Present State of Knowledge on the Orchids from Sarawak's Peat Swamps

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Bachelor of Science with Honours
(Plant Resource Science and Management)
2022

Present State of Knowledge on the Orchids from Sarawak's Peat Swamps

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A thesis submitted in partial fulfilment of the Requirement of The Degree Bachelor of Science with Honours
(Plant Resource Science and Management)

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UNIVERSITI MALAYSIA SARAWAK
2022

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ACKNOWLEDGEMENT

The completion of this final report could not have been possible without the assistance and contributions of many people.

First and foremost, I would like to express my gratitude to my supervisor, Dr Mohd Akmal bin Mohd Raffi, for his patience, motivation, enthusiasm, and immense knowledge in advising and guiding me throughout the process of conducting research and writing this thesis all the time.

In addition to my supervisor, I'd like to thank Dr. Qammil Muzzammil Abdulllah for his extensive experience and knowledge, insightful comments, and sharing pertinent information about my thesis research.

I would also like to thank my colleagues at Universiti Malaysia Sarawak who are taking the same course as me, as well as two master students, Almunah Abd Mutalib and Haziah Musa, for sharing their knowledge in conducting the thesis and for supporting and helping me develop my ideas.

I also would like to sincerely thank my family: my parents, Stephen Anak Gangga and Catherine Bong, for their prayers, love, understanding and continuing support to complete this research work.

Finally, I gratefully acknowledge the Sarawak Timber Association for providing me with a full-time degree scholarship. This sponsorship has helped cover my expenses throughout carrying out this thesis.

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ABSTRACT

The orchid diversity and distribution at Sarawak's peat swamps is considered to be understudied as most of the studies concentrate on mixed dipterocarp forests. Large areas of peat swamps in Sarawak have been threatened by uncontrolled anthropogenic activities causing the researcher difficult to collect data on orchids in disturbed areas. As a result, the current knowledge on the existence of peat swamp orchids becomes poorly understood. Hence, this study aimed to propose a provisional checklist of orchid species with their conservation status and distribution in the peat swamp areas of Sarawak. This study was conducted by collecting the information through the existing literature and documents from the internet and published books. The information on the subfamily, genus, species, habit, and distribution of the previous and currently recorded orchid species at Sarawak's peat swamp area were analysed and validated through the KEW World Checklist of Selected Plant Families. The inventory checklist of orchids in this study consists of 52 species and 26 genera from 3 subfamilies from Sarawak's peat swamps. Among the listed were classified into 42 epiphytes, eight terrestrials, and two myco-heterotrophs. Meanwhile, the present conservation status of the recorded peat swamp orchids was assessed via the IUCN Red List of Threatened Species and Malaysia Plant Red List. This study revealed that the peat swamp areas in Sarawak have become one of the most essential hotspots for orchid biodiversity and provide a deeper understanding of the current state of peat swamp orchids for future research.

Keywords: Borneo, checklist, conservation status, Orchidaceae, peat swamp.

ABSTRAK

Kepelbagaian dan taburan orkid di kawasan paya gambut di Sarawak masih kurang dikaji kerana kebanyakan kajian tertumpu kepada hutan dipterokarpa. Kebanyakan kawasan paya gambut di Sarawak telah diancam oleh aktiviti antropogenik yang tidak terkawal menyebabkan para penyelidik sukar untuk mengumpul data berkenaan orkid di kawasan yang terganggu. Akibatnya, pengetahuan semasa tentang kewujudan orkid di paya gambut menjadi kurang difahami. Oleh itu, kajian ini adalah bertujuan untuk menyenaraikan spesies orkid dengan status pemuliharaan dan taburannya yang terdapat di kawasan paya gambut di Sarawak. Kajian ini telah dijalankan dengan mengumpul maklumat melalui literatur dan dokumen sedia ada daripada internet dan buku terbitan. Maklumat subfamili, genus, spesies, tabiat, dan taburan spesies orkid di kawasan paya gambut di Sarawak telah dianalisis dan disahkan melalui KEW World Checklist of Selected Plant Families. Senarai semak inventori orkid dalam kajian ini terdiri daripada 52 spesies dan 26 genera daripada 3 subfamili dari kawasan paya gambut Sarawak. Antara yang disenaraikan telah dikelaskan kepada 42 orkid epifit, lapan orkid tanah, dan dua mikoheterotrof. Sementara itu, status pemuliharaan orkid paya gambut yang direkodkan dinilai melalui IUCN Red List of Threatened Species dan Malaysia Plant Red List. Kajian ini telah mendedahkan bahawa kawasan paya gambut di Sarawak telah menjadi salah satu kawasan yang paling penting untuk kehidupan orkid dan juga memberikan pemahaman yang lebih mendalam tentang keadaan semasa orkid di paya gambut untuk kajian masa depan.

***Kata kunci**: Borneo, senarai semak, status pemuliharaan, orkid, paya gambut.*

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LIST OF ABBREVIATIONS

LC	Least Concern
NE	Not Evaluated
Num.	Number
UNIMAS	Universiti Malaysia Sarawak

CHAPTER 1

1.0 INTRODUCTION

Orchid is a fascinating plant with various shapes and beautiful colours. It belongs to the Orchidaceae family of which it can be further divided into five subfamilies namely Apostasioideae, Cypripedioideae, Epidendroideae, Orchidoideae, and Vanilloideae. These subfamilies have different characteristics, but they shared several synapomorphic floral characters including three sepals, three petals in which one of the petals specialised into a labellum, and a consortium of reproductive structures called a column. The orchid is one of the most highly evolved and diverse flowering plants with over 25, 000 species worldwide. More than 4,000 species of orchid are reported in Malaysia of which approximately 978 species are found in Peninsular Malaysia while the remaining can be found in the Bornean states (Besi *et al.*, 2020a; Besi *et al.*, 2022; Go & Hamzah, 2008). In Sarawak, it is estimated about 1000 species of orchids have been discovered so far including those that are distributed in peat swamp areas (Forest Department Sarawak, 2022). The peat swamp area of Sarawak has a unique ecosystem that is the most extensive in coastal lowlands. It is the largest of all peatland areas in Malaysia, covering approximately 1.6 million hectares of the land. With such a wide area, it has a huge potential to harbour many plant species including one of the important plant groups to the ecosystem, the orchids. Despite of its potential, the orchid from the peat swamp area in Sarawak is considered to be understudied as most of the orchid diversity-related studies were focusing on the mixed dipterocarp forest (Besi *et al.*, 2020b). A study on orchids in the peat swamp area is expected to be challenging as a large area of Sarawak's peat swamp is deforested and transformed into agricultural land or settlement areas (Dohong *et al*., 2017). Furthermore, these anthropogenic activities to some extent have disturbed the peat swamp landscape thus causing the researchers to face difficulty in exploring and studying the diversity of orchids in the disturbed areas. As a result,

documentation on peat swamp orchids is still limited and uncontrolled anthropogenic activities pose a continuous threat that leads to the inevitable extinction of orchid species. For this reason, it is needed to prioritise orchid conservation through a thorough assessment of orchid diversity and ecology in the peat swamp areas. Therefore, the objectives of this study are to propose a checklist of orchids in the peat swamp areas of Sarawak and to assess the conservation status and distribution of the listed peat swamp orchids. The findings of this study will highlight that Sarawak's peat swamps are known as an important habitat for orchids, as well as contribute to providing data on the present state of orchid species for future studies.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Peat swamp area

Peat swamps are found in subtropical and tropical regions of the world. About 23 million hectares of peat swamps are found in Southeast Asia, mostly near the coasts of East Sumatra, Kalimantan, Papua New Guinea, Malaysia, and Brunei (Page *et al*.,2006). In Malaysia, Sarawak state has the largest peat swamp area covering about 1,657,600 hectares of the total land area of the country (Melling, 2016). It is distributed widely in the lowlands and coastal plains of Mukah and along the delta plains of the Samarahan-Sadong, Lupar-Saribas, Rajang, Baram and Limbang river (Forest Department Sarawak, 2021b; Sawal, 2004).

2.1.1 The characteristics of peat swamp area

According to Leete (2006), peat swamps are waterlogged areas that grow on a layer of organic material up to 20 metres thick. The main factor influencing peat formation is climate, particularly the even distribution of precipitation over the year. According to the Koppen climate classification, peat is abundant in tropical rainforests and temperate climates with no dry season and rainfall greater than 2500 mm/year (National Geographic Society, 2017). In humid conditions, peat accumulates faster and decomposes less than in dry regions. Apart from climatic factors, the accumulation of organic matter surpasses the rate of decomposition cause the formation of peat (Huat *et al*., 2011). The organic material such as dead leaves, mosses, and fungi in the peat is prevented from completely decomposing. This is because the inundated peat swamp has a low level of oxygen, which reduces the activity of microorganisms in organic matter decomposition (Bian *et al*., 2020). Since peat swamps are naturally inundated with water, the plants have their unique features to adapt to the

environment to survive. For instance, the woody plant has mechanical roots, buttress roots, and shrubs to strengthen the soft soil, and pneumatophores to cope with anaerobic conditions (Cronk & Fennessy, 2016). Besides, herbaceous plants like wild orchids grow on the bark of the trees to receive sufficient light and moisture (Clay & Hubbard, 2021). In Sarawak, the peat swamp areas include peat swamp forests, brackish swamp forests, mangrove swamp forests, and freshwater swamps (Ratnayake, 2020). The topography of Sarawak's peat swamps is dome-shaped and has an estimated depth peat of more than 1 metre (Melling, 2016). These areas run multifunction that benefit humans and nature. One of the functions is absorbing and storing large quantities of carbon in the peat due to the incomplete decomposition of organic matter. It is estimated that a peat swamp can store approximately 5,800 tonnes of carbon per hectare in 10-metre-deep (Adon *et al.*, 2013). Herewith it can help in reducing global warming. Besides, the peat swamp area can serve as flood mitigation. The peat acts as a natural sponge to absorb excess water during high precipitation.

2.1.2 Importance of peat swamp area in Sarawak

The potential of peat swamp areas for economic use has led to an increase in anthropogenic activities such as logging and agriculture. In Sarawak, the discovery of high-value tree species like *Shorea albida* in peat swamp areas has attracted commercial logging activity to produce wood products (Bruenig, 2019). The peat swamp areas in Sarawak are also used for agricultural development, especially oil palm plantations. Oil palm planters prefer the peat swamp area because the fruit production of oil palm is very productive on peat (Melayong & Fong, 2016). Several studies on the peat swamps of Sarawak show that they are home to many plant species. An estimated over 240 plant species have been recorded in peat swamp areas of Sarawak (World Wildlife Fund, 2016). Several wild orchid species were spotted in the peat swamps of Loagan Bunut National Park, Sarawak (Tawan *et al*., 2008).

2.2 Orchids

The name orchid is derived from the Greek, ‘orchis’, which means testicle because of the shape of the root tubers (Knapp, 2021). The orchids are cosmopolitan, occurring on all vegetated continents except Antarctica and deserts (Gaskett & Gallagher, 2018). They grow abundantly in the humid tropical and subtropical regions.

In general, most orchid flowers illustrate a zygomorphic shape which has an outer whorl of three sepals and an inner whorl of three petals. The centre petal of orchids is transformed into a unique structure called a lip, and this petal is always different from the other two petals (Cole & Waller, 2020). The lip acts as a landing platform for the pollinator. The sexual structure of the orchid flower consists of stamens and pistils that are fused into a column. Based on the stamen, the subfamilies of orchids are divided into monandrous and diandrous groups (De, 2020). Epidendroideae, Orchidoideae, and Vanilloideae are monandrous orchids with only one stamen, whereas Apostasioideae and Cypripediodeae are diandrous orchids with two stamens. The orchids have simple leaves with parallel veins. The arrangement of leaves can be alternate, opposite, or whorled on the stem. The orchid stem determines its growth patterns which are monopodial and sympodial (Zhang *et al*., 2018). Monopodial orchids have an active apical meristem and grow upward from the top of the plant while sympodial orchids grow sideways. The roots of the orchid are cylindrical and have a wiry filament and a thick sponge-like covering called velamen, which aids in water and mineral absorption (Hauber *et al*., 2020).

2.2.1 Orchids diversity and distribution

Orchids exhibit a great diversity of colours, patterns, and sizes, from microscopic plants in *Bulbophyllum* and *Platystele* to large plants in *Cyrtopodium* and *Grammatophyllum* (Stern, 2014). The high diversity of orchids could be due to small seeds that come in great

numbers, which favours the expression of genetic variability and a high rate of dispersal across ecological barriers. Malaysia is considered a biodiversity hotspot for orchids. They are widely distributed in several habitats such as limestone, peat swamps, wetlands, hills, and montane forests (Ong *et al.*, 2017). The orchid growth habits can be epiphyte, terrestrial, lithophytes, and myco-heterotrophs. The epiphytic orchids, which grow on another plant but do not parasitise, are most found in all ecosystems in Malaysia. For example, the genus Dendrobium, which is primarily epiphytes, can be found on limestone, in the mountains and lowlands, including peat swamp forests (Besi *et al*., 2019a). The other group of orchids that can be spotted in Malaysia is terrestrial plants that grow on the ground, lithophytes that grow on rocks, and myco-heterotrophs that lack chlorophyll and derive their nutrition from decaying matter in the soil. Although the orchids are among the most diverse plants, some of them are threatened due to anthropogenic activities in their habitat (Wraith & Pickering, 2018). In Malaysia, extensive deforestation since the year 2000 has led to a significant decline in orchid populations (Go, 2021). Several orchids that are native to Malaysia such as *Paphiopedilum barbatum* are classified as endangered due to logging threats (Teoh, 2021). Malaysian researchers found out that exploring the area disturbed by active logging concessionaires can lead to discoveries that will improve our knowledge of orchid diversity and distribution (Besi *et al*., 2019b).

2.2.2 Importance of orchids to the ecosystem

Orchids are involved directly or indirectly with many aspects of ecosystem function. One of the importance of orchids to the ecosystem is their interactions with another biota like plants, fungi, and animals through symbiotic relationships (Yeh *et al*., 2019). This is because the life cycle of orchids is complex and is often dependent on mycorrhiza, insects, or birds to survive. For instance, the orchids also rely on insects or birds for pollination, and they repay the pollinator agents by providing nectars. Moreover, orchids are the potential to

be bioindicators of ecosystem health (Newman *et al*., 2015). Orchids are thought to be sensitive to environmental change due to their very specific to generalist interactions with pollinators and mycorrhizae (Swarts & Dixon, 2009). It is likely that the presence or absence, growth, or reproduction of orchids will respond to various disturbances and events.

2.3 Peat swamp orchid of Sarawak

Orchids are one of the unique and delicate plant communities in the peat swamp ecosystem and they are very vulnerable to environmental changes. The orchids found in peat swamp areas are mostly epiphytic and terrestrial life forms (Go, 2019). Currently, the large area of peat swamps in Sarawak has been cleared for agricultural development such as oil palm and sago plantations (Department of Irrigation and Drainage Sarawak, 2022). Of those that remain, approximately 86, 182 hectares are the protected peat swamp areas of Sarawak including Bruit Island Wildlife Sanctuary, Loagan Bunut National Park, Maludam National Park, Mulu National Park, Samunsam Wildlife Sanctuary, Sedilu, and Ulu Sebuyau, and some remote islands in Bako National Park (Forest Department Sarawak, 2022; World Wildlife Fund, 2016). In 2001, 1019 orchid taxa of Sarawak were successfully documented in the checklist orchid of Sarawak (Beaman *et al*., 2001). Furthermore, the listed orchids were also recorded in a few areas of peat swamp in Sarawak such as Bruit Island, Loagan Bunut, and Maludam. Presently, there is still a paucity of information on orchid species presence in peat swamp areas of Sarawak (Forest Department Sarawak, 2021a). It is anticipated that there are many species of orchids yet to be discovered and collected in certain parts of the peat swamp areas in Sarawak (Darani, 2021).

CHAPTER 3

3.0 MATERIALS AND METHOD

3.1 Data collection

The data of the previously recorded orchid species in the peat swamp areas in Sarawak (including Bruit Island, Loagan Bunut National Park, Maludam National Park, Rajang Delta, Sedilu, and UNIMAS in Kota Samarahan) were collected from multiple reliable resources such as Beaman *et al*. (2001), Meekiong *et al*. (2021), Tawan *et al*. (2008) and Raffi *et al*. (2022). The updated taxonomic classification, habit, and distribution for each recorded orchid were retrieved using the information provided on the Kew World Checklist of Selected Plant Species (WCSP) website (https://wcsp.science.kew.org/). Subsequently, the conservation status of the species was assessed via the IUCN Red List of Threatened Species website (https://www.iucnredlist.org/) and Malaysia Plant Red List (https://www.mybis.gov.my/) classified them into the five threat categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) and Not Evaluated (NE).

3.2 Data analyses

The collected data of the recorded species were compiled and tabulated into a species inventory. From the inventory, a brief information on family, genus, species, and life forms were determined. The checklist included the subfamily, genus, species, habit, distribution, and conservation status of orchids in the peat swamp habitat in Sarawak.

CHAPTER 4

4.0 RESULTS

4.1 Species diversity of Sarawak's peat swamp orchids

Currently, the Sarawak's peat swamps documented a variety of orchid species that are classified into several genera and subfamilies. The result obtained from this study showed that a total of 52 species from 26 genera and 3 subfamilies (Epidendroideae, Orchidoideae, and Vanilloideae) of Orchidaceae have been recorded in the peat swamp areas of Sarawak. The most abundant subfamily recorded in Sarawak's peat swamp areas was Epidendroideae (47 species, 21 genera), followed by Orchidoideae (4 species, 4 genera) and Vanilloideae (1 species, 1 genus) (Figure 1 & Figure 2).

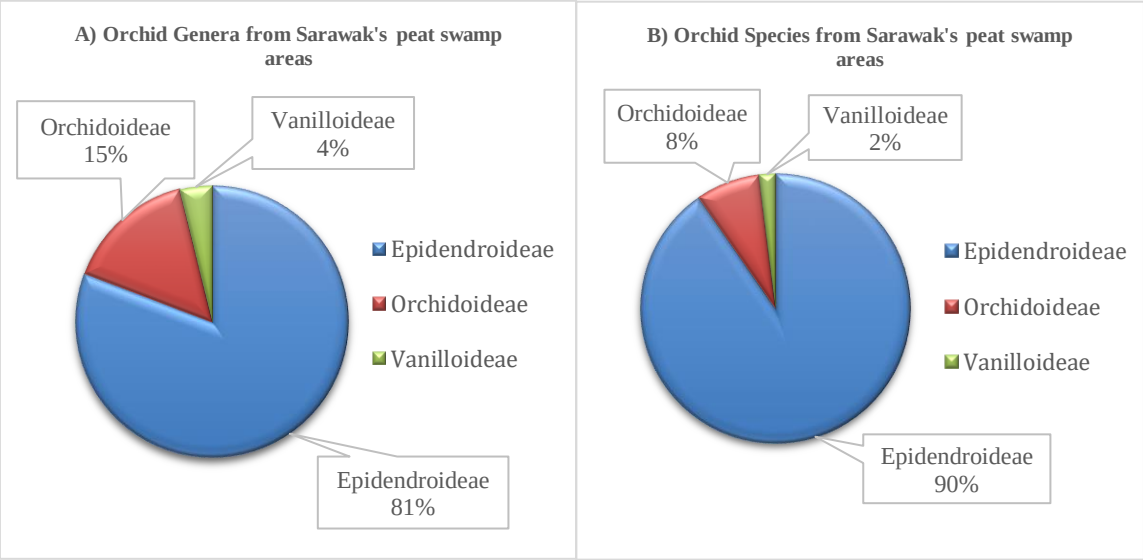

Figure 1: Percentage of orchid (A) genera and (B) species from different subfamilies found in peat swamp areas of Sarawak.

The most species-rich genera (12 species) distributed was *Bulbophyllum*, second in line (5 species) was *Dendrobium*, followed by *Appendicula*, and *Coelogyne*, both recorded 4 species, *Agrostophyllum*, *Liparis*, *Plocoglottis*, *Strongyleria*, and *Trichotosia* with only 2 species, while the least species-rich genus (1 species) recorded were *Aphyllorchis*,

Callostylis, *Cymbidium*, *Cystorchis*, *Dienia*, *Dipodium*, *Eria*, *Erythrorchis*, *Grammatophyllum*, *Mycaranthes*, *Micropera*, *Nephelaphyllum*, *Tainia*, *Thelasis*, *Thrixspermum*, *Vrydagzynea* and *Zeuxine* (Figure 2 & Figure 3).

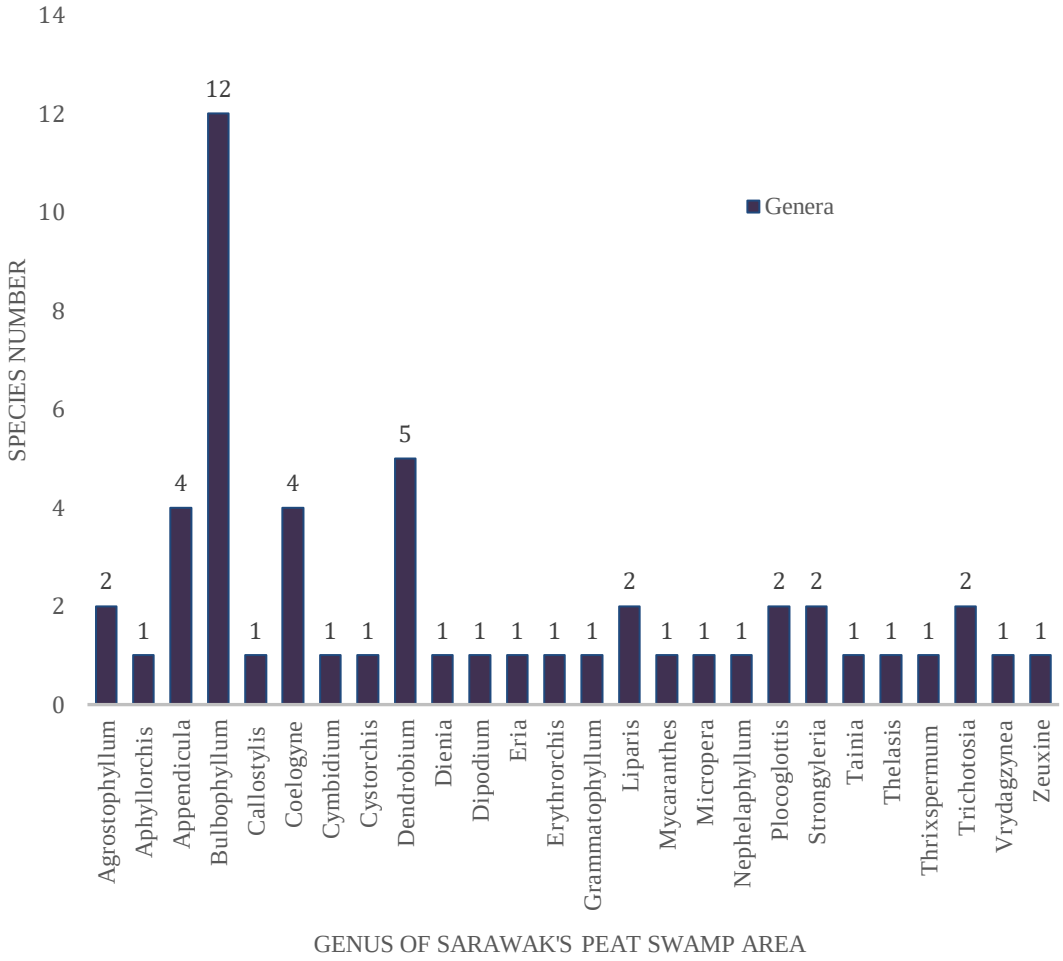

Figure 2: Number of orchid species based on genera recorded in peat swamp areas of Sarawak.

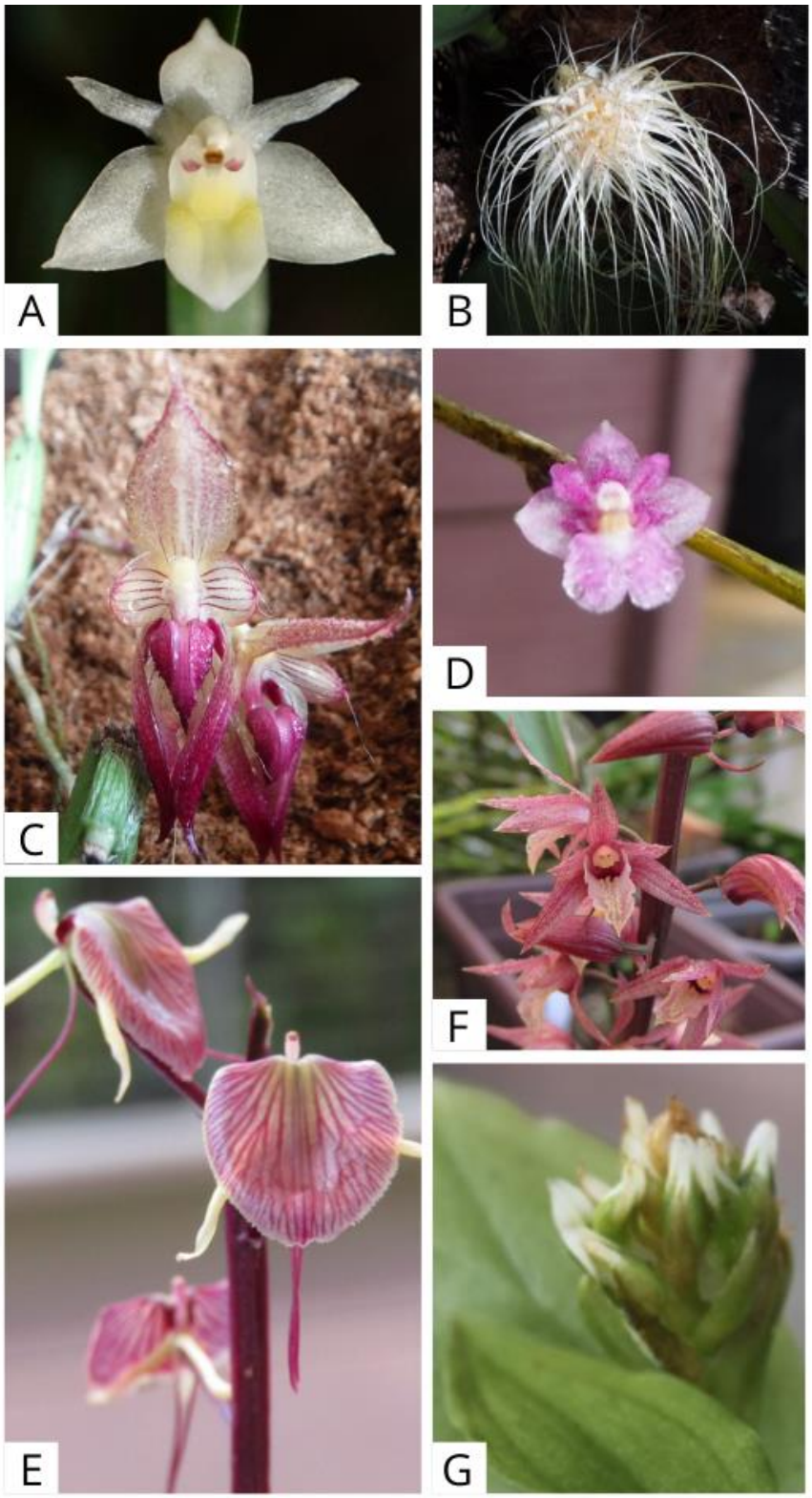

Figure 3: Diversity of orchid species from the selected genera found in the peat swamps of Sarawak. A. *Agrostophyllum stipulatum* subsp. *bicuspidatum* B. *Bulbophyllum medusae* C. *Bulbophyllum subumbellatum,* D. *Dendrobium rosellum* E. *Liparis tricallosa*, F. *Tainia paucifolia,* G. *Vrydagzynea albida.*

The checklist of Orchidaceae in Sarawak's peat swamp areas revealed that epiphyte (42 species) was the most common growth habit, followed by terrestrial orchid (8 species) and mycoheterotrophy (2 species). In terms of distribution, all the listed orchid species were most widespread in Borneo (Sabah, Sarawak, and Kalimantan). From the checklist, there were 10 species endemic to Borneo.

Table 1: Number of peat swamp orchids based on their growth habit.

Growth Habit	Num. species
Epiphyte	42
Terrestrial	8
Myco-heterotroph	2

Table 2: The checklist of orchid flora in peat swamp areas of Sarawak. (LC, least concern; NE, not evaluated.)

No	Subfamily	Genus	Species	Habit	Distribution	IUCN, 2022	Malaysia Plant Red List, 2022	Reference
1	*Epidendroideae*	*Agrostophyllum*	*Agrostophyllum majus* Hook	Epiphyte	Borneo, Jawa, Lesser Sunda Is., Malaya, Philippines, Sumatera, Thailand	NE	NE	Beaman *et al*., 2001
2	*Epidendroideae*	*Agrostophyllum*	*Agrostophyllum stipulatum* subsp. *bicuspidatum* (J.J.Sm) Schuit	Epiphyte	Borneo, Jawa, Malaya, Sulawesi, Sumatera	NE	NE	Tawan *et al*., 2008 & Raffi *et al.*, 2022
3	*Epidendroideae*	*Aphyllorchis*	*Aphyllorchis pallida* Blume	Myco-heterotroph	Borneo, Cambodia, Jawa, Malaya, New Guinea, Philippines, Sulawesi, Sumatera, Thailand, Vietnam	NE	NE	Beaman *et al*., 2001
4	*Epidendroideae*	*Appendicula*	*Appendicula anceps* Blume	Epiphyte	Borneo, Jawa, Lesser Sunda Island, Malaya, Philippines, Sulawesi, Sumatera, Thailand	NE	NE	Beaman *et al*., 2001
5	*Epidendroideae*	*Appendicula*	*Appendicula cornuta* Blume	Epiphyte	Assam, Borneo, Cambodia, China Southeast, East Himalaya, Hainan, Jawa, Lesser Sunda Is., Malaya, Myanmar, Philippines, Sulawesi, Sumatera, Thailand, Vietnam	NE	NE	Beaman *et al*., 2001
6	*Epidendroideae*	*Appendicula*	*Appendicula polita* J.J.Sm	Epiphyte	Borneo	NE	NE	Beaman *et al*., 2001
7	*Epidendroideae*	*Appendicula*	*Appendicula uncata* subsp. *sarawakensis* J.J.Wood	Epiphyte	Borneo	NE	NE	Beaman *et al*., 2001

Table 2: Continued. (LC, least concern; NE, not evaluated.)

No	Subfamily	Genus	Species	Habit	Distribution	IUCN, 2022	Malaysia Plant Red List, 2022	Reference
8	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum acuminatum* (Ridl.) Ridl.	Epiphyte	Andaman Island, Borneo, Malaya, Thailand	NE	NE	Beaman *et al*., 2001
9	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum beccarii* Rchb.f.	Epiphyte	Borneo	NE	NE	Beaman *et al*., 2001
10	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum apodum* Hook.f.	Epiphyte	Assam, Bismarck Archipelago, Borneo, China South-Central, East Himalaya, Fiji, Jawa, Laos, Lesser Sunda Island, Malaya, Maluku, Myanmar, New Caledonia, New Guinea, Nicobar Island, Philippines, Samoa, Solomon Island, Sulawesi, Sumatera, Thailand, Vanuatu, Vietnam, Wallis-Futuna Island	NE	NE	Beaman *et al*., 2001
11	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum medusae* (Lindl.) Rchb.f.	Epiphyte	Borneo, Malaya, Sumatera, Thailand	NE	NE	Raffi *et al*., 2022
12	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum otochilum* J.J.Verm.	Epiphyte	Borneo	NE	NE	Beaman *et al*., 2001
13	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum patens* King ex Hook.f.	Epiphyte	Borneo, Malaya, Myanmar, Sumatera, Thailand, Vietnam	NE	NE	Beaman *et al*., 2001
14	*Epidendroideae*	*Bulbophyllum*	*Bulbophyllum purpurascens* Teijsm. & Binn.	Epiphyte	Borneo, Jawa, Malaya, Sumatera, Thailand	NE	NE	Beaman *et al*., 2001