



Faculty of Resource Science and Technology

**Present State of Knowledge on the orchids from
Sarawak's limestone area**

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Bachelor of Science with Honours
(Plant Resource Science and Management)
Year 3

Present State of Knowledge on the Orchids from Sarawak's Limestone Area

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

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UNIVERSITI MALAYSIA SARAWAK

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ACKNOWLEDGEMENT

I would like to acknowledge and give my warmest thanks to my supervisor Dr Mohd Akmal Mohd Raffi who made this work possible. His guidance and advice carried me through all the stages of writing my project. I would also like to thank my friend Magdalina anak Stephen, senior master's student Haziah and Munah for letting my defense be an enjoyable moment, and for your brilliant comments and suggestions, thanks to you. I would also like to give special thanks to my family as a whole for their continuous support and understanding when undertaking my research and writing my project. Your prayer for me was what sustained me this far. Finally, I would like to thank God, for letting me through all the difficulties. I have experienced your guidance day by day. You are the one who let me finish my degree. I will keep on trusting you for my future.

Present State of Knowledge on the orchids in Sarawak's
limestone area

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ABSTRACT

Orchidaceae is known as beautiful flowers in the world. Orchids' beauty comes in various shapes, sizes, and color. Among the ecosystem in Sarawak, the limestone ecosystem is the prominent ecosystem as it harbour a high number of endemic orchid species. There are several documents regarding the orchid in the limestone area but there is no official record that has yet to be confirmed. In this study, a provisional checklist of the present state of orchids in the limestone area of Sarawak was proposed to assess the conservation status and endemism of the listed orchids. In order to achieve this study, the data were collected from the previously recorded data of orchids in Sarawak's limestone area from reliable resources and analysed into a table. In the result, there are 354 species of orchid from 83 genera were recorded in the study. Among the orchids, there are 26 endemic species, and several hyper endemic species of orchids were found in Sarawak's limestone area.

Key words: Orchidaceae, Sarawak orchid, limestone orchid, orchid habitat

ABSTRAK

Orchidaceae dikenali sebagai bunga yang cantik di dunia. Kecantikan orkid datang dalam pelbagai bentuk, saiz dan warna. Antara ekosistem di Sarawak, ekosistem batu kapur merupakan ekosistem yang terkenal kerana ia mempunyai bilangan spesies orkid endemik yang tinggi. Terdapat beberapa dokumentasi mengenai orkid di kawasan batu kapur tetapi tiada rekod rasmi yang masih belum disahkan. Dalam kajian ini, senarai semak sementara keadaan orkid semasa di kawasan batu kapur Sarawak telah dicadangkan untuk menilai status pemuliharaan dan endemik orkid yang disenaraikan. Bagi mencapai kajian ini, data telah dikumpul daripada data orkid yang direkodkan sebelum ini di kawasan batu kapur Sarawak daripada sumber yang boleh dipercayai dan dianalisis ke dalam jadual. Hasilnya, terdapat 354 spesies orkid daripada 83 genera telah direkodkan daripada kajian tersebut. Di antara orkid itu, terdapat 26 spesies endemik dan beberapa spesies orkid hiper endemik ditemui di kawasan batu kapur Sarawak.

Kata kunci: Orchidaceae, Orkid Sarawak, Orkid batu kapur, habitat orkid

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CHAPTER 1

Introduction

The orchid is one of the most beautiful and attractive flowers in the world. Its beauty comes in various shapes, sizes, and color. Orchids are known as good bio-indicators of ecosystem health that can be used to determine the quality of an environment and how it changes over time. In Sarawak, there are many types of ecosystems namely, mixed dipterocarp forest ecosystem, peat swamp ecosystem, and limestone ecosystem. Among them, the limestone ecosystem is one of the prominent ecosystems as it harbours a high number of endemic orchid species. The endemicity among orchids might occur due to several factors such as microclimate, and nutrient availability.

In general, limestone regions in Sarawak are known as protected area because it is subject to commercial quarrying activity for cement production. The cement production would create permanent disfigure of the limestone region and would change its natural landscape (Bishnoi *et al.*, 2020). Landform of limestone also popular as recreational for tourism attracting people to visit that place such as its rock outcrop, caves and lagoons (Dowling, 2013). If these landforms were visited by many visitors, it might disturb the orchid habitat. Apart from that, illegal collection of orchids also occur as orchid are known as beautiful plant and might be used for aesthetic purposes. These tourism activities also giving difficulties to orchid to grow and distribute well as the habitat of orchid getting loss and disturbed (Pickering & Hill, 2007).

To date, there are several documentations regarding the orchid in the limestone area but there is still no official record has yet to be confirmed because the limestone region is protected for its unique landform. Thus, it is important to know the current state of orchid from Sarawak in the limestone area because there is no official record have yet to be recorded. The results and record obtained can be useful to the related party to make the right decisions to defend limestone that are very valuable to humans which are declining in size in Sarawak in particular

and Malaysia in general.

Therefore, this study is conducted to compile the available documentation of orchids in the limestone area of Sarawak and update the checklist of the present state of orchids in the limestone area of Sarawak.

The general study aims are:

- a. To contribute information towards a more complete checklist of orchids in limestone areas of Sarawak, and
- b. As certain the conservation status as well as the endemism of orchids which have been listed in limestone areas in Sarawak

The specific study objectives, therefore are:

1. To propose a provisional checklist of the present state of orchids in the limestone area of Sarawak, and
2. To assess the conservation status and endemism of the listed orchids.

CHAPTER 2

Literature Review

2.1 Limestone

The limestone area in Sarawak has been formed about 135 million years ago, during the late Jurassic and Cretaceous periods (Yen, 2006). Generally, limestone area is made from a naturally occurring mineral that primarily consists of calcium carbonate and usually contains magnesium carbonate as its secondary component (Oates, 2010). The landform formation of limestone is usually developed through the interaction of water, climate, and rocks (Bin *et al.*, 2008). The pressure of water will compact the small rock or stone particles and form limestone (Groove, 2021). Apart from that, limestone also can be formed by the activity of reef-building marine organisms (Veron, 2011). Once it raised above the surface, the chemical and physical erosion rapidly forms the karst landscape features such as caves, sinkholes, and rock outcrops (Goltenboth *et al.*, 2006).

The limestone area of Sarawak is the element of the karst landscape, where it can be characterized by a distinct topography that develops as water dissolves soluble calcareous rock (Wasli *et al.*, 2017). Sarawak's limestone areas are mainly located in the southwest and north of Sarawak with several isolated formations in central Sarawak which account for about 0.4% of the total area of Sarawak (Abdullah, 2009).

In total, limestone areas in Sarawak have approximately less than 500 hills to be compared with 911 hills in limestone areas located in Peninsular Malaysia have about 1,393 hills altogether (Bedi, 2021). The limestone area of Sarawak can be found either in the national park such as Gunung Mulu and Niah from Miri or a nature reserve at Bau, Kuching Limestone (Sang, 2007). However, the conservation status of some limestone areas such as Padawan limestone, Baram limestone, Tatau limestone are still remains unexplored (Grinang,2013).

2.1.2 Importance and Threats of limestone area to orchid

Limestone areas are internationally recognized as having significant biological importance and groundwater value (Wong *et al.*, 2003). They are characterized with microclimate and nutrient availability, as well as unique communities of species that have evolved to deal with these conditions (Fauna & Flora International, 2018). In addition, limestone can act as an aquifer to orchid because it is ideal for storing water due to its porous karst (Geekiyanage *et al.*, 2019). Apart from that, limestone soils are generally shallow with a pH of 7 to 8, nutrient-poor, high in calcium carbonate (CaCO₃), and well-drained (Guampedia, 2021). Limestone is very valuable in the market because it can neutralize soil acidity as its pH value is alkaline (Gazey & Davies, 2009). Soil acidity can reduce plant nutrient availability and increases the aluminum and manganese toxicities (Womble, 2018). In line with Malaysian Cave and Due to their restricted natural formation and the degradation of limestone habitats, many orchids are found on limestone hills (MCKC, 2015).

Limestone hills in the tropics are considered biodiversity "arks" as it can harbour a lot ecosystem and tendency to have endemic species (Schilthuizen, 2004). The constant threat to limestone areas is quarrying activity and it is the most direct threat to their biodiversity because it destroys habitats irreversibly (Clements *et al.*, 2006). Limestone area are made of a highly valuable human resources as it is the key ingredient in the production of cement, concrete, mortar, and agriculture nutrients where it will supply various oxides to soil, reduces soil acidity and making it more hospitable environment for plants to grow in the soil (Brenner, 2019). Degradation of forests on and around limestone hills can give a negative impact on orchid biodiversity as well (Schilthuizen *et al.*, 2005). In ct, many orchids that endemics to limestone region is already extinct or on the verge of extinction (Liew *et al.*, 2014). As a result, there is an urgent need to prioritize the conservation of limestone hills as they continueto be exploited, especially by the cement industry.

2.2 Orchids of Limestone area in Sarawak

2.2.1 The Family of Orchidaceae

Orchidaceae is the most diverse flowering plant family, with over 25,000 species worldwide, accounting for 10% of all angiosperms (Dressler, 2005). The orchid family is a very large group of monocots and one of the most recently evolved plant families. The Orchidaceae species classified into five (5) subfamilies; Apostasioideae, Vanilloideae, Cyripedioideae, Orchidoideae, and Epidendroideae (Diantina *et al.*, 2020). In addition, orchids are zygomorphic and mostly orchids are resupinate, with one petal or labellum where it is always significantly modified (Rudal & Bateman, 2002). Other than that, the stamens and carpels of orchid are united, and the seeds of orchid are extremely small (De, 2020). *Orchidaceae* in limestone area based on natural habitat are broadly classified into three categories, namely terrestrial, epiphytes and saprophyte. Epiphytes orchids are orchids that grow on trees (Van & Wood, 2013). Epiphytic orchids have thick, succulent leaves with a thick cell wall, cuticles, a small sub-stomatal chamber, and have smaller stomata than terrestrial orchids (Zhang *et al.*, 2018). Terrestrial orchids can be rhizomatous or produce corms or tubers which carry a reserve carbohydrate and most terrestrial orchids do not require pseudobulbs in warm, humid areas (De *et al.*, 2015). Saprophytic orchids feed on decomposed organic materials rather than photosynthesis (Sailo *et al.*, 2014). Orchids are extremely adaptable, growing in almost all climates except the most frigid and arid place (Rainforest Alliance, 2021).

2.2.2 Orchids of Sarawak

Orchids in Malaysia in total are almost close to 4000 species and in Sarawak are about 1000 species of orchid (Go *et al.*, 2020; Beaman, 2001). In addition, Orchidaceae in the Sarawak limestone area is approximately comprised of 400 species where it covered around 30% of orchids in Sarawak (Forest Department Sarawak, 2022). These orchids can be found in several places like in Padawan, Dered Krian, Bau, and even in Miri Mulu caves. Moreover, Go *et al.* (2009) has collected about ten orchid species that were endemic to the Kuching Padawan limestone region from 188 species of orchid. In Dered Krian, Haniza *et al.* (2017) stated that there a total of 55 species with 25 genera were recorded and 1 endemic species were found which is *Paphiopedilum stonei*. On the other hand, the limestone region has an equatorial climate with high humidity and annual rainfall providing favorable to the orchids (Eng, 2012). In accordance with Lim (2008) stated that, through the presence of various microhabitats in limestone area will increasing the richness and diversity of orchids, especially the rare and restricted species. However, there is still no official record yet to confirm the current present state of knowledge of orchids in Sarawak's limestone area.

CHAPTER 3

3.0 Materials and Method

3.1 Data collection

The data of the previously recorded orchid species in the limestone areas in Sarawak (Bau, Dered Krian, Mulu, Niah and Padawan) were collected from multiple reliable resources such as Beaman *et al.* (2001), Go *et al.* (2009), Haniza *et al.* (2017), Roziana *et al.* (2017), Meekiong *et al.* (2021) and Wood (1984). The updated taxonomic classification, habit, and distribution for each recorded orchids were identified using the information provided on the WCSP website (<https://wcsp.science.kew.org/>). Subsequently, the conservation status of the species was assessed via IUCN redlist website (<https://www.iucnredlist.org/>) and classified into six threats categories. Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC). The photos of the threatened orchids were retrieved from the MyBis website (www.mybis.gov.com).

3.2 Data analysis.

The collected data of the recorded species were compiled and tabulated into a species inventory. From the inventory of genus, scientific names, distribution, and conservation status determined.

CHAPTER 4

4.0 Results

4.1 Diversity of Orchids in Sarawak Limestone area

A total of 354 species of orchids from 83 genera were collected from the reliable resources. In this study, the most dominant subfamily presence in the data is Epidendroideae. As shown in this result, *Bulbophyllum* has 53 species found in the Sarawak's limestone areas and the most dominant genera followed by *Dendrobium*. Furthermore, there are 288 species of epiphytic orchids are present the most dominant habit of orchids found in the Sarawak's limestone areas. These are followed by terrestrial orchids which has 52 species, mycoheterotroph orchids are 6 species, lithophyte orchids are 5 species, and lastly climber orchid which is 2 species. Apart from that, there are 26 species of orchid are endemic to Borneo Sarawak namely, *Adenoncos triloba*, *Appendicula tenuifolia* var. *tenuifolia*, *Appendicula tenuifolia* var. *filiformis*, *Bulbophyllum perparvulum*, *Cleistoma pinifolium*, *Cystorchis macrophysa*, *Dendrobium crenicristatum*, *Coelogyne jeffwoodii*, *Coelogyne lewisii*, *Coelogyne ramentacea*, *Coelogyne muluensis*, *Coelogyne pallidiflavens* var. *brevilabrata*, *Crepidium andersonii*, *Crepidium clemensii*, *Dendrochilum ochralabium*, *Didymoplexiella borneensis*, *Habenaria elatius*, *Liparis brookesii*, *Mycaranthes crucigera*, *Oberania longifolia*, *Paphiopedilum platyphyllum*, *Paphiopedilum sanderianum*, *Paphiopedilum stonei*, *Robiquetia crassa*, *Sarcoglyphis fimbriata*, and *Trichotosia lawiensis*.

4.2 Conservation status of Orchid in Sarawak Limestone area

In term of their conservation status category (IUCN redlist), 338 out of 353 species of orchid in Sarawak limestone area were listed as Not Evaluated (NE) followed by Least Concern (LC) which have 8 species of orchids, a species of orchid was in Vulnerable (VU), 4 species of orchid were in Endangered (EN) category which was *Paphiopedilum bullenianum*, *Paphiopedilum hookerae*, *Paphiopedilum lowii* and *Vanda scandens*. Lastly, there were 3 species of orchids were in Critically Endangered (CR) namely, *Paphiopedilum platyphyllum*, *Paphiopedilum sanderianum* and *Paphiopedilum stonei*. The information regarding the habit and conservation status of orchid in Sarawak limestone area were summarized in Figure 1, Figure 2, Figure 3 and Table 1.

Figure 1: Habits of Orchid in Sarawak limestone area

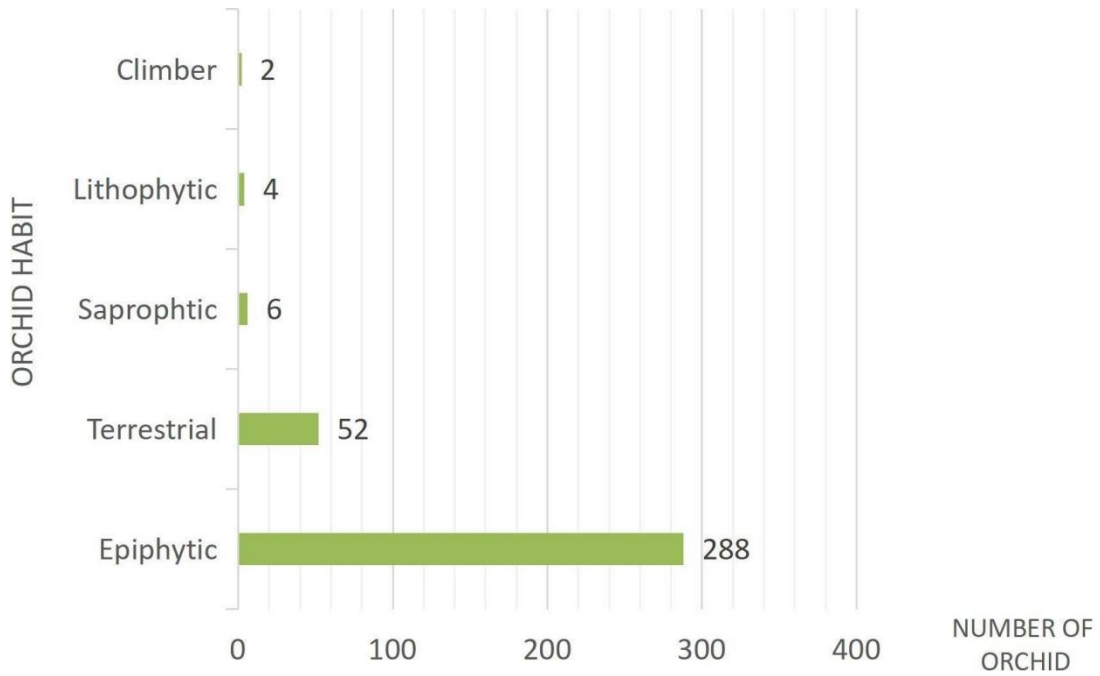


Figure 2: Conservation Status of Orchid in Sarawak's limestone area

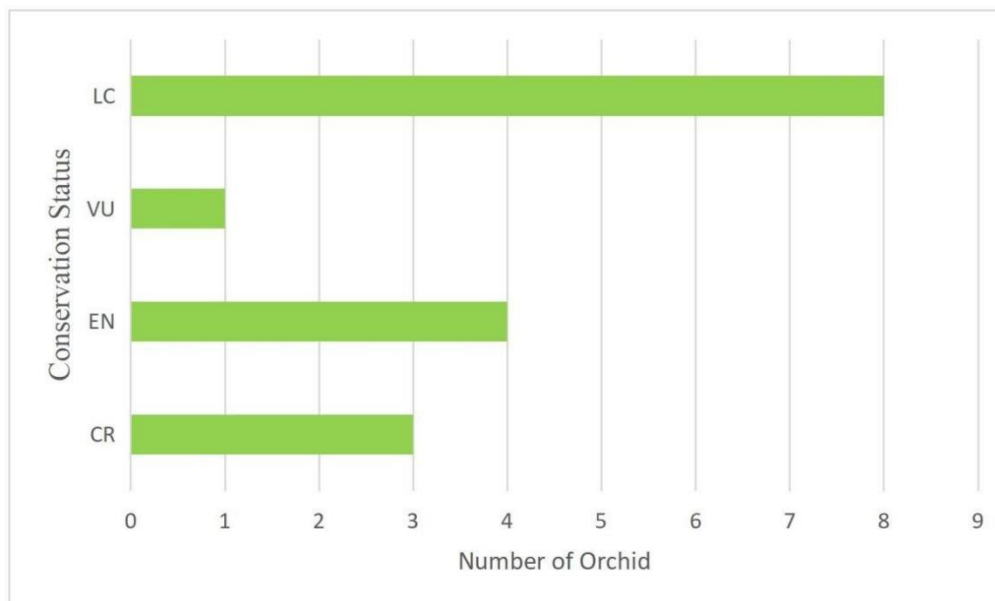


Figure 3: Conservation Status of Orchids in Sarawak limestone area

Figure 3.1: Least Concern Species (LC) of Orchids in IUCN Red List of Threatened Species



Scientific name: *Agrostophyllum cyathiforme*
J.J.Sm

Photo credit: <https://www.mybis.gov.my/sp/3841>



Scientific name: *Bromheadia finlaysoniana* (Lindl.)
Miq.

Photo credit: <https://www.mybis.gov.my/sp/13316>



Scientific name: *Claderia viridiflora* Hook. f.

Photo credit: <https://www.mybis.gov.my/sp/40205>



Scientific name: *Dendrobium aloifolium* (Bl.) Rchb.f.

Photo credit: <https://www.mybis.gov.my/sp/9592>

Figure 3.1: Least Concern Species (LC) of Orchids in IUCN Red List of Threatened Species



Scientific name: *Trichoglottis winkleri* J.J. Smith
var. *minor* J.J. Smith

Photo credit:
<https://www.mybis.gov.my/sp/45073>

Figure 3.2: Endangered (EN) Species of Orchids in IUCN Red List of Threatened Species



Scientific name: *Paphiopedilum bullenianum* (Rchb. f.) Pfitzer

Photo credit: <https://www.mybis.gov.my/sp/4417>



Scientific name: *Paphiopedilum hookerae* (Rchb.f.) Stein var. *hookerae*

Photo credit: <https://www.mybis.gov.my/sp/19168>

Figure 3.2: Endangered (EN) Species of Orchids in IUCN Red List of Threatened Species



Scientific name: *Paphiopedilum lowii* (Lindl.)

Photo credit: www.mybis.gov.my

Figure 3.3: Critically Endangered (CR) Species of Orchids in IUCN Red List of Threatened Species



Scientific name: *Paphiopedilum sanderianum* (Rchb. f.) Stein

Photo credit: www.mybis.gov.my



Scientific name: *Paphiopedilum stonei* (Hook. f.) Stein

Photo credit: www.mybis.gov.my

Table 1: The diversity of Orchids in Sarawak's limestone area

Genus	Scientific Name	Habit	Distribution	Cons. Status	References
<i>Acriopsi</i>	<i>Acriopsis liliifolia</i> (J.Koenig) Ormerod	Epiphyte	Sikkim to NW. Pacific	NE	Go <i>et al.</i> , 2009
<i>Adenoncos</i>	<i>Adenoncos sumatrana</i> J.J.Sm.	Epiphyte	Pen. Thailand to W. Malesia	NE	Beaman <i>et al.</i> , 2001
	<i>Adenoncos triloba</i> Carr	Epiphyte	Borneo, Sarawak	NE	Beaman <i>et al.</i> , 2001
<i>Aerides</i>	<i>Aerides odorata</i> Lour.	Epiphyte	China to Tropical Asia	NE	Beaman <i>et al.</i> , 2001
<i>Aeridostachya</i>	<i>Aeridostachya robusta</i> (Blume) Brieger in F.R.R.Schlechter	Epiphyte	S. Taiwan to Malesia and W. Pacific	NE	Beaman <i>et al.</i> , 2001
<i>Agrostophyllum</i>	<i>Agrostophyllum cyathiforme</i> J.J.Sm	Epiphyte	W. Malesia	LC	Roziana <i>et al.</i> (2017)
	<i>Agrostophyllum majus</i> Hook.f.	Epiphyte	Pen. Thailand to W. & C. Malesia	NE	Roziana <i>et al.</i> (2017)
	<i>Agrostophyllum laterale</i> J.J. Sm.	Epiphyte	Borneo	VU	Wood, 1984
	<i>Agrostophyllum longifolium</i> (Blume) Rchb.f.	Epiphyte	Pen. Thailand to Malesia	NE	Go <i>et al.</i> , 2009
	<i>Agrostophyllum stipulatum</i> subsp. <i>bicuspidatum</i>	Epiphyte	W. & C. Malesia	NE	Go <i>et al.</i> , 2009 Roziana <i>et al.</i>
	<i>Agrostophyllum stipulatum</i> subsp. <i>stipulatum</i>	Epiphyte	Indo-China, Malesia to Solomon Is	NE	(2017)
	<i>Agrostophyllum sumatranum</i> Schltr. & J.J.Sm.	Epiphyte	W. Sumatera, Borneo	NE	Go <i>et al.</i> , 2009 Meekiong <i>et al.</i> ,
<i>Aphyllorchis</i>	<i>Aphyllorchis montana</i> Rchb.f.	Saprophyte	Trop. & Subtrop. Asia	NE	Beaman <i>et al.</i> , 2001
	<i>Aphyllorchis pallida</i> Bl.	Saprophyte	S. Indo-China to New Guinea	NE	Beaman <i>et al.</i> , 2001

Table 1: The diversity of Orchids in Sarawak's limestone area

Genus	Scientific Name	Habit	Distribution	Cons. Status	References
<i>Appendicula</i>	<i>Appendicula alba</i> Bl.	Epiphyte	Thailand to W. & C. Malesia	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula cornuta</i> Bl.	Epiphyte	Sikkim to China (S. Guangdong) and Malesia	NE	Go <i>et al.</i> , 2009
	<i>Appendicula anceps</i> Blume	Epiphyte	Pen. Thailand to Malesia	NE	Go <i>et al.</i> , 2009
	<i>Appendicula cristata</i> Bl.	Epiphyte	Sumatera to Sulawesi	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula pendula</i> Bl.	Epiphyte	Pen. Thailand to SW. Pacific	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula pilosa</i> J.J.Sm.	Epiphyte	Sumatera, Borneo	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula purpurascens</i> Blume	Epiphyte	Jawa to Lesser Sunda Is. (Bali)	NE	Go <i>et al.</i> , 2009
	<i>Appendicula ramosa</i> Blume	Epiphyte	Sumatera to Sulawesi	NE	Go <i>et al.</i> , 2009
	<i>Appendicula tenuifolia</i> J.J. Wood	Epiphyte	Borneo, Sarawak	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula tenuifolia var. filiformis</i> J.J.Wood	Epiphyte	Borneo, Sarawak	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula torta</i> Blume	Epiphyte	Indo-China to W. Malesia	NE	Beaman <i>et al.</i> , 2001
	<i>Appendicula uncatata</i> Ridl.	Epiphyte	S. Pen. Malaysia, Borneo	NE	Wood, 1984
	<i>Appendicula undulata var. undulata</i>	Epiphyte	Pen. Thailand to W. & S. Malesia	NE	Go <i>et al.</i> , 2009
	<i>Appendicula undulata var. longicalcarata</i> (Rolfe) Ames	Epiphyte	Sumatera to Phillipines	NE	Beaman <i>et al.</i> , 2001
<i>Appendicula xytriophora</i> Rchb.f. in B.Seemann	Epiphyte	Borneo (Sarawak), Phillipines	NE	Beaman <i>et al.</i> , 2001	
<i>Arachnis</i>	<i>Arachnis flos-aeris</i> (L.) Rchb.f.	Epiphyte	S. Indo-China to W. Malesia and Phillipines	NE	Beaman <i>et al.</i> , 2001
<i>Arundina</i>	<i>Arundina graminifolia subsp. Graminifolia</i>	Terrestrial	Trop. & Subtrop. Asia	NE	Go <i>et al.</i> , 2009
<i>Ascidieria</i>	<i>Ascidieria longifolia</i> (Hook.f.) Seidenf.	Epiphyte	Thailand to W. Malesia	NE	Beaman <i>et al.</i> , 2001
<i>Brachypeza</i>	<i>Brachypeza cladostachya</i> (Hook.f.) Kocyan & Schuit.	Epiphyte	W. & C. Malesia	NE	Roziana <i>et al.</i> (2017)