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Plant Genetic Resources, Inventory, Collection and Conservation

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Preface

Plant genetic resources (PGR) are the potential sources for farming, experimenting, and conserving plants. The conservation and effective utilization of PGR have been documented centuries ago. The changing socioeconomic situation in the early 1900s has increasingly put pressure on plant biodiversity, in some cases leading to a severe loss of many native species. Thus, the crisis impacted by genetic erosion instigated global conservation schemes in the form of forest laws and regulations to protect biodiversity. Still, there are several discrepancies in global- and national-level conservation policies that require the pressing attention of authorities. The fruitful employment of advanced biotechnological approaches will undeniably aid the conservation of PGR, which will be an immense treasure for the development of our society and the socioeconomic status of mankind. It is also imperative to safeguard the indigenous plant varieties and the knowledge of many tribal groups utilizing them.

The book *Plant Genetic Resources, Inventory, Collection and Conservation* is designed considering the magnitude of PGR conservation as well as the most preferable approaches in doing the same. The book discusses the global and regional plant biodiversity, in situ, ex situ conservation strategies, biotechnological advances in conservation, bioprospecting, notable plant conservation case studies, and conservation practices followed by various tribal communities, and global and national plant conservation policies. Particular significance is given to adding chapters on medicinal PGR conservation. Concurrently, the conservation, research, and utilization and natural wild varieties of rice, an important crop plant, are also included. Besides, a chapter on dye-yielding plants is also incorporated, making the book exceptional. Thus, the readers can access and analyze the status of genetic resources conservation of different genera of plants. Conservation case studies from different geographical domains like the Philippines, Thailand, Bangladesh, South Africa, and India are also included to demarcate the conservation policies in different parts of the world. A chapter solely on the plant diversity of Mount Makiling Forest Reserve in the Philippines illustrates the conservation policies practiced in vast forest ecosystems and points to the devastating human interference in the protection of natural resources. Likewise, the book includes a chapter on how the rare forest genetic resource in Bangladesh was explored, identified, multiplied, and safeguarded. Besides, exceptional case studies on various in situ and ex situ

conservation strategies for PGR are also comprised as chapters. Furthermore, educating the young minds on the gravity of PGR is a requisite, and hence a critical analysis of the role of education on PGR conservation is also added as part of the book.

Advances in science and technology are well explored in conservation biology also. Therefore, a chapter on the utilization of geographic information system (GIS) on conservation and management of PGR for the identification of conservation sites, development of accession explorations and collection plans, and georeferencing of germplasm in gene banks is also added. Besides, the efficient amalgamation of advanced biotechnological approaches with orthodox conservation practices is also discussed in various chapters. Chapters critically reviewing the policy frameworks associated with PGR are another highlight of the book. Timely renewal of policies and their strict application considering the resources in developing and developed countries are a requisite for maintaining and implementing efficient PGR conservation globally.

The book is written and edited by leading experts in the area of ecology, conservation biodiversity, ethnobotanicals, and bioprospecting aspects of PGR. The book is intended for use by graduate and advanced undergraduate students and researchers in plant physiology, molecular biology, biochemistry, and agriculture and will also be extremely useful as a general reference for the conservation of flora and large-scale cultivation.

The authors are thankful to Vellore Institute of Technology management for their constant support. We sincerely hope that the book will be a pertinent reference for all those who are interested in conservation biology.

Vellore, India — Siva Ramamoorthy
Laguna, Philippines — Inocencio Jr. Buot
Vellore, India — Rajasekaran Chandrasekaran

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About the Editors

Siva Ramamoorthy is Professor and Dean of School of Biosciences and Technology at Vellore Institute of Technology, India. His PhD thesis was on *plant genetic diversity*, which was completed at Bharathidasan University, India. He completed postdoctoral research at Ben Gurion University (Israel) and Gyeongsang National University (South Korea). For around two decades, he has carried out extensive research on plant dyes and pigments. Dr. Siva is an IUCN species commission member for medicinal plants. He was nominated as Fellow of Linnean Society (FLS), Fellow of the Royal Society of Biology (FRSB), and Fellow of the Royal Society of Chemistry (FRSC), and he has published around 150 manuscripts in reputed journals with high impact factor. He has received many awards for his research contribution. He is the associate and academic editor of various reputed international journals. Dr. Siva has been recognized as one among the top 2% scientists of the world as per survey of a leading publisher in 2021 Stanford University and Mendeley in 2020.

Inocencio Jr. Buot is Professor of Botany and curator in the Plant Biology Division Herbarium (PBDH) and current head of the Plant Systematics Laboratory at the Institute of Biological Sciences (IBS), a Center of Excellence for Biology since 1984, University of the Philippines Los Banos (UPLB). He obtained his PhD in botany (ecology) from the University of Chiba, Japan, in 1998 through a Monbusho Scholarship of the Japan Government and a postdoctoral research training in landscape ecology from 2003–2005 through the auspices of the Japan Society for the Promotion of Science (JSPS). His laboratory is now focusing on biodiversity conservation and plant systematic studies. He has published more than 150 articles in journals. He has received many prestigious awards for his research contribution.

Rajasekaran Chandrasekaran is serving as a full-time professor in the Department of Biotechnology, Vellore Institute of Technology. He graduated in botany at the University of Madras and Annamalai University. His obtained his doctoral degree from H.N.B. Grahwal University, specified with eco plant physiology. His research focuses on ecophysiology, conservation biodiversity, bioprospecting of

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A Checklist of Some Economically Important Philippine Ferns (Eupolypod I)

1

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Abstract

This checklist provides an updated reference for the economically important ferns that can be used by stakeholders both from the community and academe such as consumers, hobbyists, students, teachers, and researchers alike. Available comprehensive online and printed materials regarding the economic uses of ferns classified under Eupolypod I were used. Furthermore, this checklist also notes the conservation status of these select ferns as categorized by the IUCN Red List and/or DAO 2017–11. A total of 40 fern species representing 20 genera and 6 families categorized under Eupolypod I were recorded to have various economical uses. Twenty-five species were ornamentals, 19 species were used as medicinals, and 6 species were edible. Five fern species were listed as threatened/endangered in the DAO 2017–11. The Philippine endemic *Platycerium grande* is categorized as Critically Endangered due to its increased horticultural value. Data derived from this paper can be a good informative guide to stakeholders on the economic uses of some ferns and stimulate future research, conservation, and management practices towards the protection of these economically important ferns.

Keywords

Eupolypod · Economic uses · Conservation · Philippine ferns

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1.1 Introduction

Eupolypod I is the largest clade of leptosporangiate fern with approximately 4208 species classified under this taxon (Rothfels et al. 2012; PPG 2016; Tan and Buot Jr 2019). This group is made up of nine families (Didymochlaenaceae, Hypodematiaceae, Davalliaceae, Nephrolepidaceae, Lomariopsidaceae, Tectariaceae, Oleandraceae, Dryopteridaceae, and Polypodiaceae) (Smith et al. 2006; PPG 2016) with great variation among their morphologies but these were grouped together based on their shared characteristic, which is the numerous vascular bundles observed in the stipe, thus delineating it from its sister clade—Eupolypod II (Rothfels et al. 2012).

Most of the species under Eupolypod I were noted to have economic importance (de Winter and Amoroso 2003) as these ferns became a vital source of food, raw materials for handicrafts, ornamentals, and most importantly medicine (McCalla 1994; Smith et al. 2006; Schippmann et al. 2002). Over the years, ferns have provided humans with these services, thus establishing the important impact of pteridophytes in society development.

But, despite these economic values, there was scarcity of published articles made to extensively record pteridophytes for their economic importance. In the Philippines, there were only few works that featured this taxon's commercial value (Delos Angeles and Buot 2012; de Winter and Amoroso 2003; Amoroso et al. 2015; Mustacisa 2016) and the information among these articles was not consolidated; thus, the full range of the economic relevance of ferns is still hard to assess. Due to these, there is a need of a comprehensive data gathering of the economic importance of ferns and consolidation of such data. Thus, this study aims to evaluate literature and collect information on the specific uses of ferns to provide a robust checklist of economically important Eupolypod I species in the country.

1.2 Materials and Methodology

A comprehensive review of published literature online and in print was conducted regarding economic importance and the current and underlying conservation status of Philippine fern species classified under Eupolypod I. Copeland's Fern Flora of the Philippines Vol. 1, 2, and 3 (1958-1960); published monographs; and online resources such as "Co's Digital Flora of the Philippines" (Pelser et al. 2011) were consulted for the distribution and accepted names of the fern species. The endemic status of each species was verified by consulting available checklists, related publications, and online resources.

1.3 Results and Discussion

A total of 40 fern species representing 20 genera and 6 families categorized under Eupolypod I were recorded to have various economic uses (Table 1.1). The most represented fern families were Polypodiaceae (21) followed by Davalliaceae (5) and Dryopteridaceae (3). The families Hypodematiaceae, Nephrolepidaceae, and Tectariaceae are represented by three fern species.

Among these ferns, 25 species were used as ornamentals as majority of fern species were known to be of aesthetic purpose (Zamora and Co 1986; Buot Jr 1999; Banaticla and Buot Jr. 2006; Delos Angeles and Buot 2012; Shukla and Khare 2014) due to their unique frond and spore patterns. With the remarkable forms of their foliage and habit (Jones 1997; Ranil et al. 2015), and their ability to adapt to a wide variety of ecology (Fernández and Revilla 2003; Dong et al. 2009), they are considered as valuable components of urban landscaping and rehabilitation of damaged environs (Ranil et al. 2015; Dong et al. 2009). They have also become a subject of domestication as they are applied to the floriculture industry, where ferns are propagated and cultivated not just outdoor but also in indoor settings as these plants are capable of purifying the air (Ranil et al. 2015). Nineteen species were also noted to be medicinal and six were edible ferns. For many years, numerous ethnobotanical and pharmacological studies were conducted on these fern flora as they have high potential for medicinal uses (de Winter and Amoroso 2003). Almost every part of ferns is an abundant source of phytochemicals which make ferns a great prospect for drug discovery.

Some species under the family Polypodiaceae are commercially known as high-priced ornamentals such as *P. coronarium* and the Philippine endemic *P. grande* (Zamora and Co 1986; Aspiras 2010; Amoroso et al. 2015; Amoroso et al. 2015). However, these species of polypods were also assessed as threatened and even *P. coronarium* and *P. grande* were specifically recorded as critically endangered indicating the declining population of this taxon in the wild (Fernando et al. 2008; Aribal and Buot Jr 2009). The recent hype of horticultural activities also resulted for these ferns to be listed as one of the top ten commonly poached plants, regardless of its threatened status (DENR Soccsksargen 2020). This certainly calls for the need of legal protection of these traded species (Flores-Palacios and Valencia-Diaz 2007). There were policies embodied in the Philippine Republic Act No. 4167 also known as "Wildlife Resources Conservation and Protection Act" established by the government to stop illegal trading and ensure protection of these wild plants. However, such dilemma in illegal exploitation undeniably persists until now mostly caused by the lack of awareness of the local public of the population status of the species and the little to no understanding on the environmental and legal consequences entailed with these illegal acts (Dadang et al. 2020). The lack of knowledge of the status of these taxa cripples the society on taking its part in conserving the species. As a consumerist society, humans may have been reliant on plants to survive; however, humans also have to take on their role in promoting protection of the environment. It is essential to practice sustainable growth without disregarding the economy, social development, and protection of the existing natural resources (UN 2018).

Table 1.1 List of Philippine economically important Eupolypod I species (sensu PPG 2016)

Family/species	Common name	Medicinal uses				References
		Ornamental	Medicinal	Edible	Raw material	
Davalliaceae						
Davallia denticulata (Burm. f.) Mett. ex Kuhn var. elata (G. Forst) Kuhn	No recorded common name	*				Yatskievych (2021)
D. embolostegia Copel.	Hare's foot fern	*				Yatskievych (2021)
D. hymenophylloides (Blume) Kuhn	No recorded common name	*				Alcala et al. (2019), Yatskievych (2021)
D. lorrainii Hance	No recorded common name	*				Yatskievych (2021)
D. solida (G. Forst.) Sw. var. solida	Rabbit foot fern	*				Yatskievych (2021)
Dryopteridaceae						
Arachniodes amabilis (Blume)	No recorded common name	*				Ranil et al. (2015)
Bolbitis heteroclita (C. Presl)	El Niño Fern	*				Balkrishna et al. (2019)
B. rhizophylla (Kaulf.) Hennipman	Pako	*				MBCF (2012)
Cyrtomium caryotideum (wall. ex Hook. and Grev.) C. Presl	Dwarf netvein hollyfern		*			Balkrishna et al. (2019)
C. falcatum (L.f.) C. Presl	Holly fern, Japanese netvein hollyfern, Japanese holly	*	*			Gul et al. (2016)
Hypodematiaceae						
Didymochlaena truncatula (Sw.)	Tree maidenhair fern	*				Roux (2003)

Hypodematium crenatum (Forssk.)	No recorded common name		*	*		Singh and Singh (2012), Sathiyaraj et al. (2015), Gul et al. (2016)
Leucostegia truncata (D. Don) Fras-Jenk	No recorded common name		*	*		Dudani et al. (2013)
Nephrolepidaceae						
Nephrolepis biserrata (Sw.) Schott	Broad sword fernAlolokdo (Philippines)		*	*		de Winter and Amoroso (2003)
N. cordifolia (L.) C. Presl	Erect sword fern Bayabang (Philippines)	*	*			de Winter and Amoroso (2003)
N. hirsutula (G. Forst.) C. Presl	No recorded common name		*	*	*	de Winter and Amoroso (2003)
Polypodiaceae						de Winter and Amoroso (2003)
Aglaomorpha quercifolia (L.) Hovenkamp and *S. Linds*	No recorded common name		*			Costa et al. (2021)
A. rigidula (Sw.) Hovenkamp and S. Linds.	No recorded common name	*	*			de Winter and Amoroso (2003)
A. sparsisora (Desv.) Hovenkamp and S. Linds.	No recorded common name	*	*			de Winter and Amoroso (2003)
Dendroconche linguiforme (Mett.) Testo, Sundue and Field	No recorded common name	*				de Winter and Amoroso (2003)
Goniophlebium benguetense (Copel.) Copel.	(an-) anam-am; Benguet fern					Reid and Madulid (1972)
Lemmaphyllum carnosum (J. Sm. ex Hook.) C. Presl	No recorded common name		*			Mannan et al. (2008)
Leptochilus longissimus (Blume) L.Y. Kuo	No recorded common name	*				de Winter and Amoroso (2003)

(continued)

Table 1.1 (continued)

Family/species	Common name	Medicinal uses				References
		Ornamental	Medicinal	Edible	Raw material	
Loxogramme avenia (Blume.) C. Presl	No recorded common name	*				Boonkerd and De Winter (2003)
L. involuta (D. Don) C. Presl	No recorded common name				*	Boonkerd and De Winter (2003)
L. scolopendrioides (Gaudich.) C.V. Morton	No recorded common name	*			*	de Winter and Amoroso (2003)
L. parallela Copel	No recorded common name	*				Janakiram et al. (2019)
Microsorum punctatum (L.) Copel.	No recorded common name	*	*			de Winter and Amoroso (2003)
Phymatosorus commutatus (Blume) Pic.-Serm.	No recorded common name	*				de Winter and Amoroso (2003)
P. membranifolius (R.Br.) S. G. Lu	No recorded common name					de Winter and Amoroso (2003)
P. scolopendria (Burm. f.) Pic.-Serm	No recorded common name	*	*			de Winter and Amoroso (2003), Stuart (2018)
Platycerium coronarium (König ex Müller) Desv.	No recorded common name	*		*		Amoroso et al. (2015)
P. grande (A. Cunn. ex Fée) J. Sm.	No recorded common name	*				Amoroso et al. (2015)
Pyrrosia lanceolata (L.) Farw	Humang anapatpat; Holog; Apatpat an dodologapdi (Luzon, Philippines)		*			de Winter and Amoroso (2003)
Pyrrosia longifolia (Burm. f.) C.V. Morton	No recorded common name		*			de Winter and Amoroso (2003)
P. nummularifolia (Sw.) Ching	No recorded common name		*			de Winter and Amoroso (2003)

P. piloselloides (L.) M.G. Price	No recorded common name		*			de Winter and Amoroso (2003)
Tectariaceae						
Pleocnemia irregularis (C. Presl) Holttum	No recorded common name	*	*			Darnaedi and Ngatinem-Praptosuwiryo (2003)
Tectaria crenata Cav.	No recorded common name	*	*	*		Rusea and Aguilar (2003)
T. griffithii (Baker) C. Chr.	No recorded common name	*				de Winter and Amoroso (2003)

It can be noted that the IUCN and the Philippines National Red List based on DAO 2017–11 (2021) have differences on the designation of conservation status. Five were listed as threatened/endangered in the DAO 2017–11 (2021). However, these species have not been evaluated in the IUCN yet (Table 1.2). The assessment between these two units varies since the DENR is localized in the Philippines, and hence, the list would represent the status of the population of such species in the country, while that of IUCN is a global assessment that considers and depends on all available data from various countries, to assess the status of the species. Without enough data on the population of the species, the IUCN could not evaluate the conservation status of such taxa.

Several conservation efforts were done and promoted by the government, academes, and NGOs to protect and conserve these floras: from conserving its natural habitat and on-site species protection (in situ) to modern practices of ex situ conservation such as fernery establishment, spore and vegetative propagation, and tissue cultures (Barnicoat et al. 2011; Mehltreter et al. 2010). All of these are aimed at restoring fern population and avoiding its possible extinction. But among these conservation strategies, in situ also known as on-site conservation of species and habitat is highly promoted and should be the first option in the conservation of fern. This is to ensure prevention of species from becoming threatened in the wild (Mehltreter et al. 2010). With this goal in mind, this would accentuate the important role of the local people specifically indigenous people (IPs) in conservation, as they are the ones interacting with these ferns in its natural habitat. These people should be educated of the sustainable utilization of these floras and should be taught of ways on how to actively practice protection and conservation of the natural resources they have at their territory (Sobrevila 2008). The role of conservation should be a collective effort and should start from the local level as represented by the IPs. Collaboration and partnership with the IP should be promoted and stakeholders from the local government, academe, and NGOs may make it their goal to enhance capability-building efforts for the indigenous people (IPs) to help them become more engaged, informed, and equipped for biodiversity management and conservation.

1.4 Conclusion and Recommendation

Several fern species of Eupolypod I are economically important as they render great service to the society. Some of their economic values include but are not restricted to ornamentals, food and nutrition, and being great sources of plant active components essential to ethnobotany and pharmacology. Due to these human services, ferns are constantly exploited which has led to the decline of its numbers in the wild. With this, it is essential to practice conservation and start implementing guidelines and management strategies towards the protection of these fern floras. Collaborative efforts towards biodiversity management and conservation should be materialized and it is recommended that the partnership of local government, academe, and NGOs with the indigenous people (IPs) should be enhanced through education and

Table 1.2 Economically important Philippine Eupolypod I fern species with available conservation status from the IUCN and/or DAO 2017–11

Family	Scientific name	Conservation status	
		IUCN status	DAO 2017–11
Davalliaceae			
	Davallia denticulata (Burm. f.) Mett. ex Kuhn var. elata (G. Forst) Kuhn	NE	OTS
	D. embolostegia Copel.	NE	OTS
	D. hymenophylloides (Blume) Kuhn	NE	–
	D. lorrainii Hance	NE	OTS
	D. solida (G. Forst.) Sw. var. *solida*	NE	OTS
Dryopteridaceae			
	Arachniodes amabilis (Blume)	NE	–
	B. heteroclita (C. Presl)	NE	–
	B. rhizophylla (Kaulf.) Hennipman	NE	–
	Cyrtomium caryotideum (Wall. ex Hook. and Grev.) C. Presl	NE	–
	C. falcatum (L.f.) C. Presl	–	–
Hypodematiaceae			
	Didymochlaena truncatula (Sw.)	LC	–
	Hypodematium crenatum (Forssk.)	NE	–
	Leucostegia truncata (D. Don) Fras-Jenk	–	–
Nephrolepidaceae			
	Nephrolepis biserrata (Sw.) Schott	NE	–
	N. cordifolia (L.) C. Presl	NE	–
	N. hirsutula (G. Forst.) C. Presl	NE	–
Polypodiaceae			
	Aglaomorpha quercifolia (L.) Hovenkamp and *S. Linds.*	NE	–
	A. rigidula (Sw.) Hovenkamp and S. Linds.	–	–
	A. sparsisora (Desv.) Hovenkamp and S. Linds.	–	–
	Dendroconche linguiforme (Mett.) Testo, Sundue and Field	–	–
	Goniophlebium benguetense (Copel.) Copel.	NE	–
	Lemmaphyllum carnosum (J.Sm. ex Hook.) C. Presl	NE	–
	Leptochilus longissimus (Blume) L.Y. Kuo	–	–
	Loxogramme avenia (Blume.) C. Presl	–	
	L. involuta (D. Don) C. Presl	–	
	L. scolopendrioides (Gaudich.) C.V. Morton	NE	–
	L. parallela Copel.		
	Microsorum punctatum (L.) Copel.	NE	–
	Phymatosorus commutatus (Blume) Pic.-Serm., Webbia	NE	–
	P. membranifolius (R.Br.) S.G. Lu	–	–

(continued)

Table 1.2 (continued)

Family	Scientific name	Conservation status	
		IUCN status	DAO 2017–11
	P. scolopendria Pic.-Serm.	NE	–
	P. coronarium (König ex Müller) Desv.	NE	CE
	P. grande (A. Cunn. ex Fée) J.Sm.[a]	–	CE
	Pyrrosia lanceolata (L.) Farw	–	–
	P. longifolia (Burm. f.) C.V. Morton	NE	–
	P. nummularifolia (Sw.) Ching	NE	–
	P. piloselloides (L.) M.G. Price	NE	–
Tectariaceae			
	Pleocnemia irregularis (C. Presl) Holttum	NE	–
	Tectaria crenata Cav.	NE	–
	T. griffithii (Baker) C. Chr.	NE	–

Conservation status: *VU* vulnerable, *CE* critically endangered, *EN* endangered, *NT* near threatened, *OTS* other threated species, *LC* least concern, *NE* not evaluated.
[a]Philippine endemic.

capability building to ensure protection and conservation of these important floras at the local level. It is recommended however to consider a priority for in situ management strategies to prevent fern species population from declining in the wild, rather than trying to avoid species loss at the last moment. Fern species may be protected within their native range by conservation of their natural habitat (in situ) or by cultivation of individual species in botanical gardens or other horticultural institutions by either growing them from spores, vegetative propagation, or tissue culture (ex situ).

Future research can move forward with pharmacological and ethnobotanical studies on the medicinal uses of ferns and investigate aspects that a particular taxon shares. Also, the availability and conservation of edible varieties can boost food security along with other cultural benefits. It is also significant to ponder on the vulnerability and urgency of biodiversity loss affecting ferns and of deforestation in the Philippines.

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