the lowland ultrabasic forest of the Northern Sierra Madre Natural Park.

	Species	
1.	*Alyxia monticola* C.B.Rob.	Other Philippine endemic
2.	*Ampelocissus ochracea* (Teijsm. & Binn.) Merr.	Other Philippine endemic
3.	*Amyema acuta* (Tiegh.) Danser	Other Philippine endemic
4.	*Antirhea caudata* (M.E.Jansen) Chaw	Other Philippine endemic
5.	*Antirhea ramosii* Chaw	Luzon endemic
6.	*Antirhea tayabensis* Chaw	Luzon endemic
7.	*Aporosa symplocifolia* Merr.	Other Philippine endemic
8.	*Archidendron scutiferum* (Blanco) I.C.Nielsen	Other Philippine endemic
9.	*Ardisia alverezii* Merr.	Other Philippine endemic
10.	*Ardisia darlingii* Merr.	Luzon endemic
11.	*Artocarpus rubrovenius* Warb.	Luzon endemic
12.	*Brackenridgea fascicularis* (Blanco) Fern.-Vill.	Other Philippine endemic
13.	*Buxus rolfei* S.Vidal	Other Philippine endemic
14.	*Calophyllum whitfordii* Merr.	Other Philippine endemic

	Species	
15.	*Canarium euryphyllum* var. *europhyllum* Perkins	Other Philippine endemic
16.	*Canarium luzonicum* (Blume) A.Gray	Other Philippine endemic
17.	*Canthium trichophorum* Quisumb. & Merr.	Isabela endemic
18.	*Casearia fuliginosa* (Blanco) Blanco	Other Philippine endemic
19.	*Croton leiophyllus* Müll.Arg.	Other Philippine endemic
20.	*Croton luzoniensis* Müll.Arg.	Luzon endemic
21.	*Croton quisumbingianus* Croizat	Other Philippine endemic
22.	*Cyrtandra disparifolia* Quisumb.	Isabela endemic
23.	*Cyrtandra oblongata* Merr.	Luzon endemic
24.	*Daemonorops mollis* (Blanco) Merr.	Other Philippine endemic
25.	*Daemonorops ochrolepis* Becc.	Other Philippine endemic
26.	*Dasymaschalon clusiflorum* (Merr.) Merr.	Other Philippine endemic
27.	*Dimorphocalyx ixoroides* (C.B.Rob.) Airy Shaw	Other Philippine endemic
28.	*Dinochloa dielsiana* Pilg.	Other Philippine endemic
29.	*Diospyros nitida* Merr.	Other Philippine endemic
30.	*Diplospora fasciculiflora* (Elmer) Elmer	Other Philippine endemic
31.	*Elaeocarpus argenteus* Merr.	Other Philippine endemic
32.	*Elaeocarpus ilocanus* Merr.	Other Philippine endemic
33.	*Elaeocarpus monocera* Cav.	Other Philippine endemic
34.	*Gardenia elata* var. *longipedicellata* K.M.Wong	Luzon endemic
35.	*Glochidion subfalcatum* var. *nitidum* (Merr.) Chakrab. & M.Gangop.	Other Philippine endemic
36.	*Glochidion triandrum* (Blanco) C.B.Rob.	Other Philippine endemic
37.	*Glochidion urophylloides* Elmer	Other Philippine endemic
38.	*Goniothalamus elmeri* Merr.	Other Philippine endemic
39.	*Greeniopsis discolor* Merr.	Luzon endemic
40.	*Greeniopsis multiflora* (Elmer) Merr.	Other Philippine endemic
41.	*Greeniopsis pubescens* Merr.	Luzon endemic
42.	*Guioa bicolor* Merr.	Other Philippine endemic
43.	*Gymnacranthera farquhariana* var. *paniculata* (A.DC.) R.T.A.Schouten	Other Philippine endemic
44.	*Gynochthodes philippinensis* (Elmer) Merr.	Other Philippine endemic
45.	*Heterospathe brevicaulis* Fernando	Luzon endemic
46.	*Heterospathe cagayanensis* Becc.	Luzon endemic
47.	*Horsfieldia costulata* (Miq.) Warb.	Other Philippine endemic
48.	*Ixora crassifolia* Merr.	Other Philippine endemic
49.	*Kibatalia blancoi* (Rolfe ex Stapf) Merr.	Other Philippine endemic
50.	*Knema glomerata* Merr.	Other Philippine endemic
51.	*Knema kunstleri* (King) Warb.	Other Philippine endemic
52.	*Knema ridsdaleana* W.J.de Wilde	Other Philippine endemic
53.	*Knema stellata* Merr.	Other Philippine endemic
54.	*Lagerstroemia paniculata* (Turcz.) S.Vidal	Luzon endemic
55.	*Lithocarpus robinsonii* Rehder	Other Philippine endemic
56.	*Lithocarpus sulitii* Soepadmo	Other Philippine endemic
57.	*Myristica colinridsdalei* W.J.de Wilde	Other Philippine endemic
58.	*Palaquium bataanense* Merr.	Other Philippine endemic
59.	*Palaquium elliptilimbum* Merr.	Other Philippine endemic
60.	*Palaquium elongatum* Merr.	Luzon endemic
61.	*Palaquium gigantifolium* Merr.	Other Philippine endemic
62.	*Palaquium globosum* H.J.Lam	Luzon endemic
63.	*Palaquium lanceolatum* Blanco	Luzon endemic
64.	*Palaquium merrillii* Dubard	Other Philippine endemic
65.	*Palaquium philippense* (Perr.) C.B.Rob.	Other Philippine endemic
66.	*Palaquium sorsogonense* Elmer ex H.J.Lam.	Other Philippine endemic
67.	*Palaquium tenuipetiolatum* Merr.	Luzon endemic
68.	*Phyllanthus tenuipes* C.B.Rob.	Other Philippine endemic
69.	*Pinanga isabelensis* Becc.	Isabela endemic
70.	*Pinanga maculata* Porte ex Lem.	Other Philippine endemic
71.	*Podochilus plumosus* Ames	Other Philippine endemic
72.	*Pothos inequilaterus* (C.Presl) Engl.	Other Philippine endemic
73.	*Psychotria nitens* (Merr.) Merr.	Other Philippine endemic
74.	*Psychotria pilosella* Elmer	Other Philippine endemic
75.	*Shorea polysperma* (Blanco) Merr.	Other Philippine endemic
76.	*Syzygium arcuatinervium* (Merr.) Craven & Biffin	Other Philippine endemic

	Species	
77.	*Syzygium bataanense* (Merr.) Merr.	Other Philippine endemic
78.	*Syzygium bernardoi* (Merr.) Merr.	Other Philippine endemic
79.	*Syzygium bordenii* (Merr.) Merr.	Other Philippine endemic
80.	*Syzygium brachyurum* Merr.	Other Philippine endemic
81.	*Syzygium ciliatosetosum* (Merr.) Merr.	Other Philippine endemic
82.	*Syzygium crassipes* (C.B.Rob.) Merr.	Other Philippine endemic
83.	*Syzygium curranii* (C.B.Rob.) Merr.	Other Philippine endemic
84.	*Syzygium everettii* (C.B.Rob.) Merr.	Other Philippine endemic
85.	*Syzygium luzonense* (Merr.) Merr.	Other Philippine endemic
86.	*Syzygium mainitense* (Elmer) Merr.	Other Philippine endemic
87.	*Syzygium mananquil* (Blanco) Merr.	Other Philippine endemic
88.	*Syzygium pallidum* Merr.	Other Philippine endemic
89.	*Syzygium phanerophlebium* (C.B.Rob.) Merr.	Other Philippine endemic
90.	*Syzygium philippinense* (C.B.Rob.) Merr.	Other Philippine endemic
91.	*Syzygium ramosii* (C.B.Rob.) Merr.	Luzon endemic
92.	*Syzygium robertii* (Merr.) Merr.	Other Philippine endemic
93.	*Syzygium subrotundifolium* (C.B.Rob.) Merr.	Other Philippine endemic
94.	*Syzygium xanthophyllum* (C.B.Rob.) Merr.	Other Philippine endemic
95.	*Terminalia darlingii* Merr.	Luzon endemic
96.	*Timonius oligophlebius* Merr.	Luzon endemic
97.	*Timonius quinqueflorus* Merr.	Luzon endemic
98.	*Trigonostemon filiformis* Quisumb.	Other Philippine endemic
99.	*Trigonostemon hirsutus* C.B.Rob.	Other Philippine endemic
100.	*Trigonostemon longipes* (Merr.) Merr.	Luzon endemic
101.	*Tristaniopsis oblongifolia* (Merr.) Peter G.Wilson & Waterh.	Luzon endemic
102.	*Villaria fasciculiflora* Quisumb. & Merr.	Luzon endemic
103.	*Xanthophyllum bracteatum* Chodat	Other Philippine endemic
104.	*Xanthophyllum discolor* Chodat	Other Philippine endemic
105.	*Xanthostemon fruticosus* Peter G.Wilson & Co	Isabela endemic
106.	*Xylopia dehiscens* (Blanco) Merr.	Other Philippine endemic
107.	*Xylopia densifolia* Elmer	Other Philippine endemic

Assessment of the conservation status of taxa in the protected area is crucial in promoting the conservation of threatened species and provides the foundation for making decisions regarding conserving biodiversity from local to global levels. Table 3 shows the status of the plant species where six (6) are critically endangered as follows: Pangalimanan (*Greeniopsis discolor* Merr.); Ridsdale duguan (*Myristica colinridsdalei* W.J.de Wilde); Ridsdale tambalau (*Knema ridsdaleana* W.J.de Wilde); Paluai-mabolo (*Greeniopsis pubescens* Merr.); Otto (*Villaria fasciculiflora* Quisumb. & Merr.); and Sierra Madre mangkono (*Xanthostemon fruticosus* Peter G.Wilson & Co). On the other hand, four (4) are endangered species as follows: *Heterospathe brevicaulis* Fernando, *Madhuca betis* (Blanco) J.F.Macbr., *Gomphandra coi* Schori and *Terminalia darlingii* Merr.

Table 3. Conservation status of plants in NSMNP's lowland ultrabasic forest.

Species	Conservation status
Agathis philippensis Warb.	Vulnerable
Anisoptera thurifera (Blanco) Blume	Vulnerable
Aquilaria cumingiana (Decne.) Ridl.	Vulnerable
Canarium luzonicum (Blume) A.Gray	Vulnerable
Dimocarpus longan subsp. *malesianus* Leenh.	Near threatened
Diospyros cauliflora Blume	Vulnerable
Diospyros discolor Willd.	Vulnerable
Falcatifolium gruezoi de Laub.	Near threatened
Gardenia elata var. *longipedicellata* K.M.Wong	Vulnerable
Gomphandra coi Schori	Endangered
Gonystylus macrophyllus (Miq.) Airy Shaw	Vulnerable
Greeniopsis discolor Merr.	Critically endangered
Greeniopsis pubescens Merr.	Critically endangered
Guioa bicolor Merr.	Vulnerable
Heterospathe brevicaulis Fernando	Endangered
Heterospathe cagayanensis Becc.	Near threatened
Horsfieldia ardisiifolia (A.DC.) Warb.	Vulnerable
Intsia bijuga (Colebr.) Kuntze	Vulnerable
Intsia palembanica Miq.	Vulnerable
Knema ridsdaleana W.J.de Wilde	Critically endangered

Species	Conservation status
Knema stellata Merr.	Vulnerable
Madhuca betis (Blanco) J.F.Macbr.	Endangered
Myristica colinridsdalei W.J.de Wilde	Critically endangered
Palaquium luzoniense (Fern.-Vill.) S.Vidal	Vulnerable
Palaquium philippense (Perr.) C.B.Rob.	Vulnerable
Pinanga isabelensis Becc.	Near threatened
Pinanga maculata Porte ex Lem.	Near threatened
Podocarpus polystachyus R.Br. ex Endl.	Vulnerable
Podocarpus rumphii Blume	Vulnerable
Prunus grisea (Blume) Kalkman	Vulnerable
Psychotria nitens (Merr.) Merr.	Near threatened
Psychotria pilosella Elmer	Near threatened
Radermachera coriacea Merr.	Vulnerable
Shorea polysperma (Blanco) Merr.	Vulnerable
Syzygium nitidum Benth.	Vulnerable
Terminalia darlingii Merr.	Endangered
Vatica mangachapoi Blanco	Vulnerable
Villaria fasciculiflora Quisumb. & Merr.	Critically endangered
Xanthostemon fruticosus Peter G.Wilson & Co	Critically endangered

Other threatened species categorized as vulnerable (22 species) and near threatened (8 species) include Almaciga (*Agathis philippensis* Warb.); Kaningning (*Guioa bicolor* Merr.); Tapol (*Horsfieldia ardisiifolia* (A.DC.) Warb.); Palawan-ipil (*Intsia palembanica* Miq.); Durugo (*Knema stellata* Merr.); Nato (*Palaquium luzoniense* (Fern.-Vill.) S.Vidal); Dilang-butiki (*Podocarpus polystachyus* R.Br. ex Endl.); Malakauayan (*Podocarpus rumphii* Blume); Lago (*Prunus grisea* (Blume) Kalkman); Labayanana (*Radermachera coriacea* Merr.); Lobagan (*Syzygium longistylum* (Merr.) Merr.); Tigang-haba (*Tristaniopsis oblongifolia* (Merr.) Peter G.Wilson & Waterh.); Lunai (*Dacryodes rostrata* (Blume) H.J.Lam.); Ditan (*Daemonorops ochrolepis* Becc.); Agoho del Monte (*Gymnostoma rumphianum* (Miq.) L.A.S.Johnson); and Bataan tagatoi (*Palaquium bataanense* Merr.). All the above species are heavy metal indicators of the ultrabasic forest.

Threats to NSMNP biodiversity are attributed mainly to anthropogenic activities such as illegal logging, wildlife hunting, forest fire due to slash-and-burn farming, migration, and infrastructure development. The information provided herein is extremely useful to strengthen biodiversity conservation and sustainable use of biological resources in the area. Moreover, it provides a basis for the present botanical knowledge which underpins further studies of the ecology and botany of the region.

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