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Vascular Plants of the Peat Swamp Forest in Caimpugan, Agusan del Sur Province on Mindanao Island, Philippines

LOWELL G. ARIBAL
ORCID No. 0000-0002-8530-3267
ariballowell@yahoo.com.ph
College of Forestry and Environmental Science,
Central Mindanao University,
Musuan, Bukidnon, Mindanao, Philippines

EDWINO S. FERNANDO
ORCID No. 0000-0003-4415-3247
esfernando.orcid@gmail.com
Department of Forest Biological Sciences,
College of Forestry and Natural Resources,
University of the Philippines Los Baños

ABSTRACT

The peat swamp forest is a newly recognized forest formation in the Philippines following its discovery to science in 2005. This paper aimed to present the checklist of plant species in the peat swamp forest of Caimpugan, Agusan del Sur, where such information has been lacking. The checklist was based on the collected specimens during the rapid assessment on November 2010, intensive fieldworks on September 2011 and in the recent site visit on September 2013. One hundred and one (101) species belonging to 56 families and 81 genera were recorded. *Tristaniopsis micrantha* (Merr.) Peter G. Wilson and J.T. Waterh and *Thoracostachyum sumatranum* (Miq.) Kurzare were the most dominant species for trees and understory vegetation, respectively. Four (4) species are considered

threatened such as *Hoya crassicaulis* Elmer ex Kloppenb, *Huperzia squarrosa* (G. Forst.) Trevis., both are endangered while *Asplenium nidus* L. and *Myrmecodia tuberosa* Jack are considered vulnerable. The families with the highest number of taxa observed were Rubiaceae (5 genera, 5 species), Orchidaceae (4 genera, 4 species), Euphorbiaceae (4 genera, 4 species), Lauraceae (3 genera, 4 species), Myrtaceae (2 genera, 6 species), Clusiaceae (2 genera, 5 species), Arecaceae (2 genera, 3 species), Pandanaceae (2 genera, 3 species), Poaceae (2 genera, 3 species), Menispermaceae (2 genera 2 species)and Apocynaceae (1 genus, 4 species). The rank abundance of taxa conforms to the observed percent indigenous and endemism pattern of the country based on the framework for Philippine plant conservation strategy action plan of DENR-PAWB.

Keywords - Species composition, Caimpugan, peat swamp forest, Agusan del Sur

INTRODUCTION

Southeast Asia is among the areas with vast expanse of peatlands. The regional environmental and topographic conditions become ideal for peat to form under a high-precipitation and high-temperature regime (Andriesse 1988).Most of these are located at low altitudes where rain forest vegetation grows on a thick mass of organic matter accumulated over thousands or tens of thousands of years, to form deposits up to 20 m thick (Anderson 1983). Unlike other neighbouring Malesian countries, little has been known about the peatlands and peat swamp forest in the Philippines. Since this forest formation has only recently been discovered, its flora is not yet fully known (Fernando et al. 2008).

The first comprehensive study on the peat swamp forests of Southeast Asia was made by Anderson in 1954 (Simbolon and Mirmanto 2000). The catalogue of the flora of the peat swamp forest in North Kalimantan specifically in Sarawak and Brunei provides remarkable information to the general species composition of Southeast Asian peatlands. Recently, various studies on plant diversity of peat swamp forests have been reported from Malaysia (Suzuki et al. 1996; Ibrahim 1997; Jussof 2007; Hassan et al. 2007), Central Kalimantan (Shepherd et al. 1997; Page et al. 1999; Suzuki et al. 1999; Mirmanto et al. 1999; Simbolon and Mirmanto 2000) and West Kalimantan (Siregar and Sambas 1999), Sumatra (Mogea and Mansur 2000) and South Aceh (Purwaning and Yusuf 2000).

OBJECTIVES OF THE STUDY

The study aimed at to provide a comprehensive list of vascular plant species of the Caimpugan peat swamp forest in Agusan del Sur Province, Mindanao Island and also to determine the species composition including species quantitative measure such as abundance, dominance and importance value.

MATERIALS AND METHODS

Study Site

The study site is located in Caimpugan, San Francisco, Agusan del Sur Province in Mindanao (Fig. 1) with geographic coordinates of 8°22'- 8°27.5' N latitude and 125°45'-125°55.6' E longitude. The peatland is part of the Agusan Marsh Wildlife Sanctuary (AMWS) and among its seven major habitat types (Mallari et al. 2001; CI-DENR PAWB-Haribon 2006). It has an area of about 5,630.31 hectares and spans within the two municipalities of Agusan del Sur *viz.*, San Francisco and Talacogon. Permit to undertake field surveys on the site and to collect voucher specimens of the vascular plants was covered by Wildlife Gratuitous Permit No. R13-2010-002 issued on 02 July 2010 by the Philippine Department of Environment and Natural Resources (DENR) Regional Office in Butuan City.

Vegetation zones

This study follows our earlier classification of the vegetation zones of the Caimpugan peatland recognizing six zones to include the *tall-pole forest*, *intermediate forest*, *sapling-size forest*, *pygmy forest* (in the centre of the peatland), *forest at Kasawangan*, and the *Huperzia-Dicranopteris* plant community.

Data collection

Twelve sampling plots were established across the tall-pole forest to the pygmy forest. The plots in the tall-pole forest to the sapling-size forest were established at 10 m x 20 m dimension. In the pygmy forest, plots were established at 10 m x 10 m dimension due to limited accessibility. Four plots with 10 m x 10 m

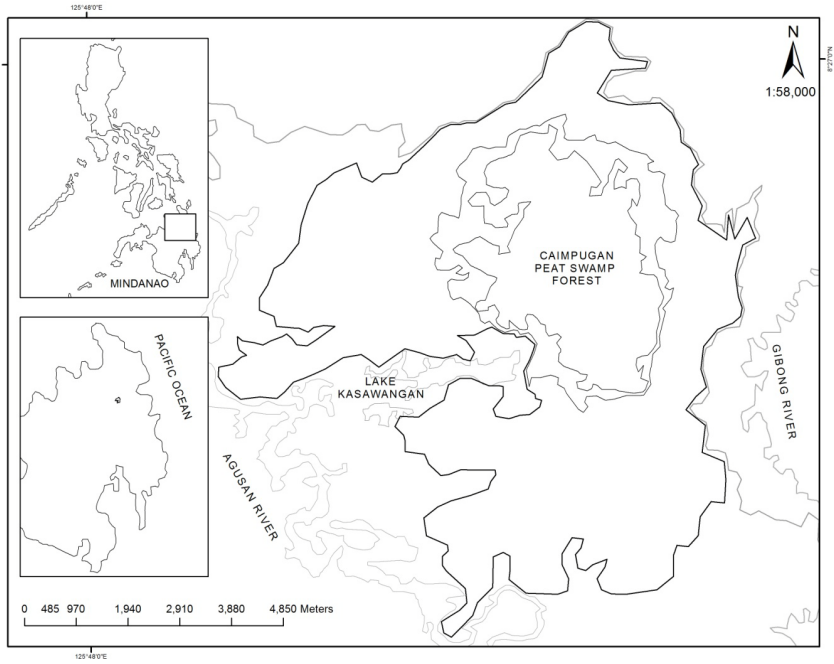

Fig. 1. Map of the study area.

dimension were also established at the forested area of the Lake Kasawangan while a random 'walk-through' method was employed within the vast sedgeland of the lakeshore. Six1 m x 1 m dimensions plots were also established in the two *Hupersia-Dicranopteris* dominated vegetation community. To assess the understory vegetation within plots, three 1 m x 1 m quadrats were randomly established.

All free-standing woody plant species with ≥ 2 cm in diameter at breast height within the plots were measured and recorded. Specimens of leaves, fruits and flowers (if present) were collected for identification and further studies. Similarly, all the understory vegetation *i.e.* herbs, shrubs, orchids, ferns, and mosses within the sampling quadrat was also recorded and collected. The identification of specimen was done with the aid of the type specimen of the National Herbarium and Fernando et al. (2008). The collected specimens were deposited at the Forestry Herbarium (LBC) of the Museum of Natural History of the University of the Philippines - Los Baños. The resulting checklist was generated from the collected specimens.

RESULTS AND DISCUSSION

A total of 101 species belonging to 56 families and 81 genera were recorded for both trees and understory vegetation. There were 3,959 plant life forms accounted belonging to various species of trees, climbers, ferns, grass, herbs, moss, orchids, palms, pandans, sedge, shrubs, and vines. The spiny sedge *Thoracostachyum sumatranum* (Miq.) Kurz. is the most abundant species in terms of the number of individuals with 1723; the highest record was observed in Plot 2 of pygmy forest. Trees were the next most abundant plant life form with 858 records, the highest was observed in Plot 3 of the pygmy forest with 129. Seedlings, vines and grasses follows with 500, 425 237 individuals recorded, respectively (Fig. 2). In general, the tall-pole forest being the most diverse zone contains most of the different plant life forms except grasses and orchids. Grasses were confined only to the two (2) *Hupersia-Dicranopteris* dominated areas and were not observed in the rest of plots. Orchids were observed only in the intermediate forest and in the forest of Kasawangan. Shrubs were found abundantly in *Hupersia-Dicranopteris* dominated areas. Pandans were observed only in the tall-pole and pygmy forest.

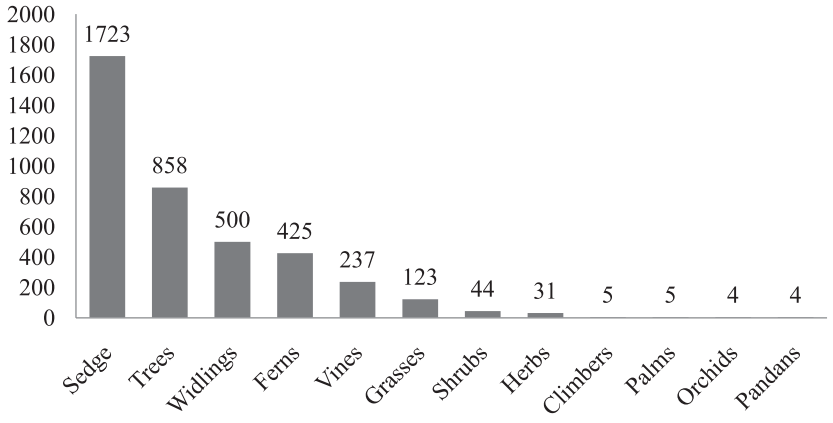

Fig. 2. Rank abundance of the different plant life forms in all the plots studied

In general, the species diversity of Southeast Asian peat swamp forests significantly vary depending on the location and size of the sampling plots. For instance, Page et al. (1999) identified 100 species on the peat swamp forest at the upper catchment of Sungai River Sebangau in Central Kalimantan, Indonesia while Mirmanto (2010) was able to classify 133 plant species belonging to 34 families. Hassan et al. (2007) has recognized 287 species belonging to 52 families in four forest reserves in Pahang, Malaysia. The highest recorded species composition in the peat swamp forest was made by Simbolon and Mirmanto (2000) in the peat swamp forest of Tanjung Puting National Park and at Sebangau River in Central Kalimantan, Indonesia with more than 310 species were identified belonging to 78 families.

The families comprising the tree species of Caimpugan peat swamp forest includes: Myrtaceae, Aquifoliaceae, Clusiaceae, Araliaceae, Gentianaceae, Lauraceae, Symplocaceae, Sapotaceae, Euphorbiaceae, Myrsinaceae, Lamiaceae, Dipterocarpaceae, Juglandiaceae, Rubiaceae, Anacardiaceae, Annonaceae, Fabaceae, Lecythidaceae, Melastomataceae, Putranjivaceae, Sapindaceae, and Theaceae. The rank abundance of taxa conforms to the observed percent indigenous and endemism pattern of the country based on the framework for Philippine plant conservation strategy action plan of DENR-PAWB.

Wyatt-Smith (1959), Morley (1981), Flenley (1985 1998), Bruenig (1990), Ibrahim and Hall (1992), and Shepherd et al. (1997) also enumerated the plant families commonly occurred in peat swamp forest in Southeast Asia which include Anacardiaceae, Annonaceae, Burseraceae, Clusiaceae, Dipterocarpaceae, Euphorbiaceae, Lauraceae, Leguminosae, Myristicaceae, Myrtaceae and Rubiaceae. In Caimpugan peat swamp forest, family Bombacaceae, Burseraceae, and Myristicaceae have no representative species identified. Moreover, Dipterocarpaceae was solely represented by *Vatica odorata* (Griff.) Symington ssp. *mindanensis* Elmer compared to 6 species observed by Page et al. (1999), 4 species by Mogea and Mansur (2000) 12 species by Simbolon and Mirmanto (2000), and 6 species by Siregar and Sambas (2000) from various peat swamp forest in Southeast Asia.

Species dominance in Southeast Asian peat swamp forests also significantly vary. For instance, Mirmanto (2010) identified *Combretocarpus rotundatus* (Miq.) Danser*, Palaquium leiocarpum* Boerl.*, Stemonurus scorpioides* Becc. And *Tristaniopsis whiteana* (Griff.) Peter G. Wilson and J.T. Water has the most dominant species in Sebangau peat swamp forest, Central Kalimantan. Siregar and Sambas (2000) enumerated the most abundant trees such as: *Cyathocalyx*

biovulatus Boerl., *Blumeodendron tokbrai* (Blume) Kurz, *Lithocarpus encleisocarpus* (Korth.) A. Camus, and *Syzygium chloranthum* (Duthie) Merr.andL.M.Perry. The peat swamp forest of Caimpugan however has *Tristaniopsis micrantha* (Merr.) Peter G. Wilson and J.T. Waterh as the most dominant tree species in terms of the number of individuals and abundance which relatively resembles to the peat swamp forest in Sumatra and E. Borneo wherein the genus *Tristaniopsis* has greater dominance according to Whitmore (1984). The same observation made by Polak (1933) in peat swamp forest on the Panch peninsula of Sumatra, the central zone is a low, open woodland dominated by a species of the somewhat confusing genus *Tristania. Tristania* species(most species now in the genus *Tristaniopsis*) also typify locally some central areas of peat swamps in Borneo, but are more generally typical of kerapah forests on deep peat between sea level and 1200 m altitude, examples are the forests in the basins of Pueh Forest Reserve in West Sarawak, of the Bionio river basin and on the Merurong plateau in central Sarawak (Bruenig 1974).

Table 1. Species recorded and their occurrence in the sampling plots. Physiognomy: TPF = Tall-Pole Forest; IF = Intermediate Forest; SF = Sapling-size Forest; PF = Pygmy Forest; KF = Kasawangan Forest; LD = *Hupersia-Dicranopteris* community.

TAXON	PHYSIOGNOMY	VOUCHER
Adiantaceae		
Adiantum caudatum L.	TPF	LGA 093
Adiantum hispidulum Sw.	TPF, SF	LGA 246
Anacardiaceae		
Mangifera caesia Jack	TPF	LGA 082
Annonaceae		
Artabotrys suaveolens Blume	TPF	LGA 070
Platymitra arborea (Blanco) P.J.A. Kessler	TPF	LGA 336
Goniothalamus malayanus Hook. f. and Thomson	TPF	
Apocynaceae		
Hoya siarae Kloppenb.	TPF, IF	LGA 029
Hoya soligamiana Kloppenburg, Siar and Cajano	TPF, IF	LGA 051
Hoya obscura Elmer ex C.M. Burton	TPF	

Hoya crassicaulis Elmer ex Kloppenb.	TPF	LGA 360
Aquifoliaceae		
Ilex cymosa Blume	TPF, IF, SF, PF, KF	LGA 072
Araceae		
Raphidophora philippinensis Engl. and K. Krause	TPF	LGA 037
Araliaceae		
Arthrophyllum ahernianum Merr.	TPF, IF, SF, PF, LD	LGA 126
Schefflera caudata (Vidal) Merr. and Rolfe	IF	LGA 187
Arecaceae		
Calamus ornatus Blume	IF	LGA 087
Calamus multinervis Becc.	IF	
Plectocomia elongata Mart. ex Blume	IF	
Aspleniaceae		
Asplenium cuneatum Lam. var. *obtusilobum* Lam.	TPF	LGA 065
Asplenium nidus L.	TPF	
Blechnaceae		
Stenochlaena palustris (Burm.f.) Bedd.	All vegetation zones	LGA 305
Clusiaceae		
Calophyllum sclerophyllum Vesque	TPF, IF,SF, PF	LGA 183
Garcinia linearifolia Elmer	PF	LGA 290
Garcinia rubra Merr.	TPF	LGA 079
Garcinia vidalii Merr.	TPF, IF, SF, KF	LGA 027
Garcinia sulphurea Elmer	IF, SF, KF	LGA 167
Combretaceae		
Terminalia copelandii Elmer	TPF	
Commelinaceae		
Amischotolype hispida (A.Rich.) D.Y.Hong	TPF	LGA 021
Cyperaceae		
Fimbristylis globolusa (Retz.) Kunth.	KF	LGA 338
Lepironia articulata (Retz.) Domin.	KF	LGA 417
Cyperaceae		
Scleria novae-hollandiae Boeckeler	KF	LGA 419

Scleria scrobiculata Nees and Meyen	KF, LD	LGA 268
Throcastachyum sumastranum (Miq.) Kurz.	All vegetation zones	LGA 181
Dipterocarpaceae		
Vatica odorata (Griff.) Symington var. *mindanaensis*	KF	LGA 355
Eriocaulaceae		
Eriocaulon merrillii Ruhland ex Perkins	KF	LGA 420
Euphorbiaceae		
Cleistanthus myrianthus (Hassk.) Kurz.	TPF	LGA 031
Macaranga tanarius (L.) Muell.-Arg.	TPF	
Omphalea philippinensis Merr.	TPF, IF	LGA 130
Trewia nudifolia Hance	TPF, SF	LGA 176
Fabaceae		
Ormosia calavensis Blanco	KF	LGA 352
Flagellariaceae		
Flagellaria indica L.	TPF, KF	LGA 315
Gentianaceae		
Fagraea racemosa Jack	TPF, SF, PF, LD	LGA 067
Gesneriaceae		
Aeschynanthus copelandii (Merr.) Schltr.	IF	LGA 052
Gleicheniaceae		
Dicranopteris linearis (Burm.f.) Underw.	PF, KF, LD	LGA 379
Hanguanaceae		
Hanguana malayana (Jack) Merr.	SF	LGA 069
Juglandiaceae		
Engelhardtia serrata Blume	TPF, IF	LGA 075
Lamiaceae		
Teijsmanniodendron ahernianum (Merr.) Bakh.	TPF	LGA 003
Lauraceae		
Cinnamomum mindanaense Elmer	TPF, IF, SF, KF	LGA 084
Cryptocarya mindanaensis Elmer	KF	LGA 319
Cryptocarya subvelutina Elmer	TPF, IF	LGA 043
Litsea velutina Merr.	TPF	LGA 351

Lecythidaceae		
Barringtonia acutangula (L.) Gaertn. ssp. *acutangula*	KF	LGA 312
Lomariopsidaceae		
Bolbitis rhizophylla (Kaulf.) Hennipman	TPF, IF, LD	LGA 058
Lycopodiaceae		
Huperzia pinifolia Trevis	LD	LGA 368
Huperzia squarrossa (G. Forst.) Trevis.	IF	LGA 230
Lygodiaceae		
Lygodium microphyllum (Cav.) R.Br.	KF	LGA 339
Melastomataceae		
Medinilla teysmanii Miq.	TPF	LGA 025
Melastoma malabathricum L.	KF, LD	LGA 325
Menispermaceae		
Arcangelisia flava (L.) Merr.	TPF,	LGA 026
Parabaena sp.	TPF	LGA 094
Myrsinaceae		
Ardisia nigro-maculata Merr.	IF, SF	LGA 054
Ardisia squamulosa C. Presl.	TPF, IF, SF	LGA 047
Myrtaceae		
Syzygium blancoi (Merr.) Merr.	KF	LGA 363
Syzygium mananquil (Blanco) Merr.	TPF	
Syzygium tenuirame (Miq.) Merr.	IF, SF, PF, KF, LD	LGA 059
Syzygium sp.	KF	LGA 323
Tristaniopsis micrantha (Merr.) Peter G. Wilson and J.T. Waterh.	TFP, IF, SF, PF	LGA 001
Nepenthaceae		
Nepenthes mirabilis (Lour.) Druce.	IF, SF, PF, KF	LGA 128
Orchidaceae		
Bulbophyllum longipetiolatum Ames	IF	
Dendrobium quisumbingii A.D. Hawkes and A.H. Heller	KF	LGA 328
Eria ventricosa Leav.	KF	LGA 152
Phreatia infundibuliformis Ames	IF	LGA 154

Pandanaceae		
Freycinetia multiflora Merr.	TPF, PF	LGA 036
Pandanus exaltatus Blanco	TPF	
Pandanus sp.	IF	
Phyllanthaceae		
Baccaurea philippinensis (Merr.) Merr.	TPF	LGA 165
Poaceae		
Isachne myosotis Nees	LD	LGA 415
Isachne pulchella Roth ex Roemer andSchultes	LD	LGA 370
Ischaemum digitatum Brongn.	KF	
Polypodiaceae		
Microsorum samarense (J.Sm.) Bosman	TPF, IF	LGA 062
Putranjivaceae		
Drypetes monosperma (Merr.)PaxandK.Hoffm.	TPF	LGA 016
Rhamnaceae		
Alphitonia philippinensis Braid.	LD	LGA 398
Rosaceae		
Rubus mollucanus L.	IF, KF	LGA 350
Rubiaceae		
Hydnophytum mindanaense Elmer	TPF	
Morinda elliptifolia Quisumb. and Merr.	SF	LGA 209
Myrmecodia tuberosa Jack	TPF, IF	LGA 018
Neonauclea calycina Merr.	KF	LGA 317
Psychotria diffusa Merr.	TPF, PF	LGA 013
Rutaceae		
Melicope triphylla (Lam.) Merr.	LD	LGA 394
Sapindaceae		
Ganophyllum falcatum Blume	TPF	
Mischocarpus triqueter Radlk.	TPF	LGA 14
Sapotaceae		
Palaquium tenuipetiolatum Merr.	TPF, IF	LGA 42
Smilacaceae		

Smilax lanceifolia var. *lucida* Merr.	TPF	LGA 094
Sphagnaceae		
Sphagnum sp.	All vegetation zones	LGA 24
Symplocaceae		
Symplocos cochinchinensis (Lour.) S.Moore var. *philippinensis* (Brand) Noot.	KF	LGA 321
Theaceae		
Ternstroemia parviflora Merr.	PF	LGA 275
Ternstroemia philippinensis Merr.	LD	LGA 271
Vittariaceae		
Anthrophyum callifolium Blume	TPF	LGA 095
Urticaceae		
Musanga cecropioides R.Br. ex Tedlie	TPF, LD	
Xyridaceae		
Xyris indica L.	KF	LGA 416

CONCLUSIONS

The checklist of species provided in this paper was based primarily on the series of rapid site assessment and intensive survey within the established plots at the eastern part of the peatland hence, the list could not be final or authoritative.

The Caimpugan peat swamp forest may have low diversity index and few threatened species however, the ecosystem has enable the species to develop adaptive mechanism for survival – a product of long evolutionary process. The specificity of the ecological conditions of peatlands, enable them to host relatively a small number of species, but such species are often very genetically distinctive.

Further, the ecosystem services and irreplaceability of Caimpugan peat swamp forest deserves to be considered as the crucial aspects of conservation rather than on the context of species diversity and endemism.

RECOMMENDATIONS

The Caimpugan peatland spans more than 5,000 hectares, diversity studies should not be confined only to the eastern side of the peatland as this study and others conducted. The Kasawangan forest at the western side of the peatland

for instance has unique species composition which differs from the typical *Tristaniopsis-Calophyllum* association at the eastern part. Hence, an exhaustive floristic inventory on all cardinal direction should also be conducted necessary to account the flora as well as validating the so-called 'concentric zonation' sequence of succession as revealed by Page et al. (1999).

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1. *Hoya crassicaulis* 5. *Amischotolype hispida*

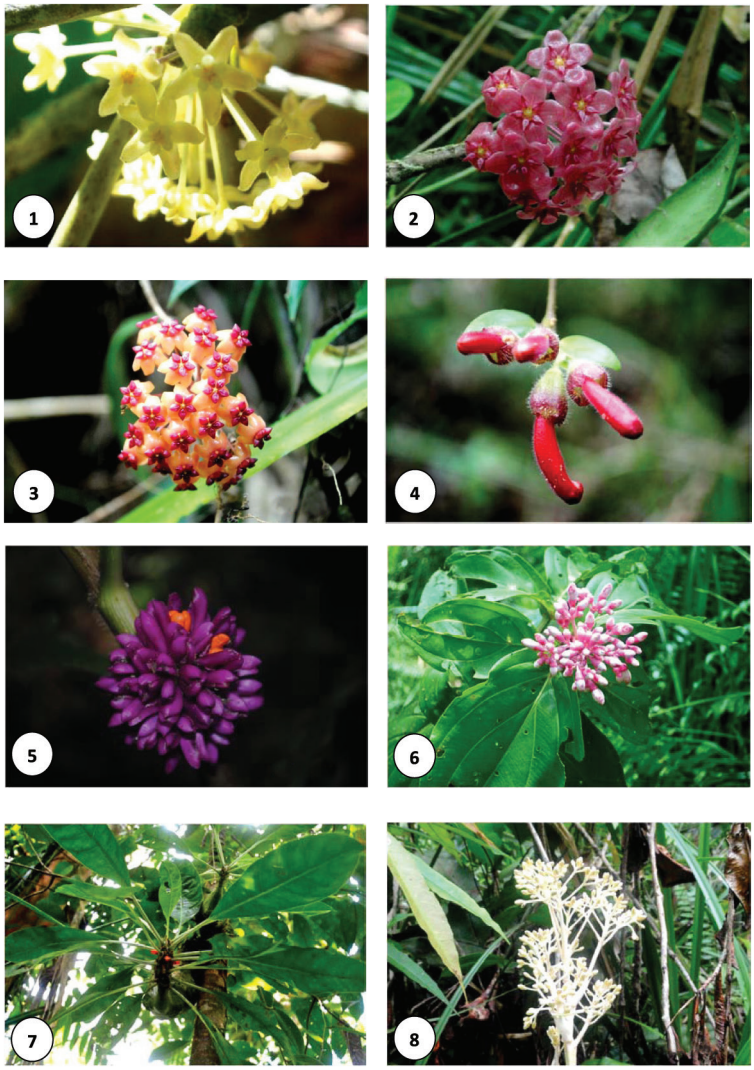

Plate 1. Some species of vascular plants in peat swamp forest in Campungan, Agusan del Sur Province.

2. *Hoya siariae*
3. *Hoya soligamiana*
4. *Aeschynanthus copelandii*
6. *Medinilla teysmanii*
7. *Myrmecodia tuberosa*
8. *Thoracostachyum sumatranum*