

## 1.0 INTRODUCTION

**P**lants are a vital part of the world's biological diversity and an essential resource for the planet. They offer the most diverse uses for local households. They are sources of firewood, herbal medicine, beverages, condiments, resins, food, and light construction materials. Plants or plant parts such as roots, rhizomes, leaves, bark and fruits are collected, prepared and either served as food or administered to treat certain illnesses. Plants or plant parts are also used as ornaments and are basic in landscaping purposes. Economically important ornamental plants, like orchids and ferns provide alternative sources of income to the local people. Ecologically, plants provide oxygen that we breathe, hold water to prevent flooding, release water to prevent drought and serve as sanctuaries for most of the faunal species, among others.

Human pressure on plant resources has led to the depletion of these resources. In recognition of the growing severity of threats to biological diversity, including plants, and the international nature of actions required to address the threats, as well as the need to operationalize the principles of sustainable development in all countries around the globe, the Nations of the world gathered to collectively map out a plan to address the twin goals of environmental preservation and economic development. This historic event, the United Nations Conference for Environment and Development (UNCED) or Earth Summit in June 1992, produced a blueprint for a global agenda known as Agenda 21. In response to UNCED's global call for nations to establish national mechanisms and to formulate and implement their own agenda of actions for sustainable development, the Philippines came up with the Philippine Agenda (PA

21) in 1996. PA 21 adopts a framework that places people and nature at the center of development activities.

UNCED also proved to be a turning point towards the conservation of the world's biological resources as it was also during the UNCED that the nations of the world adopted the Convention on Biological Diversity (CBD). Ratification of the CBD by the Philippine Government was on 08 October 1993. The objectives of this Convention are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits derived from the utilization of genetic resources. Part of the commitments of the Philippine Government to the CBD is the perpetual existence and conservation of plant diversity.

As an urgent response and as a manifestation of its commitment to implement the provisions of the CBD, the Philippines through the Department of Environment and Natural Resources (DENR) developed the National Biodiversity Strategy and Action Plan (NBSAP) in 1997. The NBSAP presented the status of the country's biological diversity and the strategies and actions on the problems, issues and gaps identified on their conservation, sustainable use, and equitable sharing of benefits.

With the emergence of new information, approaches and analyses from various conservation efforts and initiatives, the DENR-Protected Areas and Wildlife Bureau (PAWB), the Conservation International (CI), and the University of the Philippines – Center for Integrative and Development Studies (UP-CIDS), in collaboration with more than 300 individuals from more than 100 local and international institutions, developed the Philippine Biodiversity Conservation Priorities

(PBCP) in 2002. The PBCP, which is an update of the NBSAP, can provide the basis for development programs on biodiversity conservation.

In September 2002, a global review of the implementation of Agenda 21 was held in Johannesburg, South Africa through the World Summit for Sustainable Development (WSSD) where countries reiterated their commitment to work toward addressing biodiversity loss. Among the commitments and actions agreed during the WSSD is the reduction in the current biodiversity loss by 2010 by: (i) effectively promoting the conservation and sustainable use of biodiversity, promoting support initiatives for hot spot areas and other areas essential for biodiversity, and promoting the development of national and regional ecological networks and corridors; (ii) strengthening national, regional and international efforts to control invasive alien species, which are one of the main causes of biodiversity loss, and encouraging the development of effective work program on invasive alien species at all levels; and, (iii) promoting the implementation of the program of work of the Global Taxonomy Initiative (GTI).

Plant conservation was given global emphasis during the CBD – 6<sup>th</sup> Conference of the Parties (CoP) when the CoP adopted the Global Strategy for Plant Conservation (GSPC) (Decision VI/9). The ultimate aim of this global strategy is to halt the current and continuing loss of plant diversity. The CBD-CoP 6 invited Parties and Governments to support the GSPC, develop national targets, and as appropriate, incorporate these targets into relevant plans, programs and initiatives, including national biodiversity strategy and action plans. During the same CoP, the Parties also adopted the GTI (Decision VI/8). This global initiative seeks to provide the key information required for

the CBD, particularly Article 7, on identification and monitoring, through increasing the fundamental biological data essential to underpin the conservation, sustainable use and equitable sharing of the benefits from the utilization of biological diversity. The GTI thus, aims to address the problems of insufficient knowledge of all components of biological diversity (including their classification, description, value of function) and lack of taxonomic capacity, to overcome what has been termed taxonomic impediments in the implementation of the CBD.

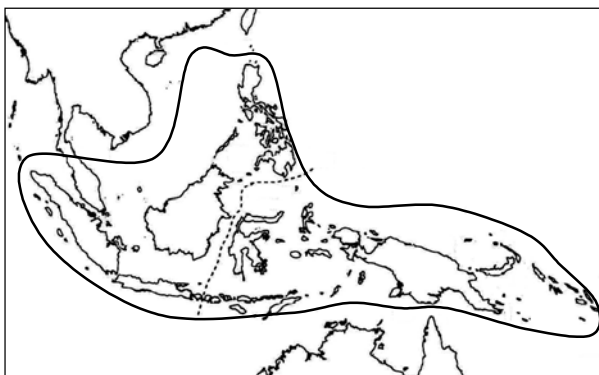
While plant conservation has found a place in the global arena, efforts at the national level appear to be more focused on the conservation of wild fauna. There is no structured project or program on plant resources conservation that is being implemented to date. Although there are several individuals and institutions undertaking certain activities/measures to conserve the Philippine flora, these, however, are fragmented, not properly coordinated with key stakeholders, and not well disseminated. For these reasons and in pursuit of the Philippine Government's commitment to the CBD, the DENR through PAWB proposed the development of a national framework on plant conservation. This proposal met the approval of known plant experts in the country during a meeting held on 28 August 2002.

On 20 January 2003, DENR Secretary Elisea G. Gozun issued Special Order No. 2003-32 formally creating the Philippine Plant Conservation Committee (Annex A). Chaired by the PAWB Director and composed of plant experts in the country, the Committee is tasked primarily to develop the **Philippine Plant Conservation Strategy and Action Plan**.

## 2.0 PLANT DIVERSITY AND CONSERVATION STATUS

### 2.1 Phytogeography

The Philippines is part of a distinct plant geographical region known as Malesia (Figure 1). Together with Malay Peninsula, Sumatra, Borneo and Java, it is part of the sub-floristic province called West Malesia (van Steenis, 1950; Jacobs, 1974). However, East Malesian (Sulawesi, Moluccas, and New Guinea) floristic elements are well-represented in the Philippines, indicating that the archipelago might have been the stepping stones (corridor) through which floristic elements from both sub-provinces are exchanged (Tan & Rojo 1989). The Philippine flora shares uniquely with Sulawesi several plant species reflecting the importance of island arcs as dispersal routes for plants (Merrill 1926; Balgooy 1987; Fernando 1990). Mainland Asiatic elements



**Figure 1.** Map of the plant geographical region of Malesia that includes the Philippines (after Johns 1995).

are present in the Philippine flora which are often associated vegetation found in medium to high elevation mountains mostly confined to Luzon (van Steenis 1950). The Philippine flora also contains an appreciable number of Australian-Papuan elements (van Steenis 1987).

Many palaeogeographic models (e.g. Roeder 1977; Mitchell *et al.* 1986; McCabe *et al.* 1987; Hall 1998) consider the archipelago to

be an assemblage of ophiolite terranes, island-arc, ocean-basin, and continental fragments of different origins and ages. This complex geological history, archipelagic nature, climatic conditions, and topographic features of the Philippines contribute to its present plant diversity pattern.

### 2.2 Diversity

Reports on the estimated number of species for the Philippine flora vary depending on the revisions done for various plant groups. An estimate credits some 12000 species of plants to the Philippines, 8000 of which are phanerogams (Madulid 1985). The total vascular flora, in the absence of a complete and comprehensive revision, is estimated to be at 9000 (Ashton 1997).

The Philippine flora is composed of at least 14000 species, representing five percent of the world's flora (DENR-PAWB, CI, & UP-CIDS 2002; Table 1). There are about 8000+ species of flowering plants or angiosperms, 33 species of gymnosperms, 1100 species of pteridophytes (Barcelona 2002), 1271 species of bryophytes, more than 3555+ species of fungi and molds, about 1355+ species of algae (DENR-UNEP 1997; Villareal & Fernando 1999), and 790 species of lichens (Gruezo 1979). The

**Table 1.** Estimated number of species of plants (including algae and fungi) currently known from the Philippines (data from Gruezo 1979; DENR-UNEP 1997; Villareal & Fernando 2000; Barcelona 2002).

Plant Group	Estimated No. of Species	Endemic Species
Angiosperms	8,120	c. 5,800
Gymnosperms	33	6
Pteridophytes	1,100	285
Bryophytes	1,271	195
Algae	1,355	?
Fungi, slime molds, water molds	3,555	?
Lichens	789	?

angiosperms constitute 22.5% of the Malesian, and 3.8% of the world's vascular flora. Taxonomic revisions and new species discoveries, as well as, geographical range extensions would undoubtedly change the estimates for the species counts. For example 162 of the 242 families of angiosperms and gymnosperms have already been revised in the Flora Malesiana.

In the recent Flora Malesiana revisions are 108 flowering plant families, represented mostly by small to moderate-sized families and a few speciose families such as Ericaceae, Meliaceae, Sapindaceae, Leguminosae (= Fabaceae). Using Merrill's (1926) account of 8210+ seed plant species as basis, it was noted that only 1363 out of 1726 species remain valid after revisions, reflecting a difference of 363. The observed net reduction (due to synonymy, new records, range extensions, etc.) will be modified further as large speciose families are revised. Examples of drastic reduction in number of species attributed to the Philippines include the following: Leeaceae, from 25 to 12 species; Rosaceae, 51 to 41; Meliaceae, 135 to 75 (Mabberley *et al.* 1995); and, Sapindaceae 123 to 63 (Adema *et al.* 1994).

About five to eight percent of the flowering plants, mosses, fungi and lichens, and five

percent of the gymnosperms are believed to be still undescribed (DENR-UNEP 1997). Within the last three years alone, at least seven species from the Philippines have been described as new to science. This include *Homalium palawanense* Regalado *et al.* [Flacourtiaceae] (Regalado *et al.* 2000), *Aeschynanthus madulidii* Mendum [Gesneriaceae] (Mendum 2001), *Heterospatha califrons* Fernando [Arecaceae] (Fernando & Sotalbo 2001), *Rafflesia speciosa* Barcelona & Fernando [Rafflesiaceae] (Barcelona & Fernando 2002), *Vaccinium oscarlopezianum* Co *et al.* [Ericaceae] (Co *et al.* 2002), *Dischidia cleistantha* Livshultz [Apocynaceae] (Livshultz 2003), and *Carruthersia glabra* Middleton [Apocynaceae] (Middleton 2003).

The rate at which new discoveries are increasing should not be underestimated. Even in areas already subjected to logging, such as Surigao in northeastern Mindanao new botanical discoveries are still being made: *Tectaridium madeanii* Copel. (new record for Mindanao of this monotypic Philippine endemic genus), *Lindsaea gueriniana* (Gaud.) Fee (erstwhile Sulawesi endemic), and *Santiria grandifolia* Kalkm. (new to the Philippines, erstwhile Bornean) (Co *et al.* in prep.)

**Table 2.** Genera of flowering plants and ferns endemic to the Philippine Islands; figures in parentheses denote the number of species in the genus (modified after van Steenis 1987; Johns 1995).

<i>Adonidia</i> (Palmae) (1)	<i>Macropodanthus</i> (Orchidaceae) (1)
<i>Amesiella</i> (Orchidaceae) (1)	<i>Merrittia</i> (Compositae) (1)
<i>Antherostele</i> (Rubiaceae) (4)	<i>Phragmorchis</i> (Orchidaceae) (1)
<i>Astrocalyx</i> (Melastomataceae) (2)	<i>Quisumbingia</i> (Asclepiadaceae) (1)
<i>Astrothalamus</i> (Urticaceae) (1)	<i>Reutealis</i> (Euphorbiaceae) (1)
<i>Catrionia</i> (Melastomataceae) (1)	<i>Sulitia</i> (Rubiaceae) (1)
<i>Clemensiella</i> (Asclepiadaceae) (1)	<i>Swinglea</i> (Rutaceae) (1)
<i>Cyne</i> (Loranthaceae) (4)	<i>Thaumasianthes</i> (Loranthaceae) (2)
<i>Dolichostegia</i> (Asclepiadaceae) (1)	<i>Vanoverberghia</i> (Zingiberaceae) (1)
<i>Fenixia</i> (Compositae) (1)	<i>Villaria</i> (Rubiaceae) (5)
<i>Gloeocarpus</i> (Sapindaceae) (1)	<i>Nannothelypteris</i> (Thelypteridaceae) (5)
<i>Gongrospermum</i> (Sapindaceae) (1)	<i>Psomiocarpa</i> (Tectaria Group) (1)
<i>Greeniopsis</i> (Rubiaceae) (6)	<i>Podosorus</i> (Polypodiaceae) (1)
<i>Leptosolena</i> (Zingiberaceae) (1)	<i>Tectaridium</i> (Dryopteridaceae) (1)
<i>Luzonia</i> (Leguminosae) (1)	

### 2.3 Endemism

Twenty-six genera of flowering plants and ferns are endemic to the Philippines (van Steenis 1987; Madulid 1991; Johns 1995; Table 2). Among these are the four genera in Rubiaceae; three each in Asclepiadaceae; two each in Zingiberaceae, and Sapindaceae; and one each in Arecaceae, Asteraceae, Euphorbiaceae, Fabaceae, Rutaceae, Urticaceae, Loranthaceae, and Melastomataceae. There are also four endemic fern genera (*Psomiocarpa*, *Podosorus*, *Tectarium*, and *Nannothelypteris*). Seventeen of these endemic genera are monotypic.

Among flowering plant families, the Orchidaceae, Rubiaceae, Euphorbiaceae, Myrtaceae and Moraceae have the highest number of indigenous and endemic species while Poaceae, Liliaceae, Ulmaceae, Leguminosae, and Rutaceae have lower endemism.

Generally, flowering plant endemism in the Philippines ranges from 45% to 60% (DENR-UNEP 1997, Amoroso 2000; Mittermeier *et al.* 1999). However, species endemism may be as high as 100% in families represented by a single or few genera, as in Rafflesiaceae (3 species, Meijer 1997; Nais 2000; Barcelona & Fernando 2002) and Daphniphyllaceae (3 species, Huang 1997). In certain families and genera endemism reaches 70% to 80% (e.g. Arecaceae, 70%, Fernando 2001; *Vaccinium* (Ericaceae) 93%, Sleumer 1966; *Amyema* (Loranthaceae) 79%, Barlow 1997; *Symplocos* (Symplocaceae), 78%, Nooteboom 1977). Many of these taxa are those especially confined to primary forests (Merrill 1923-26). The Orchidaceae, with more than 900 species and 130 genera, and the largest family of flowering plants in the Philippines, has 74% endemism (Valmayor 1997). Plant families of lower endemism include the Dipterocarpaceae, 47% (Ashton 1982),

Anacardiaceae, 44% (Ding Hou 1978) and Burseraceae, 33% (Leenhouts 1956).

Mitra (1973) reported high endemism (70% to 80%) in the following families (each with no less than 15 genera): Sapindaceae, Meliaceae, Orchidaceae, Rubiaceae, Euphorbiaceae, Asclepiadaceae, Arecaceae, Annonaceae, Zingiberaceae, Sterculiaceae, Melastomataceae, and Verbenaceae. Aside from Sapindaceae and Meliaceae, all the other families above are still being revised in Flora Malesiana. It is worth noting that the percentage endemism of these two families are presently estimated at 30% and 9%, respectively. In a research conducted for the Conservation Priority-Setting Workshop (CPSW) Process (DENR-PAWB, CI, & UP-CIDS 2002), 108 of the 141 families revised in the Flora Malesiana were cross-referenced with the listing in the Merrill's *An Enumeration of Philippine Flowering Plants* (1923-1926). The average rate of change in the number of species per family, resulting from revisions was less than 1%. This validates the estimate of Myers *et al.* (2000) and Madulid (1982) placing the present number of flowering plants at 7500 and 8000 respectively. Earlier estimates placed species endemism at 75% (Merrill 1926; Dickerson 1928; Mitra 1973). The average reduction in the rate of change in endemism resulting from revisions is approximately 35% based on the revised families in Flora Malesiana. Species endemism is placed at approximately 27% (DENR-PAWB, CI, & UP-CIDS 2002), that is close to the 25% estimate of Madulid (1985).

### 2.4 Centers of Plant Diversity and Important Plant Areas

Several areas in the country have been considered Centers of Plant Diversity. The NBSAP adopted the list of 18 sites (Table 3) identified by the Threatened Plants Unit at Kew (Cox 1988) and

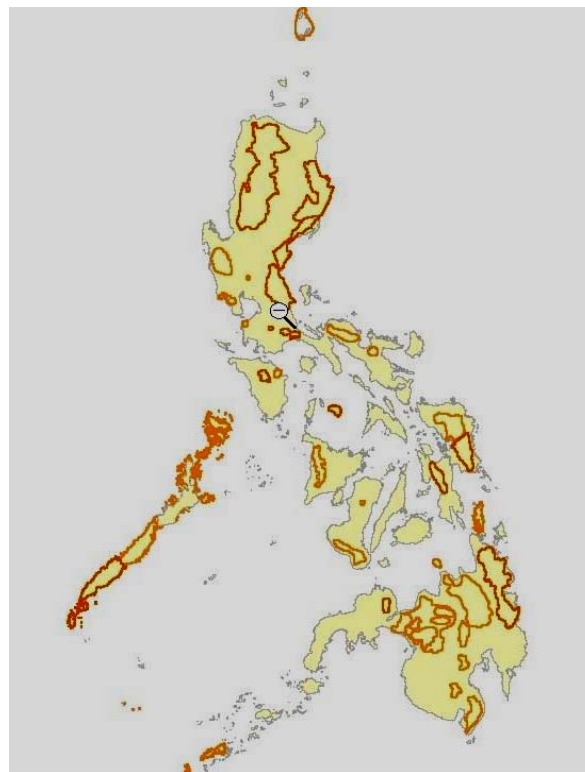
**Table 3.** Centers of plant diversity in the Philippines (after DENR-UNEP 1997).

Name of mountain or area	Location
1 Mt Iraya	Batan Island
2 Sierra Madre Mountains	Isabela Province, Luzon Island
3 Mt Pulag	Cordillera Mountains, Luzon Island
4 Mt Arayat	Pampanga Province, Luzon Island
5 Mt Makiling	Laguna and Batangas Provinces, Luzon Island
6 Lobo	Batangas Province, Luzon Island
7 Mt Isarog	Camarines Sur Province, Luzon Island
8 Mt Halcon	Mindoro Island
9 Coron	Coron Island
10 Palawan	Palawan Island
11 Southern Samar	Samar Island
12 Sibuyan	Sibuyan Island
13 Mt Kanlaon	Negros Island
14 Mt Talinis + Lake Balinsayao	Negros Island
15 Mt Baloy	Panay Island
16 Mt Kitanglad	Mindanao Island
17 Agusan Marsh	Mindanao Island
18 Mt Apo	Mindanao Island

recommended by Madulid (1993) based on the following considerations: (1) the site or vegetation type is species-rich even though the total number of species present therein may not be accurately known; (2) the site or vegetation type is known to harbor a large number of endemic species; (3) the site may harbor a diverse range of habitat or ecosystem types, e.g., terrestrial, aquatic, etc.; and, (4) the site may have a significant number of species adapted to special edaphic conditions, such as ultrabasic formation or limestone formation.

The PBCP, on the other hand, identified 43 priority areas for plant conservation (or important plant areas) (Table 4 and Figure 2; DENR-PAWB, CI, & UP-CIDS 2002) and 19 terrestrial biodiversity corridors based on their biological importance and degree of socio-economic pressure exerted on said areas.

The process in defining the priority sites was consultative in character. The sites were assessed using information from the initial available data, from the results of



**Figure 2.** Priority areas in the Philippines for plant conservation. (DENR-PAWB, CI, & UP-CIDS, 2002).

**Table 4.** Conservation priority areas for plants (Important Plant Areas or Important Plant Sites) (after DENR-PAWB, CI, & UP-CIDS 2002).

Seq. No.	Area No.	Important Plant Area	Island (Province)
1	1	Batanes Islands Protected Landscape & Seascape	Batanes Islands
2	12	Peaks of Central Cordillera (above 1000 masl)	Luzon (Abra, Mt Province, Benguet, Ifugao, and Ilocos Sur Provinces)
3	22	Mt Arayat National Park	Luzon (Tarlac, Pampanga and Nueva Ecija)
4	28	Bataan Natural Park & Subic Bay Forest Reserve	Luzon (Bataan and Zambales)
5	38	Mt Makiling Forest Reserve	Luzon (Batangas and Laguna)
6	41	Mt Palaypalay – Mt Mataas na Gulod National Park	Luzon (Cavite and Batangas)
7	53	Mt Isarog National Park	Luzon (Camarines Sur)
8	63	Mt Halcon	Mindoro (Mindoro Occidental and Mindoro Oriental)
9	64	Naujan Lake National Park	Mindoro (Mindoro Oriental)
10	82	Sibuyan Island	Sibuyan Is. (Romblon)
11	86	Central Panay Mountains: Madjaas-Baloi Complex	Panay (Aklan, Capiz, Antique, and Iloilo)
12	94	Mt Canlaon National Park	Negros (Negros Occidental and Negros Oriental)
13	108	Mt Cabalantian – Mt Capotoan Complex	Samar (Samar, Eastern Samar and Northern Samar)
14	118	Dinagat (Mt Kambinlio & Mt Redondo)	Mindanao (Surigao del Norte)
15	121	Mimbilisan Protected Landscape	Mindanao (Misamis Oriental)
16	125	North Diwata (Bislig, Mt Agtuuganon – Mt Pasian)	Mindanao (Agusan Del Sur, Compostela, Davao Oriental, and Surigao del Sur)
17	127	Mt Kaluayan – Kinabalian (Kimangkil Ridge), Bukidnon – Agusan del Norte border	Mindanao (Misamis Oriental, Bukidnon, Davao, Davao del Sur, Agusan del Norte and Agusan del Sur)
18	129	Mt Kitanglad	Mindanao (Bukidnon)
19	130	Mt Kalatungan Range	Mindanao (Misamis Oriental, Bukidnon, Lanao del Norte and Lanao del Sur)
20	132	Munai Tambo Complex (Kolambugan uplands & associated mountains)	Mindanao (Lanao del Norte and Lanao del Sur)
21	133	Lake Lanao	Mindanao (Lanao del Sur)
22	135	Mt Piagayungan (Ragang) Complex	Mindanao (Bukidnon, North Cotabato, Lanao del Sur and Maguindanao)
23	136	Mt Butig / Lake Butig National Park	Mindanao (Lanao del Sur and Maguindanao)
24	139	Marilog Forest Reserve, Bukidnon – Davao boundary	Mindanao (Davao and Davao del Sur)
25	143	Mt Apo Range	Mindanao (North Cotabato and Davao del Sur)
26	146	Mt Matutum	Mindanao (North Cotabato, Davao del Sur, Sarangani, South Cotabato, and Sultan Kudarat)
27	151	Mt Latian Complex (Sarangani Mountains)	Mindanao (Davao del Sur and Sarangani)
28	153	Mt Malindang & Lake Duminagat	Mindanao (Misamis Occidental and Zamboanga del Norte)
29	216	Isabela – Sierra Madre	Luzon (Isabela)
30	217	Aurora –Sierra Madre	Luzon (Aurora)
31	222	Mt Tapulao	Luzon (Zambales)
32	223	Northern Quezon (Central Sierra Madre)	Luzon (Quezon)
33	226	Southern Quezon (Central Sierra Madre)	Luzon (Quezon)
34	229	Bicol National Park – Mt Labo	Luzon (Camarines Sur)
35	238	Calamianes	Calamian Islands (Palawan)
36	242	Northern Palawan	Palawan
37	244	Central Palawan	Palawan
38	245	Southern Palawan, including Balabac Group of Islands	Palawan
39	256	Cuernos de Negros Region	Negros (Negros Oriental)
40	260	Sohoton – Loquilocon area	Samar (Eastern Samar and Western Samar)
41	263	Mt Pangasugan & Anonang – Lobi Range	Leyte
42	279	Mt Hibok-hibok	Camiguin Island (Misamis Oriental)
43	281	Tawi-tawi	Tawi-tawi



regional consultations, from the overlaying of relevant maps (forest cover, topographic, etc.) and from the existing knowledge of plant experts consulted. The choice of sites was based on representation, habitat importance and ecosystem characteristics of each candidate area. Scoring was made based on evaluation of the status, distribution, richness and endemism of selected plant groups and flagship species.

The identified research gaps in other significant areas prompted the consideration of additional priority sites as well as the adoption of the biodiversity corridor concept. Corridors, large interconnected networks of protected areas and surrounding land, were delineated based on the established priority sites.

## 2.5 Threatened Species

The present state of our knowledge of the Philippine flowering plants is not such that a thorough analysis can be made of how many and what species are extinct, threatened, or near-threatened. Many plant groups are still poorly known. There is very limited knowledge on what plants occur on what island, and in what sorts of habitats. With the extensive devastation of the natural vegetation and habitats, some species previously occurring in certain areas are, almost certainly, now either rare or completely absent. The situation is even more serious for endemic species that are extremely restricted in their geographical range to one or a few localities.

Nevertheless, some listings on endangered Philippine plants have appeared in the past (e.g. Quisumbing 1967; Madulid 1982, 2000; Tan et al. 1986; Gruezo 1990).

Species that have been identified as critically endangered include *Rafflesia manillana* (Rafflesiaceae) (Figure 3), *Tectona*

*philippinensis* (Verbenaceae), and *Pinanga bicolorana* (Arecaceae). *Rafflesia manillana*, although known from three islands including Luzon, has not been seen elsewhere, except on Mt Makiling, Mt Banahaw and Mt Isarog. *Tectona philippinensis* occurs only in two small areas in Lobo and Nasugbu in Batangas Province in southern Luzon, and on Ilin Island off southern Mindoro. The small area near Lobo has been converted into an exotic fruit tree plantation and the remaining individual trees are felled for charcoal production. *Pinanga bicolorana* is known only from the Bicol National Park on Luzon Island. It has been severely threatened by reduction of its natural habitat to a mere 10% of its original size, with the remaining population consisting of not more than



**Figure 3.** *Rafflesia manillana* Teschem., a species endemic to the Philippines and listed as critically endangered. Species of *Rafflesia* are always parasitic on stems or roots certain species of *Tetrastigma* (Vitaceae). Photo E.S. Fernando

100 mature individuals (Fernando & Cereno 2000).

A large number of species are also very rare, occurring only in particular habitats and localities. For example, in the large genus *Medinilla* (Melastomataceae) many of the Philippine endemics (72 out of 80 species in the Philippines) are very local in their distribution (1995). At least four species (e.g. *Medinilla binaria*, *M. apayaoensis*, *M. panayensis*, and *M. tayabensis*) are known only from one or two collections. Of the 127 taxa in



*Psychotria* (Rubiaceae), 30% are known from a single locality, over 70% from 2 or 3, and 40% have not been collected after 1930 (Sohmer 2001). In the Arecaceae, about a dozen endemic species (e.g. *Pinanga samarana*, *Heterospathe dransfieldii*, *Plectocomia elmeri*) are known only from one or two adjacent localities and some have no longer been sighted in their known areas in recent visits and are now believed to be extinct (Fernando 1990, 2001).

The 2004 IUCN (International Union for the Conservation of Nature and Natural Resources now World Conservation Union) Red List of Threatened Species includes 279 species of Philippine plants belonging to 112 genera and 50 families (Annex B). Dipterocarpaceae, Myristicaceae, Euphorbiaceae, Meliaceae, Leguminosae, Sapindaceae, Annonaceae, Apocynaceae, Sapotaceae, Lauraceae, Palmae, and Elaeocarpaceae contain the most number of threatened species in the list. It should be noted that this list is very inadequate and obviously needs some serious reassessment. Many species may, in fact, already be under the critically endangered category. On the other hand, some species included in the list are actually quite common and do not appear to be threatened.

A number of plant species are also being threatened by trade. As of December 2005, species listed under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) include species in Cyatheaceae, Orchidaceae, and Nepenthaceae, *Taxus sumatrana* (Taxaceae); and *Hedygium philippinense* (Zingiberaceae). In the Philippines, these include 41 species under Cyatheaceae; 6 species in Cycadaceae (Figure 4); 143 species in Orchidaceae; 13 species in Nepenthaceae; 2 species of Zingiberaceae; 3 species of Dicksoniaceae; 1 species of Euphorbiaceae; and, 4 species of Thymelaeaceae, (Annex C).



**Figure 4.** *Cycas edentata* de Laub., one of four currently known species endemic to the Philippines. All species of *Cycas* are listed in Appendix II of CITES. Photo E.S. Fernando



**Figure 5.** *Paphiopedilum adductum* Asher is a rare terrestrial, montane species. It is one of about 14 species of *Lady Slipper Orchids* indigenous to the Philippines. All species of *Paphiopedilum* are listed in Appendix I of CITES. Photo E.S. Fernando

exceptional circumstances (e.g., conservation-oriented studies). Presently, all species of Lady's Slipper Orchids of the genus *Paphiopedilum* (Fig. 5) are not allowed for trade, and exportation of these species may only be allowed under exceptional circumstances (e.g. conservation-oriented studies).

## 2.6 Wild Relatives of Crop Plants

Crop diversity – the diversity within and between crops and their wild relatives - is the raw material for breeding new varieties of crops. The use of diversity to produce more productive crops on farm, field experiments, and biotechnology remains one of the best ways of ensuring our food security. Wild relatives of crops in forests and other natural habitats (Table 5) help safeguard the future of a diverse and plentiful food supply. They are an essential source of genes for improving crop production. The loss of wild crop relatives will not only have an impact on the ecosystems where they grow, but will also limit our opportunities for the future.

Based on the most recent inventory of the National Plant Genetic Resources Laboratory (NPGRL) (Villareal & Fernando 2000), the laboratory holds a collection of nearly 400 species of various plants that include cereals, fibers, sugar cane, forage and pasture crops, fruit trees, legumes, nut trees, oil crops, plantation crops, root crops (including yams), small fruits,

**Table 5.** Wild relatives of crop plants and wild food plants indigenous to the Philippines; species marked with asterisks are endemic to the Philippines.

Family	Scientific Name	Edible part
Dioscoreaceae	<i>Dioscorea cumingii</i> *	tubers
	<i>Dioscorea divaricata</i> *	tubers
	<i>Dioscorea elmeri</i> *	tubers
	<i>Dioscorea loheri</i> *	tubers
	<i>Dioscorea luzonensis</i> *	tubers
	<i>Dioscorea merrillii</i> *	tubers
	<i>Dioscorea palawana</i> *	tubers
Sapindaceae	<i>Cubila cubili</i>	seeds
	<i>Nephelium ramboutan-ake</i>	fruit
	<i>Nephelium lappaceum</i>	fruit
	<i>Litchi chinensis</i> subsp. <i>philippinensis</i>	fruit
	<i>Dimocarpus longan</i> subsp. <i>malesianus</i>	fruit
	<i>Glenniea philippinensis</i> *	fruit
Moraceae	<i>Artocarpus altilis</i>	fruit
	<i>Artocarpus blancoi</i>	fruit
	<i>Artocarpus cumingii</i>	fruit
	<i>Artocarpus rubrovenius</i>	fruit
	<i>Artocarpus camansi</i>	fruit
	<i>Artocarpus odoratissimus</i>	fruit
Fagaceae	<i>Castanopsis philippinensis</i>	fruit
Actinidiaceae	<i>Saurauria bontocensis</i> *	fruit
Guttiferae	<i>Garcinia binucao</i>	fruit
	<i>Garcinia dulcis</i>	fruit
	<i>Garcinia vidalii</i> *	fruit
Anacardiaceae	<i>Mangifera odorata</i>	fruit
	<i>Mangifera altissima</i> *	fruit
	<i>Mangifera caesia</i>	fruit
	<i>Mangifera longipes</i>	fruit
	<i>Mangifera monandra</i> *	fruit
	<i>Mangifera merrillii</i> *	fruit
Apocynaceae	<i>Willughbeia sarawacensis</i>	fruit
Dryopteridaceae	<i>Diplazium esculentum</i>	frond
Blechnaceae	<i>Stenochlaena palustris</i>	frond
Pteridaceae	<i>Ceratopteris thalictriodes</i>	frond

vegetables and, about 75% of this collection is of local origin.

### 3.0 PHILIPPINE VEGETATION TYPES

#### 3.1 FOREST VEGETATION

The natural vegetation of the Philippines is generally a mosaic of different kinds of forests (often called formations, Whitmore 1984a) that differ from each other in structure, physiognomy and floristic composition. The primary vegetation may be divided into 12 types following the scheme and nomenclature used by Whitmore (1984a). The forest types described by Whitford (1911) are adapted here with some modifications. These have also recently been reviewed by Tan & Rojo (1988).

Similar formations can be recognized elsewhere in Southeast Asia on the basis of their structure and physiognomy, but the differences in floristic composition can be substantial.

##### 3.1.1 Lowland evergreen rain forest

This is the typical tropical rain forest formation in the Philippine Islands. It includes the *dipterocarp* and the *mixed-dipterocarp forests* described by Ashton (1997). This formation occurs from coastal flats up to c. 900 m elevation and is best developed in areas where rainfall is more or less uniform throughout the year (as in the eastern parts of the archipelago) or where there is only a short dry season. It is characterized by its richness in arborescent flora. The Dipterocarpaceae forms the major component of the forest and its emergents (Figure 6). Whitford (1909) has shown that the relative density of dipterocarps, among trees exceeding 40 cm in diameter, varied from 3% on Mindoro Island to 89% on Negros Island.

Variation generally occurs within the



**Figure 6.** *Shorea palosapis* (Blanco) Merr., a large tree of the Dipterocarpaceae family, reaching to 50 m tall. Dipterocarps are a major component of the lowland evergreen rain forest. Photo M.L. Castillo

tropical lowland evergreen rain forest (Whitmore 1984a). Whitford (1911) recognized sociological units (also termed subtypes or associations) within this formation in the Philippines. These are, however, often not readily distinguishable because of the large number of species concerned and the difficulty of differentiating them in the field. The change from one subtype to another is also usually gradual. The variation appears to be correlated with elevation, topography, soil-water relations and dominant species composition and perhaps even storm frequency (Ashton 1997).

This type of formation, dominant along the eastern parts of the archipelago, is battered yearly by storms coming from the Pacific. Their canopy structure is often greatly modified becoming more diffuse and allowing more light to penetrate the understory. This permits dense growth



of tangles of rattans (calamoid palms) and lianas, epiphytes, herbaceous plants on the forest floor, arecoid tree palms, and seedlings and saplings of the emergents. Ashton (1997) believes that this may explain why the Philippines is unique in Southeast Asia in having extensive dipterocarp forest in which regeneration of intermediate sizes is abundant.

### 3.1.2 *Semi-evergreen rain forest*

This formation includes deciduous trees in a mixture but with a tendency towards gregariousness (Whitmore 1984a). It occurs in areas where there is yearly water stress of some duration and perhaps bounds the zone of monsoon climates. There is, as yet, no exact delimitation of this formation in the islands, but the deciduous Lauan-apitong subtype described by Whitford (1911) probably belongs here, as well as the semi-deciduous forest reported on Palawan Island (Podzorski 1985) and the Subic Bay Forest Reserve in Zambales (Fernando 1997). These forests are characteristically dominated by a single dipterocarp species, *Dipterocarpus grandiflorus* or *Shorea contorta*. The western side of the archipelago, including Palawan and Zambales on Luzon, has a seasonally dry climate characteristic of areas where this formation occurs.

### 3.1.3 *Semi-deciduous forest*

This formation occurs in areas where water availability can be limiting to plants and the forest. They are often on the leeward side of mountains or on dry coastal hills (Ashton 1997). Merritt (1908) described extensive semi-deciduous forests in western Mindoro dominated by *Pterocarpus indicus*, *Intsia bijuga*, *Toona calantas*, *Koordersiodendron pinnatum*, *Pometia pinnata*, *Dipterocarpus validus*, *Bischofia javanica*, and *Alstonia scholaris*.

On the northwestern coastal hills of Luzon and near the east coast of Mindoro this forest is often dominated by *Vitex parviflora* (Maun 1958). Associated species include *Wallaceodendron celebicum*, *Litchi chinensis* ssp. *philippinensis*, *Pterocarpus indicus*, *Intsia bijuga*, *Lagerstroemia pyriformis*, and *Kingiodendron alternifolium*. The trees are usually unbuttressed, low-branching, and form an uneven canopy often less than 30 m tall.

In Palawan patches of this formation is still present in the Irawan valley, Calauag, and south of Roxas (Podzorski 1985). They occur on steep slopes with thin topsoil. Leaf litter is usually scanty, and the forest floor is open. Emergent trees reach 30-35 m tall; lianas are very common; ferns, epiphytes and herbs are rare. The common emergents include *Pterocymbium tinctorium*, *Pterospermum diversifolium*, *Garuga floribunda*, and *Intsia bijuga*.

Very little is known of the floristic diversity and structure of this formation.

### 3.1.4 *Forest over limestone*

This formation occupies low, karst limestone hills, either coastal or bordering large uplifted river valleys, which are mainly composed of crystalline limestone covered by a shallow or very thin soil. It is generally open and its large trees are few and scattered. The intervening spaces are filled with small trees and growth of usually sprawling, climbing and small erect bamboos. With a few exceptions, the dominant trees are short-boled, irregular in form and with wide-spreading crowns. The forest has a deciduous foliage, especially on rough topography in regions where the dry season is pronounced. In aseasonal areas, this forest includes many herbs such as begonias, gesneriads, and other species.

A number of leguminous trees are

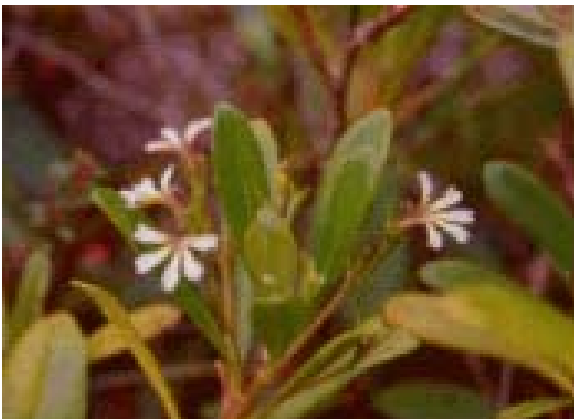
dominant in this formation, viz. *Azelia rhomboidea*, *Sindora spua*, *Intsia bijuga*, *Albizia acle*, *Wallaceodendron celebicum*, *Pterocarpus indicus* and *Kingiodendron alternifolium*. Other dominant species include *Pterocymbium tinctorium*, *Zizyphus talanai*, *Toona calantas*, *Mimusops elengi*, *Maranthes corymbosa*, *Wrightia pubescens* ssp. *laniti*, *Lagerstroemia piriformis*, and *Heritiera sylvatica*, and such smaller trees as *Diospyros ferrea*, *Pterospermum diversifolium*, and *Mallotus floribundus*.

This formation is apparently similar to the so-called Molave (*Vitex parviflora*) forest as described by Whitford (1911) on other substrates.

### 3.1.5 Forest over ultramafic rocks

This formation occurs in soil rich in heavy metals and is generally characterized by a sclerophyllous stunted vegetation with sharp boundaries. In the Philippines it is found on Palawan (Podzorski 1985), eastern Isabela and northern Zambales on Luzon, northeastern and southeastern Mindanao, and on Dinagat Island.

Some of the ultramafic forests on Palawan are only about 2-5 m tall and contain a unique flora including, among others, *Planchonella* sp. and the heavy metal indicators *Scaevola micrantha* (Figure 7), *Brackenridgea palustris* and *Exocarpus*



**Figure 7.** *Scaevola micrantha* Presl., a small tree typical of forests on ultramafic rocks.  
Photo E.S. Fernando

*latifolius* (Podzorski 1985). Other tree species include *Neissosperma glomerata* and species of *Gymnostoma*, *Suregada*, *Archidendron* and *Pouteria*. The Mt Victoria area is the largest region of ultramafic forests on Palawan and is home to the endemic tree *Embolanthera spicata*, one of only two species in the genus (the other being in Indo-China).

The ultramafic forest in northeastern Mindanao are taller reaching 15 to 20 m and include *Tristaniopsis micrantha*, *Sararanga philippinensis*, *Terminalia surigaoensis*, among others. Those on the southeastern peninsula occur at high elevations and are thus considerably shorter, in some areas not reaching even a meter tall and have sometimes been referred to as bonsai forest.

On Dinagat Island and also the northeastern tip of Mindanao and Leyte the ultramafic forest contains the endemic tree *Xanthostemon verdugonianus*.

This formation in the Philippines needs further investigation particularly for its rare and endemic flora.

### 3.1.6 Beach forest

This formation forms a narrow strip of woodland along the sandy and gravelly beaches of the seacoast. Its composition is uniform throughout Malesia and Southeast Asia and most of the representative species are pantropical. Many species have fruits and seeds adapted for water dispersal. The principal species occurring in the Philippine beach forests are: *Terminalia catappa*, *Erythrina orientalis*, *Barringtonia asiatica*, *Thespesia populnea*, *Thespesia populneoides*, *Hibiscus tiliaceus*, *Callophyllum inophyllum*, *Pongamia pinnata*, *Tournefortia argentea*, *Casuarina equisetifolia* and *Scaevola frutescens*.

Locally one or other species may become dominant, but a mixed association is more usual. *Terminalia catappa* may occur in

small patches of pure stands in rich river bottoms. On sandy flood plains near rivers, *Casuarina equisetifolia* usually forms pure stands.

*Dendrolobium umbellatum* and *Pandanus odoratissimus* also occur commonly in the beach forest. On the accreting sand there is usually a narrow strip of herbaceous vegetation dominated by *Ipomoea pes-caprae*.

### 3.1.7 Mangrove forest

This formation occurs along clayish seashores and in the tidal zones in river estuaries. It can be bordered at its inland side by old shorelines of low hills, by tidal fresh-water swamp or more or less sandy transition forest. Along its borders on the lateral side, it merges gradually into the beach formation.

The number of tree species in a mangrove forest is usually limited in the Philippines and elsewhere in Malesia. By far a total of 39 species have been recorded for the Philippines (Fernando & Pancho 1980). The number includes inland marginal species that are usually not abundant. Only about 13 species (in 5 genera and 3



**Figure 8.** *Rhizophora apiculata* Blume, a common tree species in Philippine mangrove forests. Photo E.S. Fernando

families), however, contribute significantly to the floristic composition of the forest. The following are the more common and

abundant: *Rhizophora apiculata* (Figure 8), *Rhizophora mucronata*, *Bruguiera cylindrica*, *Bruguiera gymnorrhiza*, *Bruguiera parviflora*, *Bruguiera sexangula*, *Ceriops decandra*, *Ceriops tagal*, *Avicennia marina*, *Avicennia officinalis*, *Sonneratia alba*, and *Sonneratia caseolaris*.

Species of *Avicennia* and *Sonneratia* occupy the seaward side where the soil is generally mixed with sand or coral limestone. Associated with these species is *Osbornia octodonta*, of Australian affinity, which forms almost pure thickets. *Rhizophora stylosa* also invades sandy shores and coral terraces and does not occur inland.

Species of *Bruguiera* and *Ceriops*, as well as *Lumnitzera littorea*, *Lumnitzera racemosa*, *Aegiceras corniculatum*, *Aegiceras floridum*, *Camptostemon philippinense*, *Scyphiphora hydrophyllacea*, *Excoecaria agallocha*, *Heritiera littoralis*, and *Cerbera manghas* are found on the inner edges of the mangrove formation.

The following species may be rare to frequent and occur along the borders: *Glochidion littoralis*, *Dolichandrone spathacea*, *Barringtonia racemosa*, *Xylocarpus granatum* and *Xylocarpus moluccensis*. In cut-over areas and along the edges, the swamp fern *Acrostichum aureum* and two species of spiny scandent *Acanthus* are prominent.

On the inland edge of the mangrove and the upper tidal limit of estuaries occur extensive pure stands of the distinctive, acaulescent palm *Nypa fruticans*, especially along water courses. This is sometimes referred to as the brackish-water formation but which merges with the mangrove of which it is generally considered a part.

### 3.1.8 Peat swamp forest

This formation occurs in areas where the

water table is higher than the surrounding areas, with the peat often about 50 cm deep, acidic, with a soft-crust over semi-liquid interior with large pieces of wood; the only incoming water is from rain (Whitmore 1984a). The presence of peat swamp forests in southern Philippines has been indicated by Whitmore (1984a). Small patches of this formation have been observed in southern Leyte and there could still be similar areas on Mindanao. In the Philippines, the flora of this formation has never been documented.

### **3.1.9 Fresh-water swamp forest**

This formation is regularly to occasionally inundated with mineral-rich fresh-water from rivers and streams with the water level fluctuating, thus allowing periodic drying of the soil surface. Whitmore (1984b) cited two areas of this formation in the Philippines viz., the middle Agusan valley and west of Pagalungan, both areas on Mindanao. All have now apparently been cleared for rice paddies, human settlements or other uses. There are tiny vestiges of this formation near Tungao, Agusan Province, and also in the Zamboanga Peninsula on Mindanao, in the late 1970s. The floristic composition of this type in the Philippines also has never been studied. The remaining small patches, however, indicate that the palm *Metroxylon sagu* may have been a dominant component and occurred in huge stands. It is likely that this formation was once extensive along the large river systems in the archipelago, particularly in the south.

In the vast drainage system of Agusan and adjacent provinces in Mindanao, the freshwater swamp forest is sometimes dominated by *Terminalia copelandii* and *Nauclea orientalis*. While the floristics of the area indicate that there is a relatively low diversity and endemism of plant species, it is relevant to consider the swamp forest's ecological function. Much

of this land has been converted for agricultural activities. Other co-dominants are *Albizia saponaria* and *Sesbania cannabina*. *Phragmites balatoria*, *Eriochloa procera*, *Scirpodendron ghaeri*, and *Paspalum* spp. are some common sedges and grasses found in the marshland.

### **3.1.10 Lower montane rain forest**

The lower montane rain forest in the Philippines includes the *tanguile-oak* subtype described by Whitford (1911). It occurs at elevations ranging from 400 to 950 m, with the upper limit extending up to 1500 m depending on the height of the mountain. In this formation *Shorea polysperma* is frequently dominant, along with oaks (*Lithocarpus*), oil fruits (*Elaeocarpus*), laurels (*Litsea*) and makaasim (*Syzygium*) (Brown 1919; Ashton 1997). Epiphytic ferns, herbaceous shrubs of Rubiaceae (e.g. *Psychotria*) and Acanthaceae (e.g. *Strobilanthes*) are abundant in the understorey. In gaps and gullies, *Saurauia* and species of Urticaceae can be common, including climbers such as *Freycinetia*.

In the high plateau region of the Cordillera Mountains on Luzon, in a region with a distinct dry season, *Pinus kesiya* occurs in heavily disturbed areas of the lower montane rain forests (Jacobs 1972). This pine species occurs as a fire climax tree in pure stands (pine forest) or often scattered in fire-prone grasslands. On the driest sites in western Mindoro and Luzon (Zambales and Abra Provinces) also occur another pine species, *Pinus merkusii*, in similar grassland habitats. Both *Pinus kesiya* and *Pinus merkusii* have an altitudinal range of usually 500 to 1500 m.

### **3.1.11 Upper montane rain forest**

This formation in the Philippines is commonly called the mossy forest. It occurs on mountains above 1000 m elevation with the upper limits varying depending on the locality and height of the



**Table 6.** Marine plants (seagrasses) in the Philippines (after Fortes 1990).

Family	Species
RUPPIACEAE	<i>Ruppia maritima</i> L.
CYMODOCEACEAE	<i>Cymodocea rotundata</i> (Ehrb. & Hempr.) Aschers. & Schweinf. <i>Cymodocea serrulata</i> (R. Br.) Aschers. & Magnus <i>Halodule pinifolia</i> (Miki) Hartog <i>Halodule uninervis</i> (Forssk.) Aschers. <i>Syringodium isoetifolium</i> (Aschers.) Dandy <i>Thalassodendron ciliatum</i> (Forssk.) Hartog
HYDROCHARITACEAE	<i>Enhalus acoroides</i> (L.f.) Royle <i>Halophila beccarii</i> Aschers. <i>Halophila decipiens</i> Ostenf <i>Halophila ovalis</i> (R. Br.) Hook. f. <i>Halophila ovata</i> Gaudich. <i>Halophila minor</i> (Zoll.) Hartog <i>Halophila minor</i> (a new variety) <i>Halophila spinulosa</i> (R. Br.) Aschers. <i>Thalassia hemprichii</i> (Ehrenb.) Aschers.

mountain. The topography is rough and constantly changing. It consists of steep ridges and canyons. Generally the climatic conditions are exceedingly moist, both as regards rainfall and humidity. Apposed to this is the great exposure to winds. Hence, the mossy condition and dwarfed, crooked trees is characteristic of this formation. Many trees seldom reach 20 m tall. The trunks and branches of trees are generally covered with mosses, liverworts, ferns and other epiphytes. The open places are occupied by ferns and grasses.

The floristic composition is relatively complex, but less so than the formations at lower elevations. The typical trees in this formation are conifers of the genera *Dacrydium*, *Dacrycarpus*, and *Podocarpus*, as well as, broadleaf genera such as *Lithocarpus*, *Symplocos*, *Engelhardtia*, *Syzygium* and *Myrica*. Species of Ericaceae (*Rhododendron*, *Vaccinium* and *Diplycosia*) and Melastomataceae (*Astronia*, *Medinilla*, and *Melastoma*) are common, as is the tree fern genus *Cyathea*.

### 3.1.12 Subalpine forest

In the Philippines this formation is best known on the Mt Halcon-Mt Sialdang range (2470-2587 in alt) on Mindoro Island. The vegetation is generally regarded as open shrub heaths, mainly characterized by the dominance of small, woody dicots with microphyllous-sclerophyllous leaves, forming a low, dense canopy (Merrill 1907, Mandia 2001). The soil is shallow, acidic, and nutrient poor. Many of the genera are mainly temperate in distribution (microtherms). This formation differs from the summit vegetation of the other high mountains where grasses and sedges dominate with few herbaceous elements. Certain areas on Mt Pulag (Jacobs 1974), Mt Mantalingahan and Mt Kinasalapi may have elements of a subalpine forest.

Some of the more common woody dicots on the Mt Sialdang subalpine rain forest include *Styphelia suaveolens*, *Rhododendron quadrasianum*, *Vaccinium myrtoides*, *Myrica javanica*, *Leptospermum flavescens*, and *Eurya coriacea* (Mandia 2001). This assemblage of

plants fits well with the subalpine formation on the rocky summits of Mt Kinabalu (4101 m alt., Borneo) and Mt Kerinci (3800 alt., Sumatra).

### 3.2 INLAND WATERS VEGETATION

The inland wetland ecosystems of the country include, among others, 211 lakes, 18 major rivers and 22 marshes and swamps. In general, the vegetation may be subdivided into lacustrine (lake), palustrine (marsh), and riverine types. A previous aggregate tally of plant species attributable to this type of ecosystem has identified 439 species of macrophytes (431 angiosperms, 7 pteridophytes, and 1 bryophyte) (DENR UNEP 1997).

#### 3.2.1 Lakes

In general, lake vegetation has very low diversity of vascular plants, usually consisting of taxa that often have very wide distribution range. The dominant herbaceous vegetation are sedges and grasses with the latter confined to lakeshores.

In lowland lakes, the submerged plants include *Vallisneria gigantea*, *Hydrilla verticillata*, *Ottelia alismoides*, and *Ceratophyllum demersum*. The floating species are *Nelumbo nucifera*, *Pistia stratiotes*, and *Eichhornia crassipes*. Along the lakeshore, the common plants are species of Poaceae (*Hymenachne amplexicaulis*, *Arundo donax*, *Phragmites vallatoria*, and *Pseudorhaphis squarrosa*), Cyperaceae (*Scirpus grossus*, *Cyperus* spp., and *Fimbristylis* spp.), Fabaceae (*Sesbania cannabina*), and Sterculiaceae (*Pentapetes phoenicea*).

Though species-poor like the lowland counterparts, the upland lakes may harbor certain plant species with very interesting

distribution (e.g. disjunct) pattern. This is especially true in lakes that are geologically old. Examples are *Blyxa novoguineensis* (Hydrocharitaceae), a submerged aquatic plant originally known from alpine lakes in New Guinea and discovered in one of the Mt Tabayoc lakes (approx. 2400m asl) in 1972 (Jacobs 1972), and *Isoetes philippinensis* (Isoetaceae), also a submerged plant and the only known quillwort from the Philippines discovered from a clear pool in Lanao del Norte (approx. 500m asl) (Merrill & Perry 1940, Alston 1959).

Lowland forests adjoining lowland lakes have practically been converted to other land-uses. No documentation is extant on the nature of its original vegetation aside from sporadic comments of Elmer in Lake Mainit in Agusan del Norte and Surigao del Norte border).

Residual forest near Lake Naujan is dominated by bangkal, *Nauclea orientalis* and some *Pandanus* spp., and *Scirpodendron ghaeri*. In Lake Manguao, in northern Palawan, the aquatic plant community is dominated by species of *Ceratophyllum*, *Nitella*, and *Nymphaea* growing together near the lakeshore (Podzorski 1984). *Ischaemum glaucescens* and *Pseudorhaphis spinescens* also grow in the lake margin and water.

#### 3.2.2 Rivers and Creeks

Rivers and creeks are considered forest internal borders, traversing all vegetation types in forested areas. The gallery forest and partial clearing they create, form an exclusive biotope. In Peninsular Malaysia, Corner (1940) described three (3) categories of riverine vegetation named according to its dominant constituent. Unfortunately, aside from streams influenced by tidal fluctuations (i.e. *Nypa*-dominated tidal streams), no similar categorization exists for the Philippines.

Special mention must be made to a peculiar riverine vegetation type in short-coursed, swift-flowing rivers and streams subjected to periodic flash-floods. These are referred to as *rheophytes* (river plants) or *stenophyllous* (narrow-leaved) vegetation typified by common *Homonoia riparia* (Euphorbiaceae). The preponderance of narrow leaves is part of an adaptive morphological modification to flash floodings, a sort of aerodynamic trimming designed to reduce drag and resistance to swift currents. In addition, they have strong, tough branches, as well as, a well-developed taproot system that serves as strong anchor. They occupy a variety of niches such as cascades and rapids, gorges, riverbeds of rock boulders, gravel, pebbles, sandbars, banks and sand-submerged bottoms. How their seedlings establish themselves is not yet known.

While rheophyte communities are found in most parts of the world (excepting cold regions and truly oceanic islands), it is the Indo-Malesian region where they are most strongly represented. Van Steenis (1981) listed c. 400 species (in 67 families) of rheophytes worldwide. Borneo tops the list with 82 species, while the Philippines comes fourth with 26 species. *Myrmeconuclea* (Rubiaceae), an ant-plant genus with several species in Borneo and Palawan is restricted to this habitat. *Ficus rivularis* (Moraceae), *Ligustrum stenophyllum* (Oleaceae), *Dorystephania luzoniensis* (Asclepiadaceae), *Aglaia angustifolia* (Meliaceae), *Desmodium unifoliolatum* (Fabaceae) are some examples of narrow endemics occurring in this habitat.

Well-developed expressions of this rheophyte vegetation type in the Philippines may be observed in the Sierra Madre Mountain Range, upper reaches of the Apayao River, and possibly other regions of the Philippines, especially along the eastern part.

### 3.3 MARINE VEGETATION

Seagrass beds are discrete communities dominated by flowering plants with roots and rhizomes (underground stems) that grow best near estuaries and lagoons in the Philippines. They are often associated with mangrove forests and coral reefs, often forming the ecotone between these two divergent ecosystems (Fortes, 1995). The seagrass meadows support a rich diversity of species from adjacent systems and provide primary refugia for both economically and ecologically important organisms. The plants are sensitive to fluctuations because species coming from their neighboring systems encounter "marginal conditions" and are at the extremes of their tolerance levels to environmental alterations which make them useful indicators of changes not easily observable in either coral reef or mangrove forest.

Southeast Asia, with its extensive combined coastline of more than 120,000 km, is the second most diverse area, next only to Australia, in relation to seagrasses, with the Philippines, Indonesia, and Vietnam contributing the greatest number of species in the region (19 or about 55%). So far 16 species of seagrasses have been identified in Philippine waters (Fortes 1990) (Table 6). Coral reefs with their associated seagrasses potentially could supply more than 20% of the fish catch in the country (McManus 1998).

From ocular surveys, the Philippines has sizeable seagrass areas spread discontinuously along the shallow portions of its coastlines. The number of species present appears to be largely a function of the extent of the studies made, the length of the coastline, and the emphasis countries give on the habitats. A total of 978 km<sup>2</sup> of seagrass beds have been measured from 96 sites. The areas of seagrasses reported are estimates from

selected study sites, not reflecting the area for the country.

### 3.4 GRASSLAND ECOSYSTEM

#### 3.4.1 Lowland Grassland

Large areas of Philippine grasslands on the plains and hills are covered mainly with cogon (*Imperata cylindrica*) and talahib (*Saccharum spontaneum*). Of these two, the more aggressive is cogon, a vigorous and fast-growing grass. Talahib is a much taller and coarser species, with clumping habit. In both species, the reproductive structures, light and feathery fruit, are perfectly adapted to wind dispersal. They also spread vegetatively by means of underground, lateral stems (rhizomes). The rhizomes are deep-seated so that they are not easily affected by fire when the aerial parts of the plants are burned. Cogon is usually found in clay soil, while talahib is more often found in sandy or gravelly soils.

The open and water-logged lowland areas are easily invaded by tambo (*Phragmites vallatoria*), a hardy grass reed which usually forms pure stands.

#### 3.4.2 Montane Grassland

In the pine region of central and northern Luzon, other species of grass take the place of cogon and talahib. Punaw (*Themeda australis*) a low, perennial grass is usually associated with bilaw (*Miscanthus sinensis*), a coarse, perennial grass. Both species are resistant to fire.

The summit area of Mt Pulag from about 2750 m upwards is where one might expect to find a true montane forest. This area is made up of several square kilometers of open tussock grassland.

Opinion has been expressed, especially by those who have regarded the mossy oak forest as being montane, that these grasslands represent alpine grasslands above the tree limits. However, this is doubtful as the tree limits in Southeast Asia and the tropics generally is at much higher altitudes. On Mt Kinabalu in Borneo the tree limit is not reached until 3650m.

The Mt Pulag grassland appears to be merely an upland extension of the mid-mountain grasslands. Certainly it is dominated by dwarfed bilaw (*Miscanthus*), associated with the grasses *Deyeuxia stenophylla*, *Anthoxanthum*, *Microlaena*, *Deschampsia flexuosa*, *Isachne*, and *Danthonia oreoboloides*, as well as, a dwarf bamboo, *Yushania nitakayamensis*.

True alpine herbs are lacking although such plant species as *Hypericum pulagensis* (a local endemic), *Euphrasia borneensis*, *Ranunculus philippinensis* (a Philippine endemic), *Haloraghis micrantha*, *Gentiana* spp. and *Anaphalis* suggest a subalpine habitat.

### 3.5 SECONDARY VEGETATION

A large percentage of the total area of the Philippines is now occupied by regrowth. Together with cogon grasslands, secondary vegetation or *parang* (Whitford 1906; Brown 1919; Richards 1952) form one of the country's most characteristic and extensive vegetation types. It results from man's activities. It consists predominantly of *Imperata cylindrica* and *Saccharum spontaneum*. In the lowlands, trees include fast-growing representatives of families such as Euphorbiaceae (*Macaranga*), Urticaceae (*Pipturus*) and *Trema* (Celtidaceae). In the Zambales-Bataan area, thick clumps of the bamboo *Schizostachyum lumampao* are also common in this type of vegetation. On

some very steep slopes may occur individuals of *Cycas riuminiana*.

Although logging is now extending the areas of this vegetation type, the system of shifting agriculture known as *kaingin* farming contributes to a significant extent. The virgin forest is first felled in small plots and planted with various crops for two or three years. The patch is then abandoned to revert to secondary tree growth while



**Figure 9.** *Melanolepis multiglandulosa* (Reinw. ex Blume) Reichb. f. & Zoll., a small tree common as a pioneer species in secondary vegetation. Photo E.S. Fernando

a new plot is opened up. If the cycle is repeated over the same area the succeeding regrowth phases become more and more scrubby. If fire is introduced, the area is taken over by grasses particularly the cogon grass. As the grasses can survive burning through their underground rhizomes while the tree seedlings are killed, grasses become stabilized and tree regrowth becomes more and more difficult. In the early phases and in the absence of further interference however, the forest regenerates. A dense mass of pioneer softwood trees take over, such as *Ficus*, *Pipturus*, *Antidesma*, *Melanolepis* (Figure 9), *Melochia*, *Macaranga*, *Mallotus*, *Alstonia*, *Trema*, *Artocarpus* and *Homalanthus*. In time the primary forest species appear and the regrowth becomes secondary forest.



**Figure 10.** Conversion of habitats to *kaingin* or slash-and-burn farming remains a serious threat to Philippine plants. Photo E.S. Fernando

In most areas, cogon grass, the tall wild sugarcane (*Saccharum spontaneum*) and other grasses form the dominant cover. *Phragmites vallatoria* (tambo) is found in wet to swampy situations.

## 4.0 THREATS TO PHILIPPINE PLANTS

### 4.1 Land Conversion and Habitat Degradation

The decline in the quality and quantity of the country's biodiversity is largely due to the land conversion and degradation of the habitats (Figure 10). Generally, land conversion for settlement and agricultural development, *kaingin* or slash-and-burn farming, logging, forest fire, chemical pollution, and to some extent, mining, energy projects and pest and diseases have been the causes of habitat destruction.

Mangrove areas, for example, have been converted into fishponds for the cultivation of commercially important aquatic organisms (Zamora 1995), such as milkfish (*Chanos chanos*) and prawn (*Penaeus monodon*) (Davis et al. 1990). Portions of Candaba Swamp, Manlubas Swamp, Agusan Marsh, Leyte Sab-a Basin, and Naujan Lake, among other wetland areas, have been converted into aquaculture ponds. This endangers the flora and faunal species in these areas.

Previous agricultural lands, on the other hand, have been converted into other uses. A total of 109,000 hectares of irrigated lands has, over time, been converted into industrial, commercial and residential uses. This in turn resulted to the conversion of secondary forests and grasslands into agricultural lands. Previous lowland communities were also pushed into the uplands by these developments resulting to the conversion of certain secondary forests and grasslands into human settlement areas and agricultural sites. Mt Data and other areas within the Cordillera and Mt Province are now vegetable production sites.

Seagrasses in the Philippines are under threat from loss of mangroves and coral reefs, the former acting as a filter for sediment from land, coastal development, urban expansion and dredging (Leon *et al.* 1990), the latter, serving as buffer against waves and storm surges. Other impacts include, substrate disturbance, industrial and agricultural runoff, industrial wastes and sewage discharges. In the last 50 years, between 30 and 50% of seagrass beds were lost. This is the result of industrial development, ports and recreation (Fortes 1994).

#### **4.2 Logging**

Logging, both legal and illegal, though confined to forest-rich regions, poses the most serious threat to forest biodiversity. The demand for livelihood opportunities of the increasing upland and rural population and continued operations in forest concessions altogether deplete the forest cover to a considerably vast extent. This is the common scenario in many parts of the country today. The Forest Management Bureau (1993) estimates that about 100,000 hectares of watersheds need immediate rehabilitation. Only a few areas like Palawan, Samar, and Agusan have some remaining virgin forests.

#### **4.3 Kaingin**

Kaingin activities practiced by uplanders and displaced logging workers also deplete and degrade forest habitats to a considerable extent. These people cut and burn stands of forests or burn logged forest remnants to grow cash crops such as rice, corn and vegetables. These plots are abandoned after a year or two when the soil is no longer fertile or suitable for agriculture. Because of nutrient depletion and lack of shade, the *kaingin* areas take many years before they can regenerate, if they regenerate at all.

#### **4.4 Forest fires**

Natural forest fires are common in dry montane forests, pine forests, and forests interspersed with grassland. Fires commonly occur during the dry season when the forest litter easily ignites spontaneously with high temperature. As a result, forestlands are transformed into grasslands that today form a dominant lineament in the landscape. With the *El Nino* phenomenon recurring almost annually, many of the burnt forests cannot regenerate to their original state. The forests of the Sierra Madre, Cordillera, Caraballo, Mindoro, Palawan, and Mt Malindang, Mt Kitanglad and Mt Apo in Mindanao, have been severely affected by forest fires.

#### **4.5 Pollution**

Pollution, in particular chemical pollution, is recognized around the world as one of the major reasons for the escalating loss of biodiversity. Philippine wetlands and marine waters suffer from pollution due to sewage and industrial effluents from urban areas (e.g. Manila Bay and Pasig River), tailings from mining activities (e.g. Calancan Bay in Marinduque), oil spills from shipping operations (e.g. major ports and harbors around the country), agricultural run-off

carrying fertilizers and pesticide residues (e.g. lakes, estuaries, etc.), hazardous wastes (e.g. industrial effluents along major rivers and on estuaries), and siltation as a result of erosion from watersheds (e.g. all denuded watershed areas).

Several wetlands are now considered highly polluted like Laguna Lake, Lake Lanao, Lake Mainit, Lake Leonard, Lake Wood, Lake Pinamlog, Pasig River, Agno River, Pampanga River, Agusan River, Agus River, Manila Bay, Maribojoc Bay, Bislig Bay, Panguil Bay, Puerto Princesa Bay, Honda Bay, and Ulugan Bay (Zafaralla *et al.* 1995). Presumably, many endemic species are affected by the stressed condition of ecosystems arising from chemical pollution.

#### 4.6 Pests and Diseases

Forest plantations have decreased their production because of pests and diseases which plague the trees, e.g., gall disease of *Paraserianthes falcataria*, varicose borer of *Eucalyptus deglupta*, plant lice or psyllids of *Leucaena leucocephala*, bark and shoot borers of *Pinus* species, and shoot borer of *Swietenia macrophylla*. The pine bark beetle, *viz.*, *Ips calligraphus* has attacked natural stands of pine trees in Baguio City and neighboring areas since 1959. The borer infestation reached an epidemic scale during the period 1959-1979 resulting in the death of affected trees in about 81,200 hectares of pine forest, leaving behind large denuded patches in Northern Luzon (Veracion 1978). Mangroves have been infested by barnacles (*Pollicipes mitella*, *Octolasmis cor*, *Chtamalus caudatus*) (Rosell 1986), borer (*Poecilypis falax*) and tussock moth (*Euproctis sp.*) (Sinohin & Flores 1993; see also Melana & Mapalo 1995). For dipterocarps, some of the common fungi causing decay are *Fomes luzoniensis*, *F. semitostus*, *F. merrillii*, *F. applanatus*, *F. pachyphloeus*, *Polyporus semitostus*, *Pyrolyporus merrillii*, *Elvingia*

*elmeri*, *E. fullageri*, and *Ganoderma elmeri*.

#### 4.7 Invasive Species

More than 475 plant species have been introduced into the Philippines during pre-historic times mainly from the Malayan region but a high percentage have been introduced within the past 400 years, including a great number of American origin (Merrill 1912). About 225 species are found only in cultivation for food and were not reported to cause economic or environmental harm. Alien species were introduced for economic reasons until they were observed and reported to have become invasive and have caused economic losses and environmental damage. Biosafety measures and environmental impacts were not considered before their introduction. Exotic ornamental plants, largely orchids, have been introduced into the country and many are used as parental stocks for orchid breeding. One threat is genetic dilution of native and endemic orchid species as well as the introduction of pathogens that could cause large-scale epidemics. In recent years, exotic species monocultures have been plagued with pests and diseases.

Among the invasive species introduced into the country are *Chromolaena odorata* (hagonoy weed), *Lantana camara* (largeleaf lantana), *Mikania cordata* (Chinese creeper), *Salvinia molesta* (waterfern), and *Eichhornia crassipes* (water hyacinth).

#### 4.8 Over-exploitation

Many forest species are of ornamental value and are much sought after by local and international traders. Among the highly prized ornamental plants are the jade vine (*Strongylodon macrobotrys*), giant staghorn fern (*Platynerium grande*), waling-waling (*Eunanthe sandariana*), and many tree fern species like *Cyathea spp.* and



*Cibotium spp.* Tree fern trunks are used as substitute for driftwood and serve as attractive substrate for growing orchids. Thus, tree fern trunks are over-collected in response to the high demand of the orchid industry. Non-timber forest products like resin and rattans are over harvested, thus decreasing the natural population to very low levels. At present, the populations of almaciga (*Agathis philippinensis*) and rattans (species of *Calamus* and *Daemonorops*) are threatened. Overexploitation of commercial timber species (e.g. dipterocarps, kamagong, mabolo, and narra) for the furniture industry and mangrove timber for fuelwood also remains a major concern in the country.

## 5.0 PAST AND PRESENT CONSERVATION INITIATIVES

### 5.1 In-Situ Conservation

*In-situ* conservation involves the management of biological resources in their natural environment. One of the major initiatives of the Philippine Government on *in-situ* conservation is the establishment of a comprehensive system of protected areas to ensure the perpetual existence of all native plants and animals consistent with the principles of biological diversity and sustainable development.

Efforts on *in situ* conservation started in 1932 with the National Parks System. One of the purposes for establishing national parks is the preservation of the wilderness due to its characteristic flora. Under the System, 60 national parks and 8 game refuges and bird sanctuaries were established. These are now among the areas considered as the initial components of the National Integrated Protected Areas System (NIPAS) established in 1992 through RA 7586 (NIPAS Act).

The NIPAS aims to integrate outstanding remarkable areas and biologically important public lands that are habitats of rare and endangered species of plants and animals, biogeographic zones and related ecosystems whether terrestrial, wetland or marine, all of which shall be designated as protected areas. The objectives of the NIPAS Act are carried out through the formulation of a General Management Planning Strategy that will serve as guide in the implementation of activities such as resource assessment, zoning, community management, biodiversity monitoring and research, advocacy, law enforcement, staff development, and networking.

At present, 101 protected areas covering a total area of 3.2 million hectares have been established under the NIPAS through presidential proclamation (Annex 4). Seventy-one (71) of these protected areas covering 1.61 million hectares are terrestrial representing the various vegetation types of the country

Projects for the management of protected areas were later developed and implemented through various foreign financial grants, namely: the World Bank-Global Environmental Facility (WB-GEF)-funded Conservation of Priority Protected Areas Project (CPPAP), the European Union (EU)-funded National Integrated Protected Areas Program (NIPAP), and the United Nations Development Program (UNDP)-GEF funded Samar Island Biodiversity Project (SIBP). The CPPAP was implemented in 10 priority areas (Batanes Protected Landscape and Seascape, Northern Sierra Madre Natural Park, Subic-Bataan Natural Park, Apo Reef Marine Natural Park, Mt Kanlaon Natural Park, Mt. Kitanglad Natural Park, Siargao Island Protected Landscape and Seascape, Agusan Marsh Wildlife Sanctuary, Turtle Islands Wildlife Sanctuary, Mt. Apo Natural Park) while the NIPAP focused on 8 selected sites (Mt. Pulag National Park, El Nido Managed Resource Reserve, Coron Island, Malampaya Sound Protected

Landscape and Seascape, Mt. Isarog Natural Park, Mt. Malindang Natural Park, Mts. Iglit-Baco National Park, and Mt. Guiting-guiting Natural Park). The first two projects have been completed, CPPAP in 2002 and NIPAP in 2001. The SIBP, now on its fourth year of implementation, aims to conserve the remaining natural forests and biodiversity resources of Samar Island by establishing it as a Natural Park under the NIPAS.

In addition, two of the protected areas in the country have been designated as ASEAN (Association of Southeast Asian Nations) Heritage Sites such as the Mts. Iglit-Baco National Park and Mt. Apo Natural Park due to their significance as habitats of Tamaraw and Philippine Eagle, respectively. The conservation of plant diversity in these protected areas plays a major role in the maintenance of the habitats of these threatened species.

Other government agencies, non-government organizations (NGOs) and the academe have also initiated certain *in-situ* conservation activities. Efforts are being made by the National Museum to conserve certain endangered species on site, such as *Phoenix loureiroi* in Batanes and *Tectona philippinensis* in Batangas. The National Museum also established a Biodiversity Information Center-Plants Unit (BIC-PU) since 1990. Funded initially by the John D. and Catherine T. MacArthur Foundation, the BIC-PU conducts research and field surveys to identify and gather information about critical plant sites and rare, endemic and endangered plants of the Philippines in coordination with various government agencies, schools, conservation NGOs, and local communities.

The Haribon Foundation, on the other hand, is pursuing restoration and protection activities within the Siburan Forest in Sablayan, Occidental Mindoro.

## 5.2 Ex-Situ Conservation

*Ex-situ* conservation is defined in Article 2 of the CBD as the conservation of components of biological diversity outside their natural habitat. Several initiatives have been implemented in the Philippines as mentioned in the NBSAP (1997). These include the Makiling Botanic Gardens of the University of the Philippines at Los Baños (UPLB) with 300 hectares showcasing an arboretum, nursery and recreational areas and the Living Museum of Philippine Medicinal Plants at the Quezon Memorial Circle, Diliman, Quezon City, which features indigenous plants used by indigenous peoples to remedy common illnesses.

There are gene banks established by the Ecosystems Research and Development Bureau (ERDB) of the DENR for rattans (48 species), bamboo, palm and medicinal plants.

PAWB initiated the project on *ex-situ* conservation areas for the Philippine teak (*Tectona philippinensis*). Wildlings of the species were collected and planted in other localities as a strategy to conserve the species.

## 5.3 Conservation Research and Development

Several initiatives have been undertaken on plant conservation research in the country. ERDB, for example initiated an integrated project on rattan production to identify and harness the potential of rattan species for conservation and cane production to support the handicraft and furniture industries. Among the outputs of the UNDP-funded Bamboo Research and Development Program of ERDB are: a comprehensive document on bamboo taxonomy, a guidebook for identification, and the establishment of pilot bamboo plantations.

The National Museum, on the other hand, is implementing the Flora of the Philippines Project that is aimed at collecting, processing, identifying, and documenting herbarium specimens for taxonomic study and as reference materials. Among the activities and studies undertaken by the National Museum under the Project are conservation in collaboration with international conservation NGOs; researches on rare and endangered plants such as *Tectona philippinensis*, *Phoenix loureiroi*, rare ferns and wild endemic fruits; and, inventory of rare and endangered plants of different provinces and islands.

Research on micro- and macro-propagation techniques were formulated and implemented for dipterocarps, mangrove species, medicinal plants, premium and indigenous hardwoods species, endemic ferns, fiber plants, dyes, essential oils, resins and exudates by ERDB, FPRDI (Forest Products Research and Development Institute), UPLB, ERDS (Ecosystems Research and Development Sector)-DENR, FIDA (Fiber Industries Development Authority), PTRI (Philippine Textile Research Institute), and the academe.

Handbooks and guidebooks for identification of wild food plants (Sinha 1987), and mangrove (Palis *et al.* 1997) were published. Ethnobotanical researches have also been conducted by PCARRD (Philippine Council for Agriculture, Forestry and Natural Resources Research and Development) and the academe.

Establishment of seed production areas and identification of seedling and seed sources of indigenous species (*Pterocarpus indicus*, *Intsia bijuga*, *Tectona philippinensis*, *Vitex parviflora*) have been conducted nationwide. Seed orchard establishment of *Vitex parviflora* is implemented in Pangasinan and La Mesa Dam.

#### 5.4 Long-Term Ecological Plots

Long-term ecological plots using the biodiversity monitoring system (BIOMON) protocol under the Smithsonian Institution- Man and the Biosphere Program (SIMAB) research collaboration were established. One plot was established each in Mt Makiling; Mt Guiting-guiting; Irawan, Puerto Princesa City; and, Mt Kitanglad. Tree demography starting with those with a minimum diameter of 10 cm were measured in the 1-ha plots. Periodic monitoring was started in the early 90s.

The Smithsonian Tropical Research Institute-Center for Tropical Science (SPRI-CTFS) project that is being implemented by the consortium of Smithsonian Institution, Harvard University and Arnold Arboretum established a large-scale forest dynamics plot measuring 16 hectares in Palanan, Isabela. Tree demographic census starting with those measuring 1 cm at a point 1.3 m from the ground has been taken. Individual trees were also tagged and plotted on a map. About 300 species of free-standing trees from 71,400 stems have been identified from the plot. These large-scale forest dynamics plots, some measuring as big as 50 hectares, have been replicated in the tropical realm covering Asia, Africa and South America.

The 16-ha forest dynamic plot is envisioned to serve as a field biological laboratory for biodiversity research and conservation biology (tree spatial distribution, plant-animal interaction, comparison of efficiency of sampling techniques vis-à-vis big plots).

The ASEAN Regional Centre for Biodiversity Conservation (ARCBC) conducted a study on the comparison of sampling techniques for plant diversity in a forest ecosystem. The results yielded that quadrat sampling is the appropriate method for forest ecosystem, to

determine plant biometrics and diversity indices within sampling sites. ARCBC provided financial support to study the vegetation of the lowland forest ecosystems of Panay Island and Lamon-Ragay-Tayabas Gulf.

Studies in ethnographic biodiversity conservation and management covering 66 ethno-linguistic groups in the country were compiled. Many of these studies were in agriculture and ethnobotany while some were on cultural ecology, local cosmology and medicinal plants (PEDCA, unpublished).

### 5.5 Information, Education and Communication (IEC)

The DENR through its bureaus, regional offices and projects spearheaded several initiatives to catalyze and effect positive changes in the hearts and minds of Filipinos toward plant conservation. These initiatives were in the form of awareness training and workshops, community and school visits, and production of popular and technical materials, such as:

- plant morphological and production techniques through RISE (Research Information Series on Ecosystems), the DENR Recommends Series, Canopy, Sylvatrop, Wild Food Plants, monographs, bibliographies and abstracts of researches; leaflets on CBFM (community-based forestry management) livelihood activities;
- flashcards featuring waling-waling and Philippine Teak;
- paper bags on species biodiversity and orchids;
- posters about features and benefits derived from mangroves; and,
- plastic ruler featuring photos of orchid flowers.

The National Museum published brochures and pamphlets on rare and endangered

plants and produced radio and television programs on plant conservation.

Websites on biodiversity conservation in the Philippines were launched. ([www.pawb.gov.ph](http://www.pawb.gov.ph); [www.arcbc.org](http://www.arcbc.org); [www.pnh.com.ph](http://www.pnh.com.ph)).

Public education and awareness efforts of different NGOs such as Bantay Kalikasan, ABS-CBN Foundation, Center for Environmental Concerns, CI, and Haribon Foundation on plant and protected area conservation were also recognized.

### 5.6 Capacity Building

Strategy VI of the NBSAP calls for stronger international cooperation in biodiversity conservation and management. In line with this advocacy, the PAWB proposed for the creation of the ARCBC. The proposal was approved and its establishment supported by funds from the EU. ARCBC has been running training programs to upgrade the capacities of different organizations on biodiversity conservation since its inception. Some of the training programs conducted were the National Workshop on Understanding and Managing Biodiversity at the Provincial and Landscape Levels attended by the DENR-PENROs (Provincial Environment and Natural Resources Officers); National Trainers' Training on Biodiversity Conservation and Sustainable Development Education at the Tertiary Level, attended by 35 biology teachers from the centers of excellence in science nationwide; Regional Plant Taxonomy Training attended by two participants from the Philippines who worked on the identification of the genus *Argostema* and *Neouvaria* (Annonaceae).

PAWB also ran courses on plant identification and vegetation assessment techniques at the start of the Project on

the establishment of protected areas or more popularly referred to as the IPAS (Integrated Protected Areas) Phase I. The wetland conservation, as well as the cave and cave resources conservation initiatives started with hands-on vegetation identification and assessment workshops. The Bureau also implemented a special training course on plant identification through its Wildlife Conservation and Management: A Focus on Plant Identification for PAWB and Regional technical staff.

Capacity-building training courses have also been ran by other agencies, both government and non-government. Some of these are as follows: short training courses on plant collection and herbarium techniques; macro and micro-propagation of selected premium and indigenous species by ERDB-DENR; training programs on plant conservation techniques, plant collection and identification, biodiversity assessment (flora/vegetation), herbarium curation and ethnomedicinal plants inventory and documentation, use of Botanical Resources and Herbarium Management System (BRAHMS) by the Philippine National Museum-Plants Unit; the Philippine Plant Specialist Group's training workshop on Red Listing of Threatened Species; seminars, workshops and environmental education training for Miriam College, Miriam PEACE (Public Education and Awareness Campaign for the Environment) Foundation and other institutions; and, strengthening community plant genetic resources conservation and development, through provision of technical assistance, management advice and education materials to local NGOs and people's organization by the Southeast Asia Regional Initiatives for Community Empowerment (SEARICE). Forty-seven (47) universities and colleges offering forestry, biology and natural resources courses also provide the venue for capability and skills enhancement on plant conservation. Initiatives are underway to revise the curriculum to address the

requirements of forest conservation. Occupational standards for protected area staff, where skills and knowledge are defined to effectively perform specific jobs, i.e. as botanists and resource persons on plant conservation, have also been developed.

## **5.7 Networking and Partnerships**

### **5.7.1 Local and National Networking**

The Sub-Committee on Biodiversity of the Committee on the Conservation and Management of Resources for Development of the Philippine Council for Sustainable Development which oversees the implementation of the Philippine commitments to the CBD also provides a venue for the ventilation of ideas on biodiversity conservation and management. The Foundation for the Philippine Environment (FPE) also organized the Experts Advisory Panel (EAP) or a network of experts on the various fields of conservation including plant experts. The EAPnet as it was called has been dormant for sometime but there are present efforts to revive it.

The DENR has been entering into agreements with various entities, both local and international, for the conservation and management of species and ecosystems. Most of the efforts have, however, been directed towards conservation of wild fauna. Only a few deal with vegetation assessment and management, such as the tripartite Memorandum of Agreement (MOA) with SEARCA (Southeast Asia Regional Center for Graduate Study and Research in Agriculture), the Provincial Government of Misamis Occidental and DENR, and the MOA with Ruhr University of Germany.

Some NGOs are involved in law enforcement. The Palawan Network for NGOs, Inc. (PNNI) has been actively involved in the enforcement of bioprospecting policy in the province of Palawan. This involvement has resulted to

the apprehension of several local and foreign scientists who collected certain plant specimens in Palawan without proper authorization, and seizure of illegally collected plants in favor of the government.

Several NGOs have also been involved in initiating partnerships with other institutions on plant conservation. These are the Happy Earth Foundation, which initiated a national summit towards conservation of Philippine teak (*Tectona philippinensis*) and a community project on kaong (*Arenga pinnata*), and Majent Foundation of Pangasinan which collaborated in the conservation of *Vitex parviflora*.

To strengthen networking and partnership among local government offices (GOs) and NGOs, PAWB initiated the establishment of a national framework for sharing biodiversity information through electronic and satellite-centered configuration. The framework has been adopted by 18 government offices, 8 NGOs, and 2 universities through a MOA in 2002.

Networking and partnerships at the local level have produced two major conservation frameworks as follows:

#### **5.7.1.1 National Biodiversity Strategy and Action Plan (NBSAP)**

NBSAP, the major output of the Philippine Biodiversity Country Study (PBCS) Project which was jointly implemented by the DENR and the UNDP, represents the culmination of hard work by people from a broad range of sectors; from government, non-government and peoples' organizations to universities, research institutions and individual stakeholders.

The NBSAP provides six strategies to conserve the country's biodiversity, namely; (1) Expanding and improving

knowledge on the characteristics, uses, and values of biological diversity; (2) Enhancing and integrating existing and planned biodiversity conservation efforts with emphasis on *in-situ* activities; (3) Formulating an integrated policy and legislative framework for the conservation, sustainable use and equitable sharing of benefits of biological diversity; (4) Strengthening capacities for integrating and institutionalizing biodiversity conservation and management; (5) Mobilizing an integrated Information, Education and Communication (IEC) system for biodiversity conservation; and, (6) Advocating stronger international cooperation on biodiversity conservation and management.

#### **5.7.1.2 Philippine Biodiversity Conservation Priorities (PBCP)**

The PBCP is the major product of the Philippine Biodiversity Conservation Priority-setting Project (PBCPP), a program implemented by the DENR-PAWB, CI and UP-CIDS with the intention of updating the NBSAP based on the best scientific knowledge and experience of various experts, as well as from available published information. More than 300 natural and social scientists from more than 100 local and international institutions participated in this undertaking.

The key outputs of the PBCPP are: (1) re-assessment and updating of the terrestrial and marine biogeographic regions; (2) identification of 206 biodiversity conservation priority areas; (3) identification of five strategies and actions to be pursued to ensure that conservation in the 206 priority areas is successfully implemented; (4) identification of marine and terrestrial biodiversity corridors; and, (5) state of the art assessments for each thematic group of biodiversity. These outputs are integrated in a general framework known as the Philippine

## Biodiversity Conservation Priorities (PBCP).

The five strategic actions provided in the PBCP are: (i) harmonize research with conservation needs; (ii) enhance and strengthen the protected areas system; (iii) institutionalize innovative and appropriate biodiversity conservation approaches, i.e. biodiversity corridors; (iv) institutionalize monitoring and evaluation systems of projects and of biodiversity; and, (v) develop a national constituency for biodiversity conservation in the Philippines.

### **5.7.2 Regional and International Networking**

Networking at the regional and international level is an important undertaking. Philippine plant experts have established partnerships with the ASEAN and European plant scientists on flora conservation. These global experts meet annually to review and update taxonomic accounts of plants found in the Region. The association produced bulletins and monographs on plants (Flora Malesiana).

The complementary networking by the Philippine Government, through the DENR, with the ASEAN and the EU has resulted to the establishment of the ARCBC.

The ARCBC, a joint cooperation project between the ASEAN and the EU, serves as the central focus for networking and institutional linkage among ASEAN Member Countries (AMCs) and between ASEAN and EU partner organizations to enhance the capacity of the ASEAN in promoting biodiversity conservation. ARCBC is linked to a National Biodiversity Reference Unit (NBRU) established within an existing institution in each ASEAN

member country. The NBRU interfaces the ARCBC with the national authorities and institutions, provides local instruments for in-country follow-up of project activities, and constitutes a first reference for screening of research proposals for formal endorsement to ARCBC.

Networking with international NGOs likewise produced significant results. An example of this is the Conservation and Sustainable Development of Sulu-Sulawesi Marine Ecoregion (SSME) Project with World Wildlife Fund (WWF). The SSME project was conceptualized during the Biodiversity Visioning Workshop conducted by WWF-Philippines last March 2001. The Project aims to develop and implement a long-term conservation program to protect the outstanding biodiversity and natural resources in the country, particularly in the SSME. To meet this goal, the DENR and WWF will jointly undertake the following activities: design and delineate a network of Marine Protected Areas (MPAs) in the SSME; strengthen environmental enforcement activities in marine conservation; design and initiate a Tri-National Turtle Reserve with Indonesia and Malaysia; operationalize and/or strengthen the Regional Inter-agency Technical Working Groups for Sulu-Sulawesi Seas under the Presidential Commission for Integrated Conservation of the Sulu and Celebes Seas; and, implement joint management conservation of dugongs and sea turtles in the Philippine, among others.



## 6.0 POLICIES

Several policies have been issued for the conservation of Philippine plants since early 1930s. These include the following:

### 6.1 Act No. 3983 of 1932

The fundamental law that provided protection to plants in the Philippines is Act 3983 entitled An Act to Protect Wild Flowers and Plants in the Philippine Islands and to Prescribe Conditions Under Which They May Be Collected, Kept, Sold, Exported and For Other Purposes. The Act made it unlawful for any person to take, collect, kill, mutilate or have in her or his possession, living or dead, or to purchase, offer or expose for sale, transport, ship or export, alive or dead any protected flowering plant, fern, orchid, lycopod or club moss and other wild plants in the Philippines. This was implemented through Forestry Administrative Order (FAO) No. 10-1 as amended by FAO No. 6-1.

### 6.2 Act No. 3915 of 1932

This law provided for the establishment of National Parks, declaring such Parks as Game Refuges and for other Purposes. Under this law, the Governor-General was authorized to reserve and withdraw from settlement, occupancy or disposal any portion of the public domain which, because of its panoramic, historical, scientific or aesthetic value, should be dedicated and set apart as a national park for the benefit and enjoyment of the people. It also declared it unlawful to destroy or damage in any manner timber or other forest products or forest cover therein. Subsequently, FAO No. 7 was issued setting forth the rules and regulations governing national parks. The penalties provided under Act 3915 was later increased and amended by R.A. No. 122.

### 6.3 Republic Act (RA) No. 3571 of 1963

This law provided for the protection and conservation of plants growing in public grounds. It prohibited the cutting, destroying or injuring of planted or growing trees, flowering plants and shrubs or plants of scenic value along public roads, in plazas, parks, school premises or in any other public pleasure ground. Parks and Wildlife Office Administrative Order No.1 provided for the Rules and Regulations for the Protection and Conservation of Flora in Public Grounds.

### 6.4 Presidential Decree (PD) No. 389 of 1974

The Forestry Reform Code of the Philippines (PD 389) was promulgated to effectively conserve the country's public forests, including watershed areas, protect and preserve national parks, and at the same time provide suitable agricultural lands for the people, among others.

### 6.5 Presidential Decree No. 705 of 1975, as amended

The Revised Forestry Code of the Philippines (PD 705) which amended PD 389, was aimed at the protection, development, management, regeneration and reforestation of forest lands including the development and preservation of national parks, marine parks, game refuges and wildlife sanctuaries, among others. Later amendments were issued to further strengthen the implementation of the law.

Several Department Administrative Orders (DAO) were issued by the DENR to regulate cutting, gathering, utilization of premium hardwood species such as *Pterocarpus* spp, *Vitex parviflora*, *Dracontomelon dao*, *Diospyros philippinesis*, *Instia bijuga*, *Acacia* spp., *Albizia acle*, *Mastixia philippinensis*, *Wallaceodendron celebicum*, *Litsea leytensis*, *Madhuca betis*, *Diospyros pilosanthera*, *Toona calantas*,

*Wrightia pubescens*, *Heritiera javanica*, *Pistacia chinensis*, *Sindora sp.*, *Tectona spp.*, *Afzelia rhomboidea* and *Koompassia excelsa* (DAO No. 78, Series of 1987) while a nationwide ban on the cutting of *Agathis philippinensis* was imposed by the DENR (DAO No. 74, Series of 1987).

#### **6.6 Presidential Decree 953 of 1976**

This law required the planting of trees in certain places and penalized unauthorized cutting, destruction, damaging and injuring of certain trees, plants and vegetation. Planting was specifically required on lands adjoining the edge of rivers and creeks both as a measure of beautification and reforestation; and along roads and areas intended for the common use of owners of lots in subdivisions in order to provide shade and healthful environment therein.

#### **6.7 Republic Act 7586 (NIPAS Act of 1992)**

The National Integrated Protected Areas System (NIPAS) Act of 1992 or RA 7586 was enacted by the Philippine Congress for the establishment and management of a comprehensive system of protected areas, which shall encompass outstandingly remarkable and biologically important areas that are habitats of various species of plants and animals, biogeographic zones and related ecosystems. The Implementing Rules and Regulations of the Act was approved by the Secretary of DENR on June 31, 1992 and issued as DENR DAO No. 25, Series of 1992. Subsequently, several guidelines were issued by the DENR to further implement the NIPAS Act.

#### **6.8 Executive Order (EO) No. 247**

Entitled Prescribing Guidelines and Establishing a Regulatory Framework for the Prospecting of Biological and Genetic

Resources, Their By-products and Derivatives and for Other Purposes, this EO was signed in 1995 by the President to regulate the prospecting of biological and genetic resources in the country. It regulates the research, collection, and utilization of said resources for purposes of applying the knowledge derived therefrom for academic or commercial purposes.

#### **6.9 Republic Act No. 9147**

This law, otherwise known as the Wildlife Resources Conservation and Protection Act was enacted in 2001. The Act broadened the definition of wildlife to include plants, from its original definition referring to animal species alone. It aims to conserve and protect wildlife species and their habitats, regulate the collection and trade of wildlife, pursue the Philippine commitments to related international conventions, and initiate or support scientific studies on the conservation of biological diversity. The Implementing Rules and Regulations of the Act was approved by the Secretaries of DENR and the Department of Agriculture (DA) and the Chairman of the Palawan Council for Sustainable Development (PCSD) on May 18, 2004. RA 9147 repealed Act No. 3983 (as mentioned under Item 6.1 hereof) and Act 2590 of 1916, the fundamental law protecting game and fish.

#### **6.10 Republic Act No. 9168**

The law which is known as the Philippine Plant Variety Protection Act of 2002 aims to protect the intellectual property rights of plant breeders with respect to the plant variety they may have developed. It defines the requirements and procedures for the grant of plant variety protection to these breeders and creates the National Plant Variety Protection Board which is authorized, among others, to promulgate policy guidelines for the implementation of the provisions of the Act.

## **6.11 Other laws affecting plants**

Other laws incorporating concerns on the protection of plants include RA 9072 also known as the National Caves and Cave Resources Management and Protection Act and RA 8371 or the Indigenous People's Rights Act (IPRA). The Cave Act aims, among others, to protect and conserve plants and animals found in caves while the IPRA law provides for the management and development of natural resources within ancestral domains.

## **6.12 Policy Formulation Initiatives**

### **6.12.1 Support to the Implementation of E.O. 247 (Bioprospecting Policy) Project**

This is a 2-year project between the Philippine Government through the DENR and the Government of Germany through the GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit or German Technical Cooperation) that aims to develop a policy that will strengthen the implementation of access regulation in the country. Such policy will include the guidelines establishing the parameters to determine the amount of bioprospecting fee and performance & ecological rehabilitation bond to be paid/posted by commercial researchers, as well as the quota of specimens to be allowed for collection for bioprospecting purposes, and the benefit-sharing and monitoring schemes. The policy, in the form of a Joint DENR, DA, PCSD and NCIP (National Commission on Indigenous Peoples) Administrative Order entitled Guidelines for Bioprospecting Activities in the Philippines was approved on January 14, 2005. The guidelines streamline the procedures for granting access to genetic and biological resources for bioprospecting purposes. It sets bioprospecting fees and provides equitable sharing schemes for benefits derived from bioprospecting activities among the government and the host communities or resource providers.

## **6.12.2 National Biosafety Framework Project (NBFP)**

The NBFP is a UNEP-GEF funded project that is being implemented by the DENR in collaboration with the DA, Departments of Science and Technology (DOST), Health (DOH), Interior and Local Government (DILG), Trade and Industry (DTI), Foreign Affairs (DFA) and the National Committee on Biosafety of the Philippines (NCBP). The Project aims to develop a national framework on biosafety that is consistent with the provisions of the CBD's Cartagena Protocol on Biosafety. Its components include the inventory of existing policies, rules and regulations, existing and planned projects/programs, national experts, and public participation mechanisms on issues pertaining to biosafety; assessment of current national capacity to address biosafety-related concerns; capacity building on risk assessment and management; and, biosafety framework development. The Project was completed in December 2004. One of the major outputs of the Project is a draft EO establishing the National Biosafety Framework (NBF), prescribing guidelines for its implementation, strengthening the NCBP, and for other purpose. The framework contains general principles and minimum guidelines that the relevant agencies are expected to follow and to which their respective rules and regulations must conform with.

## **7.0 INTERNATIONAL CONVENTIONS AND AGREEMENTS**

### **7.1 Convention on Biological Diversity (CBD)**

The CBD is a convention that aims to conserve the Earth's biological diversity, including the protection of a representative system of ecosystems

adequate to conserve biological diversity; promote the sustainable use of the components of biodiversity; and, provide for a fair and equitable sharing of benefits derived from the utilization of genetic resources and appropriate access to genetic resources, including transfer of relevant technologies. The CBD was signed by over 154 States on 22 May 1992 during the UNCED in Rio de Janeiro. It entered into force on 29 December 1993.

The Conference of the Parties (COP) to the CBD adopted a supplementary agreement to the Convention known as the Cartagena Protocol on Biosafety (CPB) on 29 January 2000. The CPB seeks to protect biological diversity from the potential risks posed by living modified organisms (LMOs) or genetically modified organisms (GMOs) resulting from modern biotechnology. It establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory. The Protocol contains reference to a precautionary approach and reaffirms the precaution language in Principle 15 of the Rio Declaration on Environment and Development. The Protocol also establishes a Biosafety Clearing-House (BCH) to facilitate the exchange of information on LMOs/GMOs and to assist countries in the implementation of the Protocol. The Philippines signed the Protocol in May 2000.

## **7.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)**

CITES is a treaty that aims to: encourage rational and sustainable utilization of flora

and fauna; protect species from over-exploitation resulting from unregulated international trade; promote the aesthetic, scientific, cultural, recreational and economic values of wildlife; formulate science-based decisions; and, promote international cooperation. It regulates the international trade of flora and fauna through a system of permits and certificates issued by the designated Management Authority of each member-country.

CITES was signed on 03 March 1973 in Washington, District of Columbia, USA. The Philippines became its member on 16 November 1981. Two CITES Management Authorities have been designated in the country, namely; the DENR-PAWB for terrestrial species, and the Bureau of Fisheries and Aquatic Resources (BFAR) of the DA for aquatic species.

These Management Authorities are assisted by Scientific Authorities which provide advice on whether the export or import of a certain species will not be detrimental to their population in the wild. The Scientific Authorities for terrestrial species are the DENR-ERDB, University of the Philippines-Institute of Biological Science (UP-IBS), and the National Museum of the Philippines (NMP). For aquatic species, these are the DA-BFAR, UP Marine Science Institute, UP Visayas, Silliman University, and the NMP.

The CITES provides a list of species that need to be protected against trade, nationally and internationally. This listing is categorized as CITES Appendix I, Appendix II and Appendix III. Appendix I includes species threatened with extinction, for which trade must be subject to particularly strict regulation, and exportation or importation is only authorized in exceptional circumstances.

The only Philippine taxa listed under Appendix I are species of *Paphiopedilum* (Orchidaceae) (Figure 5) commonly known as the Lady's Slipper Orchids.

Appendix II includes species which are not necessarily now threatened with extinction but may become so unless trade is strictly regulated. This further covers so-called look-alike species which are controlled because of their similarity in appearance to other regulated species, thereby facilitating a more effective control. Philippine plant species listed in Appendix II include 38 endemic species under Cyathaceae; 4 endemic species in Cycadaceae (Figure 4); 192 species under Orchidaceae; and 12, species under Nepenthaceae, majority of which are endemic.

Appendix III contains species that are subject to regulation within the jurisdiction of a Party and for which cooperation of other Parties is needed to prevent or restrict their exploitation. We have no Philippine species listed under Appendix III at present, but this may always be resorted to should there be a need to protect indigenous species which are threatened by international trade but not yet listed in either Appendix I or Appendix II.

The CITES provisions indicate that the Convention shall in no way affect the right of Parties to adopt stricter measures regarding conditions for trade, possession or transport of specimens of species listed under its Appendices. It also allows Parties to adopt domestic measures restricting or prohibiting trade, possession or transport of species not included in the Appendices.

### **7.3 Convention on Wetlands or Ramsar Convention**

The Convention on Wetlands or Ramsar Convention, is an intergovernmental treaty

which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources including plants. It was adopted in Ramsar, Iran in 1971 and entered into force in 1975. The Philippines became a contracting party to the Convention on 08 November 1994 with the DENR-PAWB as the focal point. The Conference of the Contracting Parties promotes policies and technical guidelines to further the application of the Convention.

### **7.4 International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)**

Recognizing that there are now more than 815 million people in the world suffering from hunger, the World Food Summit, organized by the Food and Agriculture Organization (FAO) in 1996, pledged to halve hunger in the world by 2015. To ensure that resources for food will be available for future generations, an international treaty to safeguard the genetic resources of plants for food and agriculture was forged. This International Treaty on Plant Genetic Resources was finalized after seven years of negotiations during the 31<sup>st</sup> Session of the FAO held in Rome in November 2001.

The Treaty establishes a multilateral system of access to plant genetic resources of Contracting Parties. It also aims to ensure the conservation of plant genetic resources that are being used for food and agriculture, promote their sustainable use, and the fair and equitable sharing of the benefits arising from their use, including benefits derived from commercial use.

To date, 54 countries have ratified the Treaty representing a broad range of both developing and industrialized countries. It entered into force on 29 June 2004.

## 8.0 GAPS

The NBSAP recognized three types of gaps based on the comprehensive assessment of Philippine biodiversity in relation to its conservation and utilization, namely; i) gaps in knowledge; ii) gaps in management; and iii) gaps in policies.

The nature of gaps in knowledge in each of the biodiversity sector is as follows:

*Forest ecosystem* – incomplete knowledge of flora and faunal diversity of Philippine forests, including the biology, ecology, conservation status, geographic, and altitudinal distribution of rare and endangered species; insufficient data to enable accurate delimitation of the biogeographic zones; and, unavailability of standard criteria for classifying forest types based on species distribution, ecology, physiognomy, and vegetation structure.

*Wetland ecosystem* – incomplete knowledge on the different aspects of biodiversity in various categories of Philippine wetlands which include 78 lakes, 421 major rivers, 4 major swamps or marshes, and numerous bays, estuaries and mudflats.

*Marine ecosystem* – absence of foundation geographic information system (GIS) on the habitats from which baseline monitoring could be designed to detect impacts and changes in the ecosystems that are ecologically and economically significant; inadequate quantitative baseline measures of temporal and spatial abundance, recruitment and mortality rates of seagrass beds and coral reefs, and data on their associated flora and fauna especially those with critical conservation status; lack of quantitative measurements of physico-chemical correlates with detailed baseline which are useful in delineating biogeographic zones; insufficient studies on indicator species and responses; and, inadequate quantification

of the values of marine ecosystems and their components.

*Agroecosystem* – inadequate records of land races and wild species of agriculture and their spatial distribution; incomplete data on endemism in agriculture; unsystematic statistics on agricultural plants and animals, especially the descriptors, and reporting formats; insufficient records of natural habitats and their biological components; and, inadequate record on genetic erosion of important agricultural crops.

In terms of management gaps, the specific gaps in each biodiversity sector are:

*Forests Ecosystem* – lack of management plans/schemes for non-timber species and weak implementation of management policies

*Wetlands Ecosystem* – absence of a viable management scheme that ensures the application of integrated and comprehensive approach to the country's wetlands conservation and management.

*Marine Ecosystem* – lack of management mechanisms that are proactive, predictive, and participatory, including the inadequacy of rehabilitation and restoration technology to effectively conserve seagrasses, coral reefs, and bottom resources, and their biodiversity.

*Agroecosystem* – weak institutional capacity for monitoring and evaluation of agrobiodiversity; and, outdated policies, rules and regulations in the light of national requirements for biodiversity conservation, enrichment, and sustainability in agriculture.

*Protected Areas* – many operational gaps related to the implementation of the management plans for protected areas in accordance with the NIPAS Law.

The specific policy gaps identified are as follows:

*Wetland Ecosystem* - absence of an overriding policy framework for Philippine wetlands.

*Marine Ecosystem* – absence of regulatory and management policies which protect the seagrass beds and coral reefs; unclear delineation of institutional responsibilities and, enforcement of policy, rules and regulations; unclear guidelines and policies governing the conservation of biodiversity in seagrass beds, coral reefs, and soft bottom communities; lack of policies for coordinated and integrated marine biodiversity conservation and sustainable use; and inadequate financial mechanisms for sustained conservation and research efforts.

*Agroecosystem* – inadequate policies concerning biotechnology in the agriculture sector.

## **9.0 PLANT CONSERVATION GAPS**

Plant experts have identified six (6) major gaps in plant conservation, namely: (i) research/knowledge; (ii) policies; (iii) information sharing and management; (iv) information, education and communication; (v) monitoring; and (vi) funding.

### **9.1 Research/Knowledge**

#### **9.1.1 Flora of the Philippines**

The writing of the Flora of the Philippines manuscript requires adoption of a user-friendly format for the flora treatment, illustrations of representative genera and checking of descriptions, nomenclature, and collaboration of other plant experts.

#### **9.1.2 Compendium of Extant Botanical Collections in the Philippines**

The DENR-ERDB implemented the Compendium of Herbarium Collections Project from April 2000 to October 2001, covering all herbaria nationwide. The Project revealed that there are a number of herbaria established and maintained in the Philippines with specific purposes like reference for teaching, repository of specimen used in research and others. These herbaria, however, are scattered in the country and specimens deposited therein are unfortunately not duly enumerated and not easily accessed by the public, the researchers and scientists in particular. The collections or herbaria are also generally associated with academic institutions, a division of botanical gardens, arboretum or museum and sometimes, privately owned.

The Compendium aims to present all available specimens housed in various herbaria nationwide, including those that are deposited in selected herbaria abroad like in Paris (*Laboratoire de Phanerogamie*), United Kingdom (Kew Gardens), the Netherlands (*Rijksherbarium/Hortus Botanicus*), etc. and to make them accessible both in hard copy and dynamic/interactive database forms.

The project collaborated with 17 different herbaria in the country holding approximately a total of 407,100 type specimens. Currently, a total of 4,979 entries from 5 herbaria have been encoded for the database.

So far, a total of 1808 species from 714 genera and 167 families have been generated from a record of 4,687 specimens from 5 institutions (against over 400,000 collections in 18 institutions identified). One can just imagine how many species of plants can be disclosed if the

collections of our herbaria nationwide are compiled, not to mention species new to science or yet to be discovered, and if these specimens can be made available to researchers, scientists and students.

All records can be made available both in dynamic database form and periodic hard copy publications but this can only be feasible if collaboration and commitment from each herbarium is strengthened. Limitations encountered, however, are not the collaboration *per se* but the availability of data a particular herbarium maintains. Almost all herbaria contacted signified their interest as partners and contributors to the Compendium project, although limited by a common factor – the unavailability of their data in digital form. These herbaria, are therefore encouraged to digitize their checklist, and contribute and share their data holdings to this existing database to come up with a complete compendium of Philippine flora.

## 9.2 Policies

There is a need to focus efforts on the development of policies specifically for the conservation and protection of our plant resources. While these concerns may be incorporated in existing wildlife policies, specific procedures and guidelines governing plant conservation activities are still lacking.

The promulgation of the list of protected plant species in the country should be prioritized. This is necessary to provide basis for all other protection and conservation efforts on plants. Other areas for policy development are: guidelines on the exchange of plant specimens between and among local and foreign institutions / organizations / individuals for taxonomic research and

other conservation-oriented purposes; policy on the registration and accreditation of commercial plant breeders; and, policy to protect indigenous knowledge on plants and their uses. Existing policies on the import, export and local transport of plants and plant genetic resources have to be reviewed and harmonized, as warranted.

## 9.3 Information Sharing and Management

At present, results of researches conducted and other information, including traditional knowledge on Philippine plants, are confined to researchers, institutions and organizations holding such information. There is no common venue for sharing of research outputs or a common repository of these information. A lot of information also needs to be assessed and disseminated. For example, the IUCN list of threatened Philippine plants has to be verified based on field observations of local scientists.

## 9.4 Information, Education, and Communication

Most publications about plant conservation are too technical and cannot be grasped by the general public. There is a dire need for translation of these information to local dialects and popular language. Although there have been several initiatives spearheaded by government and NGOs to produce information materials, distribution of these materials is limited to urban areas.

Plant uses and economic potentials are not widely understood by the masses but known only to researchers and the scientific community. Thus, the potentials for promoting plant-based trade remain less explored (e.g. gugo plantation with Unilever, Procter and Gamble, etc.).



## 9.5 Monitoring

Many research and conservation projects in the Philippines do not include monitoring and evaluation (M&E) systems (PBCP 2002). There is inadequate expertise to conduct monitoring of plant conservation measures and initiatives.

To initiate a monitoring and evaluation of plant resources status in the country, criteria and indicators to maintain a viable population of plants should be determined and developed.

## 9.6 Funding

There is low priority for funding plant conservation projects due to weak understanding and appreciation by legislators and national agencies.

There is no national body to spearhead access to international funding sources, and inadequate financial mechanisms for sustained conservation and research efforts.



*Baccaurea philippinensis* (Merr.) Merr.

## 10. PLANT CONSERVATION STRATEGY AND ACTION PLAN

### 10.1 Mission

Halt the current loss of Philippine plant diversity to ensure its perpetual existence essential to meet the present and future needs of the Filipino people and the global community.

### 10.2 Objectives

1. Provide a framework to enhance existing initiatives aimed at plant conservation, identify gaps where new initiatives are required, and promote mobilization of the necessary resources; and,
2. Provide mechanisms to enhance species and ecosystem approaches to the conservation and sustainable use of plant diversity and focus on the vital role of plants in the structure and functioning of ecological systems and assure their provision of goods and services.

### 10.3 Strategies

#### Strategy 1:

**Conserve important plant areas in the Philippines and plant species of direct importance to human societies.**

Actions:

- 1.1 Formulate criteria for identification of Important Plant Sites (IPS) or Important Plant Areas (IPA);
- 1.2 Identify and designate Important Plant Sites (IPS) or Important Plant Areas (IPA) or *In-Situ* Plant Conservation Centers;

1.3 Develop and implement conservation and management plan for each of the designated IPS. Such plan must include mechanisms that will ensure active participation of concerned local government units and other stakeholders; and,

1.4 Identify key plant species that will serve as emblem of plant conservation in each region of the country.

#### Strategy 2:

**Document Philippine plant diversity, including its uses and its distribution in the wild, *in-situ* within and outside protected areas, and in *ex-situ* collections.**

Actions:

- 2.1 Conduct specimen-based plant inventory throughout the country;
- 2.2 Develop a checklist of Philippine plants (per protected area, mountain, province, region);
- 2.3 Publish a book on the Flora of the Philippines;
- 2.4 Establish and maintain *ex-situ* conservation centers of wild plants; and,
- 2.5 Establish a National Botanic Garden that showcases the Philippine native plants.

#### Strategy 3:

**Promote and support research on the genetic diversity, systematics, taxonomy, ecology and conservation biology of plants and plant communities, and associated habitats and ecosystems.**

Actions:

- 3.1 Conduct studies on threatened endemic plants

- a. conservation biology
- b. demography / population studies;

3.2 Pursue / support / encourage taxonomic studies; and,

3.3 Develop research proposals for funding support solicitation.

**Strategy 4:**

**Promote and support research on social, cultural and economic factors that have impact on biodiversity.**

Actions:

4.1 Conduct research on plants uses by the local communities and the impact of these uses on plant species conservation; and,

4.2 Conduct research on plant resource valuation.

**Strategy 5:**

**Develop an integrated, interactive database information system to manage and make accessible information on plant diversity.**

Actions:

5.1 Enhance capacity of staff to use software or databases;

5.2 Develop / update / enhance digital information on Philippine plants to include their traditional knowledge;

5.3 Establish a system, including websites, that will ensure constant exchange of information on Philippine plant genetic resources between and among concerned institutions/organizations and make these information accessible to all interested parties; and,

5.4 Establish a system that will link the local databases to regional and international information centers.

**Strategy 6:**

**Monitor the conservation status of Philippine plant diversity.**

Actions:

6.1 Establish the National List of Threatened Philippine Plants;

6.2 Establish the National List of Economically-Important Species; and,

6.3 Assess the conservation status of all known Philippine plants periodically.

**Strategy 7:**

**Promote education and awareness about plant diversity.**

Actions:

7.1 Develop libraries on Philippine plants;

7.2 Develop and publish popular and technical papers on Philippine plants, including articles on plant conservation-related undertakings regularly;

7.3 Produce plant identification guides;

7.4 Work for the declaration and celebration of Plant Conservation Day/Week or restore the celebration of Arbor Week;

7.5 Conduct lectures/seminars and organize workshops, conferences, fora and other venues to disseminate and articulate issues relating to plants and their conservation; and,

7.6 Integrate topics on plant conservation in school curricula.

**Strategy 8:**

**Develop capacity including physical and technological infrastructure and financial support for plant conservation.**

Actions:

- 8.1 Establish the roster of plant experts and agencies, research institutions and organizations involved in plant conservation in the country;
- 8.2 Provide career opportunities for botanists and plant taxonomists;
- 8.3 Assess the plant taxonomic needs of the Philippines;
- 8.4 Develop centers of excellence on plant conservation;
- 8.5 Implement technical capacity building programs on plant conservation and management (e.g. trainings on plant identification, preservation, etc. at the national, regional and local level); and,
- 8.6 Identify and implement appropriate community training programs.

**Strategy 9:**

**Promote sustainable production and utilization of plant resources.**

Actions:

- 9.1 Produce 'how-to-manuals' on plant propagation and utilization;
- 9.2 Promote establishment of nurseries and propagation centers for

commercial plant production purposes; and,

- 9.3 Promote sustainable utilization of plant resources in production areas.

**Strategy 10:**

**Develop and enforce policies on plant conservation.**

Actions:

- a. Develop guidelines on the accreditation and registration of plant nurseries/establishments/breeders;
- b. Develop guidelines on the exchange of plant specimens between and among researchers/taxonomists, locally and internationally; and,
- c. Review and harmonize existing policies on the conservation and export, import and transport of plant genetic resources.



## References

- Adema, F., P.W. Leenhouts, & P.C. van Welzen. 1994. Sapindaceae. *Flora Malesiana* series I, 11: 419-768.
- Alston, A.H.G 1959. Isoetaceae. *Flora Malesiana* series 2, 1: 62-64.
- Anonymous 1974. Desiderata for future exploration. *Flora Malesiana* series I, 8(1): 3.
- Ashton, P.S. 1982. Dipterocarpaceae. *Flora Malesiana* series I, 9(2): 237-552.
- Ashton, P.S. 1997. Before the memory fades: some notes on the indigenous forests of the Philippines. *Sandakania* 9: 1-19.
- Barcelona, J.F. 2002. Philippine pteridophyte collections as a resource for conservation planning. *Fern Gazette* 16(6-8): 307-312.
- Barcelona, J.F. & E.S. Fernando. 2002. A new species of *Rafflesia* (*Rafflesiaceae*) from Panay Island, Philippines. *Kew Bulletin* 57(3): 647-651.
- Barlow, B.A. 1997. Loranthaceae. *Flora Malesiana* series I, 13: 209-401.
- Brown, W.H. 1919. *The Vegetation of Philippine Mountains*. 434p. Bureau of Science Publication No. 13, Manila.
- CITES. 1976. Convention on International Trade in Endangered Species of Wild Fauna and Flora. pp. 279-303. In: J.B. Simmons, et al. (eds.), *Conservation of Threatened Plants*. Plenum Press: New York.
- Co, L., D.A. Madulid, & G. Argent. 2002. A new Philippine *Vaccinium* (*Ericaceae*). *Edinburgh Journal of Botany* 59(3): 373-376.
- Cox, R. 1988. *The Conservation Status of Biological Resources in the Philippines*. IUCN, Gland, Switzerland.
- Dickerson, R.E. 1928. *Distribution of Life in the Philippines*. Bu. Printing: Manila. 322p.
- DENR-UNEP. 1997. *Philippine Biodiversity: An Assessment and Action Plan*. 298p. Department of Environment and Natural Resources and the United Nations Environment Programme. Bookmark, Inc., Makati, Philippines.
- DENR-PAWB, CI, & UP-CIDS. 2003. *Philippine Biodiversity Conservation Priorities: A Second Iteration of the National Biodiversity Strategy and Action Plan*. 113 p. Department of Environment and Natural Resources, Conservation International –Philippines, and U.P. Center for Integrated Development Studies.
- EMB-DENR. 1996. *Philippine Environmental Quality Report, 1990-1995*. 379p. Environmental Management Bureau, Department of Environment and Natural Resources, Quezon City, Philippines.
- Fernando, E.S. 1990a. A preliminary analysis of the palm flora of the Philippine Islands. *Principes, Journal of the International Palm Society* 34(1): 24-45.
- Fernando, E.S. 1990b. *The Vegetation of the Philippines and the Situation of the Flowering Plants*. Paper presented at the Fourth International Congress of Systematic and Evolutionary Biology, 01-07 July 1990, University of Maryland, College Park, Maryland, U.S.A.
- Fernando, E.S. 1997. *Vegetation of Bataan Natural Park, Philippines*. 22p. Report for the Nordic Agency for Development and Ecology, Manila, Philippines.
- Fernando, E.S. 2001. Diversity, endemism, and rarity in the palm flora of the Philippines. In: *Biodiversity – Status, Conservation and Restoration: Proceedings of the 19<sup>th</sup> International Symposium on Plant Biology* (D.S. Cho, ed.), pp. 182-195. The Botanical Society of Korea, The Botanical Society of Japan, and The Catholic University of Korea, Puchon, Seoul, Korea.
- Fernando, E.S. & R.P. Cereno. 2000. *Pinanga bicolorana*: a critically endangered palm species from the Philippines. *Species* 33: 62.
- Fernando, E.S. & J.V. Pancho. 1980. Mangrove trees of the Philippines. *Sylvatrop, Philippine Forest Research Journal* 5: 35-54.
- Fernando, E.S. & E.D. Sotalbo. 2001. A new species of *Heterospathe* with undivided leaves from the Philippines. *Palms, Journal of the International Palm Society* 45(3): 118-122.
- FMB-DENR. 1998. *Philippine Forestry Statistics*. 233p. Forest Management Bureau. Department of Environment and Natural Resources, Quezon City, Philippines.
- Gruezo, W.S. 1979. Compendium of Philippine lichens. *Kalikasan, Philippine Journal of Biology*. 8: 267-300.
- Gruezo, W.S. 1990. Endangered plants of the Philippines. *Life Today* 46(8): 16-18.
- Hall, R. 1998. The plate tectonics of SE Asia and the distribution of land and sea. pp. 99-131. In R. Hall and J.D. Holloway (eds.), *Biogeography and Geological Evolution of SE Asia*. Backhuys Publishers, Leiden.
- Heaney, L.R. & J.C. Regalado. 1998. *Vanishing Treasures of the Philippine Rainforest*. 83p. The Field Museum, Chicago.
- Heaney, L.R. 1985. 1986. Biogeography of mammals in SE Asia: estimates of rates of colonization, extinction, and speciation. *Biological Journal of the Linnean Society* 28: 127-165.
- Holmgren, P.K., N.H. Holmgren, & L.C. Barnett. 1990. *Index Herbariorum, Part 1: The Herbaria of the World*. 693p. New York Botanical Garden, Bronx, USA.
- Hoogland, R.D. 1951. Dilleniaceae. *Flora Malesiana* series I, 4(3): 141-172.
- Hou, D. 1978. Anacardiaceae. *Flora Malesiana* series

- I, 8(3): 395-348.
- Huang, T.-C. 1997. Daphniphyllaceae. *Flora Malesiana* series I, 13: 145-168.
- IUCN. 2000. *The 2000 IUCN Red List of Threatened Species*. IUCN/SSC, Cambridge, U.K.
- Jacobs, M. 1972. *The Plant World on Luzon's Highest Mountains*. 32p. Rijksherbarium, Leiden.
- Jacobs, M. 1974. Botanical panorama of the Malesian archipelago (vascular plants). pp. 263-294. In: UNESCO (ed.), *Natural Resources of Humid Tropical Asia. Natural Resources Research*, XII.
- Johns, R.J. 1995. Endemism in the Malesian flora. *Curtis's Botanical Magazine* 12(2): 95-110.
- Leenhouts, P.W. 1956. Burseraceae. *Flora Malesiana* series I, 5(2): 209-296.
- Livshultz, T. 2003. *Dischidia cleistantha* (Apocynaceae, Asclepiadoideae): A new Philippine endemic. *Novon* 13: 89-96.
- Mabberley, D.J., C.M. Pannell, & A.M. Singh. 1995. Meliaceae. *Flora Malesiana* series I, 12: 1-407.
- McCabe, R., Kikawa, E., Cole, J.T., Malicse, A.J., Baldauf, P.E., Yumul, J. & J. Almasco. 1987. Paleomagnetic results from Luzon and the central Philippines. *Journal of Geophysical Research* 92: 555-580.
- Madulid, D.A. 1982. Plants in peril. *Filipinas Journal of Science and Culture* 3: 8-16.
- Madulid, D.A. 1985. Status of plant systematic collections in the Philippines. pp. 71-75. In: S.H. Sohmer (ed.), *Forum on Systematic Resources in the Pacific*. Bernice P. Bishop Museum Special Publication 74: 1-79.
- Madulid, D.A. 1989. The Flora of the Philippines Project (Abstract). p. 44. In: *Flora Malesiana Symposium, Leiden, 20-25 August 1989* (Programme and Abstracts of Papers and Posters). Rijksherbarium: Leiden.
- Madulid, D.A. 2000. *Philippine Plants: Endangered Plants*. 50p. Island Publishing House, Manila.
- Mandia, E.H. 2001. The vegetation on the northeastern summit of Mt Halcon, Mindoro Island, Philippines. pp. 267-277. In: L.G. Saw, L.S.L. Chua & K.C. Khoo (eds.), *Taxonomy, the Cornerstone of Biodiversity*, Proceedings of the Fourth International Flora Malesiana Symposium 1998. Forest Research Institute Malaysia, Kuala Lumpur.
- Meijer, W. 1997. Rafflesiaceae. *Flora Malesiana* series I, 13: 1-42.
- Mendum, M. 2001. Three new Gesneriaceae from Palawan, Philippines. *Edinburgh Journal of Botany* 58(3): 435-441.
- Merrill, E.D. 1907. The flora Mt Halcon. *Philippine Journal of Science* 2 (Bot.): 251-309.
- Merrill, E.D. 1923-1926. *An Enumeration of Philippine Flowering Plants*. 4 vols. Bureau of Printing, Manila.
- Merrill, E.D. & L.M. Perry. 1940. A new Philippine *Isoetes*. *American Fern Journal* 30: 18-20.
- Merritt, M.L. 1908. The forests of Mindoro. *Bureau of Forestry Bulletin (Philippines)* No. 8.
- Mitchell, A.H.G., Hernandez, F. & A.P. dela Cruz. 1986. Cenozoic evolution of the Philippine archipelago. *Journal of Southeast Asian Earth Science* 1: 1-20.
- Mitra, M. 1973. The Philippines in a botanist's eye. *Bulletin of the Botanical Society of Bengal* 27: 67-70.
- Mittermeier, R.A., N. Myers, P.R. Gil, & C.G. Mittermeier. 1999. *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. Cemex, Conservation International, and Agrupacion Sierra Madre, Monterey, Mexico.
- Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. de Fonseca, & J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.
- Newman, M.F., P.F. Burgess, & T.C. Whitmore. 1996. *Manuals of Dipterocarps for Foresters: Philippines*. 124p. Royal Botanic Gardens Edinburgh and Center for International Forestry Research.
- Nais, J. 2000. *Rafflesia of the World*. 243p. Sabah Parks & Natural History Publications, Borneo. Kota Kinabalu, Sabah.
- Nooteboom, H.P. 1977. Symplocaceae. *Flora Malesiana* series I, 8: 205-274.
- Palis, H.G., C.A. Lat & B.S. Alcantara. 1997. *Guidebook on the Phenology and Identification of Philippine Mangrove Species*. 108p. ERDB. Department of Environment and Natural Resources
- PAVB-DENR. 1998. *The First Philippine National Report to the Convention on Biological Diversity*. Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources, Quezon City, Philippines.
- Philipson, W.R. 1979. Araliaceae. *Flora Malesiana* series I, 9: 1-105.
- Podzorski, A. 1985. *The Palawan Botanical Expedition: Final Report*. 89p. Hilleshog Forestry AB: Landskrona, Sweden.
- Prance, G.T. & D.G. Campbell. 1988. The present state of tropical floristics. *Taxon* 37(3): 519-548.
- Quisumbing, E. 1967. Philippine species of plants facing extinction. *Araneta Journal of Agriculture* 14: 135-162.
- Regalado, J.C. 1995. Revision of Philippine *Medinilla* (Melastomataceae). *Blumea* 40: 113-193.
- Regalado, J.C., D. Soejarto & D.A. Madulid. 2000. *Homalium palawanense*, a new species of Flacourtiaceae from Palawan Island (Philippines). *Edinburgh Journal of Botany* 57: 317-321.
- Roeder, D. 1977. Philippine arc system – collision

- or flipped subduction zones? *Geology* 5:203-206.
- Sinha, C.C. 1994. *Wild Food Plants in PA in the Philippines*, PAWB-DENR, Quezon Avenue, Diliman, Quezon City., 180p.
- Sleumer, H. 1966. Ericaceae. *Flora Malesiana* series I, 6(4,5): 649-914.
- Soepadmo, E. 1976. Fagaceae. *Flora Malesiana* series I, 7: 265-403.
- Sohmer, S.H. 1989. Basic concepts for a Flora of the Philippines Project. *Flora Malesiana Bulletin* 10: 138-141.
- Sohmer, S.H. 2001. Conservation lessons from studies in Philippine *Psychotria*. pp. 43-47. In: K.M. Wong et al. (eds.), *Species, Landscapes and Islands*. Perspectives in tropical botany:
- Tan, B.C. & J.P. Rojo. 1988. The Philippines. pp. 46-62. In: D.G. Campbell & D. Hammond (eds.), *Floristic Inventory of Tropical Countries*. New York Botanical Garden, New York.
- Tan, B.C., E.S. Fernando, & J.P. Rojo. 1986. An updated list of endangered Philippine plants. *Yushania (Taiwan)* 3(2): 1-5. [Reprinted in *PESAM Bulletin (Philippines)* 7(1): 8-9, 12 (1987)].
- Van Steenis, C.G.G.J. 1950. The delimitation of Malaysia and its main plant geographical divisions. *Flora Malesiana* series I, 1: lxx- lxxv.
- Van Steenis, C.G.G.J. 1985. The Australasian generic element in Malesia. *Brunonia* 8: 349-372.
- Van Steenis, C.G.G.J. 1987. *Checklist of Generic Names in Malesian Botany*. Flora Malesiana Foundation: Leiden. 162p.
- Villareal, R.L. & E.S. Fernando. 1999. *Biodiversity and plant genetic resources of the Philippines: utilization and conservation status*. In *Biological Diversity: Proceedings of the 11th Asian Agricultural Symposium* (T. Yamaguchi, ed.), pp. 1-17. Tokai University Educational System and Kyushu Tokai University, Kumamoto, Japan.
- Vink, W. 1981. Density indexes updated. *Flora Malesiana Bulletin* 34: 3567-3568.
- Whitford, H.N. 1911. The forests of the Philippines. *Philippine Bureau of Forestry Bulletin* No. 10, 113p.
- Whitmore, T.C. 1984a. *Tropical Rain Forests of the Far East*. 2nd ed. Clarendon Press: Oxford. 352p.
- Whitmore, T.C. 1984b. A vegetation map of Malesia at scale 1:5 million. *Journal of Biogeography* 11: 461-471.

